Pilot Validation of a Food Frequency Questionnaire to Assess Changes in Intake among Patients Counselling for Cardiometabolic Risk

by

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ABSTRACT

PILOT VALIDATION OF A FOOD FREQUENCY QUESTIONNAIRE TO ASSESS CHANGES IN INTAKE AMONG PATIENTS COUNSELED FOR CARDIOMETABOLIC RISK

Yiran Wang
University of Guelph, 2019

Cardiometabolic abnormalities are common health threats in Canada. About one in five Canadians over the age of 18 has metabolic syndrome. As diet and exercise are essential in preventing and treating cardiometabolic abnormalities, there is an urgent need for a Canadian-based dietary assessment tool to guide counselling and provide evidence for effectiveness of diet counseling delivered by Registered Dietitians (RD). This pilot study tested the feasibility of a primary-care located validation study conducted with patients and RDs, using an adapted food frequency tool, called the Diet Quality Monitoring Tool (DIETQ) against 7-day food records using the online ASA24 system. Two RDs and four patients completed the 3-month study.

The study provided valuable insights on improving the design of DIETQ, recruiting, orientation and training strategies, as well as possible changes to data analysis procedures. With the suggested improvements, validation against 7-day records is considered to be feasible in a national validation.
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LIST OF ABBREVIATIONS

AHEI: Alternate Health Eating Index

aMED: Alternate Mediterranean Diet

ASA24: Automated Self-Administered 24-hour Dietary Assessment Tool

ASA24-C: Automated Self-Administered 24-hour Dietary Assessment Tool Canadian

BMI: Body Mass Index

CCHS: Canadian Community Health Survey

CFG: Canada's Food Guide

CHO: Carbohydrates

CNF: Canadian Nutrient File

CVD: Cardiovascular Disease

DASH: Dietary Approaches to Stop Hypertension

DIETQ: Diet Quality Monitoring Tool

ED: Executive Director

F&V: Fruits and Vegetables

FFQ: Food Frequency Questionnaire

FHT: Family Health Team

GI: Glycemic Index

HDL-C: High Density Lipoprotein Cholesterol

HEI: Healthy Eating Score

HEI-C: Healthy Eating Score-Canada

LDL-C: Low Density Lipoprotein Cholesterol
MD: Mediterranean Diet
MDS: Mediterranean Diet Score
MEDAS: Mediterranean Diet Adherence Screener
MetS: Metabolic Syndromes
MetSC: Metabolic Syndrome Canada
MUFA: Monounsaturated Fatty Acids
PREDIMED: PREvención con Dieta MEDiterránea
PUFA: Polyunsaturated Fatty Acids
RD: Registered Dietitian
SFA: Saturated Fatty Acids
TD2M: Type 2 Diabetes Mellitus
TDA: Technology-assisted Dietary Assessment
Chapter 1: Overview of the Study

The overall aim of this project was to pilot test the feasibility of a proposed diet validation study of a food frequency questionnaire (FFQ) called the Diet Quality Monitoring Tool (DIETQ), which is an adapted dietary assessment tool intended for use mainly in primary care dietetic practice settings to measure key food and nutrient intake in clients with cardiometabolic risk or diseases. It was expected that through the pilot test, the feasibility of the implementation, major strengths and possible deficiencies associated with this instrument can be identified before the next stage of validation testing.

Over the past 60 years in Canada, there has been a significant decrease in mortality from cardiovascular diseases (CVD), but the increased incidence of obesity and the high prevalence of cardiometabolic conditions still pose a great threat to public health. Current cardiometabolic abnormalities are expected to significantly impact Canadians’ overall well-being and may reverse gains in decreasing CVD mortality achieved to date.

While medical interventions maintain their significance in alleviating or reversing cardiometabolic abnormalities, behavioral interventions are also effective in treating cardiometabolic risk. Under the behavioral intervention category, diet and exercise, and smoking cessation are first-line recommended interventions for preventing and treating cardiometabolic risk (1). Within diet treatment, dietary assessment is part of nutrition assessment and the first step to establishing an effective dietary intervention. In primary care settings, there is no unified Canadian-based dietary assessment instrument available for assessing key nutrients and food associated with cardiometabolic risk. Lack of such a practical tool reduces Registered Dietitians’ (RD) effectiveness in delivering and documenting the effectiveness of dietary interventions.

As there is an increasing number of people with elevated cardiometabolic risk in Canada [approximately 21% with metabolic syndrome and 39% among those who aged 60 to 79 y.o.(2)]. It is estimated that 6 million (16%) Canadians have prediabetes (3). By 2020, it is estimated that the prevalence of prediabetes would rise to one in every three Canadians (4). In Canada, problems such as lack of a consensus on dietary assessment, lack of Canadian-based dietary assessment instruments, and observed discrepancies in food intake by using different assessment tools have limited RDs’ ability to show they are providing effective and efficient dietary care. Thus, there is a need to develop a Canadian-based food assessment tool to demonstrate relevant changes in food intake over time. The development of DIETQ will potentially aid RDs practice, by providing a tool for efficient and reasonably accurate assessment of target foods and nutrients thought to influence clinical indicators of cardiometabolic risk.

Based on an intensive literature research of dietary studies, the initial design of DIETQ combined essential components from the Mediterranean Diet Score (MDS), and the moderation section from the Healthy Eating Index—Canada (HEI-Canada-2005). Common food items and serving sizes were adapted from Eating Well with Canada’s Food Guide (2007 version).

The objectives of the study are:

- To test the feasibility of conducting pilot validation of DIETQ in primary care dietetic
settings using formative evaluation methods.

- To examine the relationships of estimated food intake from the DIETQ against food intake from 7 days of food records at baseline and after 3 months of counselling.
- To gather qualitative data from RDs and patient participants on the study experience to further improve the design and content of DIETQ.

Chapter 2: Literature Research

2.1: Background of Cardiometabolic Diseases

Cardiometabolic risk conditions and diseases, such as type 2 diabetes mellitus (T2DM), and metabolic syndrome (MetS) increase risk of CVD, which remains an important cause of morbidity and mortality. This section will introduce definitions, scope of the problem and the possible mechanisms behind the development of cardiometabolic conditions, as well as major treatments.

Definition of Cardiometabolic Diseases and Risk

The term “cardiometabolic disease” was first coined by Pescatello, who described it as a cluster of cardiometabolic risk factors that lead to CVD and T2DM (5). Over the past four decades, cardiometabolic diseases and associated risk factors have been intensively researched and it is well-known that certain risk factors have significantly contributed to the steadily increasing incidence of CVDs, T2DM, and MetS observed worldwide (1, 6). Typical cardiometabolic risk factors that are significantly associated with CVD, T2DM and other diseases include: dyslipidemia [high triglycerides, high low-density lipoprotein (LDL) level, low high-density lipoprotein level (HDL), etc.], hypertension, hyperglycemia, and the presence of abdominal fat accumulation (1, 6).

As the leading cause of global premature death, CVD includes a cluster of diseases which affect heart and vessels, such as peripheral vascular diseases, coronary heart diseases, and cerebrovascular diseases (7). T2DM is another common nutrition-relevant complication, which is caused by insufficient production of insulin, low insulin sensitivity, or a combination of both problems. T2DM is associated with chronic hyperglycemia, and it is a leading cause of other cardiovascular complications (8).

Metabolic syndrome (MetS) is a combination of specific cardiometabolic risk factors. The Canada Cardiometabolic Risk Working Group defined MetS as “a specific subset of cardiometabolic risks”, which includes a broad range of risk factors (1). To be diagnosed with MetS, the subject needs to meet at least three of the following five criteria: high waist circumference, high blood pressure, high fasting plasma glucose, low HDL-cholesterol, and high triglycerides (1). These risk factors are closely associated with atherogenesis and insulin resistance (1). The presence of MetS introduces a 61% increased risk of CVD compared to individuals without it (9).
Cardiometabolic Diseases and Cost Implications in Canada

Including Canada, the incidence of CVD has decreased in developed countries in recent years (10), but the prevalence of cardiometabolic risk conditions such as obesity and T2DM have increased (11).

Heart diseases are a common category under CVD. In 2007, 1.3 million Canadians who were over the age of 12 were diagnosed with heart diseases (12). Worldwide, according to the Institute for Health Metrics and Evaluation, in 2017, ischemic heart disease ranked at the 1st place among the top ten causes of death and disability combined across all age groups, while diabetes and stroke ranked 4th and 5th, respectively (13). Thus, while progress has been made, CVD remains an important disease in Canada and worldwide.

Diabetes prevalence in Canada is currently 7.3% of Canadians aged 12 and older (roughly 2.3 million people) in 2017 (14). Prevalence of metabolic syndrome is about 21% (2).

Prevalence of the separate risk conditions remains high. During 2012-2013, the Canadian Health Measures Survey reported that 22% of Canadian adults aged 20-79 had measured hypertension and 16% of those were unaware of their condition (15). Two thirds were treated and controlled. About 22.7% of Canadian adults with hypertension also have diabetes (16). People who are obese (prevalence of having diabetes:13.7%) or overweight (6.8%) tend to have a higher prevalence suffering debates compared to people with normal weight (3.6%) (14).

In terms of dyslipidemia, the Canadian Health Measures Survey (2007-2009) suggested that 45% of Canadians aged 18-79 years had dyslipidemia or were on medication. The diagnostic criteria were measured by TG/HDL-C ratio ≥5; LDL-C ≥3.5 mmol/L; or taking lipid-modifying medications (17). Nevertheless, among Canadians who had dyslipidemia, more than half of them were not aware of their condition (17).

High body mass is another common co-mobility factor along with T2DM, hypertension, CVDs and certain types of cancers (7). The prevalence of overweight (36.3%) and obesity (26.8%) in Canada is high among adult Canadians (18-79 years old) and still increasing in 2018(18).

Thus, cardiometabolic associated conditions and diseases are a substantial economic burden to both individuals and the national economy. A project conducted by the Public Health Agency of Canada titled Economic Burden of Illness in Canada suggested that from 2005 to 2008, the total cost associated with CVDs ranked first among the common disease diagnostic categories, while diabetes ranked 14th (19). In 2010, cardiometabolic diseases (endocrine diseases:4.9%; circulatory diseases:11.7%) made up 16.6% of the total direct costs of health care associated with all disease categories (20). Similarly, the 2010 Canadian Heart Health Strategy suggested that the expense associated with treating obesity, T2DM and CVD has become a major economic burden for the Canadian health care system and it is expected that the total costs of CVD treatment will be $28.3 billion in 2020 (21). However, by incorporating proper preventive interventions, such as promoting dietary change and physical activity, another analysis suggested cumulative savings of $76.4 billion for the Canadian economy from 2005 to 2020, according to the Conference Board.
of Canada report (21).

**Possible Physiological Mechanisms**

The physiological mechanisms behind the development of cardiometabolic abnormalities are complicated. Cardiometabolic conditions are usually triggered by risk factors that interact together, rather than a single factor. On the other hand, a single risk factor may be involved in the pathology of multiple cardiometabolic abnormalities. The figure below illustrates the interactions between traditional and emerging cardiometabolic risk factors behind the major cardiometabolic conditions (1).

**Figure 1: Cardiometabolic metabolic Risk behind Major Cardiometabolic Conditions**

The underlying etiology behind CVDs, T2DM and MetS, as well as their relationships still remains controversial (5). As noted in the diagram, some cardiometabolic risk factors, such as age, gender, ethnicity, and genetic background may also be associated with cardiometabolic dysfunction (1). These risks are not amenable to change and therefore have not been a focus for most research.

Based on clinical observations, Reaven found that insulin resistance was a feature in the majority of people who were diagnosed with T2DM or impaired glucose tolerance. Insulin resistance was also observed in around 25% of non-obese individuals with normal glucose
tolerance and up to 50% cases of hypertension were associated with insulin resistance (22, 23). He hypothesized that insulin resistance and hyperinsulinemia were involved in the etiology of T2DM, hypertension and coronary heart disease (5, 22).

Although Reaven didn’t focus on a connection between obesity and insulin resistance (5), substantial evidence since confirms that increased adipose tissue is associated with insulin resistance and T2DM (24). Insulin resistance is found to increase with increasing body mass index (BMI), and high waist-hip ratio (25), which reflects the association between insulin resistance and visceral adiposity (24). Cytokines produced by excessive adipose tissue are also related to insulin resistance (24).

The presence of dyslipidemia is another significant feature of cardiometabolic problems, with most early work focused on high LDL-C. Along with the influence of insulin resistance, lipid abnormalities may be observed in all lipid fractions (24). Low HDL-C and high concentration of LDL-C are independent risk factors for cardiovascular disease; however, in the presence of insulin resistance, there is also increased VLDL triglyceride synthesis and reduced HDL particle size (24). A higher proportion of small dense LDL particles are associated with insulin resistance, even when overall LDL-C levels are in the normal range. These denser LDL particles are thought to be more atherogenic due to the higher susceptibility to oxidation; thus, LDL-C concentrations are an important indicator of cardiometabolic risk (24). Thus, most people experience various combinations of risk factors simultaneously.

Prevention and Treatments

Despite progress to date in treating risk conditions with medication and in treating CVD with medication and surgery, it is urgent for the Canadian health care system to incorporate more efficient prevention, diagnosis and intervention services to reduce the enormous expense in dealing with CVD conditions and to improve Canadians’ overall well-being. Research suggests the modification of lifestyle should receive more attention in preventing and treating cardiometabolic risk factors and conditions.

Both diet and physical activity are essential and effective in reducing cardiometabolic risk (26). Several large-scale clinical trials focused on the effectiveness of diet on reducing CVD mortality through combined lifestyle interventions (diet and physical activity). For instance, participants in the Diabetes Prevention Program (DPP) (27) and the Look AHEAD study (28) had achieved significant weight loss. The DPP was able to show a remarkable reduction in diabetes incidence and CVD morbidity and mortality compared to a control group, while the Look AHEAD trial did not report mortality reductions, partly because the health of the control group was much better than expected. On the other hand, without introducing a physical activity component, participants from the Prevención con Dieta Mediterránea (PREDIMED) study in Spain showed significantly reduced CVD incidence and mortality with a Mediterranean diet supplemented with olive oil and nuts (29).

The Global Burden of Disease Study 2010-Canada suggested the detrimental impact brought on poor diet may even exceed the impact caused by high body mass, smoking, and physical inactivity on the burden of disease in Canada (30). Similarly, the global Institute for Health Metrics and Evaluation ranked dietary risks at third place as the risk factor that drove the most
death and disability combined worldwide in 2017 (13). Nevertheless, it should be kept in mind that due to the complicated relationships among all these risk factors, it is hard to separate the effects of one vs. the others to determine each risk’s independent impact on preventing/delaying the development of CVD. Therefore, most lifestyle programs include some focus on all manageable risk factors, but may emphasize different aspects.

Thus, lifestyle interventions to prevent and treat cardiometabolic conditions deserve more attention in the health system and evidence is strong from clinical trials to support their incorporation as standard therapy. Diet and physical activity have differing effects, however, and involve changes in different behaviours. The next section considers the role of diet in more detail.

2.2: Diet and Cardiometabolic Risk

Along with medical treatment, dietary intervention is essential in preventing and delaying the progress of cardiometabolic risk. There have been hundreds of diet studies over the past 70 years, targeting different risk factors and/or using different intervention approaches. Many national guidelines for health professionals (Canada, Australia, the United States, etc.) suggest that health professionals should incorporate nutrition education and advice into their care routine with CVD risk patients (31, 32). These guidelines generally provide an extensive list of approaches, some of which are partially contradictory in practice.

Dietary management in practice is challenging, as the observable risk factors vary from person to person, the effects of dietary changes vary, and some changes are more behaviorally easy or acceptable than others. The following sections address some current diet foci, other than weight loss.

Dietary Components and Cardiometabolic Risk

**Balanced Meal Pattern**: Diet plays a key role in preventing cardiometabolic risk and delaying the progression of cardiometabolic diseases. Food intake should be treated as an integrated series of components rather than as a combination of nutrients. Although many foods are considered as excellent sources of some nutrients, different foods that vary in nutrient content should be consumed together to achieve balanced meal patterns.

The concept of the “balanced plate or meal pattern” is reflected in various national food guidelines [e.g., Eating Well with Canada’s Food Guide (33), Dietary Guidelines for Americans (34)] and found in many dietary approaches proven to be effective in preventing or reversing cardiometabolic disease [e.g., Mediterranean diet (35), Dietary Approach to Stop Hypertension (36)].

A secondary data analysis of a Canadian lifestyle intervention program “CHANGE” (Canadian Health Advanced by Nutrition and Graded Exercise) mentioned that among various dietary behavior goals, “balanced meal/balanced plate” was one of the most frequently emphasized food behavior goals by the RDs throughout the intervention (37). The concept of
eating according to food guides is also frequently mentioned in medical management practice guidelines for the risk conditions.

**Fat:** Dietary fatty acid composition has long been a focus as it affects physiological processes, including their impact on cell membranes. Studies found that high intakes of saturated fatty acids (SFA) and trans-fat are relevant to insulin resistance (38, 39) and increased risk of T2DM (7). In contrast, polyunsaturated fatty acids (PUFA) may help to prevent cardiometabolic risk by maintaining membrane lipid composition, signal transduction, gene expression regulation, and cellular metabolism (40). Thus, an adequate intake of PUFA may help to maintain insulin sensitivity and improve other cellular responses (24, 40). More recently, mono-unsaturated fats have received attention, especially with the completion of the PREDIMED diet study. Overall, fat intake was 40%, with 19% of kcal from mon-unsaturated fat at baseline – which rose to 21-22% with supplemental olive oil or nuts.

The 2015 Evidence Review of Dietary Guidance and the 2018 Interim Evidence Update published by Health Canada revealed some associations observed between fatty acids in the population and risk of developing CVD or T2DM (7, 41). The former review concluded that there was an association between intakes of dietary SFA and increased LDL cholesterol, and increased risk of CVD (7). Ten reviews from 2009-2014 identified by Health Canada suggested that lower SFA intake, along with the replacement of unsaturated fat, appears to reduce the risk of cardiovascular events, again from observational data. However, the ideal type of unsaturated fat is unclear (7). Similarly, the 2018 review indicated the improved blood lipid level in adults by substituting SFA or trans-fat with unsaturated fat (41).

Based on the data obtained from the 2004 Canadian Community Health Survey – Nutrition (CCHS-2004), Garriguet et al. reported that more than 25% of Canadian adults (aged 31-50 years) consumed greater than 35% of their total calories from fat, at the upper end of the current Acceptable Macronutrient Distribution Range (42). High intake of fat in some people may contribute to higher prevalence of overweight and obesity (around 62%) found in Canadian adults (43). The study found that 30% of the daily fat intake came from the meat and alternatives group, and about 25% from other foods (high fat/sugar foods, saturated/trans fats and oils, seasonings, beverage, etc.) (7).

The extent to which fat composition and intake affects CVD risk in individuals is less clear. Fat intake is a factor in elevated LDL-C levels in some people. Fat composition and intake can be modified in diet counselling, depending on initial intake and the types of foods eaten, and fat remains a strong focus in diet counselling.

**Sodium:** It is well documented that high sodium intake may be associated with hypertension (44, 45). High sodium intake observed in recent decades may have contributed to the 30% increase of hypertension worldwide (45). As high blood pressure is one of the main risk factors for CVD, high sodium intake also links to increased cerebrovascular disease morbidity and mortality (44). However, it should be noted that serum sodium does not solely reflect on dietary intake but is controlled by complicated mechanisms at the cellular level that maintains serum levels within a physiological range. Genetic deficits could affect an individual’s ability to maintain and excrete sodium for blood pressure control, as well (45). Thus, reducing dietary salt
intake may have differing effects on different individuals. Currently, there is no simple test to distinguish people prior to salt restriction.

Despite individual differences, clinical trials and observational studies have found there is a causal relationship between dietary salt intake and development of hypertension (36, 45, 46). The 2004 CCHS data suggested that Canadians’ sodium intake was above the tolerable upper intake level in all age and sex groups, and the usual median intake was 3479mg/day for males and 2582 mg/day for female (7). Thus, dietary salt intake is a major focus in individual diet counselling and in health promotion.

**Fiber:** There are many studies suggesting the therapeutic effects of whole grains in improving CVD markers (7). Dietary fiber may help to increase insulin sensitivity, and decrease postprandial glucose by affecting gut motility and transit time, gastrointestinal hormone secretion, and colonic fermentation (24). The 2018 Interim Evidence Update for Canada’s Food Guide found dietary fiber was associated with decreased risk of colon cancer, CVD and T2DM (41).

Canadians’ median intake of fiber (as an indicator of grain intake) was below the adequate intake level (AI) across all age and sex groups. The median usual intake for females and males (over 19 years old) was 19g and 18g, respectively (7). Whole grains are encouraged by most counselling guidelines.

**Refined Grains and Simple Carbohydrates (CHO):** Since the 1960s, there has been a significant decrease in the mean percentage of total food energy intake from total fat and saturated fat in the United States and Canada (47). However, in the same period, there was an increasing prevalence of T2DM observed (47). Epidemiological studies suggested it might due to the increased intake of refined grains and simple carbohydrates (48, 49), the inverse of the association between intake of whole grains and cardiometabolic risk (48, 49).

The earliest Canadian official nutrition survey (the Nutrition Canada Survey 1970-1972) reported on nutrient intake, but not foods, as such (50, 51). Due to the lack of data, it is unclear whether simple carbohydrate intake was increasing in Canada, but anecdotal evidence suggests that it was. Statistics Canada suggested the availability of wheat flour/person rose from 55.97 to 67.05kg during 1970 to 2000, which may also support the previous assumption (52).

Due to the lack of fiber and other complex CHO, compared to whole grains, refined grains and simple CHO have a higher Glycemic Index (GI). GI is defined as the incremental area under the blood glucose curve in response to a standardized carbohydrate load (53). At the same load of CHO, simple CHO and refined grains tend to trigger greater glycemic response, although some anomalies exist, when comparing some foods (e.g., brown rice vs potato). As a result, more insulin is released to maintain blood glucose levels. In addition, excessive intake of simple CHO and refined grains may contribute to overweight and obesity, as a high glycemic response alters fuel partitioning by promoting postprandial carbohydrate oxidation at the expense of fat oxidation (54). The benefits of consuming low GI CHO diets has been supported by numerous studies of intermediary metabolism, resulting in lower postprandial glucose and insulin responses, improved lipid control, and improved insulin sensitivity (53).
Compared to non-processed or minimally processed food, processed foods usually contain a higher fraction of simple CHO and refined grains.

**Food Processing and Cardiometabolic Risk**: Under the broad impact of industrialization and globalization, one mechanism behind the increasing prevalence of cardiometabolic diseases worldwide in recent decades may come from changes in lifestyle. As diet is one of the major factors contributing to cardiometabolic risk, evidence suggests that the transition of the global food consumption pattern from household foods to ultra-processed commercial foods may contribute to the increasing prevalence of cardiometabolic conditions (55). A similar transition in food processing evolution was observed in Canada, as convenience foods became more available (56).

A growing number of studies support an association between the extent of food processing and the nutrition quality of an overall diet (56, 57). Compared to household foods, processed foods are usually high in calories, refined CHO, sodium, and lower in micronutrients. To investigate Canadians’ diet quality, Moubarac et al. conducted an analysis based on the data obtained from the 2004 CCHS, and categorized food groups according to the Nova classification system.

The Nova classification system categorizes food items according to the extent and purpose of food processing, rather than in terms of nutrients (58). There are four categories based on the degree of food processing, as illustrated in Table 1(58).

**Table 1: NOVA Food Classification System**

<table>
<thead>
<tr>
<th>Group</th>
<th>Category</th>
<th>Definition and Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>unprocessed or minimally processed foods</td>
<td><strong>Unprocessed foods</strong>: edible parts of plants and of animals; fungi, algae and water. Including plant seeds, leaves, fruits, roots and animal muscle, fat, etc. <strong>Minimally processed foods</strong>: natural foods go through processing such as removal of inedible or unwanted parts, also including procedures to prolong shelf life. Including grounded coffee bean, dried tea leaves, etc.</td>
</tr>
<tr>
<td>Group 2</td>
<td>Processed culinary ingredients</td>
<td>Substances obtained directly from group 1 foods or from nature by processing. Including sugar, salt, vegetable oils, etc.</td>
</tr>
<tr>
<td>Group 3</td>
<td>Processed foods</td>
<td>Simple products made by adding sugar, oil, salt or other group 2 substances to group 1 foods. Including cured meat, canned V&amp;F, cheeses, unpackaged freshly made</td>
</tr>
</tbody>
</table>
The study found that 60.8% of the calorie intake of Canadians came from processed food and 48% of the calorie consumption from processed food was made up of ultra-processed foods (56). Similarly, another study conducted by Moubarac and colleagues suggested that from 1938 and 2011, Canadians’ share of household expenditures for processed food products increased from 28.7% to 61.7% (59). By comparing the nutritional quality of ultra-processed foods with the same diet fraction made up of non-ultra-processed foods, Moubarac et al. found ultra-processed food contains “150% less protein, 30% less fiber and 15% more carbohydrates, 250% more free sugars and almost 30% more fats” (56). The high energy density of ultra-processed food per gram of food may lead to excess energy intake and may contribute to the increasing incidence of cardiometabolic diseases, such as T2DM, obesity, MetS, and CVDs (60-62).

Table 2 is adapted from Moubarac et al.’s study, which compares the mean nutrient fractions between ultra-processed food and non-ultra-processed food (56). Any new tools for assessing diet in interventions to prevent or treat CVD may need to look beyond specific foods to consider the processing status of the foods eaten. Evidence that diet counselling to decrease/avoid processed foods is effective has not been published, but overlaps with the balanced plate concept.

<table>
<thead>
<tr>
<th>Group</th>
<th>Category</th>
<th>Definition and Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 4:</td>
<td>Ultra-processed food and drink products</td>
<td>Commercially available products made by industrial formulas. Including soft drinks, candies, mass-produced packaged buns and bread, cakes, pastries, etc.</td>
</tr>
</tbody>
</table>

### Table 2: Mean Nutrient Fractions between Ultra-processed Food (Group 4) and Non-ultra-processed Food (Group 1-3)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Ultra-processed foods</th>
<th>Non-ultra-processed foods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (% of total energy)</td>
<td>8.5</td>
<td>23.5</td>
</tr>
<tr>
<td>Carbohydrates (% of total energy)</td>
<td>55.1</td>
<td>47.9</td>
</tr>
<tr>
<td>Free sugars (% of total energy)</td>
<td>21.0</td>
<td>5.9</td>
</tr>
<tr>
<td>Total fats (% of total energy)</td>
<td>36.4</td>
<td>28.6</td>
</tr>
<tr>
<td>Saturated fats (% of total energy)</td>
<td>10.9</td>
<td>10.9</td>
</tr>
<tr>
<td>Sodium (mg/1000 kcal)</td>
<td>1691.9</td>
<td>1342.1</td>
</tr>
<tr>
<td>Potassium (mg/1000 kcal)</td>
<td>910.9</td>
<td>2158.2</td>
</tr>
<tr>
<td>Fiber (g/1000 kcal)</td>
<td>7.4</td>
<td>9.5</td>
</tr>
<tr>
<td>Energy density (kcal/g)</td>
<td>4.4</td>
<td>1.8</td>
</tr>
</tbody>
</table>

### Diet Counselling Process Map: As already noted many studies on diet interventions for

1 All categories are significantly different.
various cardiometabolic risk factors have been done. Dietary interventions that target MetS are challenging, as there is currently no agreement on the key features of dietary intervention for MetS beyond weight loss. To guide the dietetic practice process in a recent study in primary care (CHANGE study), Royall et al. produced an initial care map that first prioritized diet components for weight loss if feasible, then focused on improving impaired glucose tolerance or diabetes, followed by diet components to improve hypertension and dyslipidemia (18).

**Summary:** A balanced eating pattern that provides appropriate amounts of energy and other nutrients is the key to reducing cardiometabolic risk and delaying the progression to clinical diseases. Considering there are specific nutrients related to a higher incidence of cardiometabolic events, the intake of such nutrients should be monitored and incorporated into the dietary approaches for reducing cardiometabolic events. Several relevant nutrients/foods/eating patterns have been reviewed. Other food components and nutrients are also involved in CVD development, but to a lesser extent, and may be the focus of diet counselling.

Since dietary intervention can prevent and delay cardiometabolic conditions, the performance of an accurate and efficient dietary assessment tool in clinical practice is important to the success of dietary interventions. However, the accuracy of individual dietary assessment has been problematic for many reasons, including the resources (time, knowledge, tool, etc.) available for conducting dietary assessment, clients’ compliance to dietary recording, and the dietary assessment tool’s capability to capture baseline intakes as well as change in foods/nutrients intake and eating patterns of relevant foods. The next section reviews feature of dietetic practice in developed countries, the dilemmas faced by health professionals in delivering nutrition care, and the role of RDs in delivering effective dietetic services.

### 2.3: Dietetic and Nutrition Care in Developed Countries

Nutrition interventions for cardiometabolic conditions are mainly done in primary care settings in Canada. Therefore, the focus of this section is the primary care setting.

**Nutrition Care Provided by Health Professionals in Primary Care**

Primary care is the first point of contact in the health system and the setting for most preventive interventions with clients, such as the promotion of healthy eating styles. Studies reveal that in general, most health professionals’ limited nutrition education background and time constraints make it difficult for them to deliver effective nutrition education to patients (32, 63, 64). For instance, health professionals in Australia, such as general practitioners (n = 11) and practice nurses (n = 3) realized the limitations of the dietary services they provided, and self-disclosed that they felt less confident in providing nutrition education (32). While a patient-centered approach requires individualized health care, the quality of nutrition care offered by general practitioners is “superficial” and “variable” (32). Secondly, compared to the time required to perform routine health care, nutrition care is much more time-consuming, as it involves multiple steps to establish a dietary intervention plan between the client and the care provider. Thus, health professionals usually compress the time spent on nutrition education or even ignore it because of time restraints. One observational study conducted by Eaton, et al.
suggested that through the direct observation of 84 US physicians, the average time spent on dietary education was 55 seconds, and only 24% of patients received nutrition education (65), which further suggested that the nutrition advice delivered by health professionals may lack the necessary effectiveness and details.

In Ontario, Family Health Teams (FHTs) are one of several main models that deliver primary care. Besides physicians and nurse practitioners, FHTs usually involve RDs to provide comprehensive health support to individuals. One research study conducted by Bonilla and colleagues (2016) used a mixed-method approach to gather information about dietary assessment carried out by FHT providers (66). They concluded that diverse dietary assessment methods were being used by different health providers based on different work scopes. Common challenges faced by FHT members who are not RDs included time restraints to obtain, analyze and interpret dietary data, as well as the lack of appropriate dietary assessment tools. Compared to RDs, who use formal dietary assessment methods (24-hour recall, food record, etc.), other health professionals are more likely to use brief dietary assessment tools to assess certain aspects of food or nutrient intake, such as calcium calculators or carbohydrate counting tools. Patients were usually referred to RDs for detailed nutrition counselling after a few visits with the general practitioners (66). The study suggested that with the collaboration between RDs and other health professionals, it is possible to deliver high-quality nutrition care to individuals.

It should be mentioned that the quality of nutrition care also depends on clients’ compliance to dietary suggestions. Health professionals’ input is only a part of the change process. According to theoretical models of health behavior and change, behavior change involves multiple transition stages and it usually needs weeks to months to be observed (67). If most patients only visit their primary health care team a few times for health concerns, it is hard for health professionals’ nutrition advice to affect patients’ dietary habits, or to track the effectiveness of the given nutrition advice.

Registered Dietitians’ Role in Nutrition Care

Registered Dietitian (RD) is the legal title for a group of professionals who have received systematic training in the field of nutrition and diet counselling. A national semi-structured telephone interview was conducted that targeted health professionals’ views on nutrition care gathered data from 28 health professionals across a range of health disciplines in Australian general practice settings (32). The study indicated that the majority of health professionals thought that individualized, appropriate nutrition care should be provided by RDs, rather than general practitioners (32). 57% of the general practitioners surveyed by this study suggested that their patients sought additional nutrition advice from RDs, even though they had received nutrition education provided by general practitioners (32). The dietary care offered by different professions varies according to their training. One would expect that specialists such as RDs should be more effective in their work than physicians. Indeed, several reviews have confirmed the value of specialist skills in some areas of diet counselling. A systematic review based on 12 studies also revealed that nutrition intervention delivered by RDs was more effective in reducing patients’ blood cholesterol than nutrition care delivered by doctors (68). Another cluster-randomized trial that involved 60 trained general practitioners found that although nutrition intervention provided by general practitioners and RDs were both significant in
reducing the risks associated with ischemic heart disease, it was hard for general practitioners to provide long-term, consistent nutrition care in real care settings (69). As a conclusion, although it is possible for general health professionals to achieve the similar effectiveness as RD-delivered nutrition care under a controlled study setting, it is very difficult for them to have the resources to deliver the similar intensive nutrition care in actual primary care settings (32, 69). Thus, RDs are considered the most qualified health professionals to deliver nutrition care.

To deliver effective nutrition care, one core responsibility of RDs is to conduct dietary assessment at baseline and in evaluating counselling success. The next section will focus on the introduction of common dietary assessment methods, which include food records, 24-hour recalls, food frequency questionnaires, diet histories, and the emerging technology-assisted dietary assessment methods.

2.4: Common Dietary Assessment Tools

Introduction of Nutrition Assessment

Nutritional assessment is defined by Gibson as “the interpretation of information from dietary, laboratory, anthropometrics and clinical studies” (70). In the early days of dietetics, nutrition assessment mainly emphasized nutrient deficiency and aimed to identify malnutrition at the early stage (70). Nutrition assessment commonly employs dietary, anthropometric, lifestyle and medical history, and laboratory indicators to identify potential nutritional risks. In general, dietary assessment is one of the most common procedures to detect nutrition-relevant problems and it has been frequently used by health professionals with clinical history and anthropometric measurement for non-invasive examination (70).

It should be kept in mind that the gold standard for assessing individuals’ true dietary intake is generally not feasible, such as the practice of duplicate food analysis and direct observation. Duplicate food analysis requires researchers to copy the exact food that has been consumed and blend all the ingredients together to analyze nutrient content. Among the existing dietary assessment practices, direct observation with duplicate analysis of individuals’ dietary intake may have the highest accuracy (71). However, it is not feasible in assessing usual food intake due to the method’s high financial and manual cost. In addition, the act of observation may alter subjects’ eating behaviors, which then compromises the assessment result. This method is not applicable to general dietetic practice (70, 72).

On the other side, some newly developed functional tests using biomarkers, such as double-labeled water and urinary nitrogen, can be used to estimate individuals’ energy and protein intake (70). Biomarkers have shown strong relationships with some dietary components (70). However, their sensitivity to detect early nutrient deficiencies is low. Many biomarkers can only discriminate intake extremes. In addition, the interpretation of nutrition status through biomarkers requires knowledge of the metabolism of each biomarker in relation to diet. Due to the temporal relationship between dietary intake and biomarker concentrations, the interpretation will be correct if the selected biomarker reflects the dietary intake of interest over the same time period as the dietary method (70). Biomarkers are also affected by other physiological processes.
For instance, subjects’ varying abilities to metabolize and excrete biomarkers may attenuate an association between a biomarker and dietary intake. Lifestyle factors such as smoking and medication can also affect the biomarkers’ accuracy in reflecting direct dietary intakes (70).

Only a few biomarkers are frequently seen in research, which include the use of double-labeled water to validate energy intake, and the use of 24-hour urinary nitrogen estimation to validate 24-hour protein intake (70). However, the 24-hour urinary nitrogen usually underestimates nitrogen loss. For instance, fiber intake and exercise increase the external loss of nitrogen (73).

Due to high financial expense, complicated procedures and limited markers that target on specific nutrients, it is unrealistic to assess individuals’ overall dietary intake by using such techniques in general practice, either. Thus, such approaches are restricted to research (74).

Compared to observation or functional tests, dietary assessment is one of the most cost-effective methods to identify nutritional risks (70). Various dietary assessment methods have been developed over the last decades (71). Common dietary assessment methods include food records, dietary histories, 24-hour food recalls, and food frequency questionnaires (75).

However, all available dietary assessment methods can only estimate subjects’ usual food intake due to significant intra- and inter-individual variabilities in intake, as well as demands of data collection and analysis. Different methods have differing strengths and limitations in estimating food/nutrient intake and meal patterns.

It should be noted that there are differences in estimating individual dietary intake versus population dietary intake. Estimating an individual’s usual food intake is usually more costly and time-consuming, as it requires multiple replicates to reduce intrapersonal variation and to increase precision in assessing food intake (70, 71). Although many tools are valid and reliable in ranking individuals in a population, their capacity to capture usual individual dietary intake for most major nutrients has been limited. In addition, the choice of dietary instrument for individual assessment is oriented to different assessment needs. For instance, a dietary assessment tool that is used to estimate specific nutrient intake is different from the one that aims to assess overall or specific food consumption.

**Common Dietary Assessment Methods**

**Food Records:** In general, two kinds of food records are available in assessing individuals’ usual food intake, the estimated vs. weighed food record. To improve accuracy and reduce day-to-day variation, food records that cover both weekdays and weekend (or work-days vs non-work days) are recommended (70, 71).

Estimated food records require individuals or their caretakers to record all food intakes at the time of consumption. The respondent should include detailed descriptions of consumed foods (e.g., brand names, preparation and cooking methods, and portion sizes) (70). One challenge associated with estimated food records is respondents’ failure to accurately quantify portion sizes. It may be easier for participants who are familiar with using standard national measuring cups and spoons to estimate food portion size. Nevertheless, research found individuals across all ages
had general difficulties in estimating portion sizes (76).

Similar to estimated food records, weighed food records require individuals or caretakers to record the foods and beverages consumed. Instead of estimating portion size, food is weighed prior to food consumption. Weighed food records are considered the most precise method available for assessing individuals’ food intake (70).

Besides clients’ difficulties in estimating portion sizes, common obstacles associated with the completion of food records are respondents’ poor compliance with recording and limited literacy skills. As respondents are required to describe consumed food items and preparation methods in detail, they should be highly motivated and literate. Nevertheless, it was observed that respondents usually alter eating patterns or skip recording some food to simplify the process (70). Since food recording is time-consuming with a high response burden, it is not considered as the primary method to assess food intake in primary care, although there is limited data to support that compared to other care providers, RDs are more likely to use food records when assessing patients’ food intake (66). In Kirkpatrick and colleagues’ review, only 18% of Canadian nutrition intervention studies reported the use of food records to gather subjects’ food intake (74).

**24-hour Food Recalls:** 24-hour food recalls are frequently used to obtain subjects’ food intake during the preceding day or the previous 24-hour period. The completion of 24-hour recalls can be done independently or guided by trained interviewers. 24-hour recall is frequently used in dietetic practice for initial diet assessment. However, due to its dependence on memory, it is recommended that 24-hour recall should be guided by interviewers (70). In order to improve the accuracy of the 24-hour recall, a four-stage interviewing technique has been established using memory cues, called the multi-pass method (77). Visual aids (food models, photographs, measuring tools, etc.) also improve the accuracy of recalls (77).

A single 24-hour recall is not representative in estimating an individual’s usual intake, as large day-to-day variations are common (71). Thus, it is recommended to employ multiple 24-hour recalls that cover both weekday and weekend days to achieve greater representativeness (71).

**Food Frequency Questionnaires:** Food frequency questionnaires (FFQ) assess the frequency of food items/groups consumed over a specific period. The simplest form of FFQ may only include a list of foods and frequency-of-intake options. The consumption frequency can be daily, weekly, monthly, or yearly (70).

Due to the existence of an enormous variety of food items in the market, it is unrealistic for any FFQ to list all possible foods that may be consumed by respondents. However, to capture respondents’ food patterns as comprehensively as possible, FFQ list typical foods that contain a significant amount of nutrients within a cultural context (region, country, etc.). The choice of listed foods also depends on specific study scope. For instance, to assess fiber intake, the FFQ designed by Merchant and colleagues includes fiber-rich foods, such as whole grains, legumes, vegetables and fruits (78).
One great advantage of the FFQ is its simplicity in completion. FFQs can be either completed by respondents independently or guided by trained interviewers. Respondents do not need to go into the details of each food item, which makes it possible to finish most FFQs in 15-30 minutes. However, general food items listed on a typical FFQ would only be able to target the major population but may fail to capture the dietary intake of ethnic or minority groups (70). Thus, food items should be adapted to meet the specific dietary practices of the targeted population. One challenge with FFQs may be in assessing the consumption of mixed foods. For example, assessing the frequency and amount of cheese consumption could be challenging if it is on pizza, in a sandwich and mixed with pasta, compared with other foods such as whole fruits.

Compared to other dietary assessment tools, FFQs are less burdensome to complete. They are widely used in dietetic practices and in epidemiological studies (70), which made up 64% of the use of self-reported instruments found in Canadian nutrition intervention studies (74).

**Dietary Histories:** The dietary history method was described by Burke as a method to estimate detailed individual food intake (70). A traditional dietary history has three components, which includes a form to assess a respondent’s overall eating pattern, a FFQ, and a 3-day food record. Dietary histories have advantages of both food records and FFQs, which allows researchers to capture respondents’ habitual intake in a relatively accurate manner, and are more likely to capture changes in diet, compared to the 24-hour recalls or FFQs.

A traditional dietary history can be extremely burdensome for respondents to complete. To improve respondents’ compliance, food-records are sometimes omitted from dietary histories (70). From health professionals’ and researchers’ perspectives, the implementation and analysis of traditional diet histories are labor-intensive, as interviewing is usually required to obtain necessary information. One interview can be up to two hours per person (79). Although it is claimed that dietary histories can be used to estimate long-term dietary intake, due to high response burden, it is suggested that a shorter time frame (< one month) covered by dietary histories would yield highest reproducibility and validity. It may be unrealistic and inaccurate to use dietary histories to assess food intake for more than one year (70).

In dietetic practice, it is critical for dietary assessment to be feasible in tracking long-term dietary change, thus, instead of the traditional form, modified versions of dietary histories are frequently used by Canadian RDs in practice (80). A cross-sectional survey conducted by Hanning et al. found that modified dietary histories were used most frequently in ambulatory and hospitalized care, followed by FFQs, 24-hour recalls and three-day food records (80). However, the study didn’t suggest the possible forms of modified dietary histories. Compared to traditional dietary histories, modified versions have not generally been validated.

**Technology-assisted Dietary Assessment (TDA):** The completion of most traditional dietary assessment methods requires respondents to be literate. In addition, traditional dietary assessment methods may also be limited in providing a wide variety of foods, eating patterns or nutrients for respondents to choose.

Recent methodological innovations may help to improve the efficiency and accuracy of conducting dietary assessment in primary health care settings. For instance, through
photographic instruments (e.g., camera), food intake and portion size can be directly visualized by both health professionals and patients to reduce measurement error. By comparing the photo of a dish prior to and after-consumption, researchers can estimate the amount of food intake without overwhelming participants to complete a traditional dietary assessment (64-66).

Some studies employed photographic techniques to examine food intake among hospital inpatients and long-term care residents, and found the technique has good reliability and validity against weighed food records (64-66). In addition to photographs, there are five other types of TDA instruments, including interactive computer-based technologies, web-based technologies, portable devices, scan/sensor technologies, and Personal Digital Assistants (81, 82).

To better understanding health professionals’ view on using TDA instruments, Bonilla, et al. conducted a study that involved 11 interdisciplinary focus groups from FHTs throughout Ontario. Including RDs, members from FHTs (n=50) revealed their awareness of existing TDA instruments, their perceived challenges of use, as well as their recommendations for the future improvement of those instruments. The study found that TDA instruments could potentially be applied to the management of obesity, diabetes and heart disease, especially for patient self-monitoring (82). Similarly, a review conducted by Illner et al. addressed the potential use of TDA instruments in improving dietary assessment quality in general health practice (81).

Typical benefits of using TDA include improved accuracy in measuring food intake using photographs, sensors, and scans, and simplified patient input through direct data input. The direct entry of data may also reduce the chance of interviewer bias and typing errors (82). Limitations may be the unfamiliarity of software/devices, and limited access to the internet (63). Since most studies are epidemiological, the validity and reliability of such instruments are still unclear at an individual level (81). Illner et al.’s review found the validity of using Personal Digital Assistants and mobile devices to estimate individual dietary intakes was low to moderate (81). Also, inaccuracy in portion size may still be an issue for some self-reported assessment instruments. Thus, there is still room of TDAs’ development.

2.5: Assessments and Diets Relevant to Cardiometabolic Risk

Dietary intervention for cardiometabolic risk must address multiple dietary components rather than focusing on a specific food component/nutrient (26). Thus, a dietary assessment tool that can quickly capture an overall food pattern and classify clients into different consumption levels of several foods of interest may be more helpful and practical to counselling practice (83).

Several mainstream epidemiological dietary interventions showed positive effects on reversing cardiometabolic risk, such as the Dietary Approaches to Stop Hypertension plan (DASH) (84, 85) and the Mediterranean Diet (MD) (29, 86). These dietary approaches have demonstrated reduced cardiometabolic risk in clinical trials. There are relevant dietary assessment tools developed based on different dietary patterns, such as the DASH diet score and the Mediterranean Diet Score (MDS).

Nevertheless, in regard to RDs’ daily practice, one aspect of diet counselling that is
problematic has been the formal assessment of dietary intake, both at baseline and over time. Counsellors have borrowed from the methods of epidemiology, but the exact validity and reliability of most tools are still unclear.

This section will provide a general review of some major cardiometabolic-related dietary interventions/relevant tools and is followed by a discussion of obstacles in finding appropriate dietary assessment tools in counselling of cardiometabolic patients.

**DASH Diet and DASH Diet Score**

The Dietary Approaches to Stop Hypertension (DASH) diet is known for its effect on reducing blood pressure and preventing cardiometabolic risk (85, 87, 88). A typical DASH diet emphasizes the whole-food diet pattern, which is rich in magnesium, potassium, calcium, protein, low in saturated fat and sugar, and limited in sodium (87).

The initial DASH randomized trial conducted by Lawrence, et al. had enrolled 459 adults (systolic blood pressure: <160 mm Hg; diastolic blood pressure: 80-95 mm Hg) (87). All subjects were fed with a control diet for three weeks. Then participants were randomly assigned to the control diet that was rich in fruits and vegetables (F&V), or the DASH diet (rich in F&V, with low-fat dairy, and reduced saturated and total fat) for eight weeks (87). The trial showed DASH diet’s effectiveness in reducing subjects’ blood pressure as early as two weeks after the intervention started. The average reductions of systolic blood pressure and diastolic blood pressure were 5.5 and 3.0 mm Hg, respectively (87). A systematic review by Siervo et al. confirmed DASH diet’s protective effect on reducing blood pressure and cardiometabolic risk (85). Data obtained from 20 randomized trials indicated that DASH diet significantly improved systolic (-5.2 mmHg, 95% CI: -7.0, -3.4; p<0.001) and diastolic (-2.6 mmHg, 95% CI: -3.5, -1.7; p<0.001) blood pressure, along with a significant reduction in total cholesterol (-0.20 mmol/l, 95% CI:-0.31, -0.10; p<0.001) and LDL concentrations (-0.10 mmol/l, 95% CI:-0.20, -0.01; p=0.03) (85). It was estimated that adherence to a DASH diet could lead to a 13% reduction of the 10-year Framingham risk score of CVD (85).

Although DASH is proven to be successful in reducing cardiometabolic risk, the adherence to DASH-type diets among those with hypertension was poor in the United States (89). Kim and Andrade analyzed the data collected from the 2007-2012 National Health and Nutrition Examination Survey on individuals with hypertension (89). Subjects’ food intake was assessed through two 24-hour recalls and then converted into the DASH adherence score, which evaluates individuals’ intake of nine nutrients against targeted criteria (sodium, cholesterol, saturated fat, total fat, protein, calcium, magnesium, potassium, and fiber) (89). Participants who met the intake requirement of one particular nutrient would be given one point. A score of 0.5 or 0 would be assigned if a participant’s intake met the intermediate level or did not meet the requirement at all, respectively. The study found the average DASH adherence score was 2.9 out of 9, which indicated poor adherence to the DASH diet pattern at a populational level (89). The result may also indicate insufficient promotion and dissemination of DASH diet among risk populations in the United States.

There are various DASH diet scoring tools, but the most widely used one found in the
literature is composed of 8 components [whole grains, vegetables (excluding white potatoes), fruit, nuts/seeds/legumes, dairy, sodium, sugar-sweetened beverages, and red and processed meat]. A higher score indicates better intake, except for sodium, sugar-sweetened beverages, red and processed meat, which are reversely scored and based on quintile of observed intake (84). Table 3 shows the eight-component DASH score used in Fung, et al.’s study (84). Such a scoring system works well in large studies but would require more information for use at an individual level.

**Table 3: Scoring Criteria of DASH Diet**

<table>
<thead>
<tr>
<th>DASH component</th>
<th>Foods</th>
<th>Scoring criteria by intake quintile within each study²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits</td>
<td>All fruits and fruit juices</td>
<td>Q1 = 1 point</td>
</tr>
<tr>
<td>Vegetables</td>
<td>All vegetables except potatoes and legumes</td>
<td>Q2 = 2 points</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q3 = 3 points</td>
</tr>
<tr>
<td>Nuts and legumes</td>
<td>Nuts and peanut butter, dried beans, peas, tofu</td>
<td>Q4 = 4 points</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q5 = 5 points</td>
</tr>
<tr>
<td>Whole grains</td>
<td>Brown rice, dark bread, cooked cereal, whole-grain cereal,</td>
<td>Reverse scoring:</td>
</tr>
<tr>
<td></td>
<td>other grains, popcorn, wheat germ, bran</td>
<td>Q1 = 5 points</td>
</tr>
<tr>
<td>Low-fat dairy</td>
<td>Skim milk, yogurt, cottage cheese</td>
<td>Q2 = 4 points</td>
</tr>
<tr>
<td>Sodium</td>
<td>Sum of sodium content of all foods in FFQ</td>
<td>Q3 = 3 points</td>
</tr>
<tr>
<td>Red and processed meats</td>
<td>Beef, pork, lamb, deli meats, organ meats, hot dogs, bacon</td>
<td>Q4 = 4 points</td>
</tr>
<tr>
<td>Sweetened beverages</td>
<td>Carbonated and non-carbonated sweetened beverages</td>
<td>Q5 = 1 point</td>
</tr>
</tbody>
</table>

**Healthy Eating Index (HEI)**

The original Healthy Eating Index (HEI) was published in 1995 to evaluate the overall diet quality of the US population. HEI is based on the recommendation of the US Dietary Guidelines and the Food Guide Pyramid (90). It is a 10-component system that assesses five food groups and selected nutrients per 1000 kcal, with each component scored from 0-5, 0-10 or 0-20, and yields the highest possible score of 100. Any deviation from the dietary recommendations will result in a lower score (90). A score that is > 80, between 50-80, and <50 are classified as “good quality diets”, “diets requiring improvement”, and “poor diets” by the United States Department of Agriculture (91).

Higher HEI scores were found among people who have higher F&V intakes, lower saturated fat intakes and balanced consumption of food groups (90, 92). Participants who scored higher on HEI showed a similar food intake trend that may help to prevent cardiometabolic risk, which includes lower intakes of total fat, saturated fat, cholesterol, and sugar (93).

As population nutrition concerns shift over time, the content of HEI has been consistently

²Q=quintile.
updated to meet the recommendations of national guidelines. The most recent US version is HEI-2015. The National Cancer Institute published the comparison among HEI-2005, 2010 and 2015 versions on its website (94). The common features of all three versions include the use of least-restrictive standards for recommendations that vary by energy level, sex, and age groups, the density approach to set standards, and the inclusion of adequacy components/moderation components (94). On the other hand, major differences are found between HEI-2005 and HEI-2010. For instance, there are several food groups substituted or introduced into the HEI-2010, which include “Fatty Acids” (replaced the previous section called “Oils and Saturated Fat” in HEI-2005), “Seafood and Plant Proteins”, “Refined Grains” (replaced “Total Grains”) (94). All the changes made in HEI-2010 have been maintained in the latest HEI-2015. Compared to HEI-2010, changes made in HEI-2015 include the substitution of “Empty Calories” with “Saturated Fat and Added Sugars”, which addresses the 2015 Dietary Guidelines emphasis on limiting added sugars intake (<10% of the total energy intake). The alcohol component is removed, and it is included in the total calories (94). Alcohol intake is only considered as empty calories if consumed beyond moderate amounts (two drinks/day, 28 g of ethanol) (95).

Interestingly, the “Standard for Maximum Points” on sodium increases from ≤0.7 to ≤1.1 grams in HEI-2015, while the “Standard for Minimum Score of Zero” remains the same (≥2.0 grams) (94). The adjustment was made based on the least restrictive of the two levels of sodium intake (1500mg and 2300mg) recommended in the Dietary Guideline for Americans, and the maximum score assigned for sodium occurs when the diet contains less than 1,100 mg of sodium per 1,000 calories (95). However, the study didn’t explain why there is a slight increase of sodium intake compared to the HEI-2005. Please see Table 4-6 for the scoring criteria of HEI-1995 (90), HEI-2005 (96) and HEI-2010 (97).

Table 4: Scoring Criteria for Healthy Eating Index-1995

<table>
<thead>
<tr>
<th>Food component</th>
<th>Scoring Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Criteria for 0</td>
</tr>
<tr>
<td>1: Grains</td>
<td>0 servings</td>
</tr>
<tr>
<td>2: Vegetables</td>
<td>0 servings</td>
</tr>
<tr>
<td>3: Fruits</td>
<td>0 servings</td>
</tr>
<tr>
<td>4: Milk</td>
<td>0 servings</td>
</tr>
<tr>
<td>5: Meat</td>
<td>0 servings</td>
</tr>
<tr>
<td>6: Total fat</td>
<td>≥45% energy from fat</td>
</tr>
<tr>
<td>7: Saturated fat</td>
<td>≥15% energy from saturated fat</td>
</tr>
<tr>
<td>8: Cholesterol</td>
<td>≥450mg</td>
</tr>
<tr>
<td>9: Sodium</td>
<td>≥4800mg</td>
</tr>
<tr>
<td>10: Variety</td>
<td>≤six different food items/3d</td>
</tr>
</tbody>
</table>
Table 5: Scoring Criteria for Healthy Eating Index-2005

<table>
<thead>
<tr>
<th>Food component</th>
<th>Scoring Criteria</th>
<th>Criteria for maximum score</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Total grains</td>
<td>No grains</td>
<td>≥3.0 oz equiv. per 1,000 kcal</td>
<td>0-5</td>
</tr>
<tr>
<td>2: Whole grains</td>
<td>No whole grains</td>
<td>≥1.5 oz equiv. per 1,000 kcal</td>
<td>0-5</td>
</tr>
<tr>
<td>3: Total vegetables</td>
<td>No vegetables</td>
<td>≥1.1 cup equiv. per 1,000 kcal</td>
<td>0-5</td>
</tr>
<tr>
<td>4: Dark green and orange vegetables and legumes</td>
<td>No dark green or orange vegetables or legumes</td>
<td>≥0.4 cup equiv. per 1,000 kcal</td>
<td>0-5</td>
</tr>
<tr>
<td>5: Total fruit (includes 100% juice)</td>
<td>No fruit</td>
<td>≥0.8 cup equiv. per 1,000 kcal</td>
<td>0-5</td>
</tr>
<tr>
<td>6: Whole fruit (no juice)</td>
<td>No whole fruit</td>
<td>≥0.4 cup equiv. per 1,000 kcal</td>
<td>0-5</td>
</tr>
<tr>
<td>7: Milk</td>
<td>No milk</td>
<td>≥1.3 cup equiv. per 1,000 kcal</td>
<td>0-10</td>
</tr>
<tr>
<td>8: Meat and Beans</td>
<td>No meat or beans</td>
<td>≥2.5 oz equiv. per 1,000 kcal</td>
<td>0-10</td>
</tr>
<tr>
<td>9: Oils</td>
<td>No oils</td>
<td>≥12 grams per 1,000 kcal</td>
<td>0-10</td>
</tr>
<tr>
<td>10: Saturated fat</td>
<td>≥15% of energy</td>
<td>≤7% of energy</td>
<td>0-10</td>
</tr>
<tr>
<td>11: Sodium</td>
<td>≥2.0 grams per 1,000 kcal</td>
<td>≤0.7 gram per 1,000 kcal</td>
<td>0-10</td>
</tr>
<tr>
<td>12: Calories from Solid Fats, Alcoholic beverages, and Added Sugars</td>
<td>≥50% of energy</td>
<td>≤20% of energy</td>
<td>0-20</td>
</tr>
</tbody>
</table>

Table 6: Scoring Criteria for Healthy Eating Index-2010

<table>
<thead>
<tr>
<th>Food components</th>
<th>Scoring Criteria</th>
<th>Criteria for maximum score</th>
<th>Score range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequacy</td>
<td>Criteria for 0</td>
<td>Criteria for maximum score</td>
<td></td>
</tr>
<tr>
<td>1: Whole grains</td>
<td>No whole grains</td>
<td>≥1.5 oz equiv. per 1,000 kcal</td>
<td>0-10</td>
</tr>
<tr>
<td>2: Total vegetables</td>
<td>No vegetables</td>
<td>≥1.1 cup equiv. per 1,000 kcal</td>
<td>0-5</td>
</tr>
<tr>
<td>3: Greens and Beans</td>
<td>No dark green vegetables or beans and peas</td>
<td>≥ 0.2 cup equiv. per 1,000 kcal</td>
<td>0-5</td>
</tr>
<tr>
<td>4: Total fruit</td>
<td>No fruit</td>
<td>≥0.8 cup equiv. per 1,000 kcal</td>
<td>0-5</td>
</tr>
<tr>
<td>5: Whole fruit</td>
<td>No whole fruit</td>
<td>≥0.4 cup equiv. per 1,000 kcal</td>
<td>0-5</td>
</tr>
<tr>
<td>Food components</td>
<td>Scoring Criteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequacy Criteria for 0</td>
<td>Criteria for maximum score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,000 kcal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6: Dairy</td>
<td>No dairy</td>
<td>≥1.3 cup equiv. per 1,000 kcal</td>
<td></td>
</tr>
<tr>
<td>0-10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7: Total protein foods</td>
<td>No meat or beans</td>
<td>≥2.5 oz equiv. per 1,000 kcal</td>
<td></td>
</tr>
<tr>
<td>0-5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8: Seafood and plant proteins</td>
<td>No seafood or plant proteins</td>
<td>≥0.8 oz equiv. per 1,000 kcal</td>
<td></td>
</tr>
<tr>
<td>0-5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9: Fatty Acids</td>
<td>(PUFAs + MUFAs)/SFAs ≤1.2</td>
<td>(PUFAs + MUFAs)/SFAs ≥2.5</td>
<td></td>
</tr>
<tr>
<td>0-10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10: Refined Grains</td>
<td>≥4.3 oz equiv. per 1,000 kcal</td>
<td>≤1.8 oz equiv. per 1,000 kcal</td>
<td></td>
</tr>
<tr>
<td>0-10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11: Sodium</td>
<td>≥2.0 grams per 1,000 kcal</td>
<td>≤1.1 gram per 1,000 kcal</td>
<td></td>
</tr>
<tr>
<td>0-10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12: Empty calories</td>
<td>≥50% of energy</td>
<td>≤19% of energy</td>
<td></td>
</tr>
<tr>
<td>0-20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**HEI-Canada:** While HEI was developed based on the US food guidelines, it is not valid and reliable to directly apply it to a different cultural context. To deal with the problem, researchers modified the original HEI based on recommendations of domestic dietary guidelines, which made the adapted version suitable for assessing Canadians’ diet quality.

Previous Canadian modifications had been made on the HEI-1995 and HEI-2005 (98). The current available HEI-Canada was first adapted from HEI-2005. Instead of measuring score based on per 1000kcal intake, the Canadian version is based on the Canada’s Food Guideline (CFG) serving size. The latest version of HEI-Canada has been adapted from the US HEI-2010 by Jessri et al. (see Table 6), in which dietary recommendations, food groups, and serving sizes are modified based on CFG 2007 (98). However, the HEI-2010-Canada is not available for public usage yet. Based on the dietary data (n=35,107) retrieved from the 2004-2005 CCHS 2.2, researchers used weighted multivariate linear regression models to examine the association between HEI-2010-Canada scores and intake of various foods and nutrients (98). The study found that a higher HEI-2010-Canada score was associated with higher polyunsaturated fat, fiber and protein intake, and inversely associated with added sugars, alcohol, and SFA consumption (98), as would be expected. In terms of the association between HEI score and the incidence of obesity, researchers found significant associations between HEI scores that fell in quartile 1 and quartile 4. Subjects who scored lower showed a greater risk of being obese than those who got the highest score (OR:1.43; CI: 1.09-1.89; P-trend: 0.0048) (98). However, the interpretation of findings should be applied with caution, since HEI-2010-Canada did not take energy intake into account in its scoring criteria. Thus, for those who have a higher score may also at higher risk of energy-overconsumption. The assumption was supported by further data analysis, as the largest frequency of energy overconsumption was among those with the highest HEI-2010-Canada scores, although physical activity may not be accurately accounted for (98).

In this study, the average HEI-2010-Canada score was around 50.85 out of 100, which indicated that there was still improvement needed to enhance Canadians’ diet quality. As the
latest HEI-Canada was modified based on CFG 2007, Jessri et al. mentioned that lack of energy consideration in CFG 2007 may impact HEI-2010-Canada’s capability as a nutrition surveillance instrument to aid in weight management (98).

**Alternate Healthy Eating Index (AHEI):** McCullough et al. found that HEI score was only associated with a small reduction in major chronic disease risks in the US population (99). Reflecting on their findings, they developed the Alternate Healthy Eating Index (AHEI), which aims to better predict risk factors associated with chronic diseases (99).

While the design of HEI emphasizes whole food dietary patterns (90), the design of AHEI pays more attention to food patterns and eating behaviors that are related to lower incidence of chronic diseases (99). AHEI contains some food groups from the original HEI, but adjustments were made to certain food groups. It has a similar scoring system to HEI, and eight out of the nine food groups have a maximum score of 10. The major difference between HEI and AHEI is that AHEI adds specific food groups that may contribute to increased chronic condition incidence. For example, HEI-1995 emphasizes the intake of total fat, but AHEI considers the benefits of the intake of unsaturated fatty acids and gives a maximum 10 points if the ratio of PUFA:SFA is greater than 1. Similarly, a lower trans-fat intake receives a higher score (10 points for \( \leq 0.5\% \text{ kcal} \); 0 points for \( \leq 4\% \text{ kcal} \)) (99). In terms of protein take, HEI gives credit to any type of meat intake, while AHEI gives lower credit to red meat consumption. If an individual’s meat intake ratio (white: red) equals to 4:1, 10 points is given. A non-meat protein category is also mentioned in AHEI. Considering the benefits provided by fiber in reducing chronic disease risks, a higher credit is assigned to higher whole grain intake; starchy vegetables like potatoes are excluded from the vegetable category (99).

To examine the association of AHEI score and chronic disease incidence, the research team employed the dietary data obtained from two cohort studies, which included 67,271 female nurses from the Nurses’ Health Study and 38,615 male health professionals from the Health Professionals’ Follow-up Study (100). By combing the dietary data from the two cohorts, the research team calculated the relative risks as the incidence rate of major chronic disease event among participants. Diet scores that fell in each quintile were divided by the incidence rate for those in the lowest quintile.

The study found that males and females with AHEI scores in the top quintile showed significant 20% and 11% reductions in overall major chronic disease incidence compared to participants who were at the bottom quintile, respectively (99). Similar trends were observed in the reduction of CVD risk, as men and women with scores in the highest quintile compared to the lowest quintile, showed a significant decrease in CVD risks of 39% and 28%, respectively (99). Thus, the authors concluded that AHEI’s predicted reduction of incidence in chronic conditions and CVD risks was twice as high compared to the original HEI (99), which indicated AHEI’s was capturing more of the important differences in diet as a risk factor. While interesting, both cohorts recruited health professionals. Considering that health professionals usually have a higher health awareness compared to the general population, the sample is not representative of the US population. Therefore, AHEI’s ability to predict disease reduction in the general population is still unclear. Table 7 is adapted from McCullough et al.’s study (100), which illustrates the scoring criteria for AHEI.
Table 7: Scoring Criteria for Alternate Eating Index

<table>
<thead>
<tr>
<th>Food component</th>
<th>Scoring Criteria</th>
<th>Criteria for Minimum score</th>
<th>Criteria for maximum score</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Cereal fiber (g/day)</td>
<td></td>
<td></td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>2: Vegetables (servings*/day)</td>
<td></td>
<td></td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>3: Fruit (servings/day)</td>
<td></td>
<td></td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>4: Nuts and soy proteins</td>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>5: Ratio of white to red meat</td>
<td></td>
<td></td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>6: Trans fat (% of energy)</td>
<td></td>
<td>≥4</td>
<td>≤0.5</td>
<td>0-10</td>
</tr>
<tr>
<td>7: Ratio of polyunsaturated: saturated fat</td>
<td></td>
<td>≤0.1</td>
<td>≥1</td>
<td>0-10</td>
</tr>
<tr>
<td>8: Duration of multivitamin use</td>
<td></td>
<td>&lt; 5 years</td>
<td>≥5 years</td>
<td>2.5-7.5</td>
</tr>
<tr>
<td>9: Alcohol (servings/day)</td>
<td></td>
<td>Men: 0 or &gt;3.5</td>
<td>Men: 1.5–2.5</td>
<td>0-10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Women: 0 or &gt;2.5</td>
<td>Women: 0.5–1.5</td>
<td></td>
</tr>
<tr>
<td>Total score (range)</td>
<td></td>
<td>2.5</td>
<td>87.5</td>
<td>2.5-87.5</td>
</tr>
</tbody>
</table>

**Summary on HEI and Modified Versions:** As research has continued, various updated and modified versions of the HEI have been developed and used in research. The extent to which HEI and its modifications reflect the cultural norms of North America’s food habits or reflect universal principles for a healthy diet cannot yet be answered, but will emerge over time, as research continues. The main outlines of diets that support health are known but scoring and the focus on some aspects such as fat and protein sources likely need further development, in addition to studies of larger number of cohorts from different countries.

**Mediterranean Diet and Mediterranean Diet Score**

The observed low prevalence of cardiometabolic diseases and high life expectancy in the Mediterranean basin led the intensive investigation of the Mediterranean diet (MD) over the past 60 years (35). A traditional MD is marked by high consumption of olive oil, nuts, legumes, fruits and vegetables, fish, and cereal, moderate consumption of ethanol (in the form of wine), and low intake of processed meat, red meat, dairy and sweets (101).

There is evidence suggesting that adherence to MD may protect individuals from cardiometabolic risk and reduce the incidence of major cardiovascular events (29, 35, 102, 103). The initial attempt to create the Mediterranean Diet Score (MDS) was first proposed by Trichopoulou et al. in their cohort study. They recruited 182 senior residents from three Greek
villages and evaluated their overall mortality rate (103). A validated 190-item semiquantitative FFQ was used to capture participants’ dietary habits over a year (103, 104).

By developing a diet score system that includes essential MD components, researchers found that a higher MDS was significantly associated with lower mortality rate, with 17% reduction per one unit increase in score, and 50% reduction per four units increase (103), based on a score that ranged from 0 to 8. The sample size of this initial study was very small, but results were promising.

More recently, a longitudinal randomized controlled trial called “PREvención con Dieta MEDiterránea” (PREDIMED) recruited 7447 high-risk participants to investigate the effect of MD in reducing cardiovascular events among three assigned dietary regimens (105). Participants who had either T2DM or at least three of the listed risk factors (smoking, hypertension, high LDL cholesterol, low HDL cholesterol, high BMI, family history of premature coronary heart disease) were identified as “high risk” (105).

One treatment group received MD that was supplemented with extra-virgin olive oil, another treatment group received MD supplemented with nuts. The control group received lower-fat diet advice only. No differences were found between participants’ adherence and food intakes at baseline. The study found that both treatment groups showed a significantly lower incidence of cardiovascular events compared to the control group, which resulted in an absolute risk reduction of major cardiovascular events (stroke, myocardial infarction, etc.) per 1000 person-years and a 30% relative risk reduction (105). However, the original PREDIMED study was found to have some protocol deviations in randomization. After the omission of 1588 participants whose study-group assignments were known or suspected to have departed from the protocol, data were reassessed (29). Compared to the control group, researchers found the hazard ratio for CVD events remained significant, which were 0.69 (95% CI, 0.53 to 0.91) and 0.72 (95% CI, 0.54 to 0.95) for MD supplemented with extra-virgin olive or nuts, respectively (29). The revised analysis still yielded comparable results that supported MD’s effectiveness in preventing and reducing the incidence of cardiovascular events. (29, 105). It should be noted that T2DM was considered as one of the major cardiovascular risk factors, but not the major event in this study. Thus, MD’s effect in reducing the incidence of T2DM was not clear in this study.

The initial MDS created by Trichopoulou et al. has a maximum score of eight, assigned to eight categories (vegetables, fruit and nuts, legume, milk and dairy products, cereals, meat and meat products, alcohol, and MUFA:SFA) (86). Table 8 is adapted from Trichopoulou et al. (103), which illustrates the original 8-item MDS. Because the original study set the sex-specific median as the cutoff, we do not have Canadian-based reference points for advising.

**Table 8: Scoring Criteria for Mediterranean Diet Score**

<table>
<thead>
<tr>
<th>Food component</th>
<th>Criteria for Minimum score (0)</th>
<th>Criteria for maximum score (1)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Cereal</td>
<td>&lt;Median</td>
<td>&gt;Median</td>
<td>0/1</td>
</tr>
<tr>
<td>2: Vegetables</td>
<td>&lt;Median</td>
<td>&gt;Median</td>
<td>0/1</td>
</tr>
</tbody>
</table>
Food component | Scoring Criteria
---|---
| Criteria for Minimum score (0) | Criteria for maximum score (1) | Range |
3: Fruits and nuts | <Median | >Median | 0/1 |
4: Legume | <Median | >Median | 0/1 |
5: MUFA: SFA | <Median | >Median | 0/1 |
6: Meat and meat products | >Median | <Median | 0/1 |
7: Milk and dairy products | >Median | <Median | 0/1 |
8: Alcohol | >Median | <Median | 0/1 |

Similar to the development of HEI, different MD indices were developed to meet specific studies’ scopes (106). One review conducted by Bach et al. evaluated several Mediterranean diet indices that have been used in epidemiological studies. They identified three types of Mediterranean diet indices, which include indices with positive or negative component scoring, adherence indices that have standardized criteria, and adequacy indices that measure relative intake of some food components. The study found the majority of the studies used the first type of index system (e.g., MDS, etc.) in measuring adherence to MD at a populational level (106). The interpretation of indices varied depending on researchers’ subjectivity, the availability of data, the selection of food component, and the choice of cut-off points (97). The authors concluded that due to the complexity of dietary patterns and results to date, that no one dietary index had clearly emerged as superior to others.

**Modified Versions of MDS:** It should be noted that there is no official validated MDS tool modified for the Canadian context. The Ontario Public Health Association recommends that individuals can self-examine their adherence to MD by using the Mediterranean Diet Adherence Screener (MEDAS) or the Mediterranean Diet Scoring Tool (107). MEDAS is a 14-item screener that was developed and used in the PREDIMED study to assess MD adherence among Spanish seniors (108). The Mediterranean Diet Scoring Tool is recommended by the United Kingdom National Audit of Cardiac Rehabilitation (109). Nevertheless, the validity of this tool is unclear, as neither the National Audit of Cardiac Rehabilitation nor the Ontario Public Health Association had mentioned such information. Both modified versions inherit the original MDS scoring system, which uses 0 (No) and 1 (Yes) to indicate the degree of MD adherence.

Table 9 illustrates the scoring criteria for MEDAS (108).

**Table 9: Scoring Criteria for Mediterranean Diet Adherence Screener**

| Food component | Scoring Criteria³ |
|---|---|---|
| | Criteria for Minimum score (0) | Criteria for maximum score (1) | Range |
1: Olive oil as the main culinary fat | No | Yes | 0/1 |

³Due to different national dietary intake recommendations, serving sizes differ across countries and different questionnaires.
<table>
<thead>
<tr>
<th>Food component</th>
<th>Scoring Criteria³</th>
<th>Criteria for Minimum score (0)</th>
<th>Criteria for maximum score (1)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>2: Olive oil</td>
<td></td>
<td>&lt; 4 tbsp/day</td>
<td>≥ 5 tbsp/day</td>
<td>0/1</td>
</tr>
<tr>
<td>3: Tree nuts and peanuts &lt;br&gt; <strong>1 serving=30g</strong></td>
<td></td>
<td>&lt;3 servings/day</td>
<td>≥ 3 servings/day</td>
<td>0/1</td>
</tr>
<tr>
<td>4: Fresh fruit (including natural juice)</td>
<td></td>
<td>&lt;3 units/day</td>
<td>≥ 3 units/day</td>
<td>0/1</td>
</tr>
<tr>
<td>5: Vegetables &lt;br&gt; <strong>1 serving = 200g - consider side dishes as 1/2 serving</strong></td>
<td></td>
<td>&lt;2 servings/day</td>
<td>≥ 2 servings/day</td>
<td>0/1</td>
</tr>
<tr>
<td>6: Fatty fish and sea food &lt;br&gt; <strong>1 serving: 100-150 g fish, or 4-5 units or 200 g shellfish</strong></td>
<td></td>
<td>&lt;3 servings/week</td>
<td>≥ 3 servings/week</td>
<td>0/1</td>
</tr>
<tr>
<td>7: Legume &lt;br&gt; <strong>1 serving = 150 g</strong></td>
<td></td>
<td>&lt;3 servings/week</td>
<td>≥ 3 servings/week</td>
<td>0/1</td>
</tr>
<tr>
<td>8: Safrito sauce (made with tomato, garlic and herbs)</td>
<td></td>
<td>&lt;2 times/week</td>
<td>≥ 2 times/week</td>
<td>0/1</td>
</tr>
<tr>
<td>9: White meat instead of red &amp; processed meat</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td>0/1</td>
</tr>
<tr>
<td>10: Wine (optional, with meals)</td>
<td>N/A</td>
<td>≥ 7 servings/week</td>
<td></td>
<td>0/1</td>
</tr>
<tr>
<td>11: Sugar-sweetened beverages</td>
<td>≥1 beverage/day</td>
<td>&lt;1 beverage/day</td>
<td></td>
<td>0/1</td>
</tr>
<tr>
<td>12: Baked goods sweets, pastries, etc.)</td>
<td>≥ 3 times/week</td>
<td>&lt;3 times/week</td>
<td></td>
<td>0/1</td>
</tr>
<tr>
<td>13: Fat spreads (butter, margarine, cream etc.) &lt;br&gt; <strong>1 serving=12g</strong></td>
<td>≥ 1 serving/day</td>
<td>&lt;1 serving/day</td>
<td></td>
<td>0/1</td>
</tr>
<tr>
<td>14: Red or processed meat &lt;br&gt; <strong>1 serving = 100-150g</strong></td>
<td>≥ 1 serving/day</td>
<td>&lt; 1 serving/day</td>
<td></td>
<td>0/1</td>
</tr>
</tbody>
</table>

Another frequently used modified MDS is the alternative Mediterranean Diet Index (aMED) (110), which was adapted by Fung, et al. for the 1979 US Nurses' Health Study based on the original MDS (86, 103). In their study, the researchers assessed the association between different dietary-quality scores’ and plasma concentrations of markers of inflammation and endothelial dysfunction. Among the 121,700 female nurse participants, 690 nurses who had no history of CVD, cancer, or diabetes were selected as the participants. Participants were required to provide blood samples. Their dietary data were collected every four years from a validated, semi-quantitative FFQ. Then dietary intake was converted to dietary-quality scores of several dietary assessment tools (HEI, AHEI, Diet Quality Index Revised, Recommended Food Score, aMED) (110). The aMED gives a maximum score of nine on nine food groups, which include whole grains, vegetables (excluding potatoes), fruit, fish, nuts, legumes, and fatty acid ratio, red and processed meat (reversely scored), and gender-specific alcohol intake. Similar to the scoring criteria of MDS, one point is assigned to participants if they meet the recommendation level of food intake (above the median). In terms of alcohol consumption, one point is only given if the
consumption is within the recommended range (110). Table 10 is adapted from Fung et al., which illustrates the scoring criteria for aMED.

Table 10: Scoring Criteria for Alternative Mediterranean Diet Index

<table>
<thead>
<tr>
<th>Food component</th>
<th>Scoring Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Criteria for Minimum score (0)</td>
</tr>
<tr>
<td>1: Whole grains</td>
<td>&lt;Median (servings/day)</td>
</tr>
<tr>
<td>2: Vegetables (except potatoes)</td>
<td>&lt;Median (servings/day)</td>
</tr>
<tr>
<td>3: Fruits (include juices)</td>
<td>&lt;Median (servings/day)</td>
</tr>
<tr>
<td>4: Legumes</td>
<td>&lt;Median (servings/day)</td>
</tr>
<tr>
<td>5: Nuts</td>
<td>&lt;Median (servings/day)</td>
</tr>
<tr>
<td>6: MUFA: SFA</td>
<td>&lt;Median (servings/day)</td>
</tr>
<tr>
<td>7: Fish</td>
<td>&lt;Median (servings/day)</td>
</tr>
<tr>
<td>8: Red and processed meat</td>
<td>&gt;Median (servings/day)</td>
</tr>
<tr>
<td>9: Ethanol</td>
<td>&lt;5g or &gt;15g</td>
</tr>
</tbody>
</table>

The study (n=660) found that only AHEI and aMED were strongly inversely associated with the above inflammatory factors. A plausible interpretation of the data is that only AHEI and aMED address the high ratio of polyunsaturated to saturated fat in their content, which is proven to be associated with lower concentrations of inflammatory markers (111). Whereas HEI, Diet Quality Index Revised, and Recommended Food Score encourage low-fat intake and do not differentiate the types of fat intake (110).

Again, the development and adaption of aMED were based on a large cohort study specific to nurses. Its generalizability is unclear.

The benefits of MD on preventing cardiovascular risks and delaying the progression of CVD are backed up by valid evidence. The dichotomous scoring system employed by most Mediterranean diet indices provides criteria for defining a goal, which makes the score system a time-saving procedure to capture subjects’ adherence to MD. It could be widely used by either individuals for self-examination or by general health professionals. There are multiple modified versions available, which have undergone various validation studies.

**Challenges of Using Epidemiological-Based Assessment Tools**

More than 50% of referrals to diet counselling in one demonstration project in three primary care settings in the mid-2000s, were for clients with cardiometabolic conditions (112), and it is expected that clients with these conditions are still prominent in primary care.

The choice of appropriate dietary assessment tool has long been under debate. While there are various dietary assessment tools used for research purposes, and some of them claimed to
have good validity and reliability in estimating food intake, there is no unified tool that targets cardiometabolic risk available for Canadian primary care settings (74). The use of inconsistent dietary assessment tools within and between different practice settings may challenge the tracking of clients’ dietary intake changes over time and across health facilities, which causes a potential problem in information transferring. Secondly, varied qualities that reflected on different dietary assessment tools may impact the future development of an efficient individualized plan. England and colleagues’ review found that current dietary assessment tools that target the management of obesity, CVD, and T2DM are “variation in study design, settings and populations, makes it difficult to recommend one tool over another.” (83), which indicated the dilemma faced by RDs when choosing a suitable assessment tool for managing cardiometabolic risk.

A scoping review about self-reported dietary assessment tool used in Canada reported that among a variety of dietary assessment tools used in 92 collected studies, the details of these tools’ psychometric testing on validity and reliability were often lacking, which made it hard for health professionals to evaluate those tools’ capability in estimating true dietary intake (74). In addition, although many tools (Diet History Questionnaire, CCHS Annual Cycles screener, etc.) are either adapted to or developed based on the Canadian context, their validity and feasibility have only been tested for epidemiological research or specific population and not for assessing food intake change in individuals (74). In addition, without accurate tools for assessing change, it is difficult to improve effectiveness or to assess the effectiveness of dietetic services for quality improvement purposes. It is unclear that those dietary assessment tools will still be reliable and valid to assess the food pattern of clients with cardiometabolic risk in primary care settings.

To conclude, the lack of an efficient dietary assessment tool may greatly impair RDs’ working efficiency and hamper effectiveness improvement. Thus, there is an urgent need to call for a unified, validated assessment tool developed to fulfill the current gap of dietary practices and to further promote the quality of dietary services.

2.6: Using Assessment Tools with Different Scoring Systems

Assessing individual dietary intake is difficult, as it is affected by both inter- and intra-personal bias, and various measurement errors (70). To satisfy the need for rapid dietary assessment, various dietary screeners have been developed for health professionals who work in primary care practice (113). Nevertheless, dietary intake obtained by those tools may be too general for counseling purposes and less relevant to cardiometabolic risk (66). On the other hand, the use of scoring is helpful in dietetic practice, as the magnitude of the score could reflect participant’s overall dietary quality, as well as providing information for cross-sectional or longitudinal comparison. Different dietary assessment tools may have different scoring systems, which ranges from the dichotomous scoring system found in most MDS to more specific 100-point scale found in HEI.

A study conducted by Liese et al. analyzed the association between dietary indices (HEI-2010, AHEI-2010, DASH and aMED) and predicted mortality rate, in which data were obtained from three cohorts (NIH-AARP Diet and Health Study, the Multiethnic Cohort, and the
Women’s Health Initiative Observational Study (WHI-OS)) (114). The correlation between indices, and the association between dietary score and all-cause, CVD, cancer mortality were analyzed (114).

All four instruments were significantly associated with all-cause, CVD, and cancer mortality, except for the AHEI-2010 used in the WHI-OS, which was not significantly associated with cancer mortality (114). In terms of CVD mortality, high diet quality was associated with a 19–28% lower risk in women and a 14–26% lower risk in men. Researchers noted that although common dietary components (whole grains, vegetables, fruit, and plant-based protein) are shared across all instruments, there are specific food components presented in each tool. For instance, HEI-2010, AHEI-2010, and aMED include PUFAs and MUFAs, while reduced sodium content is only found in HEI-2010, AHEI-2010, and DASH diet score (114). Also, the study noted that all four indices showed a capacity to capture the essential components of a healthy diet (114).

The consistency of categorical classifications of all four dietary indices suggests that all instruments could differentiate participants who eat a higher quality diet from those who do not, and a substantial proportion of participants were ranked similarly across indices (114). Nevertheless, the results yielded by the study also suggested that there is no difference in differentiating mortality by using any one of the four tools, and there is no indication to suggest that one index is more valid than another one.

Liese et al.’s study implied that various versions of MDS and HEI are frequently used for epidemiological studies. None of the current tools are being widely used in Canadian dietetic practice, although many FHT RDs are using MDS. In terms of HEI, it is designed to monitor Americans’ dietary pattern at a population level (90). The same problem exists for HEI-Canada, and there is limited literature indicating HEI-Canada’s appropriateness for individual use.

Nevertheless, according to the results from a small-scale survey (n=44) across Ontario, RDs expressed their hesitation in using a prototype of the DIETQ in dietetic practice (115). In this undergraduate thesis project, RDs completed an online survey and three of them were interviewed for greater details about their attitudes towards using the DIETQ dietary assessment tool in actual practice (115). Reflecting on data obtained from both survey and interview, RDs indicated their doubt that DIETQ was usable in dietetic practice, and only 25% of RDs would use it for dietary assessment (115). Possible reasons put forward included a lack of consensus on the use of dietary assessment tools in practice, time restraints, lack of applicability of some MDS components in a Canadian assessment tool, and that CFG’s guide serving sizes are too small. The study concluded that RDs would like to have a dietary assessment tool that could be completed in a relatively short time, and with the capability to reflect food variety and Canadians’ dietary patterns and food preferences (115).

Again, the study results reflect the dilemma RDs face in selecting an appropriate dietary assessment tool to meet their practice goals. In general, due to time restraints, they would like to choose a tool that can be completed efficiently. It also should have necessary details reflecting eating pattern complexity and variety, as well as the cultural context. There may be a need for a brief tool or screener for patients who may only come 1-2 times, versus a more detailed tool for those who commit to longer. If there is a long-term goal set for dietary change, a detailed dietary
assessment tool is more appropriate, and the patient could see their progress in a more tangible way. Thus, the construction of a dietary assessment tool must consider diverse RDs’ expectations and types of practice.

**Recent Validation Studies on Modified MDS**

Diet counselling is increasingly being promoted as a helpful behavioral intervention. It is important to be able to have diet assessment tools that are feasible in practice, valid and will yield information on the effectiveness of counselling. Practicing RDs are very interested in using simplified tools like the MDS to assess practice, but as noted in the last section, they expressed concerns about whether MDS is feasible and applicable in the Canadian context. There have been recent validation studies on modified MDS tools in Germany, the United Kingdom and Canada. Different approaches have been used.

The German validation was done by Hebestreit et al. in 2017 (116). The original MEDAS was translated into German. The serving sizes of the German MEDAS were adjusted (116). For instance, for each serving of sweetened beverage, the German MEDAS assigned a portion size of 100mL, whereas in the original MEDAS, the serving size of sweetened beverages was not clarified (116). The scoring criteria for other MD components stayed the same, except Sofrito sauce, for which the criterion for obtaining a score of one decreased from ≥2 times/week (see table 9) to 1-2 times/week (116). Similarly, in terms of asking participants whether they are using olive oil as the main added fat, a score of one is given to participants if they use olive oil twice a week for the preparation of salad, vegetable, and meat/fish (116).

The validity of the instrument was assessed by evaluating the concordance of food items between MEDAS and a full-length FFQ. Validity varied between the items. The highest intraclass correlation coefficient (ICC) was 0.91 for pulses, vs. -0.33 for sugar-sweetened drinks. Also, some dietary intake biomarkers (omega 3-6-9, beta-carotene, c-reactive protein) in the blood were compared to some MEDAS items by using t-tests and multivariate regression. The study found that lower blood omega-6 fatty acid levels (p = 0.026) and higher omega-3 fatty acid levels (p = 0.037) were associated with higher fish consumption (≥3 portions) (116).

In the second validation of MEDAS conducted in the United Kingdoms, Papadaki et al. recruited 96 adults at high cardiovascular risk. In terms of evaluating whether participants used olive oil as the main added fat, one point is given if the total olive consumption is greater than the total consumption of other fat, including cream, butter, and margarine (117). All the serving sizes stayed the same as the original MEDAS’ (see table 9). MEDAS was completed by participants at baseline and one month later. A three-day food record was completed by participants and served as the reference instrument to establish concurrent validity of MEDAS. The predictive validation was then assessed by the association between the MEDAS-derived score with cardiometabolic risk factors and dietary intakes derived from the food records. Test-retest reliability was assessed through Pearson correlation coefficient and the ICC between the two repeated MEDAS administrations (117).

Researchers found the MEDAS score from the questionnaire was correlated moderately with the MEDAS score derived from the food record (r = 0.50, p< 0.001; ICC = 0.53, p< 0.001) and
the exact agreement within score categories and gross misclassification were 45.8% and 21.9% between the two methods, which suggested a fair concurrent validity between MEDAS from questionnaire and from the three-day food record. In terms of predictive validity, although the distribution of food intake was in the expected direction, the MEDAS-derived score was not associated with cardiometabolic risk, anthropometric, or blood pressure indicators (117). This was to be expected since risk factor levels are not expected to be directly correlated with food intake, except at the population level. The test-retest reliability was good, as indicated by similar mean score (5.5 +/-2.1 vs. 5.4 +/-2.0, P= 0.706) and good relative agreement (r =0.69, P< 0.001; ICC = 0.69, 95% CI: 0.571–0.783, P< 0.001) yielded by two MEDAS administrations one month apart (117). Thus, MEDAS was claimed to be acceptable in assessing the adherence of MD in individuals with high CVD risks in UK (117).

In Canada, a self-administered version of MDS for cardiac rehabilitation patients was validated (118). Ghisi et al. recruited a cross-sectional sample from two outpatient cardiac rehabilitation (CR) programs in Toronto, Canada (n=150). Developed on the content and design of the original 14-item MEDAS, the self-administered version kept 13 items, but deleted the wine component. The wording and order of those questions were changed. To better aid participants in completing MDS, each question was provided with visual aid for portion size.

In terms of the serving recommendations for vegetable intake, this version kept the recommendation as the original MEDAS (≥2 servings/d) (118), but failed to acknowledge that serving sizes for vegetables in Spain are about 1 cup, compared to the CFG serving size for vegetables of 125ml or 1/2 cup. In other words, Canadians who scored one point by using this self-administered MDS only met half of the serving amount recommended by MEDAS. In addition, compared to the UK and German MEDAS’ versions, serving size of sweetened beverages changed from 100mL/serving to 250mL/serving, while the number of serving recommendation remained the same (<1 serving/day) (116-118).

The criterion validity, content validity, construct validity, and internal consistency of the self-administered MDS was assessed, based on comparison of the self-administered MDS (n=150, all participants) to completion of the original MEDAS (n=50, group 1), and the three-day food record (n=50, group 2) (108). Fifty participants completed the self-administered MDS two consecutive times. The criterion validity of the self-administered MDS was assessed through comparison of the total scores by participants’ demographic characteristics and the duration in cardiac rehabilitation. Through t-tests and Person’s correlation, researchers found significant associations in total scores by duration in CR. The self-administered MDS was reviewed by an expert panel to determine its content validity. In terms of construct validity, Pearson correlation coefficients between item scores were obtained and agreement between all items was assessed. It found all items showed agreements between the original MEDAS and the self-administered MDS, and eight out of 13 items showed agreements between the self-administered MDS and the same components scored from a three-day food record. The conclusion was supported by significant associations found in all items between the self-administered MDS and the original MEDAS (r=0.30 [sweetened beverage, p<0.01] to -0.91 [fruit consumption, p<0.001]), and 8 out of 13 significant associations between the self-administered MDS and the three-day food record (r=0.11 [Sofrito sauce, p>0.05] to -0.93 [fruit consumption, p<0.001]). However, the researchers did not mention how they...
compared food items across tools, for which methodology remained unclear. The associations of total scores between the administered MDS and the original MEDAS and three-day food record were also significant, as indicated by $r=0.89, p<0.001$ and $r=0.63, p<0.001$, respectively. Lastly, an acceptable internal consistency was supported by Cronbach’s alpha (0.69) and factor analysis (118).

However, there were no significant associations found between the self-administered MDS score and several CVD risk factors, such as abdominal obesity and high lipid levels, as would be expected in a small sample. To conclude, the authors concluded the self-administered MDS is valid for individual self-examination among CR patients, but the fact that five of 13 component scores were not significantly associated with the score from a three-day food record is troubling.

Although there has been good progress in validating MD indices for assessment at one-time point, none of the validations to date have attempted to detect changes in score, a critical focus of counselling. Once again, as mentioned before, the dichotomous scoring system used across MD indices may result in a low sensitivity in detecting individual dietary changes (112). In addition, in dietetic practice, the compliance to national guidelines and certain dietary patterns is not always the primary goal for clients. Rather, the goal is to alter food habits in a desirable direction, while respecting the diversity of eating patterns among individuals.

**Using MEDAS and HEI-2005-Canada in the CHANGE study**

The CHANGE (Canadian Health Advanced by Nutrition and Graded Exercise) study provided a 1-year lifestyle modification program to 293 patients who were diagnosed with MetS. The study found that through a team-based collaboration among family physicians, RDs, and kinesiologists, a program that combined both nutrition and exercise intervention was efficacious in reversing symptoms and reducing risk factors associated with MetS, improving diet quality, and enhancing aerobic fitness (119). However, the need for a more feasible and accurate tool for assessing dietary outcomes, as well as the recent development of online 24-hour recall tools for validation, inspired researchers to address the long-standing gap in individual diet assessment tools, in the context of an effective lifestyle intervention for a common and important health condition that suits the Canadian context (119).

To evaluate the correlation between risk factors and dietary changes, the study employed MEDAS, HEI-2005-Canada and two multiple-pass 24-hour recalls assessing participants’ dietary intake at baseline, three- and twelve-months.

Table 11 compares the dietary elements covered by MEDAS and HEI-2005-Canada (113). These two tools were used in CHANGE study, as there was comparable data from PREDIMED and CCHS. Table 12 illustrates the MEDAS and HEI-2005-Canada questions that used in CHANGE study (119).

**Table 11: Comparison of Dietary Elements Assessed by HEI-C and MEDAS**

<table>
<thead>
<tr>
<th>Foods/Nutrients being evaluated</th>
<th>HEI-C</th>
<th>MEDAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total vegetables and fruits</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Foods/Nutrients being evaluated</td>
<td>HEI-C</td>
<td>MEDAS</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Total fruits</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Whole fruit</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Total vegetables</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Green and orange vegetables</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Total grains</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Whole grains</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Milk and alternatives</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Meat and alternatives</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Red or processed meats</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Poultry</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Fish/seafood</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Legumes</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Nuts</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Other foods</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Butter or cream</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Olive oil</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Commercial baked goods</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Unsaturated fats</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Saturated fats</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Sodium</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Wine</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Sweetened drinks</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Sofrito Sauce</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Table 12: MEDAS and HEI-2005-Canada Questions in CHANGE Study

<table>
<thead>
<tr>
<th>Food item</th>
<th>Food guide serving</th>
<th>Comments (prepared with added fat, sugar, salt, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total vegetables and fruits</td>
<td>[whole servings/day]</td>
<td></td>
</tr>
<tr>
<td>• Whole fruits (no juice)</td>
<td>[1/2 or whole servings/day]</td>
<td></td>
</tr>
<tr>
<td>• Juices</td>
<td>[1/2 or whole servings/day]</td>
<td></td>
</tr>
<tr>
<td>• Vegetables</td>
<td>[whole servings/day]</td>
<td></td>
</tr>
<tr>
<td>• Dark green/ orange vegetables</td>
<td>[1/2 or whole servings/day]</td>
<td></td>
</tr>
<tr>
<td>Total grain products</td>
<td>[whole servings/day]</td>
<td></td>
</tr>
<tr>
<td>• Whole grains</td>
<td>[whole servings/day]</td>
<td></td>
</tr>
<tr>
<td>Milk and alternatives</td>
<td>[1/2 or whole servings/day]</td>
<td></td>
</tr>
<tr>
<td>Meat and alternatives</td>
<td>[1/2 or whole servings/day]</td>
<td></td>
</tr>
<tr>
<td>• Red and processed meat</td>
<td>[servings/day]</td>
<td></td>
</tr>
<tr>
<td>• Poultry more than red meat?</td>
<td>Yes_    No_</td>
<td></td>
</tr>
<tr>
<td>• Legume</td>
<td>&lt;once/month</td>
<td># servings/month</td>
</tr>
</tbody>
</table>
### Average daily/weekly servings (equal to CFG serving size)

<table>
<thead>
<tr>
<th>Food item</th>
<th>Food guide serving</th>
<th>Comments (prepared with added fat, sugar, salt, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish, shellfish</td>
<td>≤once/month</td>
<td></td>
</tr>
<tr>
<td>Nuts (include peanuts)</td>
<td>≤once/month</td>
<td></td>
</tr>
<tr>
<td>Fats: butter or cream</td>
<td>≤# servings/month</td>
<td></td>
</tr>
<tr>
<td>Olive as main added fat?</td>
<td>Yes_</td>
<td>No_</td>
</tr>
<tr>
<td>Olive oil</td>
<td>[Tbsp/day]</td>
<td></td>
</tr>
<tr>
<td>Margarine and vegetable oils (other than olive oil)</td>
<td>[Tbsp/day]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other food</th>
<th>Average daily intake (size/amount)</th>
<th>Average weekly intake (size/amount)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol (exclude wine)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baked goods (cakes, cookies, muffins, granola bars, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ice cream, other desserts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chocolate, candies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salty snacks (fries, chips, nachos)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweetened drinks (pops, sports drink, hot/cold chocolate, specialty drinks)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Two secondary data analyses conducted by two master’s students, Li and Rodrigues, revealed some significant changes found in indices and dietary behaviors (37, 113). Overall, the scores of MEDAS and HEI-2005-Canada were both significantly improved at the end of the trial (MEDAS: 1.2 points on a 14-point scale; HEI-2005-Canada: 9.8 points on a 100-point scale). Some dietary behaviors in HEI-2005-Canada were achieved and maintained throughout the intervention, such as the increased intake of F&V, reduced intake of saturated fat, sodium, and other foods (sweet/salty/fatty foods and drinks). In terms of MEDAS, significant changes in “vegetables”, “poultry more than red meat”, “red or processed meat”, “nuts”, and “commercial baked foods” were observed at 3 months and maintained at 12 months (37, 113).

The serving sizes mentioned in both indices were adapted from the CFG (2007). However, there were some dietary changes that could not be detected by using MEDAS. It may be caused by the limitations of the instrument, or participants’ adherence to MD throughout the intervention or due to combined effects. For instance, there was no change found on the consumption of olive oil, Sofrito sauce, and wine throughout the intervention. Slow improvement of fish and legume intake was observed over 12 months (37).
In contrast, in the PREDIMED study, the improvement of MEDAS score was mainly attributed to the increase of olive oil and nuts (29). There were around 63% of participants in the PREDIMED control group who met the criteria for fish compared to 19% in the CHANGE intervention study at the one year follow up point. Similarly, 29% of participants in the control group of the PREDIMED study achieved the recommended legume intake, while 13% in the CHANGE study did (29, 37, 113). The comparison confirms that there are major baseline differences in MD adherence between Mediterranean and non-Mediterranean populations. In addition, it reveals the challenges of incorporating MD components into dietary counselling for non-Mediterranean populations. Some listed food items and consumption patterns that are indicated in MEDAS are less common in Canada, which limits its feasibility and sensitivity within the Canadian context.

Based on the data obtained from the CHANGE study, another graduate thesis completed by Lim found low concordance of MEDAS and HEI-Canada in assessing nutrient intake cross-sectionally at 2 time points, and change in nutrient intake over time, using simple item response theory (IRT) approaches (120). Lim compared component scores of HEI-2005-Canada and MEDAS with key nutrients (like vitamin C and A for F&V) to investigate whether scores obtained by the two instruments would correlate with nutrient intake (120). A list of key nutrients associated with food groups was used for the analysis. The key nutrients were assessed from analysis of two 24-hour recalls, one week apart, at baseline and 3 months.

Lim’s analysis showed that except for total F&V, and milk & milk alternative intake, most components did not show clear information regarding changes in nutrient intakes, indicating that analysis by food intake changes was not closely aligned with nutrient analysis. Her analysis also revealed ceiling effects in the scoring of total F&V, whole fruits, total grains, and meat & meat alternatives. It means when the majority of people achieved the highest score for the aforementioned groups, no changes would be detected. A floor effect is also possible but was not detected in this analysis (120). These issues can be partially addressed by re-designing the scoring systems in a diet assessment tool.

In terms of MEDAS, the association between MEDAS’ dichotomous score and selected nutrients was also examined by Lim. Visual inspection was used to examine the association between MEDAS score change and nutrient intake change. Only for F&V intake, was there a significant association found between MEDAS and core nutrient intake at baseline and three months or for score change over 3 months (120). Lim concluded the MEDAS scoring system, while easy to score, is too crude to detect more subtle and common changes in food intake seen in diet counselling. A new tool should include insights from Lim’s analysis and improve on the scoring system.

Other problems in scoring were detected in the analysis conducted by Rodrigues. The magnitude of sodium changes found in CHANGE was not appropriately represented by the changes in the HEI component for sodium (113), yet the score was based on the results of the 24-hour recalls. When calculated for the group, the nutrient analysis suggested that participants had an average reduction of 590 mg sodium intake, while the mean change of 1.2 points in HEI only represented a decrease in sodium intake of ~360 mg (113).
As mentioned in a former section, unsaturated fatty acids may have a protective effect on cardiovascular events, and HEI component scores for “unsaturated fats”, were also based on the 24 hour recall data, yet Rodrigues found that the strength of correlations between the “unsaturated fat” component scores in HEI-Canada and corresponding nutrients (MUFAs, PUFAs, omega 3, and 6 fatty acids) were only low to moderate. The correlations between changes in nutrient intakes and changes in HEI component scores ranged from 0.08 (omega 3) to 0.23 (MUFA) (113). Similarly, the strength of correlation between the MEDAS total score and fat intake was weak to moderate. MUFAs and PUFAs showed weak and negative correlations with MEDAS total score at baseline, and no associations at three months. These analyses confirm HEI-Canada’s and MEDAS’s weak capability in capturing changes in unsaturated fat intake.

To conclude, the above studies suggested that both HEI-2005-Canada and MEDAS adequately capture changes in F&V intake, but do not capture changes in other diet components well. The tools may have their place, but should be considered an addition, not a substitute for nutrient analysis.

**Summary:** Putting aside nutrient analysis, there is still a need for a tool that can check on adherence to change in food group intake and the scoring must be responsive to the typical diet changes seen in dietetic practices in Canada. The adequacy components of HEI could be measured through assessing serving of foods, but the moderation components are based on nutrient analysis (sodium and fats) and require a nutrient analysis, which is often not feasible in primary care dietetics, and not necessary for most counselling. All the US versions and the Jessri’s version of the HEI-Canada are based on analysis of a per 1000 kcal basis, which also requires comprehensive nutrient analysis.

It would also be desirable if the tool can be scored so that results between studies can be compared. At the moment the MEDAS has generated widespread interest and is being used in multiple countries in intervention studies. It is currently better used as a tool to check MD adherence compared to other large studies, than being used to track changes in intake by servings.

MEDAS could be modified by improving the scoring structure to be more like HEI and to include foods that are more typical of Canadian food culture, while maintaining the ability to generate a score for comparison to other work.

Assessment of salt and fat intake, while a key focus in North America, is not easily assessed without adding more foods to the questionnaire. This can be done by separating out key food sources of these nutrients. An adapted dietary assessment tool is needed, that combines and modifies the essential components from the existing validated dietary assessment tools and focuses on changes in intake. This new dietary assessment tool targets cardiometabolic risk and captures key changes in subjects’ dietary intake (113, 114).
2.7: The Development of DIETQ

Reflecting on the results obtained from the CHANGE study, the survey completed with FHT RDs on their opinions of MEDAS as well as recent validations reviewed in the previous sections, MEDAS and HEI-Canada both have important limitations for assessing dietary patterns in cardiometabolic management (115). To develop a practical dietary assessment tool that targets Canadians’ cardiometabolic risk, researchers combined and adapted the essential components from MDS and CFG, and developed a food frequency questionnaire called the Diet Quality Monitoring Tool (DIETQ) (112). Considering the significance of sodium intake on blood pressure control, additional questions on salted nuts and salty snacks were added (see Appendix 1).

The design of DIETQ keeps some key MD elements, but the serving sizes are based on CFG 2007 (121). In addition, results from the CHANGE study suggested that some foods should be assessed with smaller gradations (1/2 serving) since changes in intake of several food groups were less than one serving/day. To maintain comparability to PREDIMED and other scoring systems, some categories and serving sizes have been modified. Thus, DIETQ is intended for the Canadian context, while maintaining comparability to MEDAS/MDS and should have reasonable sensitivity to capture changes in food intake.

It should be kept in mind that responsiveness should not compromise feasibility. Detailed dietary assessment methods such as the traditional food histories are usually considered to be more accurate in capturing dietary intake and dietary changes, but they are less popular in actual practice due to high response burden (122, 123). England and colleagues emphasized in their review that dietary assessment tools needed to be easy to use, and should be able to provide immediate guidance on dietary suggestions rather than asking health professionals to conduct a time-consuming, detailed dietary assessment (83). For RDs whose primary focus is on preventing and delaying the progression of cardiometabolic diseases, an assessment tool that targets specific disease-related risk factors is more feasible than a tool that assesses comprehensive food intake (83).

To improve DIETQ’s flexibility regarding score conversion between MEDAS and a modified version of MDS, and to achieve a smoother transition from using conventional dietary assessment tools to DIETQ, two score conversion tables that help convert patients’ intake to MEDAS/MDS score are shown in Appendix 1.

The development of DIETQ emphasizes feasibility as a goal. Compared to the time-consuming food records or traditional food histories, RDs may only need to spend around 15 minutes in collecting necessary data before initiating nutrition counselling. As a promising tool for assessing dietary behaviors associated with cardiometabolic risk, DIETQ is ready for validation.
2.8: Pilot Test of DIETQ

Choice of Validation Method

Many different approaches can be used to validate a FFQ. Considering the diet counselling context, an ideal method would validate for intake at a point in time, as well as for dietary changes. Validation against selected food groups/nutrients is most relevant in cardiometabolic conditions.

Use of 24-hour recall as the reference method is attractive, as errors are likely to be uncorrelated, and the approach is potentially feasible in primary care settings. Participants’ dietary intake can be collected through multiple 24-hour recalls (124, 125). In reviewing previous studies to estimate the number of days of recalls needed, diverse approaches were found. For instance, the Dutch European Prospective Investigation into Cancer and Nutrition (EPIC) study used 12 monthly standardized 24-hour recalls to compare against the data collected by an FFQ, and found the Spearman’s correlation coefficients for males ranged from 0.21 (cooked vegetable) to 0.78 (sugar and sweet products), with a median coefficient of 0.61 (124). For females, coefficients ranged from 0.31 (vegetables) to 0.87 (alcoholic beverages), with a median coefficient of 0.53 (124). The authors concluded that the FFQ had good relative validity, but was weak in capturing vegetable intake (124).

Another study conducted by Mayer-Davis, et al. used eight telephone-delivered recalls to collect participants’ dietary intake against the validation of the multi-cultural Insulin Resistance Atherosclerosis Study FFQ (125). A total of 186 female participants who were approximately equally distributed by ethnicity were recruited. They found the correlation coefficients for validity were statistically significant for most nutrients among ethnically different subgroups (urban non-Hispanic white: r=0.62, rural non-Hispanic whites: r=0.61, African American: r=0.50, Hispanic: r=0.41) (125). The highest correlations across all sub-groups were for vitamins A and E (supplements included, r=0.63-0.94), and total fat (r= 0.40-0.66). In contrast, the lowest correlation coefficients were for micronutrients (diet only, r=0.21 to 0.62), and polyunsaturated fat (r=0.21 to 0.51). In terms of reproducibility, the mean correlation for all nutrients was 0.62, and it did not differ by subgroup (125).

The validation of DIETQ against multiple 24-hour recalls was chosen as the most rigorous validation method available. In previous studies, the number of recalls ranged from two replicates to 12 monthly 24-hour recalls (126-129). Several studies have calculated the number of replicates needed to capture the average intake of different nutrients with a desired level of precision, but there is limited consensus and the number varies depending on the food group or nutrient under consideration (130, 131). Usually, a more precise dietary estimation requires more replicates (70). For instance, 30 recalls are needed to obtain individuals’ energy intake within a +/-10% precision, compared to 3-5 recalls required to obtain the energy intake within a +/-30% precision (132). On the other side, the calculation carried out by Nelson and colleagues found that 6-8 days of 24-hour recalls were enough to achieve a correlation of 0.9 of true intake of macronutrients and energy (134).
Palaniappan et al. demonstrated the use of two approaches to obtain the estimated days of food recalls, one that considers the variance ratio of within subject/between subject variance to rank people within groups, as is often used in epidemiologic studies and one that uses only within-subject variability to estimate intake in individuals. Both within- and between-subject variances can be obtained through ANOVA if two or more days of data are available. By analyzing the dietary intake of 1543 participants from the Food Habits of Canadians Study both ways, the study showed that while ranking in groups requires only 2-6 days, obtaining estimates of individual intake within 30% of actual intake would require 3-19 days for common nutrients, and 8 – 44 days to be within 20% of long-term intake (132). Results for foods were not reported in the same detail (so we could not calculate intra-individual variance) but were even worse.

Given these estimates, it is worth considering the specific nutrients needed, and to prioritize. In general, if a specific nutrient is found in most foods, fewer days are required to estimate the usual intake of the nutrient. On the contrary, more data are required to obtain a good picture of variability if the nutrient is less common. One example is the analysis of the changes in vitamin A and Vitamin C intake. Lim indicated in her thesis that it was hard to detect the association between the change of vitamin A and F&V intake by analyzing the data from the CHANGE study, whereas the change of vitamin C intake was significantly and strongly associated with F&V intake (120). Carotenoids (provitamin A) tend to be concentrated in certain orange and green F&V, while vitamin C is more widely dispersed across F&V.

All the previous analyses were conducted prior to the availability of online 24-hour recalls from the National Cancer Institute, discussed in the next section. While basic issues in diet assessment remain, analysis is much more feasible than in the past. While most work has been done to assess intake with recall at one point in time, less work has attempted to validate change in intake. Seven days of recalls should be able to provide an estimate of mean energy intake at 2 points in time with a precision of +/-30%, according to previous analyses (131).

In summary, there is no generally accepted recommendation about the number of days of 24-hour recalls needed for a validation study (70). Although it is suggested that more replicates of recalls should be used to obtain a more precise estimation of food and nutrient intake, feasibility and acceptability are major issues. The research team explored the options, considering accuracy, fatigue of recording, learning effects of counselling, and feasibility. They decided to try 7-days of recording, given the new online tools.

The Rationale of Conducting a Pilot Test

A pilot test of DIETQ is a necessary step in most pragmatic and large-scale research. A pilot study can test a study’s data collection instruments and sample recruitment strategies ahead of time (133), which would be helpful in improving the overall study protocol. In addition, the pilot test of DIETQ allows researchers to identify problems associated with the instrument in a cost-efficient manner and provides researchers with insightful feedback on how to improve DIETQ’s design in the counselling context.
Validation Tool: ASA24 and ASA24-Canada

The Automated Self-Administered 24-hour Dietary Assessment Tool (ASA24) is a web-based, multi-pass tool developed by the US National Cancer Institute (134) (135). It enables 24-hour recalls and records to be self-administered. ASA24 collects information like dining occasion, food groups/ingredients, preparation method and portion size (136). Along with the provision of pictures of different portion sizes, recall is further enhanced by a help menu. Nutrient analysis is immediately available for download once the recall is completed.

The validation to data of ASA24 indicated that ASA24 performed well compared to researcher-administered 24-hour food recalls and observed true intakes, with a slight underestimate of mean energy intake from recovery biomarkers (135). In this validation study, researchers tested the accuracy of the Automated Multiple-Pass Method (the later ASA24) in capturing energy intake, with the comparison between the reported energy intake and total energy expenditure. The total energy expenditure was obtained by using the double-labeled water technique. To assess participants’ total energy intake, 524 volunteers (aged 30–69 years) were dosed with double-labeled water on the first day of the 2-week study period. Then researchers collected three 24-hour recalls by using the Automated Multiple-Pass Method to assess participants’ reported energy intake (135). Compared to their total energy expenditure, on average, subjects underreported energy intake by 11%, while normal-weight subjects (BMI<25) underreported energy intake by 3% (135). Thus, researchers concluded that ASA24 was accurate in reflecting energy intake among normal-weight subjects (135). All of the subjects in the DIETQ pilot study will be overweight or obese, so a larger error may be expected.

The original ASA24 was adapted into ASA24-Canada by the Food Directorate at Health Canada in 2014 (137). While the basic content and structure remained the same, food items that are specific to the Canadian marketplace and nutrient requirements were adapted from the Canadian Nutrient File (137). More recently, a 2016 version became available, which includes the nutrient database adapted from the Canadian Nutrient File 2015 and a Canadian recipe database. The 2016 version also linked back to the United States Department of Agriculture's 2011-2012 Food Patterns Equivalents Database, which provided the categories of food groups and other dietary components, such as oil and added sugar (137). The 2018 version came out in early 2019, which allows participants to report, save and modify recipes and it yields the Respondent Nutrition Report to participants (137). Due to timing of the pilot, the research team used the 2016 version.

Kirkpatrick et al. assessed the feasibility and validity of using ASA24 and ASA24-Canada (2014 version) in capturing Canadians’ dietary intake based on the data obtained from five Canadian studies (134). The first one was an observational feeding study, which captured the intake of preschoolers (aged 2–5 years) by using ASA24-Canada-2014 (n = 40). Data were collected through a two-day parenting report. The second study examined the feasibility of completing ASA24-2016 (US version) by children themselves. A total of 294 students (aged 10–13 years) were recruited and completed two online recalls at school and at home independently. The third study recruited 98 students (aged 10–13 years) from three schools in Ontario, which aimed to assess the criterion validity of ASA24-2016 (US version) and ASA24-2014-Kids in capturing intake among children in grades 5–8. Similar to the second study, children finished two
recalls independently. The fourth study recruited 331 adults (36–82 years) to assess the feasibility of using ASA24-Canada-2014 and ASA24-2016 (US version). Participants were required to complete four recalls over a four-month period. The last study used ASA24-Canada-2014 as a reference method to assess the validity and reliability of a short diet questionnaire in a cohort study. A total of 264 adults (aged 48–88 years) were invited to complete four recalls over a three-month period. Recalls were unannounced. The review found that ASA24 showed good receptivity and feasibility among participants across the five studies. However, compared to the general population, young children and seniors found challenging to complete ASA24 independently due to their unfamiliarity with the technology.

Nevertheless, the study suggested that seniors viewed their challenges in completing ASA24 as an opportunity to enhance technological skills and they were willing to spend time exploring the tool (134). Considering the barriers presented in completing ASA24, researchers suggested that it was important to pilot test the protocol of using ASA24 prior to the application of a major study (134). Providing tailored resources to support study participants was helpful to increase the completion rate of ASA24 in the five studies (134).

ASA24-Canada is freely accessible to researchers after a registration process, which makes it possible for researchers to conduct dietary assessments at a lower cost compared to the traditional interviewer-delivered method. As ASA24-Canada maintains the advantages of traditional 24-hour recall, the 2016 version allows respondents to enter data from smartphones and tablets, which greatly enhances its flexibility of use (137). Thus, ASA24-Canada is considered to be the most appropriate tool in delivering 24-hour recall for this pilot validation study, as it is validated and available on various electronic devices.

Chapter 3: Objectives

The primary objective of the pilot study was to assess the feasibility of conducting the proposed validation study.

The specific objectives of the pilot study were:
1: To assess the feasibility of conducting a validation study among patients with cardiometabolic risk factors in community primary care settings using ASA24-Canada.
2: To assess the usability and acceptability of DIETQ through the qualitative data obtained from RDs and patient clients.
3: To conduct a preliminary comparison of DIETQ food items and food groups, as well as the changes at baseline and three months to similar estimates from 7-day diet recalls by using ASA24-Canada
4: To perform a preliminary assessment of key nutrient changes in ASA24-Canada at baseline and three months

Chapter 4: Methods

This pilot validation followed a pre- & post-test study design to collect both food frequency and recall data at two-time points. Involved RDs working in the CHANGE program were asked
to perform two dietary assessments using DIETQ against two rounds of 7 days of 24-hour food 
recalls/records at baseline and three months. A range of food changes were expected and desired, 
with some people making few changes and others making more changes, as was seen in the 
previous CHANGE feasibility study (119, 138).

**Ethics Approval**

This study received ethics approval (REB#18-11-037) from the REB at the University of 
Guelph, Ontario in early 2019 (See Appendix 9 for certificate).

**Study Instruments and Sample**

**Development of Instruments:** To assess the first and second objectives, the baseline and 
post-test interview questionnaires were created to allow researchers to assess the feasibility, 
usability, facilitators, and barriers faced by RDs and patients (see Appendix 2 and 3 for 
questions). The demographic questions were similar to those used in previous studies on dietitian 
practice. Questions on experience using diet assessment tools came from an interview protocol 
developed by Lieffers for a previous proposal submission that was not funded (139).

Questions on computer literacy were added, based on a 2014 review of 14 studies that found 
that less than half of people >65 used computers (140). The three basic questions were adapted 
from Boot et al.’s study (153). Questions on facilitators and barriers were adapted from previous 
work using the Ottawa Model of Research Use, which is directed to understanding the uptake of 
research into practice (141, 142).

The baseline questionnaire for patients was reviewed by two volunteers (>50 y.o.) from the 
community, who completed the questionnaire via telephone interview. The questions were 
revised slightly based on this feedback. The revised questions are shown in Appendix 3.

Figures 2-5 illustrate the modifications made on Working Status and Previous Food Record 
Experience of the baseline interview question for patients.

**Figure 2: Original Version of Working Status**

| 4. Working status - Please put yourself into one of the following categories | _____ |
| 1= Employed | 2=Unemployed | 3=Student | 4=Retired or On disability | 5=Other |

**Figure 3: Revised Version of Working Status**

| 4. Working status - Please put yourself into one of the following categories | _____ |
| 1= Employed | 2= Part-time (including on-call, on sabbatical or seasonal work) | 3= Unemployed | 4=Student | 5=Retired or On disability | 6= Other |
Figure 4: Original Version of Previous Food Record Experience

9. Previous Food Record Experience
   Have you ever completed a food record? ________ Y/N.
   Can you describe the context?

10. Have you ever used an online diet assessment application (examples: My Fitness Pal, eaTracker)? ________ Y/N.
    Can you describe the context?

Figure 5: Revised Version of Previous Food Record Experience

9. Previous Food Record Experience
   a. Have you ever completed a food record? Y/N.
   b. If Yes, can you describe the context?
   c. Are you currently on any kind of special diet that has been prescribed/suggested by a health professional as a treatment? Y/N.
   d. Are you currently on any kind of special diet that has NOT been prescribed/suggested by a health professional as a treatment? Y/N.
   e. Have you ever used an online diet assessment apps (examples: My Fitness Pal, eaTracker)? Y/N.
   f. If Yes, can you describe the context?

To achieve the third and fourth objectives, RDs used the DIETQ (see Appendix 1) to assess patients’ food intake at baseline (the 1st session) and at 3 months (the 12th week session). The development of the DIETQ has been discussed in the Literature Review.

The patients used the ASA24-Canada to recall/record their 7-day food intake at baseline and 3 months. The development of the ASA24-Canada (2016) has already been discussed in the Literature Review. To assist participants in completing the diet recalls, the demonstration website of ASA24 (https://asa24.nci.nih.gov/demo/) and a quick user guide (https://epi.grants.cancer.gov/asa24/resources/ASA24-quick-start-guide-24hr-recall-20170830.pdf) were sent to potential patient participants, which allowed them to complete a one-day recall independently and then decide if they would like to set up a training session or to be called by the master’s student.

Two graduate students (>25 y.o.) reviewed the instructional process for the completion of ASA-24, prior to the pilot test. In addition to the graduate students and volunteers, four people tested the demonstration website and addressed significant issues that participants might encounter in the pilot study. All volunteers mentioned that the visualization of the portion sizes helped them recall food intake more accurately. The range of time for volunteers to complete a recall was between 20-30 minutes, while students completed the questionnaire in about 20
minutes.

**Sampling Frame:** Ongoing evaluation of the CHANGE program at multiple sites is underway and it provided a unique opportunity to solicit participants for the current study. The research team worked with Metabolic Syndrome Canada and determined that Family Health Teams (FHTs) in Ontario were the most suitable sampling frame to ensure the present study would not interfere with the overall program (available RDs: 10). In the CHANGE study, MEDAS (a version derived from MDS) from the PREDIMED study is the only diet assessment being done. Instead of MEDAS, DIETQ was used to assess patients’ baseline and 3-month dietary intake, but otherwise the CHANGE program was untouched. The current CHANGE program provides diet and exercise interventions over one year, with weekly group classes for the first three months (12 weeks). There are currently 16 RDs and 642 enrolled/1000 planned patients in the process of completing the CHANGE study across Canada. Timing of programs differs in each setting, so one challenge is ensuring participants are seen at baseline before program start and after 3 months.

**Sample Size Considerations:** As a pilot study, no formal sample size calculation was done. It was hoped that 5 RDs would complete the pilot protocol with 2 patients each for a total of 10 patients.

**Sample Recruitment**

As mentioned, the goal was to recruit five RDs and ten patient participants to participate.

**RD Inclusion and Exclusion Criteria:** RDs currently involved in the CHANGE program and providing weekly counselling to cardiometabolic patients met the inclusion criteria; otherwise they were excluded from the study.

**Patient Inclusion and Exclusion Criteria:** Inclusion and exclusion criteria for patient participants was the same as for the CHANGE study. Patients had to have metabolic syndrome, but no other severe associated conditions and be physically able to do aerobic exercise. The complete inclusion and exclusion criteria are listed in Appendix 4.

**Recruitment of RDs:** Upon the ethics clearance, invitation emails were sent to Executive Directors (EDs) to solicit potential RD participants (see Appendix 5). EDs forwarded the invitations to RDs who worked at specific FHTs.

The master’s student (Yiran Wang) contacted RDs who were interested in the study and attached supporting documents in follow-up emails to promote this study (See Appendix 5). Relevant documents included the Letter of Information (see Appendix 6), DIETQ questionnaire (Appendix 1), Consent Form (Appendix 7), and Baseline Interview Questionnaire for Registered Dietitian (Appendix 2).

A teleconference meeting to promote the study was arranged by the Executive Director of Metabolic Syndrome Canada with the RDs, who meet periodically by phone to discuss the progress of the CHANGE program. Three RDs were able to attend. Emails were also sent to the
other RDs to encourage participation.

Committed dietitians were contacted again by the master’s student within 1-2 weeks to set up a phone interview (15-20 mins) to obtain the RD’s verbal consent, to complete the baseline interview, and to answer any questions.

**Recruitment of Patients:** RDs were tasked with recruitment and encouraged to promote the study through emails, nurse discussions or at the introductory information sessions held at some FHTs. RDs were cautioned to avoid any appearance of influence. Patients would indicate their interest in the study at the baseline visit with the RD, and the RD would ask participants to email or call the master’s student for future information.

After patients contacted the master’s student and exhibited interest in this study, the student forwarded the Letter of Information (Appendix 6), consent form for patients (Appendix 8), and Baseline Interview Questionnaire for Patients (Appendix 3). Additionally, as patients needed to complete two rounds of 7-day diet recalls/records through the ASA24-Canada, they were offered the options to either complete diet recalls independently or to be called for seven consecutive days. Since there is no evidence to suggest that there is a significant impact on dietary assessment results comparing interviewer-administrated vs. online recording in interested volunteers, the completion of the 7-day recalls could be done either by the client independently or with the help of the master’s student by telephone. Patients who committed to take part in the study were contacted by email to set up a telephone interview (15-20 mins) to obtain their verbal consent, to complete the baseline interview, and to review their understanding of the data collection process.

Once the verbal consent was obtained and the patients were ready to start completing dietary recalls/records, the student sent the patients to the ASA24-Canada user website (https://asa24.nci.nih.gov/), along with their username and password randomly generated by ASA24-Canada. The same username was also used for labelling each participant’s diet data and interview materials, in order to protect confidentiality.

**Data Collection and Management**

**Interview Data Collection:** Both RDs and patients were interviewed by telephone at baseline and three months. The interviews were audio-recorded. The interview questionnaire was completed by the master’s student and the content was checked along with the interview audio recording files.

A master sheet for tracking phone calls/emails, as well as a researcher log was kept in order to support qualitative data analysis. Written notes or audio records obtained from interviews were collected and saved to the secure online research repository in the department at the University of Guelph. This can only be accessed by the student, supervisor and IT administrator in the department.

**Dietary Data Collection:** RDs submitted their completed Word or PDF versions of the DIETQ files to the student through official emails under a secured internet connection, within
1-3 days of the completion of dietary assessment.

RDs followed a detailed protocol to ensure the confidentiality and security of the data transmission. For instance, patients’ names were not permitted in emails.

Patients either completed their ASA24-Canada recalls/records independently or with the help of the master’s student. After the completion of 7-day recalls/records, the student downloaded patients’ input from the ASA24-Canada's website.

All data were saved to the online research repository. Data were permanently deleted immediately after saving it to the repository. Any printed materials with participants’ names or identifiers were locked in a file cabinet in the department researcher office (B13).

The process of data collection is illustrated below.

Figure 6: Process of the Study

The detailed data collection procedures were:
1. The PI and the master’s student sent emails to EDs to promote the study. Interested EDs and RDs were introduced to the study objectives and procedures.
2. Once the RD agreed to participate, the student would arrange a telephone call to get verbal consent and orient the RD to all the study procedures, including procedures for the online diet assessment, so they would know what patient participants would be asked to do.
3. RDs worked with the organization team to identify the best way to solicit volunteers. Methods could be varied. Patients were given the Letter of Information on the study and they were to be recruited before the diet counselling baseline assessment of the CHANGE program.
4. Interested patients were asked to email the student to get their questions answered and confirm participation.
5. The master’s student contacted the patient through a telephone interview, to orient them to
study, consent, and complete basic demographic questions.
6. The student contacted the RD when a patient’s consent was received, so the RD would know who was participating.
7. The RD completed the baseline assessment using DIETQ, instead of using the current CHANGE diet form. DIETQ could be used to calculate the MDS as the current diet form.
8. The RD contacted the student to let her know when baseline assessment was done, so the student would email the patient to start the 7-day diet recalls/records.
9. The patient either completed the 7-day ASA24 independently or the student conducted seven telephone assessments for the patient.
10. The RD performed CHANGE program counselling with the participant, as per usual for 3 months (12 weeks).
11. The RD arranged a 3-month CHANGE appointment with the participant and emailed the student, so the student could arrange follow-up ASA24 recalls with the participant.
12: Again, the patient either completed the 7-day ASA24 independently or the student conducted telephone assessments for the patient.
13. RD completed the 3 months assessment using DIETQ.
14. When all participants at the organization team had completed the study, the student would contact the RD for a telephone interview to assess their user experience.

Data Cleaning: All the received data were checked for completion errors and confirmed with both RDs and clients within two weeks of the interview. Common completion errors included missing entries for mixed dishes, wrong serving sizes, etc. However, since DIETQs were completed by RDs, completion errors were minimized.

The ASA24-Canada recalls/records were reviewed to identify possible errors, such as portion and nutrient outliers, and duplicate entries (143). The National Cancer Institute provides a brief guide to aid data cleaning (143). This guide also lists the cut-off points for portion and nutrient outliers, which can be referred to in the data cleaning process. These are listed below.

Table 13: Major Portion Outliers Cut Points

<table>
<thead>
<tr>
<th>Food Categories</th>
<th>Portion Outliers4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beverages</td>
<td>≥0.5 gallon (≈1895 ml)</td>
</tr>
<tr>
<td>Meat, fish, poultry greater</td>
<td>≥12 ounces (342 g)</td>
</tr>
<tr>
<td>Mixed dishes</td>
<td>≥6 cups</td>
</tr>
<tr>
<td>Snack foods (chips, nut, etc.)</td>
<td>≥8 ounces by weight (≈227 g)</td>
</tr>
</tbody>
</table>

Table 14: Major Nutrient Outliers Cut Points

<table>
<thead>
<tr>
<th>Kcal</th>
<th>Protein</th>
<th>Fat</th>
<th>Vitamin C</th>
<th>Beta-Carotene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult women ≥12 y.o.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low: 600</td>
<td>Low: 10</td>
<td>Low: 15</td>
<td>Low: 5</td>
<td>Low: 15</td>
</tr>
<tr>
<td>High: 4400</td>
<td>High: 180</td>
<td>High: 185</td>
<td>High: 350</td>
<td>High: 7100</td>
</tr>
</tbody>
</table>

4 Consumed at one eating occasion.
5 Cut points are based on the 5th and 95th percentile of intakes from NHANES data.
<table>
<thead>
<tr>
<th>Adult males ≥ 12 y.o.</th>
<th>Kcal</th>
<th>Protein</th>
<th>Fat</th>
<th>Vitamin C</th>
<th>Beta-Carotene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low: 650</td>
<td>Low: 25</td>
<td>Low: 25</td>
<td>Low: 5</td>
<td>Low: 15</td>
<td></td>
</tr>
<tr>
<td>High: 6700</td>
<td>High: 240</td>
<td>High: 230</td>
<td>High: 400</td>
<td>High: 8200</td>
<td></td>
</tr>
</tbody>
</table>

After identifying possible errors, the researcher emailed or called the participants to confirm the entry of correct data. All revised data were used for data analysis. It should be noted that it was possible to have outliers.

**Data Analysis**

Based on both quantitative and qualitative data resources, researchers evaluated this pilot study’s feasibility, as well as DIETQ’s preliminary validity.

**Semi-Qualitative and Qualitative Analysis:** Descriptive data analyses were performed on IBM SPSS 25.0. Participants’ gender, age, and occupation were used to describe participants’ demographic characteristics. For short answer interview questions, no qualitative analysis software was used but a coding framework was developed by the master’s student based on keywords identified in the baseline, post-test questionnaires and interview transcripts. Similar responses were grouped together and used for content analysis. Field notes were kept for formative evaluation to assess the feasibility of the study procedures.

**Quantitative Data Analysis:** Raw numeric agreement between two different dietary assessment methods was assessed. Statistical analyses were performed using IBM SPSS 25.0. To assess the concordance of foods and groups by DIETQ and ASA-24 the following conversion processes were undertaken.

ASA24-2016 yields the CFG serving of “Total meat & alternatives”, “Total milk & alternatives”, and “Total grain products”. No conversion needs to be made on these three food groups. However, the output is missing the CFG conversion of “Total fruit” intake. There is a variable labelled “CFG_VEG_FRUIT” and the ASA24 user dictionary explains this variable is the CFG serving of “Total vegetables” intake. Through the master’s student manual calculation, the variable “CFG_VEG_FRUIT” is more likely to be the CFG serving of both fruit and vegetables, as the CFG2007 categorized vegetables and fruit together. Therefore, the master’s student calculated the CFG serving of “Total fruit” and “Total vegetables” separately.

For each food group’s subsection (e.g., “Poultry” intake under the “Total meat & alternatives”), the master’s student converted each common food item’s amount in equivalent units or grams to the CFG units and then calculated the number of CFG serving. She then developed the food group serving size conversion procedures based on the Food Pattern Equivalents of USDA and the 2007 CFG (see Appendix 10).

To test the hypothesis that the DIETQ was able to capture food intake, the associations between DIETQ and ASA-24 data using Pearson correlation coefficients were examined. The correlation coefficient of food intake captured by DIETQ, as well as the changes of food intake, was expected to be positively associated with food intake and the changes captured by
ASA24-Canada at baseline and at three months.

It should be noted that the Pearson correlation coefficient cannot measure the level of agreement between DIETQ and 24-hour recalls, but only the strength and direction of the association that existed between the two methods (144). The expected correlation should be greater than 0.5 and in the same direction of change in order to indicate a good strength and direction of the association at an individual level (144).

Lastly, for concordance between DIETQ and ASA24 on the number of food servings and the category of food groups, the number of servings /days should match with each other, without gross misclassification at each assessment. Since MDS can be calculated from the MD components of both DIETQ and ASA24, the categorical concordance of direction and magnitude of changes between the two instruments can be evaluated by converting participants’ food intake to MDS.

**Food Groups Changes in the CHANGE Study:** Combining the dietary changes measured by both MDS and HEI-Canada in the CHANGE study at 12 months, the most promising changes were increased fruits, vegetables, nuts, and poultry intake; as well as decreased other foods (salty or sweet snacks, desserts, and beverages, etc.), commercial baked foods, red and/or processed meats intake. Nevertheless, the use of olive oil, legume, fish, Sofrito sauce, and wine component didn’t show significant changes (138).

**Table 15: Expected DIETQ Food Groups Changes over 12-week Counselling**

<table>
<thead>
<tr>
<th>Positive Changes</th>
<th>Negative Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total fruit</td>
<td>Fruit juice</td>
</tr>
<tr>
<td>Total vegetables</td>
<td>Red meat</td>
</tr>
<tr>
<td>Dark &amp; orange vegetables</td>
<td>Processed meat</td>
</tr>
<tr>
<td>Whole grain products</td>
<td>Solid fat (butter or margarine)</td>
</tr>
<tr>
<td>Olive oil(^6)</td>
<td>Salty snacks</td>
</tr>
<tr>
<td>Poultry</td>
<td>Commercial bakery and sweets</td>
</tr>
<tr>
<td>Unsalted nuts</td>
<td>Sweetened drinks</td>
</tr>
<tr>
<td>Fish &amp; shellfish</td>
<td>Wine(^7)</td>
</tr>
<tr>
<td>Legume</td>
<td></td>
</tr>
<tr>
<td>Sofrito Sauce</td>
<td></td>
</tr>
</tbody>
</table>

**Expected Nutrients Change:** The expected changes for key nutrients are illustrated in the table below, which was adapted from Rodrigues’ data analysis of the CHANGE study (113). As the pilot study was embedded into the CHANGE program, some predictions of nutrients intake were expected to align with the major dietary changes observed in the original CHANGE study. Major nutrient changes found in CHANGE including decreased caloric intake, reduced carbohydrate (majorly sugar), SFA, TFA, and sodium intake. On the other hand, improved

---

\(^6\)Although the CHANGE study promoted MD, it was hard for Canadians’ to achieve 4 tbsp olive oil each day.

\(^7\)Various versions of MDS include moderate wine consumption. Nevertheless, some Canadian RDs do not encourage participants to initiate drinking if the patients are non-drinker, neither do they encourage to achieve wine consumption listed in MDS.
components were observed in protein intake as the percent of energy, vitamin A, vitamin C, folate, magnesium, and potassium (138).

Table 16: Predicted Changes of Nutrients over the 12-week Counselling

<table>
<thead>
<tr>
<th>Positive Changes</th>
<th>Negative Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin C</td>
<td>Total Calories</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>Carbohydrate (emphasizes on added sugar)</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>SFA</td>
</tr>
<tr>
<td>Potassium</td>
<td>TFA</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Sodium</td>
</tr>
<tr>
<td>Folate</td>
<td></td>
</tr>
<tr>
<td>MUFA</td>
<td></td>
</tr>
<tr>
<td>PUFA</td>
<td></td>
</tr>
<tr>
<td>Omega-3 Fatty Acids</td>
<td></td>
</tr>
</tbody>
</table>

Concordance between DIETQ and ASA24-Canada: The intake of MD subsets in DIETQ can be converted into the MDS directly. In ASA24, individual food items were screened to categorize them into the corresponding MD groups (e.g. the frequencies of drinking sweetened drinks). It was hypothesized that if DIETQ could capture dietary intake correctly relative to the ASA24, no extreme discordance with the MDS score should be observed. Two conversion score tables (see Appendix 1) were used to transfer DIETQ to two sets of MDS. In the CHANGE study, the MDS (aka. MEDAS) used is illustrated below.

Table 17: MDS Used in the Change Study

<table>
<thead>
<tr>
<th>Food Item</th>
<th>Score Check (0=No; 1=Yes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total fruit (including juice) ≥ 3 servings/day</td>
<td></td>
</tr>
<tr>
<td>Total vegetables ≥ 4 servings/day with at least 2 servings of raw or as salad</td>
<td></td>
</tr>
<tr>
<td>Red or processed meat &lt; 2 servings/day</td>
<td></td>
</tr>
<tr>
<td>Poultry more than red meat</td>
<td></td>
</tr>
<tr>
<td>Legume ≥ 3 servings/week</td>
<td></td>
</tr>
<tr>
<td>Fish or seafood ≥ 4 servings/day</td>
<td></td>
</tr>
<tr>
<td>Nuts ≥ 3 servings/week</td>
<td></td>
</tr>
<tr>
<td>Butter, cream or hard margarine &lt; 1tbsp (15ml)/day</td>
<td></td>
</tr>
<tr>
<td>Olive oil as the main added fat</td>
<td></td>
</tr>
<tr>
<td>Olive oil ≥ 4 tbsps./day</td>
<td></td>
</tr>
<tr>
<td>Wine ≥ 7 times/week</td>
<td></td>
</tr>
<tr>
<td>Commercial based foods≤ 2 times/week</td>
<td></td>
</tr>
<tr>
<td>Sweetened drinks&lt; 1 time/day</td>
<td></td>
</tr>
<tr>
<td>Use of sofrito sauce≥ 2 times/week</td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td>14 (Maximum)</td>
</tr>
</tbody>
</table>

---

8 All serving sizes are based on CFG.
Chapter 5: Results

Three RDs and six patients were recruited, partly because fewer RDs from CHANGE volunteered than expected, timing requirements to complete baseline data collection before a group program started, time of year challenges to complete programs before summer and delays with ethics completion. As the study progressed, one dietitian and two patients dropped out from the study. Thus, the active participants in this study included two dietitians and four patients.

Compared to the original proposal, changes made to recruitment and data analysis are illustrated below.

Table 18: Changes Made of Recruitment and Analysis Focus

<table>
<thead>
<tr>
<th></th>
<th>Proposal</th>
<th>Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recruitment time frame:</td>
<td>November 2018-March, 2019</td>
<td>January 2019-May, 2019</td>
</tr>
<tr>
<td>Proposed research ending date:</td>
<td>August 2019</td>
<td>Research ending date: August 2019</td>
</tr>
<tr>
<td>RD participants:</td>
<td>n=5</td>
<td>RD participants: n=3, active: n=2</td>
</tr>
<tr>
<td>Patient participants:</td>
<td>n=5-10</td>
<td>Patient participants: n=6, active: n=4</td>
</tr>
<tr>
<td>ASA-24 training:</td>
<td>An additional training session provided</td>
<td>ASA-24 training: Participants were encouraged to practice using the demonstration website; additional training provided upon request</td>
</tr>
</tbody>
</table>

RD Participants Analysis

**RDs’ Demographic Characteristics:** The three RDs worked in different FHTs to provide counselling. Their demographic characteristics are shown in Table 19.

Table 19: RD Participants’ Demographic Characteristics

<table>
<thead>
<tr>
<th>Categories</th>
<th>N</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Years)</td>
<td>3</td>
<td>45±12</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Male</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education beyond RD (MSc, MBA, etc.)</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years of working as an RD</td>
<td>3</td>
<td>14±5</td>
</tr>
<tr>
<td>Years of working in primary health care</td>
<td>3</td>
<td>11±4</td>
</tr>
</tbody>
</table>
Table 20: RDs’ Experiences in Using Dietary Assessment Tools in Daily Practice

<table>
<thead>
<tr>
<th>Dietary assessment tool</th>
<th>HEI</th>
<th>DASH</th>
<th>MDS</th>
<th>CFG (FFQ versions)</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage frequency (never, rarely, sometimes, often, mostly)</td>
<td>Never: N=2, Rarely: N=1</td>
<td>Never: N=1, Rarely: N=2, Mostly: N=2</td>
<td>Often: N=1, N=2, Sometimes: N=2</td>
<td>N=1 E.g. self-modified FFQ from “just the basics” or “beyond the basics”</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Online dietary programs/apps</th>
<th>eaTracker</th>
<th>ESHA/Food Processor</th>
<th>ASA24</th>
<th>Eat this much.com</th>
<th>My Fitness Pal</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage frequency (never, rarely, sometimes, often, mostly)</td>
<td>Rarely: N=1, Sometimes: N=1, Mostly: N=1</td>
<td>Never: N=3</td>
<td>Never: N=3</td>
<td>Never: N=3</td>
<td>Rarely: N=2, Sometimes: N=1</td>
<td>N=0</td>
</tr>
</tbody>
</table>

**RDs’ Experiences in Using Dietary Assessment Tools:** In response to the questions about the use of diet assessment tools, all three RDs used MDS and its modified versions for counselling purposes (see Table 9). One dietitian used DASH score exclusively when counselling hypertension patients (see Table 3). One dietitian used a self-modified FFQ derived from “Just the Basics” (145) and “Beyond the Basics” (146) when counselling diabetic patients.

In terms of the usage of online dietary apps, none of the dietitians used them for clinical assessment purposes. One dietitian mentioned that she always introduced eaTracker during cooking demonstration sessions to patients for self-assessment purposes (147). All three dietitians referred “My Fitness Pal” to patients if patients wanted to monitor dietary intake independently (148). None of the dietitians used ESHA (149), ASA24 (150), or Eat This Much (151) to record or analyze patients’ food intake.

**RDs’ Experiences of Using DIETQ:** Two RDs completed the post-test interviews. Their perceptions toward the usage of DIETQ were illustrated in Table 21.

### Table 21: RDs’ Experiences of Using DIETQ

<table>
<thead>
<tr>
<th>Number of patients per dietitian</th>
<th>2 patients/dietitian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average time of completing DIETQ (mins)</td>
<td>22.5 mins</td>
</tr>
<tr>
<td>Average time of score conversion (mins)</td>
<td>5.5 mins</td>
</tr>
<tr>
<td>DIETQ’s mean score of feasibility</td>
<td>4.3</td>
</tr>
<tr>
<td>DIETQ’s mean score of acceptability</td>
<td>3.8</td>
</tr>
</tbody>
</table>

---

9 It was the CHANGE study’s requirement to convert all intake results into MDS (aka. MEDAS) for data analysis. Therefore, time spent on score conversion was also considered as part of RDs’ experiences of using DIETQ.

10 The evaluation scale of DIETQ’s properties was measured at: 1=poor; 2=fair; 3=good; 4=very good; 5=excellent.
Including probing, the average time of completion of one DIETQ was around 23 mins. The CHANGE study requires dietitians to report patients’ intake by using the MDS, the average conversion time was 6 mins.

DIETQ’s feasibility was 4.3, which was between “very good” and “excellent”; DIETQ’s acceptability was 3.8, which was slightly below “very good”. In terms of DIETQ’s score of sensitivity to dietary changes, the score was 4.0 (very good).

**RDs’ Feedback on DIETQ:** RDS’ feedback on using DIETQ are shown in Table 22.

### Table 22: RDs’ Feedback on DIETQ

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Quotes</th>
</tr>
</thead>
</table>
| Easy to use                             | - “[The questionnaire] aligns with the Mediterranean diet, so it is easy to use.”  
- “The content is clear and easy to understand …It uses CFG units, I have no problem in using it.” |
| Accurate                                | - “[DIETQ is] very detailed in food groups and portion sizes, [which] makes it is accurate…it basically captured everything.”  
- “It is more accurate than other tools I used before [e.g., food histories and 24-hr recalls].” |
| Useful in initiating education          | - “By explaining portion sizes [during the first assessment], I think it helped patients reflect on how [much] they ate.”                                                                                   |
| Integrated Canadians’ counselling purpose| - “Compared to MDS, [DIETQ] is better in adapting Canadians’ eating habits…I like the way it asked about patients’ olive oil usage.”  
- “I think it is good [that] it separates wine from alcohol.” |
| Useful in real practice                 | - “I would love to use it in my daily practice.”                                                                                                                                                        |
| Shifting focus from quantity to quality | - “It is hard for Canadian patients to achieve more than 4 tbsps. of olive oil…it is good [that DIETQ] asked the proportion of olive oil used in cooking”  
- “I like it [that DIETQ] did not ask patients to achieve the wine consumption [> 7 times/week] mentioned in the traditional Mediterranean Diet Score.” |

<table>
<thead>
<tr>
<th>Disadvantages</th>
<th>Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recall period may not be able to capture the usual intake under specific circumstances</td>
<td>- “For patients who came back from a vacation, it [was] hard to capture usual intake…so I tried to be flexible [in assessing food intake] for patients who come back from a break.”</td>
</tr>
<tr>
<td>Meal patterns and environment not captured</td>
<td>- “It didn’t capture meal patterns…meal environment was not captured [either]…[but] I always ask those questions [e.g., meal patterns and environment] during my counselling, there is no need to add them [in DIETQ].”</td>
</tr>
<tr>
<td>Time consuming</td>
<td>- “For patients who didn’t know portion, it was like a guess [of the food intake] and I needed to spend a lot of time to educate and remind [them]… I guess I like MDS better if I need to conduct a quick assessment.”</td>
</tr>
</tbody>
</table>
| Starchy vegetable should be separated   | - “I excluded starchy vegetables, such as yam, potato and peas while assessing vegetables intake…there should be a separate section [for starchy vegetables].”  
- “Some of my patients are Irish immigrants…I’ve been working to reduce their potato intake…I don’t count starchy things.” |
| Discrepancies of units compared to real life | - “Some of the units [CFG serving] are labelled in 3/4 cup. People do not use it [3/4 cup] to measure their food intake…I need to convert the unit to some equivalents I usually use… and I use 5 oz. instead of 1oz. to measure [the serving of] alcohol.” |

| DIETQ’s mean score of sensitivity to dietary change | 4.0 |
One dietitian mentioned that DIETQ was easy to use after reflecting on its adaption of CFG units and the MD components, along with a clear content. Another dietitian mentioned DIETQ’s advantages in measuring patients’ adherence to MD and its convenience regarding MDS score conversion. The statement was supported by an average conversion time of 6 minutes.

Both dietitians mentioned that DIETQ is more accurate compared to other commonly used tools because of its detailed serving size and the relatively comprehensive food group list. One dietitian mentioned that DIETQ “basically captured everything.”

In terms of DIETQ’s use of units and its comprehensive list, the two dietitians had different opinions regarding DIETQ’s feasibility in daily practice. One RD indicated the use of CFG units was easy for her to capture food intake. Additionally, it was helpful for her to initiate patients’ education in estimating portion sizes at the dietary assessment stage. Another RD preferred to use MDS for a quick assessment, because she found for patients who were not familiar with food groups or serving sizes, it was more time consuming to complete the questionnaire.

Both RDs agreed that some sections were better arranged compared to the MDS. The assessment of the usage of oils and fats emphasized participants’ preferences and changes in intake. For instance, DIETQ assessed the participants’ preferences and proportion of use in olive oil while evaluating the oil consumption, rather than addressing patients’ achievement on having more than 4 tbsp./day. Similarly, the two dietitians do not encourage patients to achieve the recommended wine consumption stated in MDS (> 7 times/week). One RD found DIETQ’s assessment on alcohol/wine consumption was better arranged compared to the MDS. Both RDs agreed that it was appropriate for DIETQ to separate wine from alcohol.

In terms of disadvantages, one dietitian mentioned that since some participants were away on vacation prior to their enrollment, DIETQ’s weekly recall period might not be able to capture participants’ usual intake but they tried to ask the patients to recall their usual intake instead. The same dietitian also mentioned that there was no section to evaluate participants’ eating patterns nor environment. Nevertheless, they mentioned that routine counselling always had questions to address these issues; thus, there was no need to include these assessments if DIETQ was administered by a dietitian. In addition, the use of different food recall periods for some foods (day, week, month), was difficult for patients to get used to at the beginning. The dietitian also mentioned that because of DIETQ’s detailed portion sizes, it could be time consuming for a dietitian to complete the initial assessment with participants who were not familiar with portion sizes.

Both RDs suggested that DIETQ should either exclude starchy vegetables from “Total vegetables” or provide an additional section, in order to be consistent with the counselling purpose of improving participants’ leafy vegetables intake.

**RDs’ Feedback on the Pilot Study:** One dietitian mentioned the DIETQ study did not interfere with their daily practices, as it was embedded into the CHANGE study. Both RDs mentioned the use of DIETQ was aligned with their counselling practices.
While one dietitian mentioned that the study procedures appeared straightforward to her, the other dietitian indicated they would have preferred a more detailed orientation that emphasized patient participants’ involvement before initiating the study, so they could be better prepared for arranging the counselling schedule.

**Patient Participants Analysis**

*Patients’ Demographic Characteristics:* A total of six patients’ demographic data and baseline interview were analyzed. Please see Table 23 for patients’ demographic characteristics.

**Table 23: Patient Participants’ Demographic Characteristics**

<table>
<thead>
<tr>
<th>Categories</th>
<th>N (total=6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Years)</td>
<td>55±12; Min:42; Max:70</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>162±10; Min:147; Max:175</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>88±12; Min:74; Max:106</td>
</tr>
<tr>
<td>BMI (kg/cm²)</td>
<td>34±5; Min:29; Max:41</td>
</tr>
<tr>
<td>Household Population</td>
<td>3±1; Min:1; Max: 4</td>
</tr>
<tr>
<td>Live with spouse</td>
<td>Yes: n=4; No: n=2</td>
</tr>
<tr>
<td>Gender</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Education</td>
<td>High School</td>
</tr>
<tr>
<td></td>
<td>College/University</td>
</tr>
<tr>
<td>Occupation</td>
<td>Employed</td>
</tr>
<tr>
<td></td>
<td>Part-time (including on-call, on sabbatical or seasonal work)</td>
</tr>
<tr>
<td></td>
<td>Unemployed</td>
</tr>
<tr>
<td></td>
<td>Student</td>
</tr>
<tr>
<td></td>
<td>Retired</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
</tbody>
</table>

The mean age of the participants was 55±12 years old. Five out of six participants were female and four of them lived with a spouse. All participants were classified overweight or obese (overweight: n=1; obese class I: n=3; obese class II: n=1; obese class III, n=1) (152). Four participants completed a high school degree and two participants obtained a college/university degree. Four participants worked either part-time or full-time, and two participants were retired. It should be noted that for the two participants who dropped out from the study, were younger, not living with a spouse, and worked part-time.

*Participants’ Computer Literacy:* Since participants needed to use ASA24-Canada to complete 7 days of dietary recalls/records, one major concern was senior participants’ computer literacy. Participants’ basic computer literacy is displayed in Table 24.
Table 24: Participants’ Basic Computer Literacy

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never Tried</th>
<th>Not at all</th>
<th>Not easily</th>
<th>Somewhat easily</th>
<th>Very easily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use computer to enter events and schedule events</td>
<td>N=1</td>
<td>N=0</td>
<td>N=1</td>
<td>N=2</td>
<td>N=2</td>
</tr>
<tr>
<td>Use Internet to search for interested topics</td>
<td>N=0</td>
<td>N=0</td>
<td>N=1</td>
<td>N=1</td>
<td>N=4</td>
</tr>
<tr>
<td>Use computer to watch videos and movies</td>
<td>N=1</td>
<td>N=0</td>
<td>N=0</td>
<td>N=1</td>
<td>N=4</td>
</tr>
</tbody>
</table>

The results showed that more than half of the participants were comfortable using computers in scheduling, searching and streaming online. Four patients mentioned that they were confident in searching and streaming services. Two patients indicated it was very easy to schedule events on the computer and two indicated it was “somewhat easy”.

Only one patient mentioned that they never tried to use a computer to schedule events or stream online. The same patient also lacked access to electronics. Therefore, the participant was provided an additional ASA24 training session, as well as being offered the option of telephone recalls assisted by the master’s student. Other patients practiced entering recalls by using the ASA24 demonstration website independently and shared their perceived challenges with the student, prior to the start of the first round of dietary recalls/records. The master’s student either provided solutions through emails or set up telephone walk-through sessions with the patient who encountered challenges.

Patients’ Dietary Behaviors: Patients’ dietary behaviors and the usage of dietary assessment tools are illustrated in Table 25.

Table 25: Patients Participants’ Dietary Behaviors at Baseline

<table>
<thead>
<tr>
<th>Dietary behaviors</th>
<th>Times of eating outside/takeaway per month</th>
<th>12±7</th>
<th>Min:4 Max:22</th>
<th>Responsible for grocery shopping</th>
<th>Mostly: N=6</th>
<th>Less than half the time: N=0</th>
<th>Participant is responsible for household cooking</th>
<th>Mostly: N=5</th>
<th>Less than half of the time: N=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of dietary tools</td>
<td>Experience of using printed food records</td>
<td>N=5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Experience of using online apps</td>
<td>N=4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current dietary regime</td>
<td>Prescribed regime by health professionals</td>
<td>N=4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unprescribed regime</td>
<td>N=0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Regarding participants’ dining habits, the times that a participant dined outside or consumed takeaway foods ranged from four times/month (n=2) to 22 times/month (n=1). Most participants were responsible for grocery shopping (n=6) and cooking (n=5).

As four patients were only available for baseline interview after the completion of the first
counselling session, they mentioned that they were going to or currently initiating diet regime changes as prescribed by the CHANGE dietitians. Although none of the participants were following other unprescribed diets at the same time, one participant mentioned that they used to follow one commercial dietary regime, which introduced severe side effects, including diarrhea and fatigue.

Most patients had either used printed dietary assessment tools (n=5) or online apps before (n=4). Examples of the online apps were the Weight Watcher (n=2) (153), MyFitnessPal (n=2) (148) and Spark People (n=1) (154).

**Patients’ Experiences in Using DIETQ:** Patients’ perceptions of the advantages and disadvantages of using DIETQ are listed in Table 26.

**Table 26: Patients’ Experiences in Using DIETQ**

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Quotes</th>
</tr>
</thead>
</table>
| Easy to understand                  | - “I think the questionnaire is quite easy to understand.”  
- “There are no other food groups needed to be explained [except for the sofrito sauce] …but I looked it online and I know what it is.”  
- “I think it is pretty straightforward.” |
| Easy to recall with the dietitian’s help | - “I found it was hard for me to recall my previous food intake. But it was easier with the dietitian’s help”  
- “It would be very hard to recall but I think my dietitian helped a lot.” |
| No Redundancies                     | - “I can’t think of any redundancies.”  
- “I don’t think there was any redundancy.”  
- “To be honest, I didn’t really remember so I assume there was no redundancy.”  
- “It was three months ago, so [it was] hard for me to recall…but I think there were no redundancies.” |
| Promote mindfulness                 | - “My knowledge of portion size started when she [the dietitian] taught me [the portion sizes] during the first session.”  
- “I think now I am more mindful about my eating habits.” |
| Disadvantage                        | Quotes                                                                                                                                 |
| Not familiar with the portion size  | - “The portion size was a little difficult for me to learn and memorize at the first beginning.”  
- “At the first I was not get used to the portions. I guess that’s why I had a hard time to recall.” |
| Do not capture tea/coffee intake    | - “I noticed it didn’t ask my coffee or my tea intake…I think it should be considered.” |
| Memory issues                       | - “Sometimes it was hard for me to recall since there was no food item [helped me to provoke my memory].”  
- “You know, my memory is not that good, so I needed my dietitian’s help.” |

All four patients thought the questions on DIETQ were easy to understand. The score of DIETQ’s easiness in answering was between 4 (very good) and 5 (excellent). DIETQ’s sensitivity in capturing changes was 4 (very good). Only one patient mentioned

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11 The evaluation scale of DIETQ’s properties were measured at: 1=poor; 2=fair; 3=good; 4=very good; 5=excellent.
that because their baseline intake was already good, they could not make many dietary changes and they were not sure if DIETQ was sensitive in capturing those minor changes.

Most patients suggested the questionnaire was easy to understand and to recall with the help from dietitians. None of the patients suggested that there were redundancies in the captured dietary information. However, the results should be interpreted with caution as two patients indicated they couldn’t remember the baseline assessment, so they assumed there were no redundancies.

Regarding disadvantages, two patients mentioned the portion size was a little bit hard to learn and memorize during the first assessment, which posed some challenges to the assessment. One patient noticed that DIETQ did not capture their coffee/tea intake. Two patients found it would be a little challenging to recall the frequencies of food consumption without a dietitian’s probing due to memory issues.

Patients’ Experiences in Using ASA24: One major component of the study was to assess the feasibility of the study protocol, including users’ experiences of using ASA24. The table below illustrated participants’ user experiences of ASA24-Canada.

Table 27: Patients’ Experiences in Using ASA24

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Score of Overall experience</td>
<td>3.0</td>
</tr>
<tr>
<td>Average time of completion</td>
<td>31 mins</td>
</tr>
<tr>
<td>Average time of completing the first recall</td>
<td>52 mins</td>
</tr>
<tr>
<td>Average time of completing the first recall (older participants-mean age=70 y.o.)</td>
<td>83 mins</td>
</tr>
<tr>
<td>Average time of completing the first recall (younger participants-mean age=49 y.o.)</td>
<td>30 mins</td>
</tr>
<tr>
<td>Advantage</td>
<td>Quotes</td>
</tr>
<tr>
<td>Accurate</td>
<td>“I feel like it was more accurate compared to other tools I tried… it was so detailed.”</td>
</tr>
<tr>
<td></td>
<td>“It allowed me to record my food intake throughout the day and I think it was more accurate than putting it all at once.”</td>
</tr>
<tr>
<td>Easy to learn</td>
<td>“I don’t think it was very hard to learn how to use [the system], but I needed time to be familiar with it.”</td>
</tr>
<tr>
<td></td>
<td>“The user guide was helpful [for teaching me to navigate the system].”</td>
</tr>
<tr>
<td>User friendly</td>
<td>“[ASA24] had questions to remind you of [commonly forgotten] items and I think it was useful.”</td>
</tr>
<tr>
<td></td>
<td>“I think the system is user friendly because [it has] the portion size illustrated.”</td>
</tr>
<tr>
<td>Multiple entries allowed</td>
<td>“I couldn’t recall my [previous] intake. I needed to record [my intake] throughout the day. The multiple entries allowed me to have my record done after each meal, so I didn’t need to do it at the end of the day [all at once].”</td>
</tr>
<tr>
<td>Ability to save food items</td>
<td>“It saved some time because I can save some common items”</td>
</tr>
<tr>
<td>Have visual aids to estimate portion size</td>
<td>“I think the portion size [illustration] helped me recall.”</td>
</tr>
<tr>
<td></td>
<td>“I think the portion [illustrated] really helped me to estimate my intake.”</td>
</tr>
<tr>
<td></td>
<td>“The visualization [of portion] made it [the recalls] more accurate.”</td>
</tr>
<tr>
<td></td>
<td>“The [portion] size was helpful…Now I have a better understanding of how much I ate.”</td>
</tr>
<tr>
<td>Promote Mindfulness</td>
<td>“By recording my food intake, I am more aware on what I had [and] how much I ate.”</td>
</tr>
<tr>
<td></td>
<td>“[ASA24] helped me reflect on what I usually have and reminded me [to make some”</td>
</tr>
</tbody>
</table>

12The evaluation scale of ASA24’s properties were measured at: 1=poor; 2=fair; 3=good; 4=very good; 5=excellent.
- “For me personally, I now eat to nourish my body instead of just eating for pleasure.”
- “I pay more attention to my food now.”

### Ability to capture changes
- “[ASA24’s ability to capture changes is] probably excellent…”

### Easy to find food
- “I found it easy to find a food item. If I couldn’t, I had no problem in finding a similar one.”

### Disadvantages

<table>
<thead>
<tr>
<th>Technical Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>- “I was trying to complete my record at the end of the day, but I had been cut off several times…I needed to complete additional records.”</td>
</tr>
<tr>
<td>- “I could not log into the system the past two days, so I missed the recalls”</td>
</tr>
<tr>
<td>- “In the beginning I was completing it on my phone which somehow made it take a lot longer…Towards the end, I completed it on my new iPad, [which] significantly reduced the time need to input data…The layout of ASA24 is different on iPhone, iPad and computer.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hard to find certain food items</th>
</tr>
</thead>
<tbody>
<tr>
<td>- “I tried to find strawberries, but I couldn’t find it because of I used the singular [strawberry] instead putting strawberries.”</td>
</tr>
<tr>
<td>- “I can tell some food items are still US-based. There was one time I tried to find a common salad bowl [sold in groceries] but I couldn’t. I needed to enter each item by myself.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time consuming</th>
</tr>
</thead>
<tbody>
<tr>
<td>- “It took much longer than I anticipated…I would say it was kind of frustrated to complete it.”</td>
</tr>
<tr>
<td>- “[To start the second round of recall], I needed to relearn it again and it took time.”</td>
</tr>
<tr>
<td>- “I found it too time consuming to complete the diet recalls. I’ve used other apps such as my fitness pal, where the time to complete food for the day just took a few minutes.”</td>
</tr>
<tr>
<td>- “I found it tedious to complete and at first it took a little while to get used to it.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relies on memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>- “I would not be able to recall the items from the previous day…so I recorded my current day’s intake”</td>
</tr>
<tr>
<td>- “I would have preferred to log my food for the current day verses completing my food log for the previous day.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inability to save meal</th>
</tr>
</thead>
<tbody>
<tr>
<td>- “I have the same breakfast every day, but I couldn’t save the meal…I needed to enter the same meal every time.”</td>
</tr>
<tr>
<td>- “the saving function didn’t allow me to save the meal.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No nutrient analysis for respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>- “I would like to see the food analysis when I submitted my recall.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Needs access to Wi-Fi and electronics</th>
</tr>
</thead>
<tbody>
<tr>
<td>- “I live in rural area and I can only do it when I have access to WIFI. It also requires electronics.”</td>
</tr>
<tr>
<td>- “If I was in my cabin during the weekend, I couldn’t use it, because there was no WIFI.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Redundancies</th>
</tr>
</thead>
<tbody>
<tr>
<td>- “I found it redundant to input certain information such as “type” of utensil used to have a drink, listing the type of utensil used, its specific size… It would have been easier for me to just say how much of a drink I consumed.”</td>
</tr>
</tbody>
</table>

Among the four patients who completed two rounds of 7-day dietary recalls/records, all patients indicated that they could complete food recalls/records independently after they tried out the demonstration website, although two patients mentioned that they needed to review the user guide again prior to the second round of recalls/records. None of them required a training session delivered by the master’s student. Overall, patients’ experiences associated with ASA24 was scored 3.0 (good).

Two patients indicated the ASA24-Canada was user friendly, as it provided detailed guidance on completing a dietary recall/record. Two patients indicated the system was easy to
learn.

All patients agreed that visualization of portion size was one of the greatest advantages of ASA24-Canada. Two patients mentioned that the detailed recall/record process also made them more mindful about dietary behaviors. The other two patients agreed that the entire process made them more mindful on eating.

Nevertheless, all patients thought it took them much longer than anticipated to complete the first few recalls, mostly due to unfamiliarity with the system and difficulties in memorizing food items. The completion time ranged from 8 mins to 96 mins, with an average completion duration of 31 mins. For each participant, the required completion time decreased as reporting days increased.

In terms of technical issues, one patient mentioned ASA24’s requirement on internet connect inconvenience the completion process. Another two patients mentioned the different layout on iPhone made the process more time consuming.

Two patients mentioned that they had difficulties in finding the right food items and/or supplements due to the limited database of commercial Canadian brands and franchises. Therefore, they needed to enter each item separately, which significantly prolonged the completion time. Also, some simple items would not show up if a singular word was put (e.g. strawberry vs. strawberries), which made participants must try multiples times to find the right items. On the other hand, two patients mentioned that they found it was not difficult in finding the right item. However, they mentioned the redundancies of items entry process was inconvenient.

Two patients mentioned that the “favorite” icon would not allow them to save repeated meals (some patients had the same breakfast every day), which was time-consuming to assemble all saved food items together.

One patient mentioned that there was no food intake analysis available for participants after they completed dietary recalls/records. The 2018 version enables the Respondent Nutrition Report as an optional module for participants to obtain food analysis results, but the 2016 version does not have this function (137).

### Food Intake Analysis

**Comparisons of food groups between DIETQ and ASA24-Canada:** In order to evaluate DIETQ’s preliminary validity, participants’ mean intake of each food group obtained by ASA24-Canada were compared to DIETQ results at baseline and three months. Table 27, 28 and 29 compare the food groups, as well as the changes in food groups captured at baseline and three months by DIETQ and ASA24-Canada, based on the conversion procedures described earlier (see appendix 10). There were challenges with certain foods in making the conversion, which is discussed later.
Table 28: Comparisons of Food Groups Captured by DIETQ and ASA24-Canada at Baseline

<table>
<thead>
<tr>
<th>Food Groups</th>
<th>DIETQ Serving*</th>
<th>ASA24-Canada serving*</th>
<th>Mean Differences ± SD</th>
<th>Sig.</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fruit/d</td>
<td>2.3</td>
<td>2.5</td>
<td>-0.2±0.01</td>
<td>0.02*</td>
<td>0.99</td>
</tr>
<tr>
<td>Fruit Juice/d</td>
<td>0.00</td>
<td>0.02</td>
<td>-0.02±0.04</td>
<td>0.39</td>
<td>-</td>
</tr>
<tr>
<td>Total Vegetables/d</td>
<td>1.9</td>
<td>4.3</td>
<td>-2.4±1.6</td>
<td>0.06</td>
<td>0.28</td>
</tr>
<tr>
<td>Dark and Orange Vegetables(^1^)/d</td>
<td>1.1</td>
<td>2.1</td>
<td>-1.0±0.8</td>
<td>0.09</td>
<td>0.80</td>
</tr>
<tr>
<td>Total Grain Products/d</td>
<td>6.6</td>
<td>3.9</td>
<td>2.8±4.7</td>
<td>0.33</td>
<td>-0.94</td>
</tr>
<tr>
<td>Whole Grain Products/d</td>
<td>3.5</td>
<td>1.2</td>
<td>2.3±2.7</td>
<td>0.19</td>
<td>0.46</td>
</tr>
<tr>
<td>Total Milk and Alternatives/d</td>
<td>1.1</td>
<td>0.9</td>
<td>0.2±0.3</td>
<td>0.30</td>
<td>0.87</td>
</tr>
<tr>
<td>Total Meat and Alternatives/d</td>
<td>2.7</td>
<td>2.8</td>
<td>-0.1±1.7</td>
<td>0.93</td>
<td>-0.53</td>
</tr>
<tr>
<td>Red Meat(^1^)/w</td>
<td>1.3</td>
<td>3.9</td>
<td>-2.6±1.7</td>
<td>0.06</td>
<td>-0.12</td>
</tr>
<tr>
<td>Processed Meat/w</td>
<td>0.38</td>
<td>0.34</td>
<td>0.04±0.50</td>
<td>0.89</td>
<td>0.28</td>
</tr>
<tr>
<td>Poultry /w</td>
<td>12.5</td>
<td>3.0</td>
<td>9.5±9.4</td>
<td>0.14</td>
<td>0.35</td>
</tr>
<tr>
<td>Legumes/w</td>
<td>1.1</td>
<td>2.4</td>
<td>-1.3±2.1</td>
<td>0.31</td>
<td>0.38</td>
</tr>
<tr>
<td>Fish/Shellfish/w</td>
<td>1.1</td>
<td>5.9</td>
<td>-4.8±2.2</td>
<td>0.02*</td>
<td>0.16</td>
</tr>
<tr>
<td>Nuts Unsalted/w</td>
<td>3.1</td>
<td>3.0</td>
<td>0.1±0.6</td>
<td>0.77</td>
<td>0.98</td>
</tr>
<tr>
<td>Nuts Salted/w</td>
<td>0.25</td>
<td>0.63</td>
<td>-0.38±0.98</td>
<td>0.50</td>
<td>-0.16</td>
</tr>
<tr>
<td>Total Nuts(^1^)/w</td>
<td>3.4</td>
<td>3.7</td>
<td>-0.3±1.5</td>
<td>0.74</td>
<td>0.87</td>
</tr>
<tr>
<td>Oil-tbsp/d</td>
<td>3.8</td>
<td>2.4</td>
<td>1.4±1.9</td>
<td>0.23</td>
<td>0.14</td>
</tr>
<tr>
<td>Solid Fats-tbsp/d(^1^)</td>
<td>0.3</td>
<td>2.0</td>
<td>-1.7±0.4</td>
<td>0.00*</td>
<td>0.65</td>
</tr>
<tr>
<td>Sofrito Sauce-times/w</td>
<td>0.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Alcohol(^1^) (wine excluded)-times/w</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0±0.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wine - times/w</td>
<td>2.0</td>
<td>0.0</td>
<td>2.0±2.0</td>
<td>0.18</td>
<td>-</td>
</tr>
<tr>
<td>Total Alcohol</td>
<td>2.0</td>
<td>0.0</td>
<td>2.0±2.0</td>
<td>0.18</td>
<td>-</td>
</tr>
<tr>
<td>Commercial Bakery-times/w</td>
<td>2.0</td>
<td>3.5</td>
<td>-1.5±2.4</td>
<td>0.30</td>
<td>-0.67</td>
</tr>
<tr>
<td>Ice Cream &amp; Desserts- times/w</td>
<td>0.0</td>
<td>0.8</td>
<td>-0.8±1.0</td>
<td>0.22</td>
<td>-</td>
</tr>
<tr>
<td>Candies- times/w</td>
<td>0.0</td>
<td>1.0</td>
<td>-1.0±2.0</td>
<td>0.39</td>
<td>-</td>
</tr>
</tbody>
</table>

\(^1^\)ASA24 categorizes dark green and orange vegetables separately, so the sum of the two categories were added up for comparison.
\(^1^\)ASA24 does not have a category named red meat, but a section measures beef, lamb, pork, veal, and game meat intake. The section was analyzed as red meat.
\(^1^\)DIETQ does not have a category to evaluate total nuts intake. At the same time, ASA24 does not differ salted nuts and total nuts. Thus, salted and unsalted nuts were added in DIETQ against the total nuts in ASA24.
\(^1^\)Both the oil and solid fat intake captured by ASA24 include natural oil and fat that presented in meat, seafoods, eggs, dairy, nuts, as well as hydrogenated oil in commercial foods. Thus, the oil intake and solid fat intake may be higher than what participates stated in DIETQ, in which only asked about added oil and solid fat intake.
\(^1^\)ASA24 does not differentiate wine from alcohol. In this analysis, only the times of wine and alcohol consumption were compared.
Except for “Total Grain Products” (r=-0.94), “Total Meat and Alternatives” (r=-0.53), “Nuts Salted” (r=-0.16), “Red Meat” (r=-0.12) and “Commercial Bakery” (r=0.67), all correlations were positive. Except for “Total Fruits” (p<0.05, p=0.02), “Fish/Shellfish” (p<0.05, p=0.02), “Solid Fats” (p<0.05, p=0.00), all comparisons were insignificant (p>0.05).

Among the positive correlations, “Total Fruit” (r=0.99), “Nuts Unsalted” (r=0.98) “Dark and Orange Vegetables” (r=0.80), “Total Milk and Alternatives” (r=0.87), “Total Nuts” (r=0.87), “Solid Fats” (r=0.65) demonstrated strong correlations (r>0.5).

It should be noted that if a food intake was 0, correlation would not be available. Despite without knowing the correlation between sweetened drinks obtained from ASA24 and DIETQ, the difference was as high as 5.3 times of consumption.

Table 29: Comparisons of Food Groups Intake Captured by DIETQ and ASA24-Canada at Three Months

<table>
<thead>
<tr>
<th>Food Groups</th>
<th>DIETQ Serving*</th>
<th>ASA24-Canada serving*</th>
<th>Mean Differences ± SD</th>
<th>Sig.</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fruit/d</td>
<td>1.9</td>
<td>1.8</td>
<td>0.1±1.0</td>
<td>0.78</td>
<td>0.82</td>
</tr>
<tr>
<td>Fruit Juice/d</td>
<td>0.04</td>
<td>0.02</td>
<td>0.02±0.09</td>
<td>0.73</td>
<td>-0.47</td>
</tr>
<tr>
<td>Total Vegetables/d</td>
<td>3.4</td>
<td>3.0</td>
<td>0.4±1.0</td>
<td>0.51</td>
<td>0.45</td>
</tr>
<tr>
<td>Dark and Orange Vegetables/d</td>
<td>1.0</td>
<td>1.1</td>
<td>-0.1±1.3</td>
<td>0.89</td>
<td>-0.73</td>
</tr>
<tr>
<td>Total Grain Products/d</td>
<td>4.0</td>
<td>3.3</td>
<td>0.7±1.2</td>
<td>0.29</td>
<td>0.84</td>
</tr>
<tr>
<td>Whole Grain Products/d</td>
<td>4.0</td>
<td>1.2</td>
<td>2.8±1.4</td>
<td>0.03*</td>
<td>0.51</td>
</tr>
<tr>
<td>Total Milk and Alternatives/d</td>
<td>0.9</td>
<td>1.0</td>
<td>-0.1±0.1</td>
<td>0.07</td>
<td>0.99</td>
</tr>
<tr>
<td>Total Meat and Alternatives/d</td>
<td>3.4</td>
<td>2.7</td>
<td>0.7±1.1</td>
<td>0.30</td>
<td>-0.81</td>
</tr>
<tr>
<td>Red Meat/w</td>
<td>1.8</td>
<td>6.1</td>
<td>-4.4±1.4</td>
<td>0.01*</td>
<td>0.16</td>
</tr>
<tr>
<td>Processed Meat/w</td>
<td>1.1</td>
<td>0.6</td>
<td>0.5±0.2</td>
<td>0.01*</td>
<td>0.69</td>
</tr>
<tr>
<td>Poultry /w</td>
<td>4.5</td>
<td>6.7</td>
<td>-2.2±2.8</td>
<td>0.21</td>
<td>0.96</td>
</tr>
<tr>
<td>Legumes/w</td>
<td>1.4</td>
<td>0.1</td>
<td>1.3±0.8</td>
<td>0.048*</td>
<td>-0.78</td>
</tr>
<tr>
<td>Fish/Shellfish/w</td>
<td>1.9</td>
<td>2.3</td>
<td>-0.4±1.1</td>
<td>0.49</td>
<td>0.88</td>
</tr>
</tbody>
</table>

18Sweetened coffee and tea are excluded.
<table>
<thead>
<tr>
<th>Food Groups</th>
<th>DIETQ Serving*</th>
<th>ASA24-Canada Serving*</th>
<th>Mean Differences ± SD</th>
<th>Sig.</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuts Unsalted/w</td>
<td>4.0</td>
<td>2.7</td>
<td>1.3±1.3</td>
<td>0.13</td>
<td>0.92</td>
</tr>
<tr>
<td>Nuts Salted/w</td>
<td>0.0</td>
<td>0.6</td>
<td>-0.6±1.1</td>
<td>0.39</td>
<td>-</td>
</tr>
<tr>
<td>Total Nuts/w</td>
<td>4.0</td>
<td>3.3</td>
<td>0.7±1.8</td>
<td>0.48</td>
<td>0.89</td>
</tr>
<tr>
<td>Oil-tbsp/d</td>
<td>2.1</td>
<td>1.8</td>
<td>0.3±0.8</td>
<td>0.47</td>
<td>0.55</td>
</tr>
<tr>
<td>Solid Fats-tbsp/d</td>
<td>0.4</td>
<td>2.4</td>
<td>-2.0±0.4</td>
<td>0.00*</td>
<td>0.92</td>
</tr>
<tr>
<td>Sofrito Sauce-times/w</td>
<td>1.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Alcohol (wine excluded)-times/w</td>
<td>0.8</td>
<td>0.5</td>
<td>0.3±0.5</td>
<td>0.39</td>
<td>1.00</td>
</tr>
<tr>
<td>Wine - times/w</td>
<td>0.8</td>
<td>0.8</td>
<td>0.0±0.8</td>
<td>1.00</td>
<td>0.87</td>
</tr>
<tr>
<td>Total Alcohol</td>
<td>1.5</td>
<td>1.3</td>
<td>0.3±0.5</td>
<td>0.39</td>
<td>0.96</td>
</tr>
<tr>
<td>Commercial Bakery-times/w</td>
<td>1.6</td>
<td>2.7</td>
<td>-1.1±2.7</td>
<td>0.46</td>
<td>-0.05</td>
</tr>
<tr>
<td>Ice Cream &amp; Desserts- times/w</td>
<td>1.5</td>
<td>1.3</td>
<td>0.3±2.0</td>
<td>0.82</td>
<td>0.09</td>
</tr>
<tr>
<td>Candies- times/w</td>
<td>1.4</td>
<td>0.0</td>
<td>1.4±0.8</td>
<td>0.04*</td>
<td>-</td>
</tr>
<tr>
<td>Sweetened Drinks- times/w</td>
<td>0.5</td>
<td>2.0</td>
<td>-1.5±0.6</td>
<td>0.01*</td>
<td>0.71</td>
</tr>
<tr>
<td>Salty Snacks-times/w</td>
<td>1.4</td>
<td>1.5</td>
<td>-0.1±0.3</td>
<td>0.39</td>
<td>0.96</td>
</tr>
</tbody>
</table>

*p<0.05

“Total Fruit” (r=0.82), “Total Grain Products” (r=0.84), “Whole Grain Products” (r=0.51), “Total Milk and Alternative” (r=0.99), “Processed Meat” (r=0.69), “Poultry” (r=0.96), “Fish /Shellfish” (r=0.88), “Nuts Unsalted” (r=0.92), “Total Nuts” (r=0.89), “Oil” (r=0.55), “Solid Fats” (r=0.92), “Alcohol (wine excluded)” (r=1.0), “Wine” (r=0.87), “Total Alcohol” (r=0.96), “Sweetened Drinks” (r=0.71), and “Salty Snacks” (r=0.96) demonstrated strong correlations, which indicated good concordance between DIETQ and ASA24 among these food groups.

However, “Fruit Juice” (r=−0.47), “Dark Green and Orange Vegetables” (r=−0.73), “Total Meat and Alternatives” (r=−0.81), “Legume” (r=−0.78), and “Commercial Bakery” (r=−0.05) appeared to be negatively correlated between DIETQ and ASA24, which suggested errors during data collection or data analysis.

The comparisons of “Whole Grains”, “Red Meat”, “Processed Meat”, “Legume”, “Solid Fats”, “Candies”, “Sweetened Drinks” were significant (p<0.05), which indicated there were significant differences of intake assessed by DIETQ and ASA24. The mean differences of intake that were more than two servings were found in Whole Grain Products”, “Red Meat”, “Poultry”, and “Solid Fats”, which were relatively large differences.
Table 30: Changes of Food Groups Intake Captured by DIETQ and ASA24-Canada at Baseline and Three Month

<table>
<thead>
<tr>
<th>Food Groups</th>
<th>DIETQ Serving Changes</th>
<th>ASA24-Canada Serving Changes</th>
<th>Mean Differences ± SD</th>
<th>Sig.</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fruit/d</td>
<td>-0.3</td>
<td>-0.7</td>
<td>0.4±0.9</td>
<td>0.47</td>
<td>0.42</td>
</tr>
<tr>
<td>Fruit Juice/d</td>
<td>0.04</td>
<td>0.00</td>
<td>0.04±0.09</td>
<td>0.49</td>
<td>-0.04</td>
</tr>
<tr>
<td>Total Vegetables/d</td>
<td>1.6</td>
<td>-1.2</td>
<td>2.8±1.9</td>
<td>0.06</td>
<td>-0.43</td>
</tr>
<tr>
<td>Dark &amp; Orange Vegetables/d</td>
<td>-0.1</td>
<td>-1.0</td>
<td>0.9±0.9</td>
<td>0.15</td>
<td>0.55</td>
</tr>
<tr>
<td>Total Grain Products/d</td>
<td>-2.6</td>
<td>-0.6</td>
<td>-2.0±3.8</td>
<td>0.37</td>
<td>-0.87</td>
</tr>
<tr>
<td>Whole Grain Products/d</td>
<td>0.5</td>
<td>0.00</td>
<td>0.5±0.5</td>
<td>0.60</td>
<td>0.59</td>
</tr>
<tr>
<td>Total Milk and Alternatives/d</td>
<td>-0.27</td>
<td>0.04</td>
<td>-0.31±0.40</td>
<td>0.22</td>
<td>0.79</td>
</tr>
<tr>
<td>Total Meat and Alternatives/d</td>
<td>0.6</td>
<td>-0.2</td>
<td>0.8±0.8</td>
<td>0.14</td>
<td>0.12</td>
</tr>
<tr>
<td>Red Meat/w</td>
<td>0.5</td>
<td>2.3</td>
<td>-1.8±0.9</td>
<td>0.03*</td>
<td>0.42</td>
</tr>
<tr>
<td>Processed Meat/w</td>
<td>0.8</td>
<td>0.3</td>
<td>0.5±0.5</td>
<td>0.12</td>
<td>-0.13</td>
</tr>
<tr>
<td>Poultry (chicken, turkey)/w</td>
<td>-8.0</td>
<td>3.7</td>
<td>-11.7±11.0</td>
<td>0.12</td>
<td>-0.51</td>
</tr>
<tr>
<td>Legumes/w</td>
<td>0.3</td>
<td>-2.4</td>
<td>2.6±2.7</td>
<td>0.15</td>
<td>-0.47</td>
</tr>
<tr>
<td>Fish/Shellfish/w</td>
<td>0.8</td>
<td>-3.6</td>
<td>4.3±2.7</td>
<td>0.05</td>
<td>-0.02</td>
</tr>
<tr>
<td>Nuts Unsalted/w</td>
<td>0.9</td>
<td>-0.3</td>
<td>1.2±0.9</td>
<td>0.07</td>
<td>0.64</td>
</tr>
<tr>
<td>Nuts Salted/w</td>
<td>-0.3</td>
<td>-0.1</td>
<td>-0.2±1.5</td>
<td>0.82</td>
<td>0.17</td>
</tr>
<tr>
<td>Total Nuts/w</td>
<td>0.6</td>
<td>-0.4</td>
<td>1.0±1.0</td>
<td>0.15</td>
<td>0.55</td>
</tr>
<tr>
<td>Oil-tbsp/d</td>
<td>-1.7</td>
<td>-0.6</td>
<td>-1.1±1.5</td>
<td>0.26</td>
<td>0.91</td>
</tr>
<tr>
<td>Solid Fats-tbsp/d</td>
<td>0.13</td>
<td>0.45</td>
<td>-0.33±0.32</td>
<td>0.13</td>
<td>0.25</td>
</tr>
<tr>
<td>Sofrito Sauce-times/w</td>
<td>1.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Alcohol (wine excluded)-times/w</td>
<td>0.8</td>
<td>0.5</td>
<td>0.3±0.5</td>
<td>0.39</td>
<td>1.00</td>
</tr>
<tr>
<td>Wine - times/w</td>
<td>-1.3</td>
<td>0.8</td>
<td>-2.0±2.5</td>
<td>0.20</td>
<td>-0.41</td>
</tr>
<tr>
<td>Total Alcohol</td>
<td>-0.5</td>
<td>1.3</td>
<td>-1.8±2.1</td>
<td>0.19</td>
<td>-0.96</td>
</tr>
<tr>
<td>Commercial Bakery-times/w</td>
<td>-0.4</td>
<td>-0.8</td>
<td>0.4±2.7</td>
<td>0.80</td>
<td>-0.62</td>
</tr>
<tr>
<td>Ice Cream, Other Desserts- times/w</td>
<td>1.5</td>
<td>0.3</td>
<td>1.2±2.5</td>
<td>0.39</td>
<td>0.32</td>
</tr>
<tr>
<td>Candies- times/w</td>
<td>1.4</td>
<td>-1.0</td>
<td>2.4±1.5</td>
<td>0.05</td>
<td>0.78</td>
</tr>
<tr>
<td>Sweetened Drinks- times/w</td>
<td>0.5</td>
<td>0.8</td>
<td>-0.3±0.5</td>
<td>0.39</td>
<td>0.58</td>
</tr>
<tr>
<td>Salty Snacks-</td>
<td>-0.4</td>
<td>0.5</td>
<td>-0.9±2.8</td>
<td>0.58</td>
<td>-0.10</td>
</tr>
</tbody>
</table>
While comparing the changes of mean intake between DIETQ and ASA24, strong positive correlation ($r>0.5$) were observed in “Dark Green and Orange Vegetables”, “Whole Grain Products”, “Total Milk and Alternatives”, “Nuts Unsalted”, “Total Nuts”, “Oil”, “Alcohol (wine excluded)”, “Candies”, and “Sweetened Drinks”.

Multiple food groups demonstrated negative correlations, which are problematic. They include “Fruit Juice”, “Total Vegetables”, “Total Grain Products”, “Processed Meat”, “Poultry”, “Legume”, “Fish/Shellfish”, “Wine”, “Total Alcohol”, “Commercial Bakery”, and “Salty Snacks”. “Red Meat” was the only food group that was statistically significant. However, “Total Vegetables”, “Total Grain Products”, “Poultry”, “Legume”, “Fish/Shellfish”, “Wine”, and “Candies” indicated that the mean differences of food intake assessed by DIETQ and ASA24 were more than 2 servings, which should be paid attention.

**Comparisons of Nutrients between Baseline and Three Months:** Since DIETQ cannot provide detailed information about nutrient intake, key nutrients captured by ASA24 were compared at baseline and three months. The list of key nutrients was adapted from the CHANGE study (113, 138).

**Table 31:** Key Nutrient Intake Captured by ASA24 at the Baseline and Three Months

<table>
<thead>
<tr>
<th>Key Nutrients</th>
<th>Baseline Mean/day</th>
<th>Three Months Mean/day</th>
<th>Differences ± SD</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A (mcg RAE)</td>
<td>743.6</td>
<td>570.0</td>
<td>-173.6±170.2</td>
<td>0.13</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>84.7</td>
<td>48.1</td>
<td>-36.6±40.6</td>
<td>0.17</td>
</tr>
<tr>
<td>Vitamin D (mcg)</td>
<td>8.3</td>
<td>3.8</td>
<td>-4.5±2.2</td>
<td>0.027*</td>
</tr>
<tr>
<td>Folate (mcg)</td>
<td>257.9</td>
<td>203.6</td>
<td>-54.3±12.2</td>
<td>0.003*</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>581.6</td>
<td>552.7</td>
<td>-28.9±54.1</td>
<td>0.36</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>10.7</td>
<td>10.3</td>
<td>-0.4±0.4</td>
<td>0.13</td>
</tr>
<tr>
<td>Potassium (mg)</td>
<td>2636</td>
<td>2388</td>
<td>-248±190</td>
<td>0.08</td>
</tr>
<tr>
<td>Magnesium (mg)</td>
<td>280.5</td>
<td>278.0</td>
<td>-2.5±31.8</td>
<td>0.89</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>2811</td>
<td>2740</td>
<td>-71±324</td>
<td>0.69</td>
</tr>
<tr>
<td>Total Fat (g)</td>
<td>69.4</td>
<td>72.0</td>
<td>2.6±6.9</td>
<td>0.50</td>
</tr>
<tr>
<td>Total Fat (%E)</td>
<td>38.8</td>
<td>38.7</td>
<td>-0.1±3.2</td>
<td>0.93</td>
</tr>
<tr>
<td>Monounsaturated fatty acids(g)</td>
<td>27.4</td>
<td>26.8</td>
<td>-0.65±4.69</td>
<td>0.80</td>
</tr>
<tr>
<td>MUFA (%E)</td>
<td>15.3</td>
<td>14.4</td>
<td>-0.9±2.7</td>
<td>0.52</td>
</tr>
<tr>
<td>Polyunsaturated fatty acids (g)</td>
<td>18.5</td>
<td>17.9</td>
<td>-0.6±3.3</td>
<td>0.75</td>
</tr>
<tr>
<td>PUFA (%E)</td>
<td>10.3</td>
<td>9.6</td>
<td>-0.7±1.6</td>
<td>0.42</td>
</tr>
</tbody>
</table>
The intake of vitamin D, folate, omega-3 fatty acids (EPA, DPA, DHA), saturated fatty acids, carbohydrate% energy, dietary fiber, total sugar, total sugar % energy assessed by ASA24 were statistically significant between baseline and three months. Regarding dietary changes that may be associated with positive health outcomes, there were reductions found in sodium, total fat, % energy, carbohydrate, carbohydrate % energy, total sugar, total sugar % energy and added sugar, as well as a slight increase found in protein % energy.

**Concordance between DIETQ and ASA24-Canaada:** The MDS score converted base on DIETQ and ASA24 is compared in Table 32.

Table 32: Categorical Concordance of Direction and Magnitude of Changes Measured by MDS

<table>
<thead>
<tr>
<th>Key Nutrients</th>
<th>Baseline Mean/day</th>
<th>Three Months Mean/day</th>
<th>Differences ± SD</th>
<th>Sig. (two-tailed)</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omega-3 Fatty Acids (g)&lt;sup&gt;19&lt;/sup&gt;</td>
<td>0.7</td>
<td>0.2</td>
<td>-0.5±0.2</td>
<td>0.008*</td>
<td></td>
</tr>
<tr>
<td>EPA (g)</td>
<td>0.21</td>
<td>0.04</td>
<td>-0.17±0.05</td>
<td>0.008*</td>
<td></td>
</tr>
<tr>
<td>DPA (g)</td>
<td>0.06</td>
<td>0.03</td>
<td>-0.03±0.01</td>
<td>0.005*</td>
<td></td>
</tr>
<tr>
<td>DHA (g)</td>
<td>0.4</td>
<td>0.1</td>
<td>-0.3±0.1</td>
<td>0.01*</td>
<td></td>
</tr>
<tr>
<td>Saturated fatty acids (g)</td>
<td>17.7</td>
<td>21.3</td>
<td>3.6±2.2</td>
<td>0.046*</td>
<td></td>
</tr>
<tr>
<td>SFA (%E)</td>
<td>9.9</td>
<td>11.5</td>
<td>1.6±1.1</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Protein (g)</td>
<td>74.1</td>
<td>82.0</td>
<td>8.0±9.1</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>Protein (%E)</td>
<td>18.4</td>
<td>19.5</td>
<td>1.1±1.6</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>Calories (kcal)</td>
<td>1612</td>
<td>1680</td>
<td>68±78</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>181.9</td>
<td>167.4</td>
<td>-14.6±14.5</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>Carbohydrate(%E)</td>
<td>45.1</td>
<td>39.7</td>
<td>-5.4±3.1</td>
<td>0.04*</td>
<td></td>
</tr>
<tr>
<td>Dietary Fiber (g)</td>
<td>18.4</td>
<td>13.1</td>
<td>-5.3±1.6</td>
<td>0.007*</td>
<td></td>
</tr>
<tr>
<td>Total sugar (g)</td>
<td>65.9</td>
<td>51.4</td>
<td>-14.5±7.1</td>
<td>0.027*</td>
<td></td>
</tr>
<tr>
<td>Total sugar (%E)</td>
<td>16.3</td>
<td>12.2</td>
<td>-4.1±1.7</td>
<td>0.017*</td>
<td></td>
</tr>
<tr>
<td>Added Sugar (tsp eq.)</td>
<td>7.2</td>
<td>5.7</td>
<td>-1.5±1.9</td>
<td>0.21</td>
<td></td>
</tr>
</tbody>
</table>

<sup>19</sup>Omega 3 fatty acids are made up by eicosapentaenoic acid [EPA], docosapentaenoic acid [DPA] and docosahexaenoic acid [DHA] based on the ASA analysis database. Thus, the true intake of omega-3 fatty acids may be underestimated.
The MDS assessed by DIETQ and ASA24 showed strong correlation at baseline ($r=0.85$) and three months ($r=0.52$), which suggested a good categorical concordance of direction between the two instruments. In terms of magnitude of changes, DIETQ-MDS demonstrated an improvement of 1.8 out of 14 points, while ASA24-MDS indicated that participants’ MDS remained the same between baseline and three months.

**Chapter 7: Discussion**

**Feasibility of Recruitment**

_**Feasibility of Recruiting RD participants:**_ While most EDs and RDs involved in the CHANGE study expressed their interest in the DIETQ study, recruitment over the study period proved challenging. A much longer time frame and more intensive approach will be needed in any planned larger study in the typical practice setting. Each FHT had unique issues regarding timing of the recruitment.

Besides time conflicts in starting new group programs, the RDs’ overall busy schedules also posed difficulties for recruitment. The EDs and RDs needed to communicate multiple times to decide each specific FHT’s eligibility and the RD’s availability to participate in this study. RDs were not being reimbursed for any extra time that the study would take. While we reduced the RD commitment to a minimum, provided draft posters and emails etc. for patients, as well as detailed information to RD and EDs on the process, including a draft letter for EDs to submit, such delays are likely inevitable. For future studies, it is suggested that recruitment needs to be high priority from the start, with multiple online webinars or teleconferences, arranged ahead at least 3 months at a time, (we did only one) along with the written materials already developed. A dedicated coordinator with a main focus on recruitment will be needed.

This pilot test was arranged with one program that the principal investigator had already been working with since 2012. The program is recruiting up to 1000 patients in the current round of work and enrollment has been completed for 642 patients as June 17, 2019. Multiple other team-based primary care groups exist in Canada, as outlined in a 2018 environmental scan by the Dietitians of Canada (155). Evidence to date suggests that cardiometabolic issues make up at least one half of the RD caseloads in these settings, so there certainly are sufficient numbers of patients to support a validation study (156). Most practices will not be offering a program of intervention as intensive as the CHANGE program (21 visits in a year), and for a validation study a range of change is actually desirable. Expanding recruitment targets will be helpful in soliciting more participants, including sending emails through Dietitians of Canada and provincial RD primary care networks.

_**Feasibility of Recruiting Patients:**_ Participants also encountered various time conflicts, such as work and leisure activities. Some patients may not check email very frequently, while others have many competing demands on their time. During recruitment, the master’s student first contacted potential patient participants by email. If the email had not been responded for more
than one week, the student called the patients by phone instead. The approach usually yielded a response. On average, the period between the first email sent to completion of a baseline interview was 2-4 weeks. Similar issues are to be expected in any planned recruitment with middle-aged and older participants, the age groups with identified cardio-metabolic risks.

**Feasibility of Instruments**

*Feasibility of RD and Patient Interview Questionnaires:* Participants in this study did not comment on the interview questionnaires, since the master’s student interviewed them and asked probing questions when needed. For most questions, the respondents had no problems in understanding and answering them. If the interview questionnaires will be adapted for self-report in a future study, some revisions will be needed. For instance, RDs were asked about the feasibility and acceptability of using DIETQ with clients in the post-test interview. As the two terms were sometimes overlapped during interviews, in order to distinguish feasibility and acceptability, it is necessary to introduce the two terms, either through probing questions or written definitions. In general, feasibility includes the operational capabilities of DIETQ used in this study, while acceptability is participants’ willingness of using the instrument in daily practices (157). The researcher found it was common for dietitians to discuss one term (e.g., feasibility) while connecting to the other property (e.g., acceptability), so it is important to clarify and organize the data during interviews.

Reflecting on patients’ performances in answering the post-test interview questionnaire, it was found patients had difficulties in reflecting on DIETQ’s ability in capturing changes in food intake and to evaluate the presence of redundancies. Participants faced some challenges in recalling the first assessment when they were interviewed after three months. Secondly, as patients were usually unfamiliar with food assessment terminologies at the baseline assessment, they probably would not be able to reflect on the food intake captured by DIETQ. Therefore, the two questions may need to be modified or removed. A similar question was included in RD’s post-test interview questionnaire. A question that asks patients’ perceived dietary changes over the three months may be more realistic, for which results can later be compared with DIETQ results [See Appendices 2 and 3 for questions listed in RDs’ post-test interview questionnaire (questions 6 & 7) and patients’ post-test interview questionnaire (question 2 & 3)].

The interview questionnaire did not include ethnicity. Including ethnicity may help researchers to further examine suitability of DIETQ and current dietary counselling services. The researcher was informed that some FHTs target different ethnical groups that share different food cultures and practices; hence, it is worth considering adding one question to assess ethnicity in a larger scale validation.

*Feasibility of Using ASA24 as a Validation Tool:* The major advantage of using ASA24-Canada as a validation tool is it is online and can provide a relatively accurate estimation of both food groups and nutrients that are adapted to the current Canadian context. Nevertheless, patients’ experience of using ASA24-Canada suggested that some available items and brands were still US-based.

From the researcher’s perspective, the unit conversion from ASA24 remained a challenge as
all food groups and food items were labelled by cup equivalent or ounce equivalent. As mentioned in Methods, all consumed food items from the ASA24 were converted to equivalent units first (e.g., ounce equivalent to cup), and then converted to the CFG serving sizes. Although the intake of each food item in the ASA-24 is labelled in grams, the direct conversion is only possible when the CFG serving is labelled by weight. Some food items in CFG (e.g., vegetables, fruits, hot cereal, nuts, fluids, legumes, etc.) use volumetric units only (either cups or milliliters); thus, they needed to be converted to grams using ESHA or the Canadian Nutrient File (149, 158). In addition, this method is not applicable to mixed food items. For a food item that combines multiple ingredients, only the food item’s weight is labelled in grams. For instance, ASA24 provided the cup equivalent of nut intake when the given food item contains mixed nuts or nut butter (e.g., homemade cookies, multigrain bread). Neither the name nor the grams of nuts were provided in these instances.

During the process of developing the unit conversion procedures, major discordances of the food group classifications were found in meat alternative conversion between ASA24 and DIETQ. For example, while DIETQ considered 3/4 cup of shelled nuts as one CFG serving, the information provided by ASA24 did not mention whether the analysis was based on shelled or unshelled nuts. Thus, the master’s student ran a test by entering one cup of each common nut in ASA24 and converted the output to CFG servings to calculate the conversion ratio. Similar tests were also performed for yogurt, cereal, and legumes, due to the differences in standard serving sizes (see Appendix 10).

Additionally, when translating the food intake obtained by ASA24 into MDS, ASA24 does not specify the kinds of oils used or distinguish sofrito sauce in the output. Therefore, the estimates for use of olive oil and sofrito sauce obtained from ASA24 were assumed to be as same as DIETQ’s. However, this may contribute to errors as patients might not have achieved the same level of consumption as they recorded in DIETQ.

The 2018 version mentioned a small portion of codes used in ASA24-2016 could not be matched to Canadian foods, those codes and nutrient values were then adjusted (137). At the same time, while the current 2018 version employs the 2007 CFG food groups, Health Canada is developing a tool to assess adherence to new CFG released early in 2019 (137). Some changes on food groups of ASA24 may be expected in the future.

Reflecting on patients’ feedback, the advantages of using ASA-24 were the visuals of portion size, perceived accuracy, and its effect on promoting mindfulness during mealtime. Also, given the need to validate the DIETQ, the accuracy of ASA24 is an advantage.

Despite ASA-24 being a validated tool in assessing dietary recalls, the relatively long completion time and high commitment of 7-day of recalls will make recruitment and retention in a future study more challenging. The average time of completing the first recall was 52 mins, while the average time of completing each recall was 31 mins. It was found that older patients had more difficulties in navigating ASA24. For instance, two senior patients (≥70 y.o.) spent around 83 mins in completing the first recall at baseline, compared to the time the other two younger participants used (30 mins). It was previously reported that for older adults, the time required of completing one recall ranged from 15 min to 2 h (134). This pilot study’s results were
consistent with the review and confirmed that some senior participates experienced more difficulties in using ASA24 (134).

The relatively high attrition rate in this pilot (patient: 33%) was not unexpected. Others doing validation studies have also struggled to find the best balance between feasibility and accuracy. For instance, the attrition rate of CHANFGE study was 28% (138). Multiple strategies could be considered in a future study. For example, using a trained interviewer as the default for completing recalls, improving the number of Canadian food options, having people only record selected foods, could all be considered. But it should be noted that including dropped out patients, all participants thought it was more flexible to complete recalls independently; none of them required interviewer-delivered recalls/records. In terms of a national validation, the number of days may be reduced if the sample size is sufficient. However, detecting changes in consumption of foods eaten less often will remain a challenge if the number of recall days is decreased. Two patients mentioned that even though the process was time consuming, they understood that 7-day recall was still acceptable.

To conclude, despite being time-consuming and having some minor technical issues (see Table 27), ASA24-Canada is feasible to use in similar studies. For future studies, the 2018 version has an updated database, which may help participants in finding food items more efficiently. Its new function of reporting, modifying and saving recipes may also save participants’ time in assembling repeated meals.

**Proposed Revisions to the DIETQ:** One major issue raised by both RDs was the definition of “Total Vegetables.” They mentioned that during their counselling, they did not count starchy vegetables (i.e. potato, peas, yams) in the total vegetable consumption; primarily because starchy vegetables would reduce participants’ leafy vegetable intake and contribute to CHO intake. One dietitian mentioned that their participants were mainly Irish immigrants and that it was important for their patients to reduce their intake of potatoes. A newly published review on food-based guidelines mentioned that starchy vegetables were separated in some countries’ food guidelines, but there was no consensus on how they should be grouped (159).

Due to the CHANGE study’s diet goals, RDs involved in this study excluded starchy vegetables (potato, yam, corn) during the dietary assessment. They suggested that DIETQ should specify starchy vegetables under the “total vegetable intake” category or provide a separate section to calculate starchy vegetable intake. Thus, separating starchy vegetable from total vegetable intake may be helpful in counselling individuals with metabolic abnormalities. The ASA24 includes all vegetables under “Total Vegetables”, while providing separate section for starchy vegetables, which makes the comparison possible.

As CHANGE program emphasizes the promotion of a Mediterranean-style diet, three dietitians also raised concerns about the promotion of olive oil. All RDs mentioned that patients have difficulties in achieving 4 tbsps.’ of olive oil, which is one of the categories in the MDS questionnaires (35, 108, 109). Olive oil is expensive in Canada and overall fat intake in Canada is much lower than in Spain. There is controversy as to olive oil’s specific importance in achieving reversal of metabolic syndrome, since in the PREDIMED trial, very similar results were achieved by both the nut and olive oil supplemented intervention groups. This issue cannot
be resolved at this point, but to be able to compare results across studies using similar questionnaires, it is likely wise to keep both questions on olive oil and add some questions on other sources of fat in the Canadian diet.

**Figure 7: Assessment of Fat Intake in MEDAS**

<table>
<thead>
<tr>
<th>Butter, cream or hard (hydrogenated) margarine &lt; 1 Tbsp (15 ml) / day</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Olive oil as main added fat</td>
<td></td>
</tr>
<tr>
<td>Olive oil ≥ 4 Tbsp / day</td>
<td></td>
</tr>
<tr>
<td>Includes oil used for cooking, seasoning, frying, salads etc.</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 8: Assessment of Fat Intake in DIETQ**

<table>
<thead>
<tr>
<th>7. Added Fats / Oils in cooking and eating</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of main cooking oil</td>
<td>Tbsp/day</td>
</tr>
<tr>
<td>Butter or hard margarine</td>
<td>Tbsp/day</td>
</tr>
<tr>
<td>Olive oil as main added fat?</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Reflecting on the data analysis, it is better for DIETQ to assess the frequencies of consumption of sweet snacks/beverages, wine, alcohol, and salty snacks on a weekly basis than estimating the amount. Or it is suggested that snack foods be tabulated in DIETQ by eating time, type of snack and frequency to ease the validation process. Other approaches should also be considered, due to the importance of these food items in diet counselling practice. The current statement on DIETQ may be confusing for RDs in evaluating such items’ intake, as it does not explicitly mention whether the amount or the frequencies should be recorded. Revisions should be made to emphasize the capture of frequencies.

One issue with using DIETQ to assess patients’ food intake, is the accuracy of capturing foods eaten less frequently. For instance, for food groups/items consumed occasionally the questionnaire will not be able to detect consumption unless a longer time frame is established. The current version focused on consumption in the past week to coincide with the 7-day recall, but items like fish/shell fish or legumes may only be eaten occasionally (120). Therefore, DIETQ may need to include more time frame options in order to detect less commonly eaten foods.

Reflecting on the design of DIETQ and prevalence of use of supplements, a section that asks about dietary supplements would be helpful as a check on excessive micronutrient intake. Statistics Canada found that in 2015, 45.6% of Canadians (>1 y.) used at least one nutritional supplement. Among people aged 51 to 70 years old, 65.1% of women and 42.5% of men used...
supplements (160). Major supplements were multivitamins (23.1%), omega-3 fatty acids (11.8%), and supplements containing calcium and vitamin D (33.5%) (160). In this study, two patients reported that they take supplements daily. One dietitian mentioned that compared to supplement intake, food intake was more important to metabolic syndrome treatment. Therefore, a section on supplement intake may be considered but is not highest priority.

The classifications of some food groups in DIETQ may need adjustments in order to help enhance the concordance of comparison between DIETQ and ASA24 (see Table 34). Firstly, it is important to establish a standardized unit conversion procedure for each food group. Secondly, some food categories in DIETQ cannot be easily assessed by ASA24; namely sweetened snacks/drinks, salty snacks, wine, and olive oil. But the frequencies of consumption of those food items can be screened by examining the ASA24 analysis output (except olive oils). A comprehensive list of common sweetened snacks/beverages and salty snacks should be developed to reduce intrapersonal misclassification. Currently, there is no time-efficient solution to identify the amount of some mixed food items assessed by ASA24, which means some errors may be unavoidable at this moment. It is possible, but time-consuming, for researchers to review food recalls/records manually to identify and summarize consumption.

**Discussion on Data Analysis**

To fulfill this pilot study’s purpose of preliminary examination of food groups, as well as assessing changes over the three months between DIETQ and ASA24, the analysis results are illustrated in Tables 28-30. The changes of nutrients assessed by ASA24, and the comparison of MDS score derived by DIETQ and ASA 24 can be found in Table 31 and Table 32.

Combining the findings found in baseline and post-test, food groups that consistently demonstrated strong positive correlation at baseline and post-test are highlighted below.

**Table 33: Food Groups Demonstrated Strong Correlations**

<table>
<thead>
<tr>
<th>Food Groups with Strong Correlation at both Baseline and Post-test</th>
<th>Changes of Food Group with Strong Correlation between Baseline and Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fruit</td>
<td>Dark Green and Orange Vegetable</td>
</tr>
<tr>
<td>Total Milk and Alternatives</td>
<td>Total Milk and Alternatives</td>
</tr>
<tr>
<td>Nuts Unsalted</td>
<td>Nuts Unsalted</td>
</tr>
<tr>
<td>Total Nuts</td>
<td>Total Nuts</td>
</tr>
<tr>
<td>Solid Fat</td>
<td>Oil</td>
</tr>
<tr>
<td></td>
<td>Alcohol (wine excluded)</td>
</tr>
<tr>
<td></td>
<td>Candies</td>
</tr>
<tr>
<td></td>
<td>Sweetened Drinks</td>
</tr>
</tbody>
</table>

The above food groups demonstrated strong correlations at both baseline and post-test or the changes assessed by DIETQ and ASA24 during the three-month period indicated strong correlations. The results may indicate DIETQ’s capabilities in capturing these food groups and
their changes. Compared to baseline assessment, more food groups demonstrated strong positive correlations in posttest (baseline n=6; n=16). It may due to participants’ improved abilities in food estimation as the counselling continues and their repeated practicing ASA24. It may also suggest the post-test assessment was more accurate compared to the baseline assessment. To support the argument, patients did mention that they felt challenged in using portion sizes to estimate food intake, and expressed their unfamiliarity of using ASA at the beginning (see Table 26 and Table 27). It indicates that the accuracy of estimating food intake can be enhanced by proving additional training to patients prior to the start of the baseline assessment.

While sample size was limited, consistent low or negative correlations found in the changes of food groups may suggest misclassification between DIETQ and ASA24. These food groups are illustrated below.

Table 34: Food Groups Demonstrated Low or Negative Correlations

<table>
<thead>
<tr>
<th>Food Groups with consistent Low or Negative Correlation at Baseline and Post-test</th>
<th>Food Groups Changes with low or Negative Correlation between Three Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Meat &amp; Alternatives</td>
<td>Total Vegetables</td>
</tr>
<tr>
<td>Red Meat</td>
<td>Total Grain Products</td>
</tr>
<tr>
<td>Commercial Bakery</td>
<td>Processed Meat</td>
</tr>
<tr>
<td></td>
<td>Poultry</td>
</tr>
<tr>
<td></td>
<td>Legume</td>
</tr>
<tr>
<td></td>
<td>Fish/Shellfish</td>
</tr>
<tr>
<td></td>
<td>Wine</td>
</tr>
<tr>
<td></td>
<td>Total Alcohol</td>
</tr>
<tr>
<td></td>
<td>Commercial Bakery</td>
</tr>
<tr>
<td></td>
<td>Salty Snacks</td>
</tr>
</tbody>
</table>

A low or negative correlation suggested there were misclassifications or measuring/calculation errors. Especially when assessing the correlation of changes, more errors accumulated during the analysis. Researchers should pay attention to these food groups in order to investigate the underlying errors.

Some of the discrepancies were explainable. For instance, the correlation coefficients of the intake of “Total Vegetables” were weak to moderate at baseline (r=0.28) and post-test (r=0.45), with the change across instruments was negative (r=-0.43). Both RDs suggested that they excluded starchy vegetables when assessing food intake, which may partially contribute the discrepancies observed in vegetable intake. Future analysis should make sure that the definition and measurement of food groups are standardized among RDs and researchers.

Some weak and negative correlation of food groups might also be caused by non-consecutive recalls/records. For instance, during the baseline recall, one patient had a few days interrupted due to time conflicts. During the post-test recall/record period, all four patients
had several interruptions on their proposed consecutive recalls/records. Three patients’ recalls/records were collected over a two-week period. As the purpose of setting the 7-day consecutive recall/record was to capture participant’s usual food behaviors over a complete week cycle, multiple interruptions may have disrupted the process.

Also, as there is no official conversion available from equivalent units to CFG units, it is possible that the small discrepancies in conversion added together also contributed to the negative correlations. Memory issues could also play a part in reducing the accuracy of food assessment, especially for senior participants. Even with the help with dietitians, it may be hard for them to accurately recall past food intake.

Besides the general issues explained above, some other incidents could also have contributed to the negative results.

**Baseline Discrepancies:** For discrepancies observed of baseline comparison (‘‘Total Grain Products”, “Total Meat and Alternatives”, “Red Meat”, “Processed Meat” and “Fish/Shellfish”), multiple discrepancies were found in two patients’ DIETQ baseline intake compared to their ASA24 data (mainly grain products and meat intake). The dietitian mentioned that they noticed the patients had challenges in estimating portion size during the baseline food assessment. Thus, the food intake captured by DIETQ likely does not accurately reflect patients’ real intake at baseline. Additionally, the delays in doing the 7-day records as they began the CHANGE program could also have impacted the results. Ideally patients would be familiar with diet assessment methods before the validation study, but having them complete a pre-test may or may not be feasible.

It was interesting to notice that almost all participants reported to the RD that they had less sweetened desserts (ice cream, candies) and beverages at baseline, but the data obtained from ASA24 indicated a much higher intake. The differences of frequencies of consuming sweetened drinks between ASA24 and DIETQ was as high as 5 times (See Table 28). Social desirability bias is well described in diet assessment; it is interesting that self-report was higher and potentially more accurate.

**Post-test discrepancies:** When comparing the post-test data between DIETQ and ASA24, multiple food groups demonstrated negative correlations (n=11). It should be noted that two patients mentioned during the interview that their dietary behaviors were improved during the past three months, but the ASA recall period fell into a stressful time period when they were not able to eat as well. Additionally, one dietitian mentioned that the two patients were not able not come to the three-month session in person due to time conflict, so the food intake was assessed through the telephone. Without visual demonstration of portion sizes, it could also introduce some errors during the post-test food assessment.

To summarize, all these issues could have contributed to errors in this pilot study of four people. Revision of DIETQ design, offering mandatory training of participants, deferral of intervention until after data completion, should improve correlations.

In addition, reflecting on the discrepancies, it is necessary to understand that due to the small
sample size, the results could be heavily skewed by outliers. Even though all the potential outliers were checked with dietitians and the data cleaning procedure recommended by ASA24 was followed, some outliers were unavoidable due to the influence of counselling, possible social desirability bias, and unpredictable time conflicts.

**Comparison with the CHANGEA Study:** Compared to the CHANGE study’s results at three months (113), similar changes associated with positive outcomes were seen in these 4 patients by nutrient analysis (see Table 31); reduced sodium intake (DIETQ: -71mg; CHANGE: -594mg), sugar (DIETQ: -14.5g; CHANGE: -4.4g); decreased CHO intake (DIETQ: 14.3g; CHANGE: 14.6g); total fat percentage over calorie intake (DIETQ: -0.1%; CHANGE: -1.5%), increased protein (DIETQ: 8.0g; CHANGE: 3.0g), and increased protein percentage over calorie intake (DIETQ: 1.1%; CHANGE: 2.2%). Some other significant improvements found only in the DIETQ study were reduced percentage of carbohydrate and sugar intake as a % of calorie consumption, which were 5.4% ($p=0.04$) and 4.1% ($p=0.017$), respectively.

However, when the CHANGE study observed a significant decrease in total energy (-138kcal) and saturated fatty acids (-8.4g), the result of DIETQ indicated that there was a slight increase of total calories (68kcal) and saturated fat intake (2.6g). Similar contradictory observations were found for fiber, vitamin A, vitamin C, vitamin D, potassium and omega 3, which were significantly increased in the CHANGE study at three months, but decreased in this DIETQ study.

The significant decrease found in fiber and folate may be associated with the reduction of total vegetables between baseline and post-test according to the ASA24 (-1.2 servings, see Table 30). Similarly, the reduction in omega-3 fatty acids, mono- and poly-unsaturated fatty acids, may be associated a decrease of fish/shellfish intake at the three months assessed by ASA24 (-3.6 servings, see Table 30).

Similar to the CHANGE study, participants found it was challenging to increase their fish/shellfish and legume intake. At the end of 12 months, CHANGE found there was limited improvement in fish, legume and olive oil intake. ASA24 does not differentiate the kinds of vegetable oil consumed, thus, it was challenging to tell whether the amount of olive oil was increased. According to the post-test DIETQ, every patient mentioned that they used olive oil as the main added fat (baseline: n=3; post-test: n=4), but a reduction of 0.6 tbsp’s captured by ASA24 might also indicate participants’ difficulties in increasing olive oil intake.

In the CHANGE study, the increase of MDS was 1.4 points between baseline (mean: 4.8) and three months (mean: 6.2), and the improvement was maintained to 12 months. The MDS score derived from DIETQ showed an increase of 1.8 points (baseline mean: 6.0, post-test mean: 7.8), which was consistent with the direction of change found in the CHANGE study. Both the DIETQ and ASA24 derived MDS scores suggested that participants in the pilot study had better eating habits at baseline (DIETQ mean: 6.0; ASA24 mean: 6.3), when compared to CHANGE study’s MDS baseline score (mean: 4.8). For DIETQ participants, they might have less room to improve their dietary behaviors; thus, there were subtle improvements found. It also aligned with the observation that no further improvement found in ASA24 derived MDS between the baseline and post-test, as the opportunities of improvement were limited.
The differences of changes found in DIETQ-MDS (mean of differences: 1.8) and ASA24-MDS (mean of differences: 0) between the baseline and post-test could either suggest low concordance of food intake between DIETQ and ASA24, as mentioned previously; or, it may point out MDS’s weak ability to detect subtle changes.

**Strengths of the Pilot study:** The study provided insights on how to improve the design of DIETQ, including a re-classification of food groups to meet counselling targets, and to improve the concordance between DIETQ and ASA24.

Additionally, it generated understanding on how to advance the study procedures. For instance, reflecting on the recruitment strategies, the study should expand its promotion target and arrange interactive solicitation sessions to increase the sample size. The study also assessed patients’ and RDs’ perceived challenges towards the use of ASA24-Canada and DIETQ. More explicit orientations and training sessions are needed for participants prior to the start of the study, especially the emphasis on the required time commitment.

The pilot study also confirmed that ASA24 can be used as a powerful tool for similar validation studies, but more training is needed for participants. Patient participants agreed that ASA24’s visualization of portion sizes, and its detailed steps allowed them to capture food intake more accurately. Despite the fact participants encountered technical issues occasionally, ASA24 routinely upgrades its system according to participants’ feedback. The future version may have these issues fixed.

The study explored dietitians’ attitudes to DIETQ in their daily practices. It also explored dietitians’ opinions on other current, available dietary assessment tools, which provides guidance on the development of a similar tool.

**Limitations of the Pilot Study:** Reflecting on the results of the data analysis, the conversion procedures may not accurately translate the amount of food intake assessed by ASA24 to CFG servings. Further examination and validation are necessary. Also, due to the challenges of time, some participants were not able to complete ASA24 recalls right after the completion of DIETQ assessment. This also may have contributed to the weak and negative correlations of some food groups observed in the study.

The study had a relatively high attrition rate. As previously mentioned, the major challenges for RDs were patient recruiting and time conflicts. One dietitian mentioned the procedures were not clear, especially regarding required time commitment and patient participant’s responsibilities throughout the study. Although detailed instructions were sent to dietitians by email, a detailed orientation through teleconference is needed. Dietitians are usually busy in arranging CHANGE counselling, which left little time available on reading sent materials. An online orientation can emphasize the study procedure and answer RDs’ questions more easily. For patients, the imposed burdens were the difficulties in completing two rounds of 7-day dietary recalls/records and the relatively long research time frame (around three months). Therefore, mandatory trainings on ASA24 and orientations that outline the study’s time commitment are necessary. Detailed modifications are discussed in the next section.
**Recommendations for Next Steps:** To conduct a validation test for assessing individual change in food intake after counselling a much larger sample will be needed, in the range of 100-300 people, depending on how sample size is calculated. Therefore, more efficient recruiting strategies are needed.

For RDs, a detailed orientation is needed to enhance RDs’ engagement. The pilot study pointed out if the recruiting relied only on email communication. Sending recruiting information and orientation doodle by email at the same time will allow researchers to set up online orientations over a relatively short time period; thus, reducing time spent on recruitment. During the process of email communication and online orientation, providing a detailed study schedule will help RDs reduce potential time conflicts that delay the study progress.

Regarding the promotion of DIETQ, establishing collaboration with health institutions will be helpful to attract more users. Except the CHANGE study, numerous institutes also offer similar services to patients in primary care settings, which would be a good resource of recruitment.

In order to reduce patients’ attrition rate, detailed orientations and training will help. Since participants will be well informed about their responsibilities and required time commitment of the study, it is hoped that fewer participants will withdraw from the study due to unexpected challenges.

The burden faced by participants in completing two rounds of 7-day recalls/records suggested that some modifications are necessary to reduce dropouts. As discussed earlier, reducing the number of recalls/records may fail to capture food items that are occasionally consumed and impact the accuracy of food assessment. Several data transforming methods may help researchers to estimate participants’ usual food intake based on fewer days of recalls (≥ 2 days), such as the NCI (161) and ISU (162) methods. In general, based on the results of national dietary surveys, these methods analyzed the possibility of consuming a specific food item/day, in order to develop an estimate of usual intake. These methods are being used for epidemiological studies, but not for validation of individual assessment. One significant issue associated with these methods is that they do not account for intrapersonal variability in food intake estimates. It is known that intrapersonal variabilities in food groups are even greater than the variabilities in nutrients (132); thus, these methods’ accuracy in assessing individual’s food intake is still unknown. A few studies tested these methods by using simulated samples, and compared output of selected nutrients and food groups (163, 164). Both studies found the mean bias was small, but the bias increased as the sample size decreased (163, 164). For instance, Laureano et al. found compared to other similar methods, NCI was less accurate if the sample size was less than 300 (163). Similarly, Souverein et al. noticed bias increased when the sample size was less than 500 (164). Therefore, it was unclear that whether these methods would be applicable to all food groups, or to a smaller sample size. But the methods are worth considering in a future validation study.

Another valuable insight raised by Conrad and Nöthlings (165) is worth considering as well. As previously stated, there were some food groups (e.g., fish/shellfish, legume, etc.) consumed
less frequently by Canadian participants. In light of this, fewer days of 24-h recall may not capture these food groups. However, if ASA24 can be supplemented with a FFQ, which aims to capture the frequency of rarely consumed food groups, fewer days of recalls/records are needed.

Aside from the modifications that could be made to the validation methods, some other arrangements can be applied to the study procedure.

First of all, it noticed that patients usually spent more time in completing the first few recalls, especially senior participants (≥70 y.o.). To better prepare participants for using ASA24, researchers should remind participants who are less proficient in computer use, that the completion time will be longer for them. Also, mandatory training is necessary. Even when patients performed the demonstration recall independently, researchers should guide each patient in completing their first recall/record, as normal procedure. This will be an effective way to teach recall techniques and rehearse data entry skills. In addition, researchers should develop solutions to common problems identified by participants regarding the completion of ASA24 recalls/records. For instance, the ASA24 user guide does not address that some food items cannot be found if its singular form is entered in the research bar.

Secondly, if recall/record of a comprehensive diet is burdensome for participants, to have them recall/record key food groups relevant to cardiometabolic diseases may be helpful, but it is not applicable if ASA24 is used as a validation tool. Thus, the validation tool would need to be another dietary record or dietary history instrument. This method is less applicable because it means another pilot validation is needed.

To conclude, providing detailed orientation and training to RDs and patients may be the best way to maintain their involvement and reduce dropouts, while maintaining the accuracy of the validation.

Regarding the validation process, the unit conversion procedure needs to be standardized. Although the master’s student checked the procedure multiple times, systematic errors could still exist. It is necessary for different researchers to check the conversion protocols and achieve a consensus in unit conversion. In addition, due to the limited research period, the master’s student could only convert the units of typical food items. It will be more accurate to convert each individual food ingredient by using CFG units and categorize them based on food groups. It is possible to do so with the updated ASA24 system and a larger team to analyze the validation of the conversions.

Reflecting the low concordance found in some food groups between DIETQ and ASA24, it is necessary to standardize the assessment procedures to enhance the accuracy of the validation. Two strategies can be used to resolve the issues identified in the pilot study. Firstly, it should achieve a consensus of the definition of each food group with RD participants through a detailed orientation. Discussing the inclusion and exclusion criteria of each food group with RDs will help reduce the errors in assessing food intake. The establishment of such standards had already been done by previous students as the CHANGE study progresses, but the pilot study suggested that engaging new participants would still need a review and discussion of the relevant topics. Secondly, regarding observed discrepancies in food intake, patient participants should only start
the 7-day recalls/records when they have time to do so consecutively. It is also suggested for RDs to deferral intervention unless participants completed the baseline recalls and assessment, and to perform baseline and post-test assessment right after participants’ completion of 7-day recalls/records (within one day), in order to achieve a good concordance of recalling period and to reduce the impact of undergoing counselling on dietary behaviors. Nevertheless, while this approach may enhance the consistency of the study, it may also impact the study’s generalizability. In practical settings, most patients who come for dietary counselling may not have necessary knowledge (e.g., portion size) to accurately complete the questionnaire. Therefore, their first food assessment using DIETQ, may have reduced estimation accuracy compared to participants who have previously completed 7-day recalls/records prior to completing the baseline assessment in the proposed study.

For future validation that will have a large sample size, the study could examine the correlation between food and diseases by incorporating biomarkers and the changes of anthropometric data. These data can be obtained through the CHANGE’s database, which can be used to establish the relationships between food intake and health outcomes.

Chapter 8: Conclusions

This pilot study provided valuable insights on improving the design of DIETQ and it explored the possible improvements that could be made in preparation for the national-level validation, including changes could be made on recruiting strategies and data analysis procedures. The study also indicated that DIETQ is a promising tool to be used in Canadian settings for accurate dietary assessment.

By having two rounds of 7-day recalls/records delivered by ASA24-Canada is applicable for the national validation. It is important to note that participants found it challenging to remain a part of this study due to high time commitment; thus, to prepare participants with mandatory training sessions and detailed orientations is necessary.
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## APPENDIX

**Appendix 1: Diet Quality Monitoring Tool (DIETQ) and Conversion**

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Food item</th>
<th># Average Daily or Weekly Servings</th>
<th>Comments (e.g. prepared /contains added, fat, sugar, salt?)</th>
</tr>
</thead>
</table>
| 1           | **Total Fruit** (not including juice)  
1 serving = 1 fruit, ½ cup (125 mL, ~100g) fresh or frozen | servings/day | |
| 2           | **Fruit juice**  
1 serving = ½ cup (125 mL) 100% fruit juice | servings/day | |
| 3           | **Total Vegetables**  
1 serving = ½ cup (125 mL, 100g) fresh, frozen or cooked, or 1 cup (250 mL) raw leafy vegetables | servings/day | |
|             | **Dark Green/ Orange Vegetables**  
1 serving = ½ cup (125 mL, 100g) fresh, frozen or cooked, or 1 cup (250 mL) raw leafy vegetables | servings/day | |
| 4           | **Total Grain products**  
1 serving = 1 slice bread or ½ cup (125 mL) cooked rice or pasta, or ¼ cup (175 mL, 30 g) cereal | servings/day | |
|             | **Whole Grain products**  
1 serving = 1 slice bread or ½ cup (125 mL) cooked rice or pasta, or ¼ cup (175 mL, 30 g) cereal | servings/day | |
| 5           | **Total Milk and Alternatives**  
1 serving = 1 cup (250 mL) milk or fortified soy beverage, ¼ cup (175 g) yogurt or kefir, or 1½ oz (50 g) cheese | servings/day | |

Client ID: ____________________________________________________
<table>
<thead>
<tr>
<th>Item Number</th>
<th>Food item</th>
<th># Average Daily or Weekly Servings</th>
<th>Comments (e.g. prepared /contains added, fat, sugar, salt?)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td><strong>Total Meat and Alternatives</strong></td>
<td>servings/day</td>
<td></td>
</tr>
<tr>
<td>6.1</td>
<td>Red meat</td>
<td>servings /week</td>
<td></td>
</tr>
<tr>
<td>6.2</td>
<td>Processed Meat (hotdog, bacon, luncheon meat, etc.)</td>
<td>servings /week</td>
<td></td>
</tr>
<tr>
<td>6.3</td>
<td>Poultry (chicken, turkey)</td>
<td>servings /week</td>
<td></td>
</tr>
<tr>
<td>6.4</td>
<td>Legumes (canned, cooked, fresh beans, lentils, chickpeas, etc)</td>
<td>servings /week</td>
<td></td>
</tr>
<tr>
<td>6.5</td>
<td>Fish/Shellfish</td>
<td>servings /week</td>
<td></td>
</tr>
<tr>
<td>6.6</td>
<td>Nuts (including peanuts) unsalted</td>
<td>servings /week</td>
<td></td>
</tr>
<tr>
<td></td>
<td>*Nuts (including peanuts) salted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td><strong>Added Fats / Oils in cooking and eating</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type of main cooking oil</td>
<td>Tbsp/day</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Butter or hard margarine</td>
<td>Tbsp/day</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Olive oil as main added fat?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Vegetables, pasta, rice or other dishes seasoned with <strong>sofrito sauce</strong></td>
<td>Times/week</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(i.e. sauce made with tomato, onion, leek, garlic, simmered with olive oil)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Report the following as **Average Daily OR Weekly Intake in actual amounts (mL, g or cups, oz)**

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Other foods</th>
<th>Average daily intake (size or amount)</th>
<th>Average weekly intake (size or amount)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Alcohol (excluding wine) 1.5 oz hard liquor; 12 oz beer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Wine 4 oz glass</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Report the following as **Average Daily OR Weekly Intake** in actual amounts (mL, g or cups, oz)

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Other foods</th>
<th>Average daily intake (size or amount)</th>
<th>Average weekly intake (size or amount)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Commercial Baked goods (e.g. cakes, cookies, pie, muffins, doughnuts, granola bars, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Ice cream, other desserts including smoothies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Chocolate, candies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Salty/savory snack foods (e.g. French fries, potato chips, nachos, crackers, pretzels, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Sweetened drinks (e.g. pop, fruit drinks, sports drinks, hot or cold chocolate or specialty drinks, etc.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*subsection

**Number of meals / snacks eaten at home**

_________ meals/week  _________ snacks/week  

**Types** - prepared, packaged foods (e.g. frozen dinners, instant, etc.)

_________ times/week  

**Frequency of eating out or take-out**

_________ times / week
Diet Score Conversion Tables between DIETQ and MEDAS (PREDIMED)

<table>
<thead>
<tr>
<th>Items Number</th>
<th>Items in DIETQ</th>
<th>Serving Requirement</th>
<th>Items in MEDAS</th>
<th>Serving Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1: the # of servings total fruit (not including juice)/d 2: fruit juice/d</td>
<td>≥ 3 servings/d 1 serving = 1 fruit, ½ cup (125 mL, ~100g) fresh or frozen</td>
<td>the # of fruit units/d (including fruit juice)</td>
<td>≥3 units/d</td>
</tr>
<tr>
<td>2</td>
<td>3: the # of servings of total vegetables/d</td>
<td>≥ 4 servings/d (≥2 servings raw or as a salad), 1 serving = 1 fruit, ½ cup (125 mL, ~100g) fresh or frozen; side dishes as 1/2 serving</td>
<td>the # of vegetable servings/d</td>
<td>≥2 servings/d (≥1 serving/d raw or as a salad) 200g=1 serving, [side dishes as 1/2 serving]</td>
</tr>
<tr>
<td>3</td>
<td>6.1: the # of servings of red meat/d 6.2: the # of servings of processed meat/d</td>
<td>red meat: &lt; 1 serving/d processed meat: &lt; 1 serving/d total: red meat or processed meat &lt; 2 servings/d 1 serving=2½ oz (75 g)</td>
<td>the # of servings of red meat, hamburger, or meat products (ham, sausage, etc.)/d?</td>
<td>&lt;1 serving/d 1 serving=100-150g</td>
</tr>
<tr>
<td>4</td>
<td>6.3: the # of servings poultry consumed/week</td>
<td>consuming poultry more often than red meat</td>
<td>consuming chicken, turkey or rabbit meat instead of veal, pork, hamburger or sausage</td>
<td>yes</td>
</tr>
<tr>
<td>5</td>
<td>6.4: the # of legumes consumed/week</td>
<td>≥3 servings/week 1 serving = ¼ cup (175 mL)</td>
<td>the # of legumes consumed/week</td>
<td>≥3 servings/week 1 serving=150g</td>
</tr>
<tr>
<td>6</td>
<td>5: the # of fish or shellfish consumed/week</td>
<td>fish: ≥4 servings/week shellfish: ≥6 servings/week 1 serving = 2½ oz (75 g)</td>
<td>the # of fish or shellfish consumed/week</td>
<td>≥3 servings/week 1 serving: 100-150 g fish 4-5 units 200 g shellfish</td>
</tr>
<tr>
<td>7</td>
<td>8.6: the # of servings of nuts (including peanuts) consumed/week</td>
<td>≥3 servings/week 1 serving = ¼ cup (60 mL) shelled nuts or 2 tbsp (30 mL) nut butters</td>
<td>the # of servings of nuts (including peanuts) consumed/week</td>
<td>≥3 servings/week 1 serving=30g</td>
</tr>
<tr>
<td>8</td>
<td>7: the # and type of cooking oil/d</td>
<td>Vegetable oil: 2-3 tbsp/day (if no olive oil consumed) or olive oil: ≥4 tbsp/d</td>
<td>the # of olive oil /d</td>
<td>≥4 tbsp/d</td>
</tr>
<tr>
<td>9</td>
<td>7: the # of margarine/butter consumed/d</td>
<td>Margarine/butter: &lt; 1 tbsp/d</td>
<td>the # of margarine/butter/cream consumed/d</td>
<td>&lt;1 serving/d 1 serving=12g</td>
</tr>
<tr>
<td>10</td>
<td>8: using olive oil</td>
<td>yes</td>
<td>using olive oil as the</td>
<td>yes</td>
</tr>
<tr>
<td>Items Number</td>
<td>Items in DIETQ</td>
<td>Serving Requirement</td>
<td>Items in MEDAS</td>
<td>Serving Requirement</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------</td>
<td>---------------------</td>
<td>----------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>11</td>
<td>9: using Sofrito sauce/week</td>
<td>≥2 times/week</td>
<td>using Sofrito sauce/week</td>
<td>≥2 times/week</td>
</tr>
<tr>
<td>12</td>
<td>11: wine/week</td>
<td>≥7 / week</td>
<td>wine/week</td>
<td>≥7 glasses/ week</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 serving = 3 oz - 6 oz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>14: the # of times commercial baked goods (e.g. cakes, cookies, pie muffins, doughnuts, granola bars, etc.) consumed per week</td>
<td>&lt;2 times/week</td>
<td>the # of times of commercial sweets or pastries (not homemade), such as cakes, cookies, biscuits, or custard consumed per week</td>
<td>&lt;3 times/week</td>
</tr>
<tr>
<td>14</td>
<td>18: the # of sweetened drinks (e.g. pop, sports drinks, hot or cold chocolate or specialty drinks, etc.)/d</td>
<td>&lt;1 time /d</td>
<td>the # of sweet/carbonated beverages consumed/d?</td>
<td>&lt;1 time /d</td>
</tr>
</tbody>
</table>

Total score

* One score is assigned to each food group that achieves the amount of recommendation, with a maximum of 14.
## Diet Score Conversion Table between DIETQ and FHT-based MDS

<table>
<thead>
<tr>
<th>Items Number</th>
<th>Items in DIETQ</th>
<th>Serving Requirement</th>
<th>Items in FHT-MDS</th>
<th>Serving Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1: the # of servings total fruit (not including juice)/d 2: fruit juice/d</td>
<td>≥ 3 servings/d 1 serving = 1 fruit, ½ cup (125 mL, ~100g) fresh or frozen</td>
<td>the # of fruit units/d (not including fruit juice)</td>
<td>≥ 3 servings/d 1 serving = 1 whole fruit or ½ cup</td>
</tr>
<tr>
<td>2</td>
<td>3: the # of servings of total vegetables/d</td>
<td>≥ 4 servings/d (≥ 2 servings raw or as a salad) 1 serving = 1 fruit, ½ cup (125 mL, ~100g) fresh or frozen; side dishes as 1/2 serving</td>
<td>the # of vegetable servings/d</td>
<td>≥ 2 servings/d 1 serving = ½ cup raw/cooked or 1 cup salad greens</td>
</tr>
<tr>
<td>3</td>
<td>8.1: the # of servings of red meat/d 8.2: the # of servings of processed meat/d</td>
<td>red meat: &lt; 1 serving/d processed meat: &lt; 1 serving/d 1 serving = 2½ oz (75 g)</td>
<td>the # of servings of red meat, hamburger, or meat products (ham, sausage, etc.)/d</td>
<td>&lt; 1 serving/d 1 serving = 1 CFG serving?</td>
</tr>
<tr>
<td>4</td>
<td>8.3: the # of servings poultry consumed/week</td>
<td>consuming poultry more often than red meat</td>
<td>routinely consuming chicken, turkey or rabbit meat instead of veal, pork, hamburger or sausage</td>
<td>yes</td>
</tr>
<tr>
<td>5</td>
<td>6.4: the # of legumes consumed/week</td>
<td>≥ 3 servings/week 1 serving = ¼ cup (175 ml)</td>
<td>the # of legumes consumed/week</td>
<td>≥ 3 servings/week 1 serving = ½ 2/3 cup</td>
</tr>
<tr>
<td>6</td>
<td>6.5: the # of fish or shellfish consumed/week</td>
<td>fish: ≥ 4 servings/week shellfish: ≥ 6 servings/week 1 serving = 2½ oz (75 g)</td>
<td>the # of fish or shellfish/seafood consumed/week</td>
<td>≥ 3 servings/week 1 serving: 100-150 g or 3.5-5 oz fish: 4-5 pieces of seafood</td>
</tr>
<tr>
<td>7</td>
<td>6.6: the # of servings of nuts (including peanuts) consumed/week</td>
<td>≥ 3 servings/week 1 serving = ¼ cup (60 mL) shelled nuts or 2 Tbsp (30 mL) nut butters</td>
<td>the # of servings of nuts (including peanuts) consumed/week</td>
<td>≥ 3 servings/week 1 serving = 30g</td>
</tr>
<tr>
<td>8</td>
<td>7: the # and type of cooking oil/d</td>
<td>vegetable oil: 2-3 tbsp/day (if no olive oil consumed) or olive oil: ≥ 4 tbsp/d</td>
<td>the # of olive oil/d</td>
<td>≥ 4 tbsp/d</td>
</tr>
<tr>
<td>9</td>
<td>7: the # of margarine/butter consumed/d</td>
<td>&lt; 1 tbsp/d</td>
<td>the # of margarine/butter/cream consumed/d</td>
<td>&lt; 1 tbsp/d</td>
</tr>
<tr>
<td>Items Number</td>
<td>Items in DIETQ</td>
<td>Serving Requirement</td>
<td>Items in FHT-MDS</td>
<td>Serving Requirement</td>
</tr>
<tr>
<td>--------------</td>
<td>----------------</td>
<td>---------------------</td>
<td>------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>10</td>
<td>8: Using olive oil as the main added fat</td>
<td>yes</td>
<td>using olive oil as the main added fat</td>
<td>yes</td>
</tr>
<tr>
<td>11</td>
<td>9: using Sofrito sauce/week</td>
<td>≥2 times/week</td>
<td>using Sofrito sauce/week</td>
<td>≥2 times/week</td>
</tr>
<tr>
<td>12</td>
<td>11: wine/week</td>
<td>≥7 servings/ week</td>
<td>wine/week</td>
<td>≥3 glasses/ week</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 serving = 3 oz - 6 oz</td>
<td></td>
<td>1 glass=150ml or 5oz</td>
</tr>
<tr>
<td>13</td>
<td>12: the # of times commercial baked goods (e.g. cakes, cookies, pie muffins, doughnuts, granola bars, etc.) consumed per week</td>
<td>&lt;2 times/week</td>
<td>the # of times of commercial sweets or pastries (not homemade), such as cakes, cookies, biscuits, or custard consumed per week</td>
<td>&lt;2 times/week</td>
</tr>
<tr>
<td>14</td>
<td>16: the # of sweetened drinks (e.g. pop, sports drinks, hot or cold chocolate or specialty drinks, etc.)/d</td>
<td>&lt; once /day</td>
<td>the # of sweet/carbonated beverages consumed/d?</td>
<td>&lt;1 can /d</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 can=355ml or 12oz</td>
</tr>
</tbody>
</table>

Total score
Appendix 2: Baseline and Post-test Interview Questions for RD

RD Baseline Interview Protocol and Questionnaire

Anonymous Interviewee ID:
Interviewer:
Date of Interview:
Time of Interview:

Hello, my name is XXX (self-introduction). Recently, you administered a questionnaire called the DIETQ to two patients in your practice receiving nutrition counselling to decrease cardiometabolic risk factors.

Thank you for agreeing to participate in a research interview about your perspectives with this questionnaire.

We distributed a letter with information about the study recently. Did you receive this letter and have you had the opportunity to read it? Do you have any questions? Is this still a good time to complete the interview?

I am going to be asking you questions about your perspectives with the DIETQ questionnaire. This is a conversation more than anything and it should take up to 15 minutes.

Is it ok if I audiotape the interview? This will allow me to accurately capture what was said.

I want to stress that everything that you say here is confidential and will only be heard by members of the research team. You won’t be identified personally. As well, if you are not comfortable answering any questions, please let me know and we can skip them. Likewise, if you do not want to continue the interview at any point, please let me know and we can stop.

Do you have any questions before we begin? I am going to turn on the voice recorders now.

About You:
1. Birthdate _____________
2. Gender ________ (Male, female, other) What is your self-identified gender?
3. Advanced or other formal education beyond RD (e.g. CDE, MSc, MBA) _________________

Work History:
4. How many years have you been a RD? Including periods when you may have worked part-time, or been seeking work?
5. How many years have you been working in primary care as a Registered Dietitian, including part-time work?

Recruitment and Adjustments to Protocol:
6. How are patients recruited into the CHANGE program in your workplace? Will you be using the script, email and letter of Information? Do you need any modification or different resources?
7. Are there any modifications needed in the study protocol in your view for your setting?

Use of Selected Diet Assessment Tools:
8. How many of the following diet assessment tools have you ever used or had clients use in diet counselling and recording of food intake? Please discuss the context and how you used the tools?
9. Rate the frequency of use of each tool in your current counselling.

<table>
<thead>
<tr>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Most Clients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Brief Food Frequency Questionnaires

- Healthy Eating Index
- Mediterranean Diet Score (any version)
- Canada’s Food Guide as FFQ
- DASH score
- Other nutrition screeners (describe)

Online Diet Assessment Tools

- eaTracker
- ESHA/Food Processor
- ASA24 (any version)
- My Fitness Pal
- EatThisMuch.com
- Other

Orientation to ASA24 and DIETQ:
10. Let's review the ASA24 directions. You will not need to be involved in this aspect of data collection. Do the instructions need any modification? Are the instructions clear? If not, what needs to be revised?
11. If you are interested, you can try the ASA24 program. Are you interested in doing that? I will send the link.
12. Do you have a copy of the DIETQ? Any questions about the layout or content? (We have used the 2007 Canada’s Food Guide servings.)

Communication:
13. Finally, what is the best way to communicate with you, so we ensure patients experience the study as seamless. I need at least one email address and a phone number.
14. Any other issues we need to review?

Interview Closure:
Is there anything else that you would like to add to what we discussed today?

I am very appreciative of the valuable information that you provided today. It will go a long way in helping us to improve these types of tools for dietitians. Thank you again for completing the interview.
Anonymous Interviewee ID:
Interviewer:
Date of Interview:
Time of Interview:
Interview method: telephone

Hello again, Yiran Wang here. Now we have completed the DIETQ diet data collection part of the study, we are doing a final interview with both dietitians and participants. Your comments will help us design a larger study, so are very important for identifying more subtle issues or challenges we could not identify. I am going to be asking you questions about your perspectives with the DIETQ questionnaire. This is a conversation more than anything and it should take up to 10-15 minutes. Did you receive the questions by email when we were arranging this phone call?

Is it ok if I audiotape the interview? This will allow me to accurately capture what was said. I want to stress that everything that you say here is confidential and will only be seen by members of the research team. You won’t be identified personally. As well, if you are not comfortable answering any questions, please let me know and we can skip them. Likewise, if you do not want to continue the interview at any point, please let me know and we can stop.

Do you have any questions before we begin? I am going to turn on the voice recorders now. Turn to Interview Questions

1. With how many clients did you administer the DIETQ questionnaire?
2. How many minutes did it take you to administer the DIETQ questionnaire each time with a client?
3. How many minutes did it take you to score the DIETQ questionnaire each time you used it with a client?
4. On a scale of 1 to 5 (1=poor, 2=fair, 3=good, 4=very good, 5=excellent), how would you rate the feasibility of administering the DIETQ questionnaire with clients? Please explain.
5. On a scale of 1 to 5 (1=poor, 2=fair, 3=good, 4=very good, 5=excellent), how would you rate the acceptability of using the DIETQ questionnaire with clients? Please explain.
6. On a scale of 1 to 5 (1=poor, 2=fair, 3=good, 4=very good, 5=excellent), how well do you think the DIETQ questionnaire captures the changes in dietary intake over a three-month period of the CHANGE program? Please explain.
7. Is there any dietary information that is not captured with the DIETQ that is a focus of your nutrition counseling with patients in the CHANGE program? Are there any redundancies in the dietary information that is captured?
8. What did you like about the DIETQ questionnaire?
9. What did you dislike about the DIETQ questionnaire?
10. Is there anything that you would recommend changing in the DIETQ questionnaire?
11. Were there any challenges with participating in the pilot study you would like to bring to our attention, to avoid in the future?
12. Any other suggestions or comments?

Interview Closure:
Is there anything else that you would like to add to what we discussed today?

I am very appreciative of the valuable information that you provided today. It will go a long way in helping us to improve these types of tools for dietitians. Thank you again for completing the interview.
Appendix 3: Baseline and Post-test Interview Questions for Patients

Patients Baseline Interview Protocol and Questionnaire

Anonymous Interviewee ID:
Interviewer:
Date of Interview:
Time of Interview:

Hello. My name is XXX (self-introduction). Recently, your dietitian administered a questionnaire called the DIETQ to you during some of your nutrition counselling sessions.

Thank you for agreeing to participate in a research interview about your perspectives with this questionnaire.

We distributed a letter with information about the study recently. Did you receive this letter and have you had the opportunity to read it? Do you have any questions? Is this still a good time to complete the interview?

I am going to be asking you questions about your perspectives with the DIETQ questionnaire. This is a conversation more than anything and it should take up to 15 minutes.

Is it ok if I audiotape the interview? This will allow me to accurately capture what was said. I want to stress that everything that you say here is confidential and will only be heard by members of the research team. You won’t be identified personally. As well, if you are not comfortable answering any questions, please let me know and we can skip them. Likewise, if you do not want to continue the interview at any point, please let me know and we can stop.

Do you have any questions before we begin? I am going to turn on the voice recorders now.

About You:
1. Birthdate ______________ MM/DD/YYYY
2. Gender __ (Male, female, other) What is your self-identified gender?
3. Education
What is the highest level of school or education you have completed or the highest degree you have received? __________
4. Working status - Please put yourself into one of the following categories
1= Employed | 2= Part-time (including on-call, on sabbatical or seasonal work) 3=Unemployed | 4=Student | 5=Retired or On disability | 6=Other
5. Household Members
   a. Number of people currently living in the household _______
   b. Do you have a spouse or partner in the household _____ Y/N
6. Food Purchasing and Preparation
   a. Number of eating occasions (e.g. beverages, snacks, meals) away from home, delivered ready to eat or as a takeaway from a food outlet (on average or in the past month) _______
   b. How much of the household grocery shopping do you do? _______
      1= Most of it; 2= less than half; 3= None or almost none of it
   c. How much of the household cooking do you do? _______
      1=Most of it; 2= Less than half; 3=None or almost none of it
7. Body measurements
   a. Height __________
   b. Weight __________
8. Computer Use
   1=Never tried 2=Not at all 3=Not very easily 4= Somewhat easily 5=Very easily
I can:
a. Use a computer to enter events and appointments into a calendar ________
b. Use a computer to watch movies and videos ________
c. Find information about my hobbies and interests on the Internet ________

9. **Previous Food Record Experience**
   a. Have you ever completed a food record? Y/N
   b. If Yes, can you describe the context?
   c. Are you currently on any kind of special diet that has been prescribed/suggested by a health professional as a treatment Y/N
   d. Are you currently on any kind of special diet that has NOT been prescribed/suggested by a health professional as a treatment? Y/N
   e. Have you ever used an online diet assessment apps (examples: My Fitness Pal, eaTracker)? Y/N
   f. If Yes, can you describe the context?
Hello again, Yiran Wang here. Now we have completed the DIETQ diet data collection part of the study, we are doing a final interview with both dietitians and participants. Your comments will help us design a larger study, so are very important for identifying more subtle issues or challenges we could not identify. This is a conversation more than anything and it should take up to 10-15 minutes. Did you receive the questions by email when we were arranging this phone call?

Is it ok if I audiotape the interview? This will allow me to accurately capture what was said.

I want to stress that everything that you say here is confidential and will only be heard by members of the research team. You won’t be identified personally. As well, if you are not comfortable answering any questions, please let me know and we can skip them. Likewise, if you do not want to continue the interview at any point, please let me know and we can stop.

Do you have any questions before we begin? I am going to turn on the voice recorder now.
1. On a scale of 1 to 5 (1=poor, 2=fair, 3=good, 4=very good, 5=excellent), how would you rate the ease of answering the DIETQ questions? Please explain.
2. On a scale of 1 to 5 (1=poor, 2=fair, 3=good, 4=very good, 5=excellent), how well do you think the DIETQ questionnaire captured changes in your diet over the three-months of the CHANGE program. Please explain.
3. Is there any dietary information that is not captured with the DIETQ that was a focus of your changing diet? Are there any redundancies in the dietary information that is captured?
4. On a scale of 1 to 5 (1=poor, 2=fair, 3=good, 4=very good, 5=excellent), how would you rate your experience in doing the diet recalls using the ASA24-Canada-2016. Please explain.
5. Were there any challenges with participating in the pilot study you would like to bring to our attention, to avoid in the future?
6. Any other suggestions or comments?

Interview closure:
Is there anything else that you would like to add to what we discussed today?

I am very appreciative of the valuable information that you provided today. It will go a long way in helping us to improve these types of tools for dietitians. Thank you again for completing the interview.
Appendix 4: Inclusion and Exclusion Criteria of Patients

Patient Inclusion Criteria:
1: ≥18 years old
2: Meets 3 out of the 5 criteria for metabolic syndrome i.e.,
   a. Blood Pressure of > 130/85 mm Hg or receiving pharmacotherapy
      • both systolic and diastolic have to be beyond these ranges
   b. Fasting Blood Glucose > 5.6 mmol/L or receiving pharmacotherapy
   c. Fasting Triglyceride of > 1.7 mmol/L or receiving pharmacotherapy
   d. Fasting HDL-C < 1.0 mmol/L males and <1.3 mmol/L females
   e. Abdominal circumference as determined by a pre-specified technique:
      • Canadian and US Whites, Europids, Whites, sub-Saharan Africans, Mediterranean, middle east (Arab)
      Or ethnicity unknown
         > 94 cm Males, 80 cm Females
      • Asian and South-Central Americans
         > 90 cm Males and 80 cm Females
3: Could understand and communicate in English

Exclusion Criteria:
1. Diagnosis of Type 1 diabetes mellitus
2. Advanced stage of type 2 diabetes mellitus defined as severe hyperglycemia > 11 mmol/L. However, can be enrolled if blood sugars are stabilized i.e. FBS < or equal to 11 mmol/L with medication prior to starting of the program
3. Significant medical co-morbidities, including uncontrolled metabolic disorders (e.g., thyroid, renal, liver), stroke, and ongoing substance abuse
4. Clinically significant renal failure, as per Family MDs discretion
5. Diagnosis of psychiatric disorders (cognitive impairment) that would limit the ability to comply with the program
6. Diagnosis of cancer (other than non-melanoma skin cancer) that was active or treated with radiation or chemotherapy within the past 2 years or a terminal illness and/or in hospice care
7. Pregnant, lactating or planning to become pregnant during the program
8. Clinically active chronic inflammatory diseases
9. Body Mass Index >40
Participants with an of BMI 35-40 is likely to respond to diet/exercise in the long term, may enroll with caution. However, BMI >40 not expected to see improved outcomes with program hence do not enroll.
10. Use Saxenda (Liraglutide, Trade name Victoza)
Participants who are on Saxenda may experience weight loss, thus researchers will not be able to attribute the changes in the individual’s response to lifestyle change if they are on Saxenda.

*the inclusion/exclusion criteria of this study are adapted from the CHANGE study. Consistency with the CHANGE study’s inclusion/exclusion criteria allows researchers to compare the data between this pilot validations study and the CHANGE study. Thus, we still kept the 9th and 10th exclusion criteria even though the pilot validation only focused on 3-month dietary counselling.
Appendix 5: Invitation Email for EDs, RDs, and Patients

Recruitment Email for Executive Directors (ED) or Administrative Lead for CHANGE Program Implementation

Subject line: The Diet Quality Monitoring (DIETQ) Pilot Study (REB# 18-11-037)

Dear XXXX (individual name):

Thank you for Family Health Team’s participation in the CHANGE Program.

I am one of the members of the team that developed the CHANGE Program and I am writing to see if it would be possible to have your Registered Dietitian (RD) who is involved in CHANGE, help us with a small pilot study on diet assessment, provided she is interested in volunteering.

I have been working closely with Metabolic Syndrome Canada to ensure that the CHANGE Program continues to maintain a good balance between being evidence-based and feasible. As you may know, I have provided the CHANGE diet training to your RD and we have identified that there is a need for better tools that reflect Canadian eating habits.

My team has developed such an adapted tool (called DIETQ), but it needs to be pilot-tested and validated. We are looking for up to 5 RDs to assess diet with about 10 patients from all the FHTs that are offering CHANGE. If you would approve, this would mean that your RD would identify 1 or 2 CHANGE patients from your FHT and the patients would follow the steps outlined on the next page. We have designed the study to be separate from CHANGE and patient care, both to meet patient privacy and security requirements and to minimize any effects on the CHANGE program. We have also minimized RD workload as much as possible.

Below we outline the research process plan for both RDs and patients.

Procedures for RDs (estimated additional time per patient ~ 2 hours total)

1. Once the RD agrees to participate, the graduate student (Yiran Wang) will arrange a telephone call to get RD consent and orient them to all the study procedures and what is expected of patient participants.
2. The RD will work with the organization team to identify the best way to solicit patients who may wish to participate. It is expected that methods of identifying possible volunteer patients will vary by organization. Methods could include advertising the opportunity at a patient information session, a broadcast email to all people on the waitlist for the next CHANGE program, or in conversation with individual patients.
3. RD to give the Letter of Information on the study to the interested patient. Patients are to be recruited BEFORE the diet counselling baseline assessment of the CHANGE program. Prospective participants contact the graduate student, Yiran Wang, directly to express interest in the study.
4. After Yiran advises RD of participant consent obtained, RD does baseline assessment using new DIETQ, instead of current CHANGE diet form. The new DIETQ can be used to calculate the same score as the current diet form.
5. RD contacts Yiran to let her know when baseline assessment is done, so Yiran can work with the participant to get 7 days of diet recalls done (see below).
6. RD does CHANGE program with the participant, as per usual.
7. RD arranges 3-month CHANGE appointment with participant and emails Yiran to let her know, so Yiran can arrange follow-up diet recalls with the participant.
8. RD does 3-month assessment using DIETQ; not current CHANGE diet form.
9. When all participants at the organization have completed the study, Yiran will contact RD for telephone interview to review RD experience. Takes 10-15 minutes to complete.
Procedures for patient participants ($100 honorarium/participant)
U of Guelph graduate student, Yiran Wang to coach the participant through the steps.

1. Interested patients email U of Guelph graduate student, Yiran Wang, for the phone interview.
2. Each participant has two interviews with Yiran by telephone before baseline CHANGE visit.
3. 1st interview – consent, demographic info and explain the online diet system. Yiran will attach the online recall information and ask if they would prefer to complete 7 days of online diet recalls themselves or be interviewed each day to complete the online recall (~15-20 minutes).
4. 2nd interview – Yiran does a trial run of completing a diet recall with the participant by phone and answers their questions, etc. for training purposes. This is done before the baseline RD assessment (20-40 minutes).
5. Shortly after the baseline RD visit, the participant completes 7 days of diet recalls with Yiran.
6. The participant goes through the CHANGE lifestyle program.
7. Shortly after the 3-month RD assessment, the participant completes 7 days of diet recalls using the same diet record system as at baseline with Yiran.
8. Once diet recalls are done, the participant completes a telephone interview with Yiran on the study experience and use of the online system. Takes 10-15 minutes to complete.

If you agree, we will need a letter of support from the responsible administrator of your FHT, to meet requirements for University of Guelph ethics approval.

Thanks for considering this important study that will provide a valuable tool for your RDs. Please contact me if you would like to discuss further, have any questions or need additional details on the study.

Sincerely

Paula Brauer, PhD, RD, FDC | Associate Professor
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519-824-4120 Ext. 54831 | pbrauer@uoguelph.ca
Webpage: http://www.uoguelph.ca/family/faculty/brauer-paula
Google Scholar: https://scholar.google.ca/citations?user=VpgnLmlAAAAJ&hl=en
Recruitment Email for Registered Dietitians Working on CHANGE Program Implementation

Subject line: The Diet Quality Monitoring (DIETQ) Pilot Study (REB#18-11-037)

Dear XXXX (individual name):

Thank you for your participation in the CHANGE Program.

As you know, I am a member of the original research team who developed the CHANGE Program and I have been working closely with Metabolic Syndrome Canada to ensure that the CHANGE continues to maintain a good balance between being evidence-based and feasible. Your participation in offering and evaluating the diet aspects of the program is central to this effort.

I am emailing you now to see if you would be interested in helping us with a small pilot study on diet assessment, on a voluntary basis. As you will agree, there is a need for better diet assessment tools in counselling that capture diet changes, reflect Canadian eating habits and are specific to cardiovascular risk and diabetes.

The proposed work is being undertaken by my team and we have developed an adapted tool (called DIETQ) but it needs to be pilot-tested and validated. We are looking for up to 5 RDs to assess diet with about 10 patients (each RD will identify 1-2 patients at the most). The tool will be validated against 7 days of diet recalls. See steps outlined on the next page.

We have designed the study to be separate from CHANGE and patient care, both to meet patient privacy and security requirements and minimize any effects on the CHANGE program. We have also minimized RD workload as much as possible. Rupinder Dhaliwal is a co-investigator on the project, in addition to several other diet assessment researchers. We are hoping to submit for a national study next year.

Below we outline the research process plan for both RDs and patients.

Procedures for RDs (estimated additional time per patient ~ 2 hours total)

1. Once the RD agrees to participate, the graduate student (Yiran Wang) will arrange a telephone call to get RD consent and orient them to all the study procedures and what is expected of patient participants.
2. The RD will work with the organization team to identify the best way to solicit patients who may wish to participate. It is expected that methods of identifying possible volunteer patients will vary by organization. Methods could include advertising the opportunity at a patient information session, a broadcast email to all people on the waitlist for the next CHANGE program, or in conversation with individual patients.
3. RD to give the Letter of Information on the study to the interested patient. Patients are to be recruited BEFORE the diet counselling baseline assessment of the CHANGE program.
4. After Yiran advises RD of participant consent obtained, RD does baseline assessment using new DIETQ, instead of current CHANGE diet form. The new DIETQ can be used to calculate the same score as the current diet form.
5. RD contacts Yiran to let her know when baseline assessment is done, so Yiran can work with the participant to get 7 days of diet recalls done (see below).
6. RD does CHANGE program with the participant, as per usual.
7. RD arranges 3-month CHANGE appointment with participant and emails Yiran to let her know, so Yiran can arrange follow-up diet recalls with the participant.
8. RD does 3-month assessment using DIETQ; not current CHANGE diet form.
9. When all participants at the organization have completed the study, Yiran will contact RD for a telephone interview to review the RD’s experience. Takes 10-15 minutes to complete.
Procedures for patient participants ($100 honorarium/participant)

U of Guelph graduate student, Yiran Wang to coach the participant through the steps.

1. Interested patients email U of Guelph graduate student, Yiran Wang, for the phone interview.
2. Each participant has two interviews with Yiran by telephone before baseline CHANGE visit.
   a. 1st interview – consent, demographic info and explain the online diet system. Yiran will attach the recall demonstration website and ask if they would prefer to complete 7 days of online diet recalls themselves or be interviewed each day to complete the online recall (~15-20 minutes).
   b. 2nd interview – Yiran does a trial run of completing a diet recall with the participant by phone and answers their questions, etc. for training purposes. This is done before the baseline RD assessment (20-40 minutes).
3. Shortly after the baseline RD visit, the participant completes 7 days of diet recalls with Yiran.
4. The participant goes through the CHANGE lifestyle program.
5. Shortly after the 3-month RD assessment, the participant completes 7 days of diet recalls using the same diet record system as at baseline with Yiran.
6. Once diet recalls are done, the participant completes a telephone interview with Yiran on the study experience and use of the online system. Takes 10-15 minutes to complete.

Thanks for considering this important study that we hope will result in a valuable tool for our profession! Please contact me if you would like to discuss further if you have questions or need more details on the plan. The following pages have details of the study procedures. We are also contacting the administrative lead of your FHT, as a letter of support will be needed from each participating organization, to meet requirements for University of Guelph ethics approval.

If interested, please discuss within your group.

Sincerely

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Google Scholar: https://scholar.google.ca/citations?user=VpgnLmIAAAAJ&hl=en
Recruitment Email to Patients on Waitlist for the CHANGE Program

Subject line: Recruiting for Diet Quality Monitoring (DIETQ) Pilot Study (REB# 18-11-037)

Dear CHANGE program participants:

We hope you are looking forward to joining the CHANGE program being offered at your clinic. This email is being sent to all people on the waitlist to offer an opportunity to volunteer for a separate research study on diet assessment. Your healthcare and participation in the CHANGE program are not affected in any way, whether you choose to participate in this extra study or not.

The study is being conducted by Dr. Paula Brauer, a dietitian researcher and her team at the University of Guelph. We are doing this study because we need better methods of measuring the changes that people make in their diets in programs like CHANGE. Diet is complex and current diet assessment tools in everyday health care are either too simple or too complicated. We need a few interested people to help us pilot a new diet assessment tool, the DIETQ, against 7-days of diet recalls. Computer skills are an asset but not required.

Your participation is critical to the development of better tools in lifestyle change programs. Interested? Attached is a detailed Letter of Information explaining the study. A $100 honorarium is offered to thank you for participating.

Have questions? Email or phone me or Dr. Brauer to arrange a time to talk and get your questions answered. My name is Yiran Wang, and I am completing a master’s degree under Dr. Brauer. I will be your main contact throughout the study.

I am looking forward to hearing from you.

Best Wishes

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Google Scholar: https://scholar.google.ca/citations?user=VpgnLmIAAAAJ&hl=en
Appendix 6: Letter of Information

LETTER OF INFORMATION
Diet Quality Monitoring (DIETQ) Pilot Study
(REB # 18-11-037)

PROJECT BACKGROUND AND DESCRIPTION

The DIETQ is a new diet assessment tool designed for use in Canadian lifestyle programs like the CHANGE program. Diet is complex and current diet assessment tools are either too simple or too complicated, or do not reflect Canadian eating habits and foods. Validation research is needed to ensure the DIETQ will be useful and accurate. Testing requires volunteers to complete both DIETQ and keep track of food intake for 7 days at two-time points in the CHANGE program, at the beginning and 3 months. We will be using a new online diet system to keep track of food intake, either by having volunteers complete it on their own or with the help of a student interviewer.

CONNECTION BETWEEN THE CHANGE PROGRAM AND THIS STUDY

Paula Brauer, a member of the research team who developed the original CHANGE program, is conducting this DIETQ study. The DIETQ study is, however, being conducted completely separate from your regular health care and from the CHANGE program. Volunteering for the DIETQ study in no way affects your regular care and NO information will be shared, except the dietitian completion of the DIETQ results.

ELIGIBILITY

DIETQ has been developed specially for people who have been told by their physician that they are eligible for the CHANGE program to decrease the risk of heart and similar diseases. If you are eligible for the CHANGE program you are eligible for this study.

PROCEDURE

1. Interested patients email U of Guelph graduate student, Yiran Wang, to express interest, find out more and to arrange a phone interview. Yiran sends the personal information questionnaire, the consent form, the ASA-24 user guide and demonstration website before the phone call.
2. The participant has one or two interviews with Yiran by telephone.
   a. 1st interview – complete verbal consent, answer basic questions. Yiran will attach the recall demonstration website and ask if they would prefer to complete 7 days of online diet recalls themselves or be interviewed each day to complete the online recall (~15-20 minutes). The interview is audio-recorded to document consent and answers to the questions. Will take ~15-20 minutes.
   b. 2nd interview – For those who want to enter data online themselves and need more guidance, Yiran will send instructions again and will do a trial run of completing a diet recall with the participant by phone. She or another student helper will be available to answer any questions on the system, and participants can always opt to be phoned instead. This process is done before the baseline dietitian assessment for the CHANGE program. Will take 20-40 minutes.
3. Yiran lets the dietitian know that the participant will be doing the DIETQ study. The RD completes baseline DIETQ with the participant, instead of the usual diet questionnaire. A copy of the completed questionnaire is sent by mail to the University of Guelph.

4. Shortly after the baseline RD visit, the participant completes 7 days of diet recalls with Yiran, either by themselves or with an interviewer completing the online version. The program is secure and only the research team has access to the data.

5. The participant goes through the CHANGE lifestyle program, as per usual.

6. The dietitian completes the 3-month assessment with the participant, using the DIETQ. A copy of the DIETQ is mailed to the U of Guelph. The dietitian emails Yiran to let her know.

7. Yiran contacts participant to complete 7-days of diet recalls again.

8. In the end, Yiran contacts the participant and arranges the final telephone interview. The questions are sent to participants prior to the interview and will address the participant’s experience, use of the online system, and any suggestions for improving the DIETQ. The interview will take 10-15 minutes to complete and will be audio-recorded.

**BENEFITS**

There is no direct benefit to you from taking part in this study. The pilot study results are needed to support the development of the DIETQ and to continue to improve the CHANGE program. A $100 gift certificate for a Canadian retailer is offered on completion of the study. If you are unable to complete the study you will still receive a $20 gift card.

**RIGHTS/RISKS/DISCOMFORTS**

*Participation in this research is completely voluntary.* You are free to decline answering any questions or to withdraw from the study at any time, without affecting your usual health care. You will need to spend time answering study questions over the phone. The student will train you or guide you through all procedures.

**CONFIDENTIALITY**

Only your RD, the student and Dr. Brauer will know your name. For the rest of the research team, you will be assigned a de-identified numbering system to protect your privacy. More details on our methods for ensuring confidentiality are outlined in the Consent form, should you decide to participate.

*Interested but Need More Information?* Please contact us!

**Yiran Wang, M.Sc. Student** | Student Researcher  
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Appendix 7: Consent Form for RD

You are invited to take part in a research study conducted by Dr. Paula Brauer (Family Relations and Applied Nutrition) and her graduate student, Yiran Wang. Yiran is completing her MSc thesis based on this project. If you have any questions or concerns about the research, please feel free to contact us.

Purpose of the Study
The purpose of this pilot study is to assess the feasibility and preliminary validity of the DIETQ food frequency questionnaire in assessing food intake and capturing dietary changes among patients with metabolic syndrome in the CHANGE program.

Procedures for RDs (estimated additional time per patient ~ 2 hours total)
1. Once the RD agrees to participate, the graduate student (Yiran Wang) will arrange a telephone call to get consent and orient them to all the study procedures, including procedures for the online diet assessment, so they know what patient participants will be asked to do.
2. RD will work with the organization team to identify the best way to solicit volunteers. It is expected that methods of identifying possible volunteer patients will vary by organization. Methods could include advertising the opportunity at a patient information session, a broadcast email to all people on the waitlist for the next CHANGE program, or in conversation with individual patients. Patients would be given the Letter of Information on the study. Patients are to be recruited BEFORE the diet counselling baseline assessment of the CHANGE program.
3. Interested patients will be asked to email the U of Guelph graduate student (Yiran Wang) to get their questions answered and confirm participation.
4. Yiran contacts the patient participant to do telephone interview to orient participant to study, get consent, complete basic demographic questions and to orient them to the online diet recall tool.
5. Yiran contacts RD when consent received, so RD knows who is participating.
6. RD does baseline assessment using new DIETQ, instead of current CHANGE diet form. The new DIETQ can be used to calculate the same score as the current diet form.
7. RD contacts Yiran to let her know when baseline assessment is done, so Yiran can work with the participant to get 7 days of diet recalls done (see below).
8. RD does CHANGE program with the participant, as per usual.
9. RD arranges 3-month CHANGE appointment with participant and emails Yiran to let her know, so Yiran can arrange follow-up diet recalls with the participant.
10. RD does 3-month assessment using DIETQ; not current CHANGE diet form.
11. When all participants at the organization have completed the study, Yiran will contact RD for telephone interview to review RD experience. Takes 10-15 minutes to complete.
Potential Risks
There are minimal risks involved in participating in the study, but it does require you to spend extra time in completing the study.

Potential Benefits to Participants and/or to the Society
There are no direct benefits to you in participating in this research, beyond the satisfaction of participating in work to improve documentation of diet assessment in dietetic practice.

Payment for Participation
No payment is being offered for participation.

Confidentiality
Every effort will be made to ensure the confidentiality of any identifying information that is obtained in connection with this study. The following measures are being taken to ensure the confidentiality of the data collected. All data, including audio recordings, will be housed in a digital research repository managed by the IT administrator for the Department of Family Relationship and Applied Nutrition, at the University of Guelph. Access is restricted to the IT administrator and the researchers for this project. Your data may be included as part of the thesis manuscript but will not include names and no one will be able to identify you.
* Please note the confidentiality cannot be guaranteed while data are in transit over the internet.

Participation and Withdrawal
You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw up to one month after the final interview. You may exercise the option of removing your data from the study at the time of withdrawal. You may also refuse to answer any questions you don’t want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise that warrant doing so.

Rights of Research Participants
If you have questions regarding your rights and welfare as a research participant in this study (REB18-11-037), please contact:

Director, Research Ethics
University of Guelph
reb@uoguelph.ca
(519) 824-4120 (ext. 56606).

You do not waive any legal rights by agreeing to take part in this study. This project has been reviewed by the Research Ethics Board for compliance with federal guidelines for research involving human participants.

Option to Receive Final Report
You have the option to receive the final report in August 2019 by email.

Signature of Participant or Legal Representative
I have read the information provided for the study “Diet Quality Monitoring (DIETQ) Pilot Study” as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form and provided verbal consent. I have also indicated whether I wish to receive a copy of the final thesis report.
Yiran Wang, M.Sc. Student | Student Researcher
Family Relations and Applied Nutrition | University of Guelph
519-824-4120 x56174 (leave message) | ywang36@uoguelph.ca

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Appendix 8: Consent Form for Patients

Consent Form for Patient Volunteers

CONSENT TO PARTICIPATE IN RESEARCH

Diet Quality Monitoring (DIETQ) Pilot Study (REB # 18-11-037)

You are invited to take part in a research study conducted by Dr. Paula Brauer (Family Relations and Applied Nutrition) and her graduate student, Yiran Wang.

Purpose of the Study

The purpose of this pilot study is to assess the feasibility and preliminary validity of the DIETQ food frequency questionnaire in assessing food intake and capturing dietary changes among patients with metabolic syndrome in the CHANGE program.

Procedures

1. Interested patients email U of Guelph graduate student, Yiran Wang, to express interest, find out more and to arrange a phone interview. Yiran sends the baseline interview questionnaire, the consent form, the ASA24-Canada user guide and the demonstration website before the phone call.

2. The participant has one or two interviews with Yiran by telephone.
   - 1st interview – complete verbal consent, answer basic questions. Yiran will attach the recall demonstration website and ask if they would prefer to complete 7 days of online diet recalls themselves or be interviewed each day to complete the online recall. The interview is audio-recorded to document consent and answers to the questions. Will take ~15-20 minutes.
   
   - 2nd interview – For those who want to enter data online themselves and seek for more guidance, Yiran will send the instruction again and do a trial run of completing a diet recall with the participant by phone. She or another student helper will be available to answer any questions on the system, and participants can always opt to be phoned instead. This process is done before the baseline dietitian assessment for the CHANGE program. Will take 20-40 minutes.

3. Yiran lets the dietitian know that the participant will be doing the DIETQ study. The RD completes baseline DIETQ with the participant, instead of the usual diet questionnaire. A copy of the completed questionnaire is sent by mail to the University of Guelph.

4. Shortly after the baseline RD visit, the participant completes 7 days of diet recalls with Yiran, either by themselves or with an interviewer completing the online version. The program is secure and only the research team has access to the data.

5. The participant goes through the CHANGE lifestyle program, as per usual.

6. The dietitian completes the 3-month assessment with the participant, using the DIETQ. A copy of the DIETQ is mailed to the U of Guelph. The dietitian emails Yiran to let her know.

7. Yiran contacts participant to complete 7-days of diet recalls again.

8. In the end, Yiran contacts the participant and arranges the final telephone interview. The questions are sent to participants prior to the interview and will address the participant’s experience, use of the online system, and any suggestions for improving the DIETQ. The interview will take 10-15 minutes to complete and will be audio-recorded.
Benefits
There is no direct benefit to you from taking part in this study. The pilot study results are needed to support development of the DIETQ and to continue to improve the CHANGE program. A $100 gift certificate for a Canadian retailer is offered on completion of the study. You will be required to acknowledge receipt of the gift card by email. If you are unable to complete the study you will still receive a $20 gift card.

Rights/Risks/Discomforts
Participation in this research is completely voluntary. You are free to decline answering any questions or to withdraw from the study at any time, without affecting your usual health care. You will need to spend time answering study questions over the phone. The student will train you or guide you through all procedures.

Confidentiality
Only your RD, the student and Dr. Brauer will know your name. For the rest of the research team, you will be assigned a de-identified numbering system to protect your privacy. The following measures are being taken to ensure confidentiality of the data collected. All data, including audio recordings, will be housed in a digital research repository managed by the IT administrator for the Department of Family Relationship and Applied Nutrition, at the University of Guelph. Access is restricted to the IT administrator and the researchers for this project. Your data may be included as part of the thesis manuscript but will not include names and no one will be able to identify you.
* Please note the confidentiality cannot be guaranteed while data are in transit over the internet.

Participation and Withdrawal
You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw up to one month after completion of the final interview. You may exercise the option of removing your data from the study at the time of withdrawal. You may also refuse to answer any questions you don’t want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise that warrant doing so.

Rights of Research Participants
If you have questions regarding your rights and welfare as a research participant in this study (REB18-11-037), please contact:

Director, Research Ethics
University of Guelph
reb@uoguelph.ca
(519) 824-4120 (ext. 56606)

You do not waive any legal rights by agreeing to take part in this study. This project has been reviewed by the Research Ethics Board for compliance with federal guidelines for research involving human participants.

Verbal Consent
I have read the Letter of Information and been provided a copy of this Consent form for the study “Diet Quality Monitoring (DIETQ) Pilot Study”. My questions have been answered to my satisfaction, and I agree to participate in this study.

Yiran Wang, M.Sc. Student | Student Researcher
Family Relations and Applied Nutrition | University of Guelph
519-824-4120 x56174 (leave message) | ywang36@uoguelph.ca
Paula Brauer, PhD, RD, FDC | Associate Professor
Family Relations and Applied Nutrition | University of Guelph
519-824-4120 Ext. 54831 | pbrauer@uoguelph.ca
Webpage: http://www.uoguelph.ca/family/faculty/brauer-paula
Appendix 9: Ethics Approval Certificate

The members of the University of Guelph Research Ethics Board have examined the protocol which describes the participation of the human participants in the above-named research project and considers the procedures, as described by the applicant, to conform to the University’s ethical standards and the Tri-Council Policy Statement, 2nd Edition.

The REB requires that researchers:
- Adhere to the protocol as last reviewed and approved by the REB.
- Receive approval from the REB for any modifications before they can be implemented.
- Report any change in the source of funding.
- Report unexpected events or incidental findings to the REB as soon as possible with an indication of how these events affect, in the view of the Principal Investigator, the safety of the participants, and the continuation of the protocol.
- Are responsible for ascertaining and complying with all applicable legal and regulatory requirements with respect to consent and the protection of privacy of participants in the jurisdiction of the research project.

The Principal Investigator must:
- Ensure that the ethical guidelines and approvals of facilities or institutions involved in the research are obtained and filed with the REB prior to the initiation of any research protocols.
- Submit an Annual Renewal to the REB upon completion of the project. If the research is a multi-year project, a status report must be submitted annually prior to the expiry date. Failure to submit an annual status report will lead to your study being suspended and potentially terminated.

The approval for this protocol terminates on the Expiry Date, or the term of your appointment or employment at the University of Guelph whichever comes first.

Signature: Date: January 11, 2019

Stephen P. Lewis
Chair, Research Ethics Board-General
Appendix 10: Conversion Procedure

Total fruits, cup eq./day
1 cup equivalent = 1 fruit; 1 cup of chopped, cut, cooked and raw fruit;
1 serving in DIETQ = 1 fruit, ½ cup (125 mL, ~100g) fresh or frozen
1 cup eq.=1 serving of whole fruit (factor: 1) *; 2 servings of fruit if in cups (factor: 2)
*ASA24 converted whole fruit into cup eq., so 1 cup eq.= 2 servings is used in the calculation

Fruit juice, cup eq./day
1 cup equivalent = 1 cup of juice
1 serving in DIETQ = ½ cup (125 mL) 100% fruit juice
1 cup eq.=2 servings of fruit juice (factor: 2)

Total vegetables, cup eq./day
1 cup equivalent = 1 cup of raw or cooked vegetables/vegetable juice, 1 cup of cooked leafy vegetables, 2 cups of raw leafy greens (legume excluded)
1 serving in DIETQ = ½ cup (125 mL, 100g) fresh, frozen or cooked, 1 cup (250 mL) raw leafy greens (legume excluded)
1 cup eq.=2 servings of fresh, frozen or cooked vegetables (factor 2) and 2 servings of raw leafy greens (factor 2)

Dark green+ Orange Veggie, cup eq./day*
1 cup equivalent = 1 cup of raw or cooked vegetables/vegetable juice, 1 cup of cooked leafy vegetables, 2 cups of raw leafy greens
1 serving in DIETQ = ½ cup (125 mL, 100g) fresh, frozen or cooked, 1 cup (250 mL) raw leafy vegetables
1 cup eq.=2 servings of dark & orange vegetables (factor 2)
*ASA 24 does not have a section for total green and orange vegetables. In order to calculate it, orange and dark green vegetable subsections are added together

Total Grain products, oz eq./day*
1 oz equivalent = 1 slice of bread, ½ cup of cooked rice, pasta, cooked cereal, 1 cup of ready-to-eat cereal
1 serving in DIETQ = 1 slice bread, ½ cup (125 mL) cooked rice or pasta, or ¾ cup (175 mL, 30 g) ready-to-eat cereal
1 oz eq. = 1 serving of bread, 1 serving of cooked rice or pasta (factor 1), 1.33 servings of cereal (factor 1.33)
*do not need to calculate the CFG servings of total grains as ASA2016 will yield the result automatically

Whole Grain, oz eq./day
1 oz equivalent = 1 slice of bread, 1 cup of ready-to-eat cereal, or ½ cup of cooked rice, pasta, cooked cereal
1 serving in DIETQ = 1 slice bread or ½ cup (125 mL), ¾ cup (175 mL, 30 g) cereal, or cooked rice or pasta
1 oz eq.= 1 serving of bread, 1 serving of cooked rice or pasta (factor 1), 1.33 servings of cereal (factor 1.33)

Milk and Alternatives, oz eq./day*
1 oz equivalent = 1 cup of milk, yogurt, or soymilk (soy beverage), 1 ½ ounce (50g) of natural cheese, or 2 ounces(66g) of processed cheese can be considered
1 serving in DIETQ = 1 cup (250 mL) milk or fortified soy beverage, 1½ oz (50 g) cheese, or ¾ cup (175 g) yogurt or kefir

1 oz eq.= 1 serving of milk and soymilk (factor 1), 1 serving of natural cheese (factor 1), 1.33 servings of yogurt/kefir (factor 1.33)
*do not need to calculate the CFG servings of milk & alternatives as ASA2016 will yield the result automatically

Total Meat and Alternatives, oz eq./day*

1 oz equivalent=1 ounce of cooked meat, poultry or fish, ¼ cup cooked beans (including raw soybean), 1 egg, 1 tablespoon of peanut butter, or ½ ounce of nuts or seeds; 1/4 cup of tofu and roasted soybean; 2 tbsp (30 ml/ 0.12 cup) hummus

1 serving in DIETQ = 2½ oz (75 g) cooked meat; ¾ cup cooked beans and hummus (175 mL); ¼ cup (60 mL, 1.3 oz) shelled nuts or 2 Tbsp (30 mL) nut butters; 150 g, 175 mL, ¾ cup tofu; 2 eggs

1 oz eq.=0.4 servings in DIETQ cooked meat, poultry or fish, 0.33 servings of legume and 0.16 servings of hummus, 0.33 servings of tofu and soybean, 0.5 servings of nut butter, 0.44 servings of nuts; 0.5 servings of egg
*do not need to calculate the CFG servings of total meat and alternatives as ASA2016 will yield the result automatically

Red meat, oz eq./week

1 oz equivalent=1 ounce of cooked meat, poultry or fish

1 serving in DIETQ = 2½ oz (75 g) cooked

1 oz eq.=0.4 servings red meat

Processed Meat, oz eq./week

1 oz equivalent=1 ounce of cooked meat, poultry or fish

1 serving in DIETQ = 2½ oz (75 g) cooked

1 oz eq.=0.4 servings processed meat

Poultry, oz eq./week

1 oz equivalent=1 ounce of cooked meat, poultry or fish

1 serving in DIETQ = 2½ oz (75 g) cooked

1 oz eq.=0.4 servings poultry

Legumes (cooked) oz eq./week*

1 oz equivalent= ¼ cup cooked beans, 2 tbsp (30 ml/ 0.12 cup) hummus

1 serving in DIETQ = ¾ cup (175 mL) cooked beans or hummus

1 oz eq.=0.33 servings in DIETQ legume or 0.16 servings of hummus
*raw soybean-edamame is included.

Nuts (including peanuts) oz eq./week*

1 oz equivalent= ½ ounce or 14 g of nuts or seeds; 1 tbsp of nut butter

1 serving in DIETQ= ¼ cup (60 mL) shelled nuts or 2 Tbsp (30 mL) nut butters

1 oz eq.=0.5 servings of nut butter, 0.44 servings of nuts
*ASA24 database does not specify whether nuts are shelled or unshelled, but the ASA input interface indicated that it may use the unshelled nuts. There is no agreement of conversion factors of nuts. But by running through a trail in ASA24, we got 1/4 cup of ASA nut input equals to approximately 1 CFG serving. 1 CFG serving (1/4 cup) equals to an average of 2.3 oz eq. Salted nuts were screened in ASA24 items to calculate the total amount of salted nuts.
A detailed list of common nuts/seeds conversion
1 oz eq of almonds=0.4 CFG/DIETQ servings (1 serving=2.52 oz eq.)
1 oz eq of peanuts=0.4 CFG/DIETQ servings (1 serving=2.57 oz eq.)
1 oz eq of pecans=0.57 CFG/DIETQ servings (1 serving=1.74 oz eq)
1 oz eq of cashews=0.44 CFG/DIETQ servings (1 serving=2.29 oz eq)
1 oz eq of walnuts=0.49 CFG/DIETQ servings (1 serving=2.06 oz eq)
1 oz eq of hazel nuts=0.42 CFG/DIETQ servings (1 serving=2.38 oz eq)
1 oz eq of macadamia nuts=0.43 CFG/DIETQ servings (1 serving=2.33 oz eq)
1 oz eq of pistachio nuts=0.44 CFG/DIETQ servings (1 serving=2.26 oz eq)
1 oz eq of sunflower seeds=0.42 CFG/DIETQ servings (1 serving=2.38 oz eq.)
1 oz eq of brazil nuts=0.41 CFG/DIETQ servings (1 serving=2.27 oz eq.)
1 oz eq of pine nuts=0.42 CFG/DIETQ servings (1 serving=2.38 oz eq.)

Numbers of commercial bakery, candies, ice cream & dessert
Times of consumption are all checked in ASA24 items and are based on weekly consumption

Fats and Oils
Oils 14g=1 tbsp
Fats 12g*=1 tbsp (margarine 11g=tbsp; lard 12.81g=tbsp; butter 14g=1 tbsp)
*the standard is as the same as the MEDAS used in PREDIMED study, in which 1 tbsp of fat=12g