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ASSESSING THE IMPACT OF A NUTRITION EDUCATION AND SKILLBUILDING INTERVENTION ON DIET QUALITY IN OBESE INDIVIDUALS: A PILOT STUDY

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ASSESSING THE IMPACT OF A NUTRITION EDUCATION AND SKILL-BUILDING INTERVENTION ON DIET QUALITY IN OBESE INDIVIDUALS: A PILOT STUDY

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ABSTRACT

With 1 in 4 Canadians obese, effective dietary approaches for weight loss are needed. Traditionally, restrictive dietary plans are used, but they have proven ineffective in long-term weight loss maintenance; therefore, alternative approaches are warranted. Using the Canadian Healthy Eating Index (CHEI) as a framework, this six-month nutrition education and skill-building pilot intervention was examined for its acceptability and impact at improving the overall diet quality of healthy, obese adults (n=7). Post-intervention interviews and surveys were analyzed for program acceptability and to assess key changes in participants' behaviours and self-efficacy towards diet quality improvement. In addition, changes in CHEI score and body weight were assessed. While no change in body weight was observed, all participants perceived the intervention as beneficial and practical and the CHEI score improved by 9.9 points (p=0.10). This pilot intervention was well-received by participants and may offer an alternative to restrictive diets for weight loss.

KEYWORDS: diet quality, healthy eating index, obese, nutrition education, self-efficacy

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1.0 INTRODUCTION

Obesity has become a major health concern worldwide. The prevalence of obesity in Canada has nearly doubled in the past 25 years and is approaching one-quarter of the nation's population (1). In 2007, self-reported data from the Middlesex London Health Unit region indicated similar findings with 24.5% of adults aged 35-44 years being obese (2). The World Health Organization (WHO) reports that 10% of all Canadian deaths in 2002 were attributed to excessive weight or an elevated body mass index (BMI) (3). Additionally, the direct costs associated with obesity and 18 comorbidities, including Type 2 diabetes, cardiovascular disease, and a variety of cancers was estimated at $3.9 billion in Canada in 2006, or 2.6% of the overall healthcare costs (4). Therefore, obesity is of the utmost importance as a public health priority.

Obesity is defined as having a BMI greater than 30 kg/m^2 (kilograms per metre squared) (5). BMI is a standardized weight-for-height calculation that is approved for use as a body weight classification system by Health Canada (5). As an index measurement, BMI does not directly measure body fatness; rather it provides a classification of body weight, relative to height, that is directly correlated with chronic health risks, including Type 2 diabetes and coronary heart disease (5). As it is non-invasive and reasonably simple to calculate, BMI is a commonly used measurement by both researchers and health practitioners to quickly assess and classify participants according to predetermined criteria.

Multiple factors are believed to contribute to the obesity epidemic. Psychosocial contributors include: lower socioeconomic status which has been studied for its relationships with dietary intake and health (6), diet quality (7), and obesity (1); and lack

of social support as a barrier to healthy eating and to physical activity (8). Additionally, the impact of genetics and the built environment are also believed to have important roles in the development of obesity (9,10); however, all of the aforementioned contributors are beyond the scope of this thesis which focuses primarily on personal and behavioural aspects of dietary practices. One's diet consumption is a blend of diet quality characteristics (e.g. fibre, fruits, vegetables, whole grains, and unsaturated fats) and diet quantity [e.g. total energy intake (TEI) or amounts of total fat]. Differences have been demonstrated between the intakes of obese Canadians and their non-obese counterparts whereby obese persons consume less vegetables and fruit (1,11), less fibre (12), and greater TEI (12). Of these aforementioned differences, only TEI has been associated with increased odds of obesity development; however, greater fibre intake has been shown to be protective against obesity development in men, but not in women (12). While this suggests that reducing overall energy intake, intentionally or unintentionally, is fundamental to decreasing obesity, it is likely also important to include strategies that enhance the consumption of key foods and nutrients known to be beneficial to health.

Although achieving a negative energy balanced diet has been deemed necessary for weight loss (10,13), to date, energy-restricted, prescriptive diets have not provided the long-term solution to the obesity epidemic due to low adherence and attrition rates (14-24). As an alternative to these approaches, ad libitium interventions may offer more promising long-term weight loss results. Ad libitum studies are designed to encourage participants to eat by internal cues of hunger and satiety and to not restrict energy intake, thereby promoting a non-restrictive dietary approach to weight loss. To date however, most ad libitum interventions have focused on single aspects of the diet, such as reducing

glycemic load or increasing protein intake (25-31), while incorporating highly intensive (25-28) or controlled (29,31,32) study protocols that could be considered extensive enough to confound the true ad libitum nature of these studies. With a gap in the literature in terms of 'true' ad libitum dietary approaches (i.e. no diet prescription or restraint and allowing one to eat typical foods according to their hunger, satiety, and personal preferences) and their impact on weight loss in free-living obese persons, it can be speculated that as one's overall diet quality improves, quantity reduction may ensue inadvertently as a result of enhanced satiety from nutrients such as protein or low glycemic foods.

The aim of the present study is to focus primarily on behavioural and lifestyle attributes that may have an impact on one's dietary practices and hence their energy balance. We propose that a group-based nutrition education and skill-building intervention focusing on improving overall diet quality, with little or no mention of diet quantity, while providing opportunities for group walking and socialization, will foster social support and personal self-efficacy towards a higher quality diet. Furthermore, this enhanced diet quality is speculated to provide the opportunity for some modest and spontaneous weight loss of approximately 5% of total body weight. Due to the pilot nature of this study, the primary objective is to conduct a formative evaluation to determine the feasibility, practicality, and acceptability of this intervention. The secondary objectives are to determine if the intervention improves participants' overall diet quality, including an increase in vegetables, fruits, whole grains, and unsaturated fats, by enhancing their self-efficacy toward a healthier lifestyle, which may potentially result in a spontaneous modest weight reduction.

2.0 REVIEW OF LITERATURE

2.1 Dietary intake of Canadians

The Canadian Community Health Survey 2004, Cycle 2.2 (CCHS 2.2) provides a comprehensive overview of the Canadian diet (33-35). Results from this survey have demonstrated that the majority of Canadians are not meeting the current dietary recommendations, based on Health Canada's Eating Well with Canada's Food Guide (EWCFG) and the Institute of Medicine's Dietary Reference Intakes (DRI). Specifically, approximately 50% of Canadian adults are not meeting their daily recommendations for fruit and vegetable consumption (36) and 90% are not meeting the Adequate Intake level (AI) for fibre, 25 g/d (37). While overall fat intake was 31% of TEI, 25% of adults over 19 years of age, consumed approximately 35% of TEI from fat (33), which is at the upper limit of the Acceptable Macronutrient Distribution Range (AMDR) (37). Finally, with respect to dietary balance, almost 25% of TEI was attributed to the consumption of foods from the 'other foods' category (36), which includes foods that are high in sugar and fat.

In addition to the above analysis, CCHS 2.2 findings were recently analyzed using the Canadian Healthy Eating Index-2005 (CHEI) (38). This index is an adaptation of the Healthy Eating Index (HEI) that was developed by Kennedy et al. (39) and used as a comprehensive assessment of Americans dietary adherence to US dietary guidelines and food guidance systems (i.e. MyPyramid). In order to assess Canadians' adherence to dietary guidelines, an adaptation of the HEI was needed as Health Canada uses EWCFG (40) instead of US Department of Agriculture's (USDA) MyPyramid (41). Using the CHEI, Garriguet (38) reported that the overall quality of an average Canadian diet was 58.8 (out of a possible 100). This score falls within the 'needs improvement' category

(50-80 points) and is comparable to the diet quality scores previously reported by the USDA (58.2) (42). Further analysis of this data revealed that 83% of Canadians had a diet quality score in the 'needs improvement' range; less than 1% had a 'good quality diet' (> 80 points); and 16% reported diets in the 'poor diet quality' range (< 50 points) (38). Taken together, these findings suggest that Canadians are currently not meeting dietary guidelines and that the diets of Canadians need to be optimized by increasing the intake of fruits, vegetables and dietary fibre, and reducing the intake from 'other foods'.

For decades, researchers have been examining dietary intake as it relates to obesity. Results from CCHS 2.2 demonstrate that TEI is positively associated with increased odds of obesity in both men (odds ratio, OR = 1.08, CI 1.05-1.11) and women (OR = 1.15, CI 1.11-1.19), with energy intakes of obese vs non-obese men and women respectively at 2820 vs 2600 kcal/d and 2160 vs 1970 kcal/d (12). Furthermore, obese men had a greater intake of total fat (34.3% vs 32.1% of TEI), saturated fat (11.5% vs 10.2% of TEI), and monounsaturated fatty acid (MUFA) (14% vs 13% of TEI) intakes than non-obese men, with no differences detected between obese and non-obese women (12). Interestingly, an overview of Canadians' eating habits reveals a paradox between the rise in obesity prevalence over the past 25 years and the reduction in fat intake from 40% of TEI (1970-72 Nutrition Canada Survey) to 31% of TEI as reported in the 2004 CCHS 2.2 (36). This paradox suggests that dietary fat intake is unlikely to be independently responsible for the escalation in obesity prevalence rates.

Further to the above, reports have demonstrated that the prevalence of obesity in Canadians is associated with suboptimal intakes of vegetables and fruits (1,11), and lower intakes of dietary fibre in men (OR = 0.58), but not women (12). With respect to dietary

intake, obese men and women consumed less fibre than their non-obese counterparts (men 0.7g vs 0.8 g/100 kcal; women 0.8 vs 0.9 g/100 kcal), and obese men consumed fewer carbohydrates (45.5% vs 48.1% of TEI) than non-obese men, with no reported difference in the intakes of women (12). Merchant et al. (43) suggested that a carbohydrate intake in the range of 47% to 64% of TEI (approximately 290 to 310 g/d) was protective against developing overweight or obesity, which is congruent with the AMDR for carbohydrates at 45 to 65% of TEI (37). Taken together, the average quality of the Canadian diet is at the low end of the 'needs improvement' range according to CHEI and obese Canadians consume suboptimal intakes of certain food items, including fruits and vegetables and fibre. Therefore, efforts to optimize diet quality, including the aforementioned food items, rather than merely restricting nutrients, such as fat, may have a greater long-term impact on the prevalence of obesity.

2.2 Approaches to weight management

Modifying one's usual dietary intake is not uncommon for the majority of overweight and obese people (44). In 2003, more than half of overweight or obese Americans reported that they were trying to lose weight, primarily through energy restriction and/or low-fat dieting (44). Of the general Canadian population, the Canadian Council of Food and Nutrition recently reported that approximately 10% of their respondents had tried some type of diet in the past year, with the most popular being Weight Watchers followed by Atkins and South Beach (45). Typically, dietary approaches to weight loss involve not only a restriction on the quantities of foods consumed, but they often also modify the dietary quality. For example, the Atkins diet is known to restrict fruit and grain consumption, which ultimately could lead to an overall

reduction in diet quality. In fact, weight loss diets with similar macronutrient distributions to the above mentioned diets have been assessed for diet quality using the HEI. It has been reported that low-carbohydrate diets (< 30% TEI from carbohydrates) resulted in a 'poor quality diet' (44.6 points) while higher carbohydrate diets (> 55% TEI from carbohydrates) and lower fat diets were rated as diets that 'needs improvement' (71.2 and 70 points respectively) (46). These findings suggest that diet quantity and quality are not mutually exclusive approaches to weight management. Furthermore, diet quantity approaches tend to be restrictive in both food selection and portion sizes, which may conjure up negative dieting images or feelings of hunger or deprivation. In contrast, enhancing diet quality may promote a more gradual lifestyle change that better encompasses one's personal dietary preferences without feelings of depravity.

2.2.1 Energy-restricted approaches

For many years the majority of dietary interventions that have been designed to prevent or treat obesity have focused on prescriptive, restrictive-type approaches (14-24). Restrictive approaches are intended to limit energy intake by approximately 500-1000 kcal/d which would lead to an estimated one to two pound weight loss per week (13,47). This negative energy balance is most commonly approached by increasing physical activity and/or by reducing the TEI from fats or carbohydrates. With respect to the latter, the fact that fat has a limited impact on satiety and a higher energy density (9 kcal/g) when compared with carbohydrates and protein (4 kcal/g), it would appear to be the obvious macronutrient to modify when striving for an energy deficit to promote weight loss (13). However, observational studies do not support the hypothesis that fat intake alone is associated with weight loss, as two nutrition reports have demonstrated that fat

intake has been reduced by approximately 9% of TEI and yet obesity rates have continued to rise (36,48). Furthermore, the traditional low-fat, high carbohydrate diets (25-30% TEI from fat, 50-60% TEI from carbohydrate) have been somewhat successful in supporting a modest weight loss in the short-term (approximately 2-6 kg in less than 6 months) (14-21); however, much of the weight is re-gained (2-3 kg regain) within 1-2 years due to low adherence rates as participants revert back to preferred dietary patterns (14,16-21). These low adherence rates, in combination with high attrition rates (10-43%) (14-21), suggests that participants find it challenging to follow this prescriptive, restrictive pattern of eating and may explain why weight loss outcomes are modest and not sustained.

As alternatives to low-fat diets, various energy-restricted, low-carbohydrate, high-protein diets have been studied and debated (17-19,22-24). These diets typically have a macronutrient distribution consisting of 25-34% of TEI from protein and 40-55% from carbohydrates, with the balance from fat (17-19,22-24). Proponents of energy-restricted, high-protein dietary patterns suggest that protein is a more satiating macronutrient when compared with fat and carbohydrate (28,31,49); however, satiety is rarely measured and reported (19). Furthermore, the greater dietary induced thermogenic (DIT) effect of protein has also been suggested to have a role in weight management studies when compared with fat and carbohydrate (30,50), although it is questionable whether or not an modest increase in DIT could contribute significantly to weight loss (28). Regardless of the mechanism by which these diets promote weight loss, they tend to have similar attrition rates to low-fat diets and typically do not appear to promote any greater weight loss in the long-term. With a weekly assessment and diet intake review with a Registered

Dietitian for one year, Layman et al. (22) reported good dietary compliance with a high-protein diet; however, the 9.3 kg weight loss was not significantly different than the high carbohydrate group. Additionally, a short-term intervention (12 weeks) (23) with a 5 year follow-up (24) also reported no significant differences between a high-protein and high-carbohydrate diet and reported an average 4.5 kg weight loss at 5 years. These researchers seemed to have observed greater absolute weight losses in their interventions; however, the intensive monitoring of participants limits the use of these approaches for community-based weight loss interventions. Furthermore, these diets are extremely restrictive and not extensively recommended or promoted by nutrition professionals (13) due to the risk of not meeting the AMDRs (i.e. protein 10-35% of TEI, fat 20-35%, and carbohydrate 45-65%) (37), and the potential harmful effects for those at risk of cardiovascular disease, diabetes, or underlying renal insufficiency (13,49).

Within a prescriptive, energy-restricted diet approach, some researchers have simultaneously altered the quality of single dietary components, such as the glycemic index (GI) in conjunction with energy restriction. The GI is a system to rank carbohydrate-containing foods in 50 g portions compared with either 50 g of white bread or glucose (51,52). McMillan-Price et al. (53) assessed 4 diets (2 high-protein, 2 high-carbohydrate) and compared high-GI vs low-GI in each diet group. Weight loss ranged from 3.7-5.3 kg across diet groups at 12 weeks, but were not statistically significant between groups (53), suggesting that longer interventions are needed to assess the effectiveness of low GI diets on weight loss. Theoretically, low GI carbohydrates are more satiating and they tend to have a higher fibre content which enhances their potential to support weight loss (51,52,54); however, a systematic review does not support their

consistent effect on increasing satiety (55). GI as an independent weight loss strategy remains controversial and long-term clinical trials are outstanding (55,56), which is arguably attributed to its complexity and expected challenges for dietary adherence.

Lastly, the Mediterranean-type diet has also been assessed for its efficacy as an energy-restricted dietary intervention for weight loss (20,21). The Mediterranean diet promotes the increase in MUFAs (typically olive oil, nuts or seeds), vegetables and fruits, and replacing red meats with poultry or fish (20). Few Mediterranean diet interventions in healthy obese subjects exist; however, two research groups have reported greater weight loss outcomes in those who followed the Mediterranean diet compared with those on a low-fat diet (20,21). At 24 months, Shai et al. (20) reported a 1.5 kg greater weight loss in the Mediterranean group (4.4 kg vs 2.9 kg) compared to the low-fat group, whereas McManus et al. (21) observed a 7 kg difference with the Mediterranean group losing weight (4.1 kg) and the low-fat group gaining weight (2.9 kg) by the end of the 18 month intervention. While dietary adherence was good in both studies, the attrition rates were quite different [15 vs 46% in the Shai et al. (20) and McManus et al. (21) studies respectively] and were likely attributed to the location and intensity of the interventions. Overall, these findings are encouraging and suggest that enhancing quality nutrients and food choices, such as MUFAs, vegetables and fruits, within the context of an energy-restricted diet, may be a more reasonable alternative to a low-fat diet for weight loss; however, as it is still prescriptive and energy-restricted, this may be a deterrent to adopting it as a permanent lifestyle approach to weight management.

Restrictive and prescriptive dietary patterns do not appear to be the most efficacious in terms of sustained weight loss outcomes in the obese population. With

declining dietary adherence and relatively high drop-out rates, it is not surprising that prescriptive diets fail to demonstrate sustainable weight loss results. Promoting diet quality such as increasing MUFAs or lowering GI offer promising components for effective weight loss diet plans; however, these studies still incorporate an aspect of restriction which may contribute to the lack of sustainable results. Furthermore, weight loss studies that improve overall diet quality, and not just one nutrient, are also lacking. In general, specific diets or programs involving energy reduction can work for short-term weight loss; however, if gradual changes to eating patterns or behaviours are not adopted, the participant may find that the program does not fit his or her lifestyle which can hinder adherence and long-term sustainable weight loss (57). These findings imply that investments into nutrition education programs that are less restrictive and prescriptive, while incorporating gradual changes into one's lifestyle and food preferences, may be warranted to promote long-term success.

2.2.2 Ad libitum dietary approaches

Ad libitum dietary approaches are based on the premise that they do not restrict food intake, but instead promote the unlimited access to foods and encourage participants to eat based on internal cues of hunger and satiety. While this approach could offer a promising alternative to energy-restricted diets in that they are less prescriptive, to date few 'true' ab libitum interventions have been studied. Most interventions, claiming to be ad libitum, focus on only one or two key nutrients or food groups and have inadvertently included varying degrees of control which ultimately confounds the ability to truly measure the effectiveness of ad libitum food intake (25-32).

Similar to restrictive interventions, a low GI carbohydrate diet has been assessed in an ad libitum manner. Previous studies have compared the effectiveness of an ad libitum, low-glycemic load diet to an energy-restricted, low-fat diet on weight loss in overweight or obese adults (25-28). Although not statistically significant, the majority of these findings demonstrated greater absolute weight losses in the low-GI diets (range 3-7.8 kg) compared to the low-fat diets (2-6.1 kg) (25-27). This greater weight loss may be the result of a spontaneous mean daily energy reduction of 350-500 kcal/d (25-27) due to an enhanced feeling of satiety (25) as previously discussed. Conversely, Brehm et al. (28) observed significant weight loss differences between the low GI diet group (9.8 kg) and the low-fat diet group (6.1 kg) at 4 months; however, energy intake was reduced in both groups by approximately 800 kcal/d. While initially these findings appear promising, the attrition rates in these studies were not unlike those observed in low-fat interventions (22-47%). Furthermore, there were mechanisms of dietary control (i.e. restriction) incorporated into the intervention procedures, whereby regular dietary feedback guided the participants' intake in order to achieve undeclared macronutrient or GI load targets. By doing so, not only have the researchers confounded the ab libitum nature of their studies, but they have called into question the interpretation of the true effectiveness of ab libitum low GI diets to promote weight loss independent of energy restriction.

In addition to changes in carbohydrate intake, dietary fat has also been assessed using ad libitum approaches to determine its effectiveness on sustainable weight reduction. Specifically, high fat ad libitum diets (35-40% TEI from fat) promoting high intake of MUFAs (> 20% of TEI) have been employed (29,32). In a crossover design

involving overweight and obese men, Piers et al. (32) compared a high saturated fat/low MUFA diet with a low saturated fat/high MUFA and reported that the high MUFA diet promoted a significant weight loss whereas the low MUFA diet resulted in a minimal weight gain. Assessing weight loss sustainability following a very restrictive 3-week run-in diet, Due et al. (29) compared the effectiveness of three different diets on weight loss maintenance: 1) a Healthy Eating Pyramid diet (35-45% of TEI as fat with 20% from MUFA); 2) the USDA Food Guide Pyramid (20-30% of TEI from fat); and 3) a moderate fat (35% of TEI from fat) control diet. Within six months, all diet groups experienced a 2.2-3.8 kg weight regain, with no significant differences observed between diets (29). Due to limited intervention studies assessing MUFA diets for weight loss, their effectiveness on sustainable weight loss remains unclear; however, as with the low glycemic load studies previously discussed, the available studies have methodological concerns. Although both studies claim an ad libitum approach, allowing participants to eat until satiety, both study protocols exerted a significant amount of control over the participants' food choices to ensure that targeted macronutrient distribution ranges were achieved. Piers et al. (32) used modular diets, while Due et al. (29) utilized a controlled supermarket model for food selection. With respect to the latter, although participants could choose the foods that they wanted, they were not allowed to leave the supermarket until they had met their intended macronutrient target (32). While these studies had similar attrition rates to other ad libitum studies (8-28%), these measures of monitoring and control significantly limit the feasibility of using such strategies in community-based interventions. Furthermore, the sustainability of weight loss and dietary changes may also be limited in that participants' may not have built the necessary self-efficacy to

choose higher quality foods (e.g. foods with MUFAs) for themselves in a free-living environment.

Ad libitum studies have also been conducted using a low-carbohydrate, high-protein approach. One of the most popular approaches used is the Atkins diet. This diet does not restrict energy intake from fat and protein; however, the restriction on carbohydrate intake is exceptionally stringent and typically limited to 20-120 g/d (17,18) which is below the AMDR and minimum daily glucose requirement (130 g/d) (37). Participants in these studies are encouraged to eat to satiety, although satiety is rarely measured (15-18,20). These studies have reported an average 2 kg greater weight loss with the high protein diet compared to the traditional low-fat restricted diet (25-30% of TEI from fat) (15,16,18,20). Using a more moderate carbohydrate restriction (45-58% of TEI), Skov et al. (30) reported that a high protein diet (25% of TEI) resulted in nearly twice the amount of weight loss at six months (8.7 kg vs 5 kg respectively) compared to a moderate protein diet (12% of TEI). This greater weight loss was attributed to a spontaneous reduction in energy intake (- 400 kcal/d) (30) and may suggest a greater level of satiety achieved in the high protein group, but this was not evaluated. This study also involved the use of a monitored grocery store approach (30), which, when removed in a six-month extension study, resulted in some weight regain in the high protein group (31). Taken together, it appears that higher levels of protein may be beneficial for weight loss. As with other ad libitum studies, attrition rates were high (22-48%) and the high degree of monitoring makes these interventions difficult to transfer to a free-living environment. Finally, as previously mentioned (section 2.2.1) the safety of these diets in the long-term remains unknown and may not be suitable for all individuals.

In summary, ad libitum dietary approaches offer an alternative to restrictive, prescriptive weight loss diets. Instead of restricting energy intake, these diets are based on the concept of altering some component of the diet, allowing subjects to eat when hungry and to satiety which may intrinsically result in an energy deficit (25-31). The intensity of ad libitum trials can vary as some investigators control the dietary selections from a 'study grocery store', and hence control the participants' diet composition (29,30). Alternatively, some researchers have worked with free-living participants and provided intense diet education and monitoring (25,26). Taken together, the restriction of macronutrient distribution via intense monitoring and environmental control inadvertently confounds the ad libitum nature of the study and limits the use of these approaches in free-living individuals. To date, we know of no study that has examined the effect of overall diet quality on body weight without altering some aspect of diet quantity (e.g. reducing carbohydrate glycemic load, controlling macronutrient distributions), suggesting that there are gaps in the area of ad libitum diet interventions, specifically in a group of free-living obese individuals. Therefore, 'true' ad libitum dietary quality approaches in free-living obese subjects, that involve no type of dietary restriction and focus on the overall diet, are needed as they may more readily fit one's lifestyle and enhance self-efficacy which ultimately may improve the likelihood of sustainable weight loss outcomes.

2.3 Diet quality indexes used in interventions

Due to the fact that individuals consume a wide variety of foods, not single foods, food groups or nutrients, a comprehensive diet indicator offers a potentially more valuable measurement of diet sufficiency than simply monitoring a single nutrient or food

group. Approximately 15 years ago, the USDA developed the HEI to provide an objective measurement of population dietary adherence to US dietary guidelines (39). This HEI was recently updated in 2005 (HEI-2005) (58) to reflect the new USDA MyPyramid (41) and Dietary Guidelines for Americans (59) (Appendix I). As previously mentioned (section 2.1), the HEI was recently adapted by Garriguet (38) to be more reflective of Canadian dietary guidelines and consumption patterns (Appendix II). This index (CHEI) includes both adequacy (e.g. EWCFG food group recommendations) and moderation (e.g. saturated fat, sodium and other foods) components, which together provide an overall indicator of diet quality. Specifically, the scoring criteria for each adequacy component is based on Katamay et al.'s (60) food guide serving recommendations for age and gender as established for Health Canada's EWCFG (40) (Appendix III). The moderation scores are based on nutrition recommendations for saturated fat (61), DRIs for sodium (38,62), and consumption patterns for 'other foods' (38).

Although the CHEI (38) and HEI-2005 (63) have similar high content and construct validity to national guidelines and perceived healthful diets respectively, the usefulness of the CHEI in observational studies related to obesity is presently unknown. Alternatively, HEI diet quality scores have demonstrated strong negative correlations with BMI (64-67), although not consistently (68). In a cross-sectional review of National Health and Nutrition Examination Survey III (NHANES III) data, a poor quality diet (score <50 points) was associated with an increased odds of developing overweight and obesity in men (OR = 1.5 and 1.9, respectively) and obesity in women (OR = 1.7) (64). Conversely, McCullough et al. (67,68) observed that HEI scores were protective of

excessive weight in men (67), but not in women (68), suggesting potentially greater sensitivity in males than females. Lastly, a 1-point increase in HEI scores has been reported to reduce the risk of obesity by 1.4% in males and 0.8% in females (65), whereas the same diet quality improvement, as measured by Gao et al.'s (66) HEI-05, has decreased the risk of obesity by 3% in white males and females. Together these findings suggest that improvements in diet quality, irrespective of weight loss, may reduce the risk of developing obesity and thereby may be a useful tool to not only assess Canadians' compliance with dietary guidelines, but also to guide public health interventions.

To date, we know of no study that has either used the CHEI as a framework to guide dietary interventions or as an outcome indicator for diet intervention research. A few studies, however, have used American diet quality indexes (HEI or Diet Quality Index-Revised - DQI-R) as an outcome indicator (69-73). Notably, of the five nutrition interventions that have used a diet quality index to assess outcomes, all have used cognitive-behavioural theory constructs as part of their intervention strategies (69-73), with the majority using the Social Cognitive Theory (SCT) (70-73). Sallit et al. (70) conducted a 12-week cognitive-behavioural nutrition intervention and examined its impact on both diet quality and body weight. Post-intervention, the participants significantly improved their diet quality by increasing their mean HEI score by 15.5 points and losing 4.6 kg of body weight. At 9 month follow-up, these improvements slightly diminished (11.5 point diet quality improvement and net 2.6 kg weight loss) (70), but the sustained weight loss results were comparable to those demonstrated in restrictive diet interventions as previously discussed (14,16-21). In another study, Snyder et al. (71) designed their six-month intervention using the DQI-R as a framework and provided

tailored nutrition feedback based on each of its dietary components. As hypothesized, the intervention group had a greater diet quality improvement after six months, than those receiving health promotion materials only (69.8 vs 64.6 out of 100 respectively, p = 0.003) (71). The remaining interventions reported differences between intervention and control groups for post-program diet quality scores (69,72,73). Overall, these studies suggest that promoting an overall improvement in diet quality may be an effective alternative to restrictive, prescriptive dietary interventions with respect to weight loss. Although the sensitivity of the CHEI as an outcome measure remains unknown in intervention studies, its ability to comprehensively incorporate current recommended dietary guidelines into an educational framework would ensure that the nutrition intervention is designed to inclusively incorporate aspects of the diet known to be promote health, reduce the risk of obesity, and prevent certain chronic diseases. Therefore, it appears to be reasonable to use the CHEI as a framework and an outcome measure for a community-based nutrition education intervention.

2.4 Other considerations

Changing dietary behaviours in individuals is complex as there are many factors that contribute to dietary preferences and patterns (74). Bandura's (75,76) SCT describes this as 'reciprocal determinism', whereby personal (e.g. knowledge, preferences, skills, and self-efficacy), environmental (e.g. physical environment and social support including friends, family, and food availability), and behavioural (e.g. self-evaluation including self-monitoring, goal setting, and problem-solving) factors are intertwined determinants of human behaviour and personal self-efficacy. As a component of the SCT, self-efficacy has been suggested as one of the key mediators to influence long-lasting

behaviour change (76,77). Furthermore, including behavioural-based strategies, such as social support, goal setting, and self-evaluation as part of a multidimensional program, has been promoted as key elements for augmenting dietary changes (57,77,78). Specifically, lack of social support has been reported as a barrier to healthy eating and physical activity (8) and a recent review has found that social support, self-efficacy, and knowledge were the strongest predictors for increasing fruit and vegetable consumption, out of a possible 25 constructs (79). Finally, social support has aided in the adoption and frequency of physical activity (80,81), which also has been reported to enhance the feasibility of sustainable, long-term weight maintenance (10). On average, these types of multidimensional programs, incorporating behavioural strategies, dietary changes, and an increase in activity level, typically result in weight losses of approximately 5-10% or a reduction of 2 BMI units (kg/m^2) (13,78). Additionally, diet quality interventions that have incorporated behavioural strategies have reported improvements in overall diet quality (69-72) or individual diet quality components related to the focus of the intervention (73). Utilizing behavioural theory, within the context of an ad libitum dietary intervention, may improve diet quality components and help guide an effective community-based program as a weight loss alternative to restrictive, prescriptive programs.

2.5 Summary of the literature review

Obesity is often considered a modifiable health risk that can be addressed in part through healthy eating, physical activity and by adopting behavioural practices or strategies, such as self-monitoring and goal setting, that would help individuals towards attaining a healthier weight (13,14,57). While suboptimal intakes of fruits and vegetables

have been associated with the prevalence of obesity (1,11), the association with fibre intake has been inconsistent (12), and no association has emerged with fat intake (12). Regardless of this, many approaches to weight loss interventions continue to focus on prescriptive, energy-restricted, low-fat diets although success has been limited to modest weight loss outcomes (2-3 kg) within 1-2 years (14-21). Although some energy-restricted plans have attempted to assess the quality of a single dietary component, such as GI (53), long-term studies are needed to assess if this is more effective than low-fat diets. Ad libitum approaches to date have offered less restriction in certain areas of the diet but frequently have imposed environmental controls (29,30) or intense education and monitoring (25-28), thereby confounding the 'true' ad libitum approach. Furthermore, ad libitum approaches that alter single dietary components rather than a holistic diet approach may prove futile for sustainable weight loss approaches at both the community- and population-levels.

The CHEI takes a more comprehensive diet approach and focuses on key nutrients and foods known to be beneficial to health (38). Recently, the average diet quality of Canadians was assessed, using CCHS 2.2 data, and found to be 58.8 out of 100 or 'needs improvement' (38), a finding similar to US reports (58.2) (42). HEI improvements have been suggested to reduce the risk of being overweight or developing obesity (64-67). To date, we know of no study that has used the CHEI as both an educational framework and an outcome measure in a nutritional intervention as a mediator to potential weight loss. Given that the CHEI focuses on key nutrients and food groups known to reduce the risk of chronic disease development, its use as a framework and as an outcome measure in a community-based nutrition education and skill-building

intervention appears reasonable for assessing improvements in dietary patterns. Furthermore, its holistic dietary approach may promote better adoption and adherence in participants than previously demonstrated in nutrition-based interventions that focus on single nutrients or dietary components as it allows more flexibility to individuals' dietary preferences and patterns.

2.6 Purpose, hypotheses and objectives

Using the CHEI as an educational framework, we propose that a six-month nutrition education and skill-building intervention, offered over 10 sessions, will be practical, well-received and enhance the quality of our obese participants' diet. This intervention focuses not only on increasing knowledge concerning diet quality, but also engages participants to build skills and self-efficacy towards achieving a healthier lifestyle (i.e. a higher quality diet). Additionally, a light intensity walking program will be provided to augment opportunities to provide social support in conjunction with the nutrition sessions. We expect that this nutrition intervention will educate participants about high quality foods, which in turn will lead to dietary changes toward a higher quality diet. It is anticipated that these changes will arbitrarily replace and/or reduce less healthy foods (e.g. energy dense or 'other' foods) and potentially result in a net reduction in energy intake which may then lead to a spontaneous and modest (5%) weight loss.

Due to the pilot nature of this intervention, the purpose of the present study is to evaluate the acceptability and impact of a nutrition education and skill-building intervention on improving the diet of obese individuals. The primary objective of this study is to conduct a formative evaluation that would appraise the 'delivery strategies during development or draft stage, before full-scale' implementation, as defined by

Myers (82). This pilot study, as a measure of formative evaluation, is designed to determine the feasibility, practicality, and acceptability of the intervention. The secondary objective is to determine if this intervention improves the participants' diet quality, as calculated by the CHEI, and enhances their self-efficacy towards a healthier lifestyle potentiating a spontaneous, modest weight loss. We hypothesize that this intervention will be well-received by participants and will demonstrate feasibility and practicality if implemented on a larger scale. Furthermore, we hypothesize that participants will improve the quality of their diets and self-efficacy toward a healthier lifestyle and demonstrate a modest (5%) weight reduction.

3.0 METHODS

3.1 Participants and recruitment strategy

Eligible participants were recruited (April-October 2009) via poster advertisements placed throughout London, Ontario in places such as family health team offices and medical centres, grocery stores, and pharmacies. Additionally, e-flyers were sent to local workplaces and the Middlesex London Health Unit to broaden the recruitment strategy and a two-week advertisement was placed in the Penny Saver Health Classifieds.

Eligible participants included obese, inactive, otherwise healthy males and females between the ages of 18-50 years that were currently not participating in a weight loss program. For the purposes of this study: obesity is classified as having a BMI greater than 30 kg/m^2; inactivity is classified as $\leq$ 30 minutes of physical activity $\leq$ 3 days per week (or $\leq$ 90 minutes weekly); and healthy is considered as an individual who has not been diagnosed with a chronic disease (e.g. type 2 diabetes, cardiovascular disease, etc) or condition by their family physician that would preclude them from participating in this study. Approval to conduct this six-month pilot intervention was obtained from the University of Western Ontario's Health Sciences Research Ethics Board (Appendix IV).

During the initial contact, either via telephone or e-mail, researchers screened potential participants to confirm that they met the inclusion criteria with respect to age, inactivity, absence of chronic disease, and lack of participation in any type of weight loss program. Once these criteria were confirmed, a mutually convenient meeting time was established so that researchers could take anthropometric measurements (height and weight) (Appendix V); and verify that participants met the BMI cut-point (> 30 kg/m^2).

Once eligibility was confirmed, participants were provided with the Letter of Information (Appendix VI), and written informed consent was obtained. Following this, participants were asked to complete a Physical Activity Readiness Questionnaire (PAR-Q) (Appendix VII) (83). This questionnaire is used to screen individuals who are planning to partake in any form of physical activity that is beyond their usual activity level. Participants who answered yes to any question on the PAR-Q were asked to discuss the study with their physician and obtain approval to participate.

Thirteen participants met the inclusion criteria; however, two dropped out before the study started identifying personal concerns with workload and the inability to meet the time commitment needed to participate in the program. Eleven participants began the study, of which four participants dropped out throughout the course of the intervention, two citing personal issues and two for health issues unrelated to the study. This left seven participants who completed the study.

3.2 Pre-intervention procedures

Approximately 1-2 weeks prior to the start of the intervention, dietary intake was obtained from the participants using two separate three-day diet intake records. Each food record consisted of two weekdays and one weekend day and included all food, beverages and supplements consumed. Upon completion of their diet records, participants sent the records to the study researchers by mail, e-mail or confidential fax, whichever was their preferred method before the first group session. The dietary records were reviewed by study personnel to ensure that the data provided was sufficiently detailed. When further clarification was required, participants were contacted via e-mail

to provide such clarification. Section 3.5.2 provides details of how these food records were analyzed.

To confirm anthropometric data, height and weight was re-measured just prior to the first education session. Height and weight measurements were taken in a separate room with only the participant and researcher present to maintain privacy and minimize discomfort (i.e. embarrassment) to the participant. Standing height was measured to the nearest 0.1 cm (centimetre) using a stadiometer (Health-o-meter, Continental Scale Corporation, Bridgeview, Illinois, USA). Participants removed shoes, belts, hats and coats, and were instructed to stand against the wall, facing directly ahead with feet together and arms at their sides. Participants' heels, buttocks and upper back were confirmed to be in contact with the wall, with their chin parallel to the ground. Two measurements were performed and when measurements were within 0.5 cm of each other, the average was calculated. If the measurements are greater than 0.5 cm, a third measurement was taken and the average calculated for the two closest measurements. Weight was measured to the nearest 0.1 kg using the digital Tanita Body Composition Analyzer (Model# TBF-300a, Japan). After the participant was stabilized on the platform and his/her entire bare foot was confirmed to be in contact with the metal platform, the researcher performed the measurement. As with the height measurement, weight was measured twice and an average calculated.

The final piece of data collected just prior to the first education session was a demographics questionnaire which included questions regarding age, gender, level of education, marital status, household occupancy, ethnicity, occupation, and income, as

well as three additional questions comprising current special diet restrictions or practices, historical weight loss practices, and current activity level (Appendix VIII).

3.3 Intervention - overview

This six-month diet quality pilot intervention utilized a non-experimental pre-post-test design. The study was carried out from October 2009 to March 2010. The CHEI was used both as the educational framework and the impact measure for the intervention. In addition, we applied constructs of the SCT as a theoretical model to guide this intervention. Specifically, we included constructs addressing personal factors (e.g. knowledge, skills and self-efficacy), behavioural factors (e.g. self-evaluation including self-monitoring, and goal setting), and environmental factors (e.g. social support) (75,76) (Table 1).

Table 1. Constructs of the SCT applied to improve diet quality.

Construct	Intervention Strategies
Behavioural capability (knowledge and skills)	Nutrition education classes, grocery store tour, cooking class, label reading session, handouts and tools (see Table 2)
Observational learning	Cooking classes including recipe revisions and enhancements
Self-efficacy	Small steps/changes approach, goal setting, self-reflection, application of skills (cooking, label reading), diet quality feedback post-intervention, post-intervention behavioural survey self-assessment
Goal setting	SMART goal setting sheets, discussions and reinforcement at group education and walking sessions
Self-evaluation / self-regulation	Self-assessment audits with reflection component, goal setting
Self-monitoring	Achievement of goals and physical activity, usual food intake with diet quality feedback
Social support	Group sessions, walking program
Environmental support	Self-assessment audit for reflection

The intervention consisted of two components: 1) a nutrition education and skill-building intervention aimed at improving participants' awareness, knowledge, skills and self-efficacy toward a higher quality diet; and 2) a walking program aimed at encouraging social support and improving participants' willingness to lead a more active lifestyle.

3.3.1 Nutrition education component

Over six months, ten nutrition education and/or skill-building classes were lead by a Registered Dietitian (RD) on Tuesday or Thursday evenings from 7-8:30 pm. Sessions were offered twice per month for the first four months then once per month thereafter. An outline of these ten classes is provided in Table 2 where the first three sessions were classroom-based and dedicated almost exclusively to building the nutrition knowledge and awareness of the participants. The final seven sessions were designed to improve participants' behavioural capacity using a combination of cognitive and skill-building components, including cooking classes, label reading and grocery store tours. As part of the first session, participants were advised how to set a specific, measurable, attainable, realistic and timely (SMART) goal as a means of self-evaluation and regulation throughout the intervention. Thereafter, participants were encouraged to set a goal at each session (i.e. total of nine goals) and to report on their success or lack of success on meeting their defined goal at the following group session. The sharing of these successes, or lack thereof, in a group setting aimed to provide participants with social support and collective problem-solving strategies. Participants were free to set whatever goal they wanted to work on, without influence from the researchers, in efforts to remain true to the individualistic, lifestyle nature of this study; however, the researchers were

Table 2. Nutrition education and skill-building intervention framework

Session	Aim	Handouts / Tools / Audits
Week 1 – Overview of the program and introduction to the diet quality concept	Information / Education	**Handout:** EatWise Pyramid, Perceived Exertion Rating **Tool:** Goal setting sheets **Audit #1** – Diet Quality Audit
Week 2 – Mind-full eating	Information / Education	**Handout:** Making a healthy lunch **Tool:** 7-day Menu planner **Audit #2** – Personal Environment
Week 3 and 4 – Label reading and grocery shopping / Grocery Store Tour	Information / Education & Skill-building	**Handout:** Label reading **Tool:** Grocery shopping list **Audit #3** – Personal Behaviour
Week 5 and 6 – Carbohydrates and glycemic index / Cooking	2 cooking classes - Information / Education & Skill-building	**Handout:** Glycemic index **Tool:** Participant baseline HEI scores consultation with RD to tailor goal-setting **Audit #4** – Mind-full eating questionnaire
Week 7 and 8 – Fats and Protein / Cooking	2 cooking classes - Information / Education & Skill-building	**Audit #5** – Self-efficacy Questionnaire
Week 9 - Eating away from home / Cooking	Cooking class (skill building)	
Week 10 – Putting it all together, celebration and potluck	Information / Education	Open forum – sharing recipes Post-intervention behavioural survey distributed (Appendix X).

available for goal refinement if the participants were struggling and requested assistance.

To help participants identify personal areas for improvement and thereby support goal setting, five self-assessment audits and a CHEI-based diet quality feedback form were provided. The self-assessment audits focused on: diet quality; promoting mind-full eating habits; personal behaviours related to healthy eating choices and physical activity; environmental eating cues; and self-efficacy (Table 2). The Diet Quality self-assessment

audit is provided as an example of one created by the research team to support participants with self-assessment, reflection, and to promote SMART goal setting (Appendix IX). While none of the self-assessment audits were collected for data assessment purposes; they were distributed to foster individualized self-evaluation and stimulate awareness of one's environment and dietary behaviours. The CHEI feedback form was based on the participant's baseline dietary intake as assessed by the two dietary intake records, and analyzed against the CHEI framework (Appendix II). Additionally, to enable participants' to recall the progress that they made throughout the intervention and to highlight remaining areas for improvement, post-intervention CHEI diet quality feedback was also provided to participants at the end of the intervention.

Each session had a similar format which included discussing goals (as outlined above) followed by a brief overview of the diet quality improvement concepts to be taught in that educational session. Throughout the presentation and the interactive skill-building components, open discussion was supported and encouraged. At the end of each session, the highlights were recapped and small nutrition-related changes were promoted. Participants were encouraged to set a SMART goal, and to self-monitor their changes or progress (i.e. diet, goals, activity). Educational tools (e.g. goal setting sheets, menu planner), handouts (e.g. label reading resources, EatWise Pyramid), and/or self-reflective audits (e.g. diet quality audit, personal environment audit) were provided along with a copy of the presentation to assist with comprehension, recall, and transferability of new knowledge into the participants' current dietary practices. Each participant was provided with a binder that could be used to collate all of the information provided in the classes and participants were requested to bring this binder to each class.

3.3.2 Walking component

The walking program was offered three times per week and participants were asked to attend two of these sessions. Sessions were offered Tuesday and Thursday evening at 6:15 pm just prior to the nutrition education classes and Sunday mornings at 10 am. At least one leader of each walking session was certified in cardio-pulmonary resuscitation (CPR). Each session was approximately 40 minutes in length with a 5 minute warm-up stretch, 30 minute walk and a 5 minute cool-down stretch. Participants were advised to walk at a pace at which they felt comfortable, applying a 'somewhat easy to somewhat hard' level of intensity as per the rating of the Perceived Exertion Scale (84). This scale provides a validated pictorial gradient of exertion for adults while they are walking (or running) (84) and was distributed to all participants in the initial education session for their use and reference. While physical activity is known to enhance the feasibility of sustainable, long-term weight maintenance (10), it was not the intention of this intervention to evaluate the effectiveness of physical activity on weight loss. In essence, the walking program in this intervention served two distinct purposes. First, it was included as a control variable, which aimed to standardize the amount of physical activity performed by our participants rather than to encourage an increase in the amount or the intensity of activity. Our hope was that by promoting some form of physical activity we would potentially foster willingness and self-efficacy toward being more active post-intervention. Secondly and most importantly, the walking component provided opportunities for peer and leader support (i.e. environmental support). Social support has been identified as a significant factor to facilitate the adoption of physical activity into one's lifestyle (80,81), which may enhance self-efficacy for other health

behaviours. At the walking sessions, the leader encouraged and facilitated discussion among the participants regarding the educational material and skill-building activities presented throughout the intervention and the progression of particular goals and their attainment. These walking sessions also allowed the leader to inquire about the acceptability of the intervention as it was implemented and any suggestions for improvement.

3.4 Post-intervention procedures

Upon completion of the intervention, participants were required to complete all anthropometric measurements and dietary intake records as previously described. In addition, the participants were required to complete a post-intervention behavioural survey which included sections regarding: 1) achievement of behavioural goals including their perceived changes in diet quality components, their perception of the usefulness of handouts provided in class, as well as the changes in their activity level over the course of the six-month intervention; 2) a self-efficacy assessment where they could report their level of confidence is making and continuing changes in diet quality components; and 3) a knowledge, awareness, and skill self-evaluation which captured what the participants learned throughout the intervention (Appendix X). Finally, participants shared further information in a one-on-one interview which was conducted by a moderator, independent of the research team, to illicit personal perceptions of the intervention utilizing a semi-structured guide (Appendix XI).

3.5 Data analysis

3.5.1 Formative evaluation

For the purposes of this intervention, formative evaluation is defined as the 'appraisal of delivery strategies during development or draft stage, before full-scale implementation', as defined by Myers (82). Attendance rates to group sessions and the walking program were monitored as measures of acceptability, feasibility, and practicality of the intervention. Throughout the six months, researchers requested feedback from the participants on how to improve the intervention content to make it more acceptable or effective and, when possible, these suggestions were incorporated throughout its implementation. Post-intervention, one-on-one interviews were conducted to encourage participants to be forthcoming in their perceptions and suggestions about the feasibility, acceptability, and practicality of the intervention. These interviews were tape recorded and transcribed verbatim by a person external to the research team. Transcripts were reviewed independently by two members of the research team who applied inductive latent content analysis to the transcripts, whereby key words and concepts were coded and grouped into themes. The researchers later met to compare their findings and a common theme template was developed. The data were organized using Microsoft Office Word 2007.

3.5.2 Impact evaluation

For the purposes of this intervention, impact evaluation is defined as the 'appraisal of the program's impact', as defined by Myers (82). Diet quality scores and anthropometric data are presented as means ± standard deviation (SD). The two sets of repeated diet intake records were entered into a food processor computer program (Food

Processor SQL 10.5, ESHA Research Inc., Salem OR) and were averaged to determine the participant's usual daily nutrient intake and eating patterns separately for both pre- and post-intervention. This average daily nutrient intake data was then used to calculate diet quality scores using the CHEI (Appendix XII) (34). Diet quality scores were then categorized as either a 'poor quality diet' (< 50 points out of 100), diet quality that 'needs improvement' (50-80 points), or 'good quality diet' (> 80 points). Additionally, diet quality was assessed based on the two main sub-component sub-totals (adequacy and moderation), as well as the scores for the individual components. The adequacy component includes food groups and specific recommendations according to EWCFG (i.e. total fruits and vegetables, whole fruit, green and orange vegetables, total grains, whole grains, milk and alternatives, meat and alternatives and unsaturated fats) (Appendices II and III). The moderation component includes saturated fats, sodium, and 'other foods' such as those that are high in sugars and fats (Appendix II). Finally, the post-intervention individual components were ranked as highest and lowest contributors to the overall CHEI score. This was determined based on their relative maximum score. For example, whole grains contribute 3.9 raw points to the overall score, but this is equivalent to a 78% weighting based on its relative maximum possible score (3.9/5 x 100%).

Using independent t-tests, baseline findings between completers and non-completers were compared to assess for differences in age, diet quality, and weight. For completers, paired t-tests were used to elucidate differences in pre- and post-intervention total CHEI diet quality scores, adequacy score, moderation score and each component of the CHEI, BMI, and body weight. For exploration purposes, pre-post changes were also

evaluated for fibre, saturated fat, sodium and number of servings per each of the four food groups according to EWCFG (40). Correlation analyses were performed to assess relationships between baseline BMI and body weight and CHEI scores. Further correlation analyses were performed to assess relationships between change in BMI pre-post intervention and changes in the following pre-post intervention variables: 1) total CHEI scores; 2) CHEI Adequacy score; 3) CHEI Moderation score; 4) each component of the CHEI; and 5) each food group as defined by EWCFG. Finally, correlations were also conducted between potential confounding factors (attendance to nutrition sessions and walking program; attainment of goals and activity targets; and the number of skills attained throughout the course of the intervention) and the change in CHEI scores and BMI units. Attendance rates were calculated as a percentage of sessions attended (# of sessions attended/# of possible sessions x 100). The number of skills attained was considered to be those reported on the post-intervention behavioural survey as self-reported by each participant. All data was analyzed using a computer statistics program (SPSS 18.0, SPSS Inc., Chicago IL). Results were considered statistically significant at a $p \leq 0.05$ level in two-tailed testing.

4.0 RESULTS

4.1 Participant characteristics and baseline findings

Eleven participants were enrolled in this six-month diet quality pilot study. Demographic, anthropometric and diet quality characteristics are shown in Tables 3 and 4. At the end of this pilot study, seven of the eleven participants remained, which equated to a 36% attrition rate. Tables 3 and 4 provide analyses of the baseline findings for all of the participants who entered the study (n = 11), the completers (n = 7), and the non-completers (n = 4).

For all of the participants who entered the study (n = 11), the average weight at baseline was 106.7 kg (SD 19.5 kg) and average BMI was 40.9 kg/m^2 (SD 7.6 kg/m^2) (Table 3). The majority of participants had tried some form of structured diet in the previous six months (n = 10) and reported less than 60 minutes of weekly physical activity (n = 8) (Table 3). Diet quality, as measured by the CHEI, was found to be in the 'needs improvement' range (50-80 out of 100), with a mean score of 56.8 (SD 11.0) (Table 4). The range of diet scores were 43.4 - 75.6 out of 100 with almost one-third of the participants (n = 4) reporting a 'poor quality diet', and no participant reporting a 'good quality diet'. The completers and non-completers did not differ demographically nor in overall diet quality (p = 0.08) when analyzed by independent t-tests (Table 3); however, differences were found with respect to anthropometric data (Tables 3 and 4). Specifically, the completer group had a greater weight (107.7 kg, SD 24 kg vs 104.8 kg, 10.7 kg; p = 0.04) and BMI (41.5 kg/m^2, SD 8.2 vs 39.2, SD 4.5; p = 0.02) at baseline.

Table 3. Baseline characteristics – comparison of all participants, completers and non-completers

Variable	All		Completers		Non-completers	
	Mean ± SD[a] n = 11		Mean ± SD[a] n = 7		Mean ± SD[a] n = 4	
Age (years)	37.0 ± 9.0		40.5 ± 7.9		30.0 ± 7.6 (NS)	
Weight (kg)	106.7 ± 19.5		107.7 ± 24.0		104.8 ± 10.7[b]	
Range	84.8 - 142.7		84.8 - 142.7		92.0 - 117.7	
BMI (kg/m^2)	40.9 ± 7.6		41.5 ± 8.2		39.2 ± 4.5[b]	
	N	**%**	**n**	**%**	**n**	**%**
Gender						
Female	10	91	7	100	3	75
Male	1	9	0	0	1	25
Ethnicity						
Canadian	9	82	6	86	3	75
Italian	2	18	1	14	1	25
Marital Status						
Married	7	64	4	57	3	75
Not married	4	36	3	43	1	25
Highest level of education						
Highschool	8	73	5	71	3	75
Post-secondary	2	18	1	14	1	25
Graduate school	1	9	1	14	0	0
Occupation						
Student	1	9	1	14	0	0
Part-time	1	9	0	0	1	25
Full-time	7	64	6	86	1	25
Self-employed	1	9	0	0	1	25
Unemployed	1	9	0	0	1	25
Income						
< $21,359	0	0	0	0	0	0
$21,359-66,343	7	64	5	71	2	50
>$66,343	2	18	1	14	1	25
No response	2	18	1	14	1	25
Structured diet program (previous six months)						
Yes	10	91	7	100	3	75
No	1	9	0	0	1	25
Physical Activity (per week)						
<30 minutes	5	46	4	57	1	25
30-60 minutes	3	27	2	28	1	25
61-90 minutes	2	18	1	14	1	25
>90 minutes	1	9	0	0	1	25

[a] SD = standard deviation

[b] $p \leq 0.05$, between completers and non-completers

NS = non-significant

Table 4. CHEI baseline diet quality scores – comparison of all participants, completers and non-completers

Diet Quality	All	Completers	Non-completers
	Mean ± SD[a] n = 11	Mean ± SD[a] n = 7	Mean ± SD[a] n = 4
Diet quality:			
Total CHEI score (out of 100)[b]	56.8 ± 11.0	59.5 ± 12.6	52.1 ± 6.2 (NS)
Adequacy score (out of 60)	36.9 ± 7.7	39.7 ± 5.2	32.1 ± 9.8
Moderation score (out of 40)	19.9 ± 10.7	19.8 ± 10.9	20.0 ± 12.0
Range of Total CHEI	43.4 – 75.6	43.4 – 75.6	47.5 – 61.0

[a] SD = standard deviation

[b] Diet quality category: < 50 points = poor diet quality; 50 – 80 points = needs improvement; >80 = good diet quality

Correlation analysis was performed between baseline BMI and diet quality scores. For all participants (n = 11), no correlation was observed between BMI and CHEI scores ($r = -0.34$, $p = 0.31$) (data not shown). Furthermore, separate analysis of completers and non-completers at baseline demonstrated no correlation between BMI and CHEI scores ($r = -0.50$, $p = 0.21$; $r = 0.48$, $p = 0.52$, respectively) (data not shown).

4.2 Post-intervention interview

The post-intervention interview provided the research team with descriptive information regarding the acceptability, feasibility and practicality of this pilot study. Where possible, the findings from the post-intervention behavioural survey were compared with the observed dietary changes to validate participants' responses and help the researchers evaluate if important topics of the program were implemented into one's lifestyle. From the post-intervention interview, it appears that the pilot study was acceptable and well-received by the majority of the participants. A summary of key points and themes are provided in Table 5. Overall, participants agreed that the intervention provided: educational and skill-building components, including the cooking classes and label reading; social support, both in the nutrition education classes and the

Table 5. Post-intervention interview themes

Overall impression
"I did learn a lot and I will be using the information that I did learn. I think it is a very worthwhile study and I hope that more people get the opportunity to participate"
"Like I said, sure we have the Canada food guide. This goes into much more detail. Making better food choices, making yourself more aware"
Acceptability of the program (location, social support, informative)
"I think it was really well done. Central location"
"I live in the area"
"I liked the socialization aspect of it…. getting to know the other people in the program"
"Very supportive and always there if you had any questions"
"Not necessarily not always learning new things, but definitely reinforcing them"
"Reiterated it you know, and um just made your more aware"
"I think she's got it and it's great. It's great information."
Key aspects of the program (label reading, cooking classes)
"reading of food labels…Practical stuff that you can apply every day."
"the food labels was really a big thing. Like I check constantly now, like whenever I pick something up."
"I think that the label would be first and then the cooking"
"I thought the way they incorporated the cooking classes in the lesson was good...substitute things and remembering to get the good oil in and stuff like that."
"The cooking classes I loved. I thought it was great. You learned different menus that are healthy. A healthier way of cooking."
Usefulness of materials (goal setting, audits)
"I think what I got the most out of was the goal setting, and that, and the analysis of yourself. You know, taking the time to think about what you, how your current behaviour looks. How you can change it, and the effect of that behaviour or that change."
"I'll set more goals and and then, accomplish more things with that. I really liked the goal setting part of it."
"The environment (audit) one surprised me! …I thought that was very worthwhile because you don't realize how much your environment does play a role in your behaviour, and it does."
"The auditing portion of it, I thought was helpful because sometimes if you, I am more of a visual person. So if I see it on paper, it will come back to me"
Suggestions for improvement
"I think that we could have more educational ones on top of cooking classes."
"…having a larger group. I know it started off fairly big and then the numbers dwindled a little bit."
"The slides were so small you couldn't read. Bigger print."
"If they are going to do the less frequent meetings, maybe e-mail reminders"
"At the beginning especially, maybe assistance with setting goals"

walking program; and the opportunity to have already learned concepts reinforced through the education and application components of the intervention. Increased awareness of healthier food choices and options was a recurring theme. This was reinforced through the grocery store tour, the label reading component, and the cooking classes, as well as through the supportive guidance provided by the researchers (e.g. goal setting and e-mail reminders). Many participants made references to learning some new concepts, but their main appreciation of the intervention was that their current knowledge was reinforced and that the application of this knowledge was enhanced through the label reading, grocery store tour and making simple, healthy recipes in the cooking classes. Self-assessment (e.g. audits) and self-monitoring strategies (e.g. goal setting) were noted as tools that could be useful post-intervention to help participants enhance their self-efficacy towards sustaining a healthier diet. Overall, the pilot study was well-received. Suggestions for improvements primarily consisted of logistical concerns such as font size on handouts, having a larger group of participants, providing more support and assistance with goal setting, increasing the number of education and cooking classes, and increasing the contact time with the researchers when the session frequency tapered in the fourth month.

4.3 Diet quality outcomes

Changes in diet quality scores over the course of the six-month intervention are summarized in Table 6. The mean CHEI score pre-intervention was 59.5 (SD 12.6) and post-intervention was 69.4 (SD 10.1) which resulted in a non-significant improvement in diet quality by 9.9 points ($p = 0.10$) among the participants who completed the intervention ($n = 7$). The CHEI scores were further divided into adequacy and

moderation sub-components. Adequacy was found to improve by 4.6 points to a total of 44.3 out of 60 (SD 6.5; $p = 0.11$), and while not significant, is reflective of how the participants improved their dietary intake towards meeting the recommendations outlined in EWCFG (40). Additionally, the moderation score also improved non-significantly by 5.3 points to 25.1 out of 40 (SD 10.1; $p = 0.10$) as the participants improved their diets by reducing their consumption of 'other foods' such as ice cream, donuts and chocolate bars.

Assessing individual CHEI components, the three greatest contributors to the overall pre-post-intervention change in the diet quality score were the total fruits and vegetables (2.2/100), saturated fat (2.0/100), and the 'other foods' components (2.9/100), which combined equated to 7.1 out of the 9.9 point improvement (Table 6). The total fruit and vegetables and the green and orange vegetables components significantly improved over the course of the six-month pilot study ($p = 0.05$ and $p = 0.02$ respectively) (Table 6). These improvements equal an increase of vegetables and fruits by 1.8 servings/d, of which approximately 0.5 servings were green or orange vegetables. The saturated fat and 'other foods' scores did not result in significant changes ($p = 0.10$ and $p = 0.19$ respectively); however, these improvements are reflective of making more healthful dietary choices. The improvements in these components' scores signifies a reduction in the saturated fat content of the diet from 12% of TEI to 10.5% of TEI and a reduction in the contribution of 'other foods' from 23% of TEI to 18% of TEI.

Based on their weighted contribution to the post-intervention CHEI score, the top contributors were meats and alternatives (9.2 out of 10 or 92%), milk and alternatives (7.9 out of 10 or 79%), whole grains and total grains (both 3.9 out of 5 or 78%). With respect to the latter, it is noteworthy that the slight decline in total grains (-0.2 points or

Table 6. Pre- and post-intervention comparisons of completers for total diet quality and diet quality components as measured by CHEI

Variable	Pre-intervention Mean ± SD[a]	Post-intervention Mean ± SD[a]	Difference	p value
Total CHEI score (out of 100):	59.5 ± 12.6	69.4 ± 10.1	9.9	0.10
Adequacy (out of 60)	39.7 ± 5.2	44.3 ± 6.7	4.6	0.11
Moderation (out of 40)	19.8 ± 10.9	25.1 ± 10.1	5.3	0.10
Adequacy components :				
Total fruits and vegetables (out of 10)	4.3	6.5	2.2	**0.05**
Whole fruit (out of 5)	2.6	3.5	0.9	0.32
Green and orange vegetables (out of 5)	1.8	3.5	1.7	**0.02**
Total grains (out of 5)	4.1	3.9	-0.2	0.66
Whole grains (out of 5)	2.9	3.9	1.0	0.35
Milk and alternatives (out of 10)	7.2	7.9	0.7	0.51
Meat and alternatives (out of 10)	9.8	9.2	-0.6	0.32
Unsaturated fats (out of 10)	7.0	5.9	-1.1	0.11
Moderation components:				
Saturated fat (out of 10)	4.9	6.9	2.0	0.10
Sodium (out of 10)	5.3	5.7	0.4	0.78
Other foods (out of 20)	9.6	12.5	2.9	0.19

[a] SD = standard deviation

decrease of < 0.5 servings) occurred concurrently with an increase in whole grains (1 point or approximately 1 serving according to EWCFG), suggesting that whole grain choices replaced non-whole grain choices in our participants' diets. Conversely, the lowest contributors to our post-intervention score were unsaturated fat (5.9 out of 10 or 59%), other foods (12.5 out of 20 or 63%), total fruits and vegetables (6.5 out 10 or 65%) and sodium (6.9 out of 10 or 69%). The decline in the unsaturated fats (7.0 to 5.9 points or less than 5 mL, p = 0.11) throughout the intervention was an undesirable finding given that an entire nutrition session was dedicated to educating our participants about sources of unsaturated fats and how to incorporate unsaturated fat sources (e.g. oil, olives, nuts) into their diet (via cooking classes). Essentially our participants kept their intake of

unsaturated food sources to approximately one tablespoon of unsaturated oils or 15 mL/d, which is 50% of the recommendations according to EWCFG. Finally, despite a significant improvement in both the total fruits and vegetables and green and orange vegetable scores, total fruit and vegetable consumption remained a low contributor to diet quality in our participants.

Overall diet quality was improved in 6 out of 7 participants throughout this six-month nutrition intervention. Figure 1 highlights the diet quality changes made by each participant. The one participant whose score did not improve over the course of the intervention had a relatively low attendance rate (50% or 5 sessions) to the nutrition education and skill-building classes. Other notable findings are that two of the participants improved from 'a poor quality diet' to a 'needs improvement' diet quality over the course of six months, with no participants remaining in the 'poor quality diet' range by the end of the intervention. Furthermore one participant achieved a 'good quality diet' (score > 80) at the end of the intervention. Lastly, despite the overall improvement in the diet quality score of 9.9 points over the six-month pilot study, the average post-intervention score remained in the 'needs improvement' range (69.4 points, SD 10.1) (38).

To further evaluate the impact of the dietary changes that occurred throughout the intervention, certain nutrients were compared against the DRIs. Figure 2 displays changes in sodium, saturated fat and fibre intake. In general, sodium intake was not altered pre-post-intervention (-145 mg/d, $p = 0.71$) and the post-intervention intake at 2823 mg/d (SD 1248 mg; Figure 2) remained above the tolerable upper intake level (2300

Figure 1. Diet quality rating of completers pre- and post-intervention as determined by CHEI scores

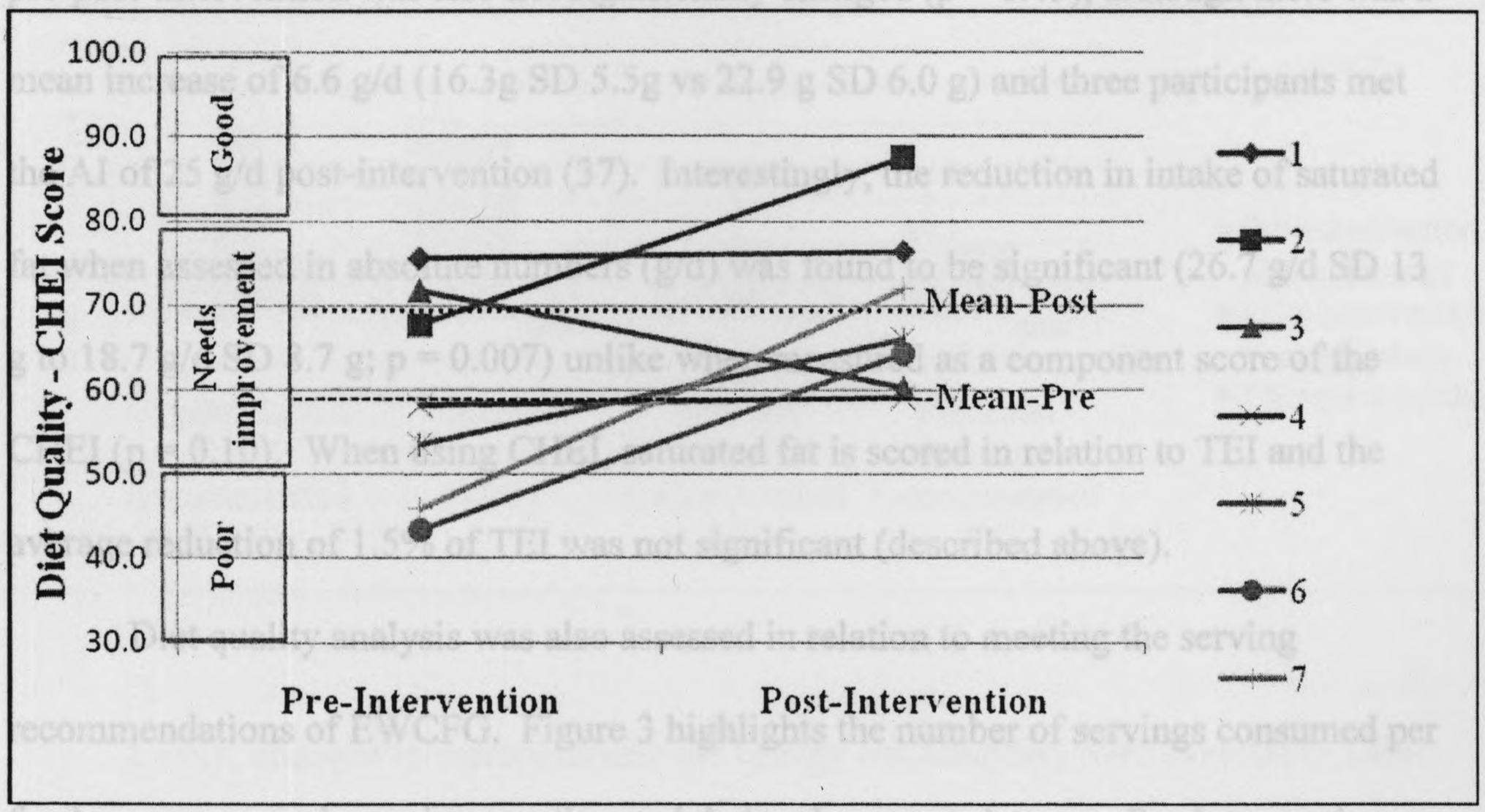
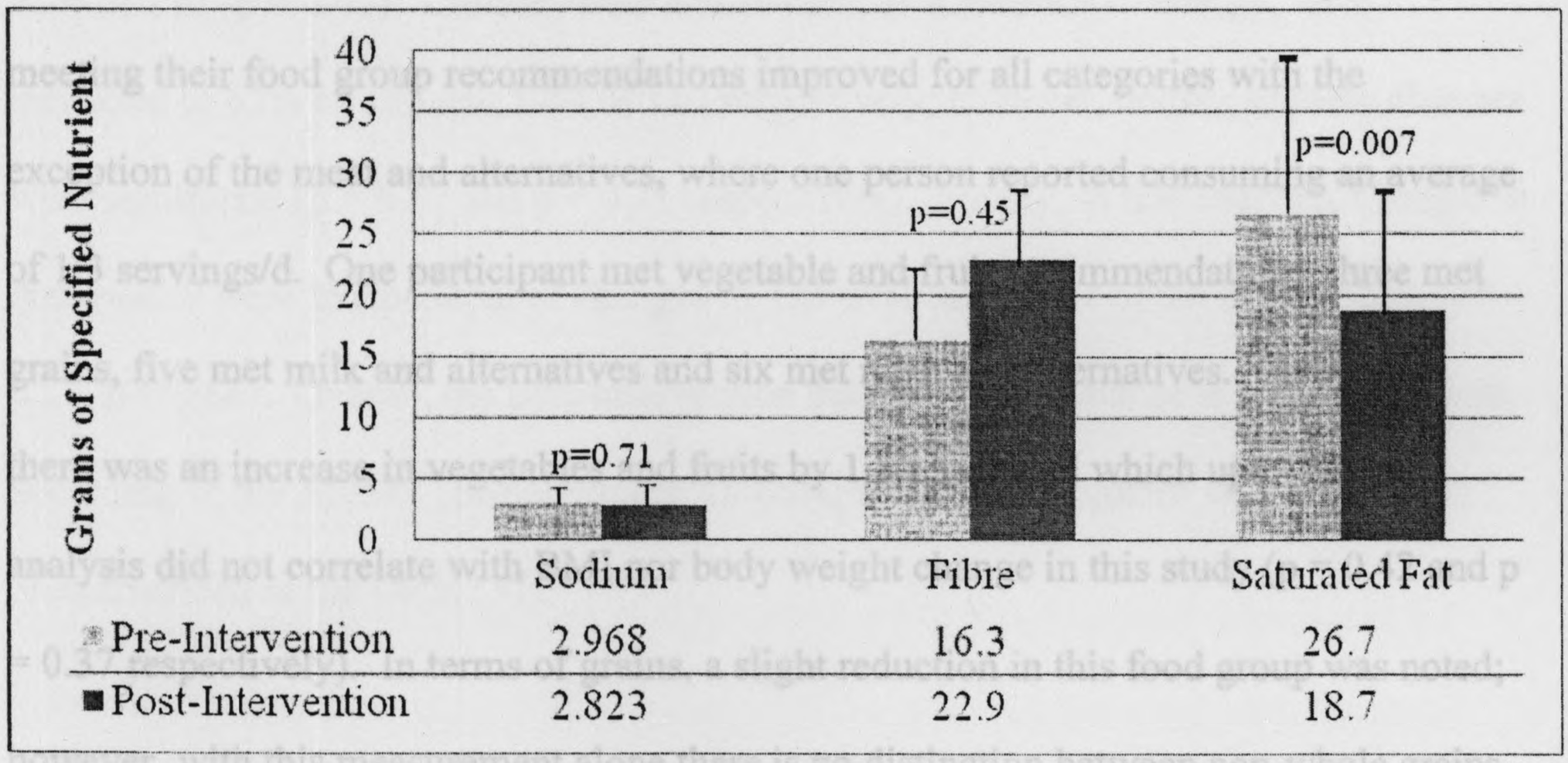


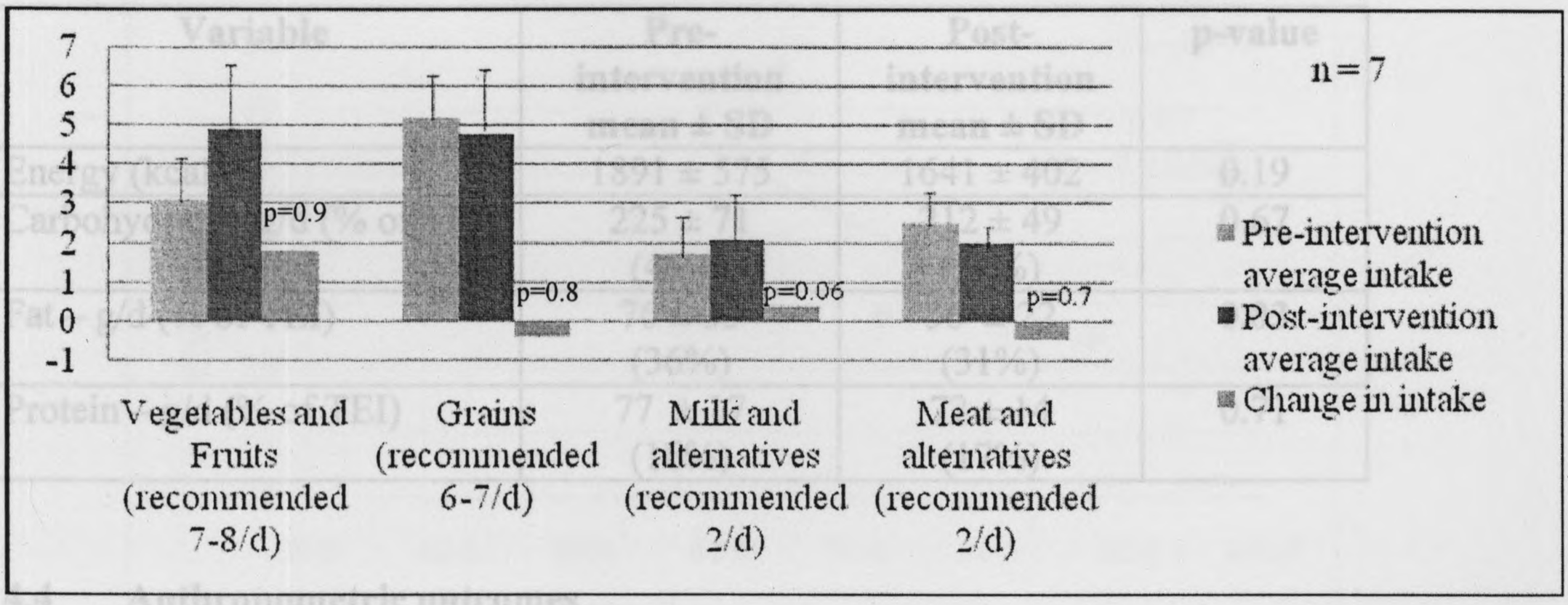
Figure 2. Selected nutrient intakes pre-post-intervention



mg) and almost double the AI level (1500 mg) according to the DRIs (62). Fibre intake pre-post-intervention was also not significantly changed ($p = 0.45$), although there was a mean increase of 6.6 g/d (16.3g SD 5.5g vs 22.9 g SD 6.0 g) and three participants met the AI of 25 g/d post-intervention (37). Interestingly, the reduction in intake of saturated fat when assessed in absolute numbers (g/d) was found to be significant (26.7 g/d SD 13 g to 18.7 g/d SD 8.7 g; $p = 0.007$) unlike when measured as a component score of the CHEI ($p = 0.10$). When using CHEI, saturated fat is scored in relation to TEI and the average reduction of 1.5% of TEI was not significant (described above).

Diet quality analysis was also assessed in relation to meeting the serving recommendations of EWCFG. Figure 3 highlights the number of servings consumed per food group pre- and post-intervention and their subsequent changes. Pre-intervention, no participant met the recommended number of servings for vegetables and fruits, two met the grain servings, three met the milk and alternatives servings, and all met the recommendation for meat and alternatives. Post-intervention, the number of participants meeting their food group recommendations improved for all categories with the exception of the meat and alternatives, where one person reported consuming an average of 1.3 servings/d. One participant met vegetable and fruit recommendations, three met grains, five met milk and alternatives and six met meat and alternatives. On average there was an increase in vegetables and fruits by 1.8 servings/d which upon closer analysis did not correlate with BMI nor body weight change in this study ($p = 0.42$ and $p = 0.37$ respectively). In terms of grains, a slight reduction in this food group was noted; however, with this measurement alone there is no distinction between non-whole grains and whole grains.

Figure 3. Pre- and post-intervention EWCFG average number of servings and changes



Lastly, changes in macronutrient and energy consumption were evaluated (Table 7). TEI was reduced non-significantly by 250 kcal/d ($p = 0.19$) to a final intake of 1641 kcal/d. Mean fat intake was reduced by 20 g/d to a post-intervention intake of 56 g/d which contributed to a significant reduction of its proportional energy intake from 36% to 31% of TEI ($p = 0.03$). Carbohydrate and protein, as a measure of energy, were increased to 52% of TEI and 17% of TEI respectively; however, neither of these changes were significant ($p = 0.67$ and $p = 0.71$ respectively). Finally, in this analysis, changes in diet quality were independent of changes in TEI over the course of the intervention ($r = -0.21$, $p = 0.66$). Overall, the post-intervention macronutrient balance is more favourable according to the AMDR (carbohydrates 45-65%; fat 20-35%; protein 10-35% of TEI) recommended in the DRIs (37).

Table 7. Pre- and post-intervention macronutrient and energy intakes and correlation analysis with change in BMI

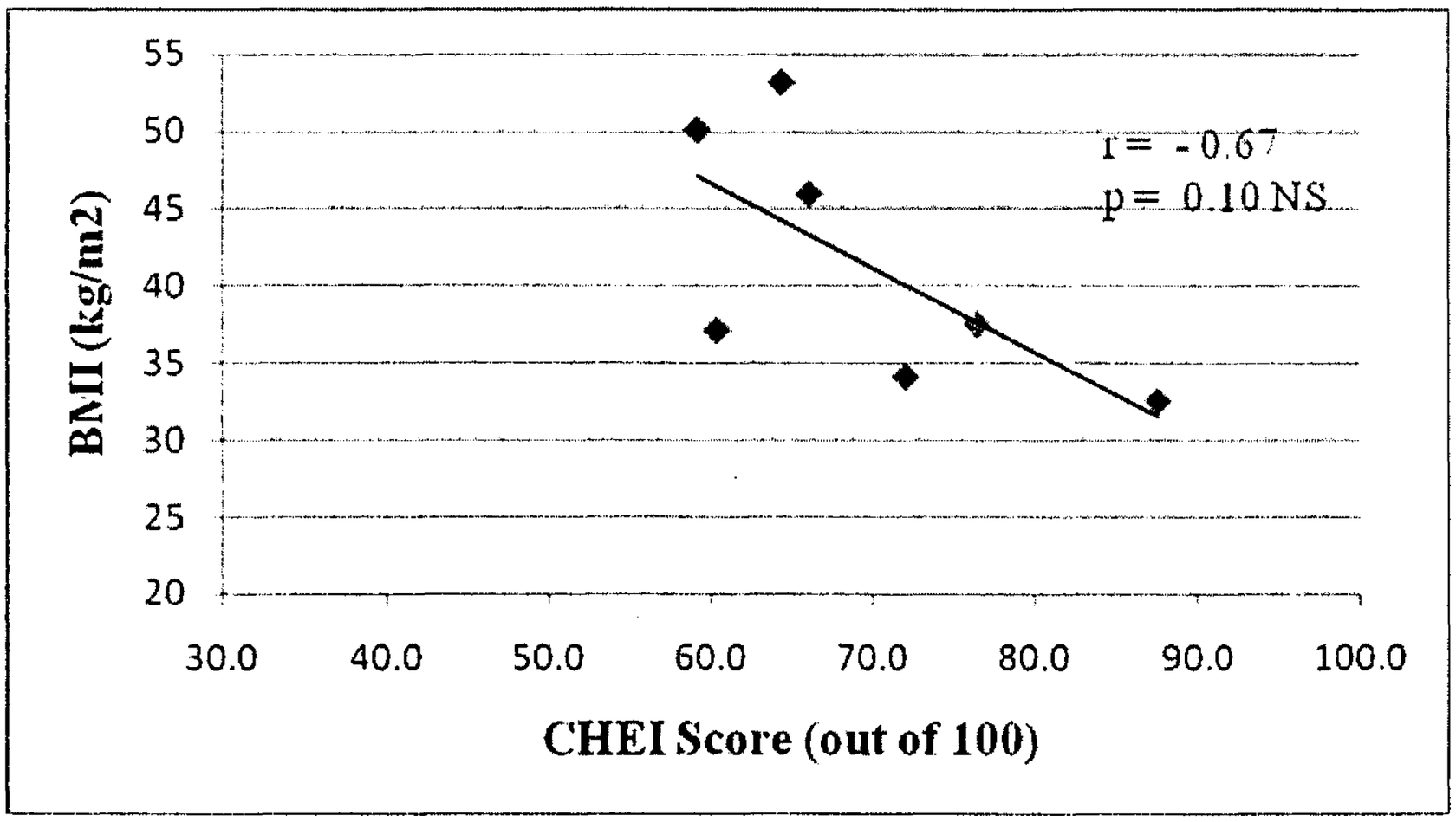
Variable	Pre-intervention mean ± SD	Post-intervention mean ± SD	p-value
Energy (kcal/d)	1891 ± 575	1641 ± 402	0.19
Carbohydrate - g/d (% of TEI)	225 ± 71 (48%)	212 ± 49 (52%)	0.67
Fat – g/d (% of TEI)	76 ± 33 (36%)	56 ± 22 (31%)	**0.03**
Protein – g/d (% of TEI)	77 ± 17 (16%)	72 ± 14 (17%)	0.71

4.4 Anthropometric outcomes

Six of the seven participants lost or maintained their weight during the six-month study. The post-intervention mean body weight was 106.5 kg (SD 21.3 kg; range 84.3-139.7kg) and BMI was 41.5 kg/m^2 (SD 8.2; range 32.5-53.2 kg/m^2). The mean change in weight among all participants was a 1.2 kg reduction (SD 4.5kg, p = 0.5; range -5.8 to +7.9 kg) which equated to a 1.1% weight loss. Four participants lost more than 2% of their body weight in the six months, two maintained, and one gained 9% of their body weight. Of the six participants who maintained or reduced their body weight, they also improved their CHEI score (data not shown). Further, the one participant who gained weight also demonstrated a lower diet quality post-intervention, which again may be a result of the lower commitment as suggested in the attendance rate (50%). Finally, the mean change in BMI units was a reduction of 0.4 kg/m^2 (p = 0.56; range -2.2 to 3.1 kg/m^2) with three participants (out of seven) losing between 1-2 BMI units (kg/m^2).

CHEI results and individual components were assessed in relation to BMI. As demonstrated in Figure 4, there was an inverse trend for post-intervention BMI and CHEI scores (r = -0.67, p = 0.10). No correlation was found however, between the change in

Figure 4. Post-intervention correlation analysis of BMI and CHEI scores



BMI and change in CHEI scores (r = -0.5, p = 0.27), nor for the change in BMI in relation to changes in adequacy (r = -0.4, p = 0.36) or moderation (r = -0.5, p = 0.25) components (data not shown). Further BMI correlation analysis was performed for each of the CHEI components (data not shown). An increase by 1 point for whole grains (Table 6), equivalent to an increase of approximately 0.7 servings per day of grains according to EWCFG, was inversely correlated with BMI (r = -0.83, p = 0.02). No other individual components were found to be correlated with BMI, although there appeared to be a trend toward an inverse correlation for milk and alternatives and 'other foods' scores (r = -0.71, p = 0.07; r = -0.72, p = 0.07 respectively). Lastly, changes in food guide servings (e.g. fruits and vegetables and grains) and for nutrients (e.g. grams of fibre and saturated fat) that were not specifically assessed by the CHEI were analyzed for correlations to change in BMI and no relationships were identified (data not shown).

4.5 Post-intervention behavioural survey

The behavioural survey provided descriptive data regarding the participants' perceived changes in their diet quality, knowledge, skills or self-efficacy which could be used to affirm or refute some of the findings from the food intake analysis and diet quality changes. Six out of seven participants reported that they increased their total fruit and vegetable and whole fruit consumption and all participants reported a decreased intake of other foods. Of the handouts and tools distributed in class (Table 2), the majority of participants reported that they plan to continue to use 4 out of 7 of them in the future, including: making a healthy lunch; grocery list; label reading resources; and the goal setting sheets. Furthermore, the respondents reported that their greatest achievements at the end of the study were increasing vegetables and fruits, an increased awareness of healthier types of foods, and greater skills concerning label reading. These findings were reiterated in the post-intervention interviews (Table 5).

The second part of the behavioural survey assessed the participant's self-efficacy for sustaining a healthier diet. At least five out of seven reported that they 'know they can': eat fruit and vegetables daily; eat whole fruit more than juice; choose unsaturated fats over saturated fats; limit sodium; eat whole grains more often; and eat breakfast daily. The majority of these aforementioned self-efficacy reports were corroborated in the pre-post intervention dietary intake records as evidenced by improvements in component scores of the CHEI (Table 5). The one exception was choosing unsaturated fats over saturated fats, as there was a slight decline in unsaturated fat intake (< 5 mL).

Lastly, based on the SCT framework, we assessed changes in awareness, knowledge and skills following the intervention. The majority of participants (4 out of 7)

reported that because of their participation in the study, they were more aware and had attained a greater knowledge about eating a healthier diet, choosing higher quality proteins, preparing healthier meals and snacks, reading a food label, the importance of planning a menu, the benefits of being physically active, and the importance of SMART goal setting. Finally, the skills that participants reportedly gained or made improvements in were label reading, SMART goal setting, preparing meals and snacks with vegetables and fruits, using unsaturated oils and choosing higher fibre foods. Notably, the number of skills attained, by participant, did not correlate with their respective changes in CHEI score ($r = 0.65$, $p = 0.11$; data not shown).

4.6 Participation and goal attainment rates

Participation was tracked for each of the nutrition classes and the group walking program. Four participants attended 80% or more of the nutrition classes, while the remaining three attended 50-60% of the classes. The average nutrition class attendance was 74%. In the walking group, only two participants walked consistently with the group and they attended 80% or more of the walking sessions that were offered three times per week. The remaining five participants elected to not walk with the group as their primary mode of activity and chose to walk independently or partake in some other form of activity which resulted in an overall walking participation rate of 34%. Reasons cited for not walking with the group included time commitment (busy with work or school), poor weather (cold, icy, risk of falls), and enjoyment in alternative forms of exercise (gym membership). Group participation was encouraged but not enforced as there was a perceived risk of setting a negative tone to the group walking sessions and of further loss of participants; therefore, the group walking program did not control for physical activity

as originally intended. Attendance to nutrition classes and changes in BMI or CHEI scores were not significantly correlated ($p = 0.25$ and $p = 0.31$ respectively), nor was attendance to the walking program and changes in BMI or CHEI scores ($p = 0.25$ and $p = 0.51$ respectively).

Both physical activity and nutrition goal attainment were also monitored. On a weekly basis, participants reported if they had attained their SMART goal and whether or not they walked twice per week as per the initial requirement of the intervention. Self-reported activity attainment demonstrated that 4 of the 7 participants met the walking or activity commitment of twice per week. On average, the group reported meeting their SMART goals 75.8% of the time. Notably, the two participants that consistently committed to the group walking program reported meeting 75% and 100% of their personally defined SMART goals. Although the specific details of the goals for the participants were not monitored by the research team, the types of goals that were set were asked as part of the post-intervention behavioural survey. Some examples of goals that were reported included: eating more vegetables and fruits; trying new fruits and vegetables; drinking more water; no more than two drive-thru meals per week; and eating fish at least once per week. Self-reported goal attainment was not correlated with BMI change ($p = 0.65$) nor CHEI change ($p = 0.14$) (data not shown). However, activity attainment was correlated with BMI change ($r = 0.84$, $p = 0.02$) and there was a trend towards a correlation between physical activity attainment and change in CHEI score ($r = 0.66$, $p = 0.10$) (data not shown). While we cannot explain the link between physical activity attainment and improved diet quality directly, the greater engagement in physical activity may signify an enhanced commitment to a more healthful lifestyle.

5.0 DISCUSSION

Several dietary approaches have been undertaken to reverse the obesity epidemic across North America, with the majority of these attempts intentionally or unintentionally involving some form of dietary restriction (14-32). To our knowledge, this pilot study was the first 'true' ad libitum nutrition-based approach to solely promote comprehensive diet quality enhancements, with no restrictive, prescriptive diet plan, and to assess this impact on spontaneous weight loss. We found that, in general, the participants enjoyed the program and found it acceptable and feasible to attend. Additionally, participants identified numerous skills (e.g. label reading, preparing meals and snacks with fruits and vegetables, etc) that they will continue to use due to their participation in this intervention. As well, they had enhanced self-efficacy towards adopting healthier dietary behaviours including eating fruits and vegetables daily and eating whole grains more often, which is an important mediator of long-lasting behaviour change (76,77). In addition, participants found that the nutrition education sessions provided practical information that allowed them to easily incorporate the information provided into their current lifestyle. Program effectiveness and adoption was evident as we detected an overall diet quality improvement of 9.9 points using the CHEI, with 9 out of 11 individual component scores improving or remaining unchanged. Furthermore, a decline in BMI of 0.4 kg/m^2 (1.1% weight loss) was detected, although neither the overall diet quality improvement nor weight change outcomes reached statistical significance. Due to the fact that this pilot study was primarily conducted as a feasibility study, the lack of statistical significance is not surprising and is likely attributed to lack of power with the small sample size.

5.1 Formative evaluation

Post-intervention interviews suggested that the intervention was well-received by participants and generally met their preliminary expectations prior to enrolling in the study. All of the participants felt that study personnel were approachable, supportive and knowledgeable which are important socio-environmental attributes that support people in working towards changing behaviours (75). Most participants found the location and length of the sessions to be acceptable; however, some suggested that they would have liked some additional contact with researchers (e.g. e-mail tips and reminders) particularly when the meeting frequency was reduced from twice to once per month in the latter part of the study. Furthermore, while most enjoyed the small group setting, some participants stated that they might have enjoyed a larger group as it would have allowed for more group discussion and sharing of ideas. These references to larger group size and additional contact with the researchers addresses the desire for social support (76) which has resulted in greater diet quality improvements when compared with groups receiving health promotion material only and no researcher contact (69-71).

Furthermore, as part of the formative evaluation of this pilot intervention, participants provided continuous feedback throughout the six months, and, where plausible, these improvements were implemented immediately to meet the participants' needs. For example, participants' repeatedly commented that they enjoyed the cooking classes, especially for the social support and idea sharing (e.g. problem-solving strategies); therefore, three cooking classes were added to the originally proposed program outline by study personnel. During the post-intervention interviews, participants commented on the willingness of study personnel to implement their recommendations.

It is likely that by engaging participants in the intervention development and implementing their recommendations, this may have enhanced their acceptance and participation. This concept relates to Bandura's (75) SCT which states that personal influence within a social system has an impact on change and adaptation. Incorporating the recommended enhancements, in addition to the social support from peers and study personnel, may have contributed to the high participation rates to the nutrition sessions (74%) with four participants attending more than 80% of the sessions. Taken together, the environmental conditions and the time commitment appear to have been a worthwhile use of these participants' time.

In addition to the above, participants reported that the program was effective in reinforcing their existing nutrition knowledge and even moreso in increasing their awareness and skills about 'how-to' practically incorporate a higher diet quality into their current dietary patterns and practices (e.g. substituting unsaturated fats into recipes, preparing meals and snacks with fruits and vegetables). These findings are consistent with the SCT in that developing behavioural capability (i.e. knowledge and skills) can promote preferential behavioural changes (75). Furthermore, the usefulness of many of the tools (e.g. environment audit, grocery shopping list), handouts (e.g. label reading resources, SMART goal setting sheets), and added skill development activities (e.g. label reading, cooking) were repeated themes among participants in the post-intervention individual interviews (Table 5). In fact, most participants reported in their post-intervention behavioural survey that they intended to use the majority of these skills and tools in the future, suggesting that the program had enhanced their self-efficacy in these

particular areas (75,76), and that the information and skill-based activities were found to be practical and sustainable for ongoing use and reference.

As with the cooking classes, self-assessment was reported by participants to be an invaluable aspect of the program which helped them to reflect on their current practices and target areas in their diet, behaviours and/or environment that needed some improvement. Three strategies comprised the self-assessment component including personal diet quality feedback, self-assessment audits, and goal setting. Diet quality feedback has been used in two previous diet quality programs and resulted in greater diet quality improvements when compared with the control group (71,72). In our study, an overall diet quality improvement of nearly 10 points was observed; however, this finding was non-significant. Three self-assessment audits were incorporated into the preliminary six-month program outline; however, due to the informal participant feedback regarding the usefulness of these audits, two additional self-assessment audits were developed (total of five audits) and provided to the participants (e.g. mind-full eating and self-efficacy questionnaire) (Table 2). Although these audits were not collected by study personnel for data analysis purposes, they were intended to stimulate awareness of current dietary behaviours and/or environmental factors which may impede healthier eating and to set goals. Self-evaluation supports goal setting and motivation (75) which can further aid in the development of self-efficacy toward and attainment of healthier dietary behaviours (77). These mediators of behaviour change may have been the impetus to our participants' success in that they reported meeting 76% of their identified goals (e.g. eat breakfast daily, no more than two drive through meals per week, plan a grocery list before going to the store etc). Previous nutrition-based interventions that have

incorporated goal setting into their methodology have reported dietary improvements in both College students (85) and adults (86). In the future, collecting these goals or providing assistance with setting goals, as has been done in other diet quality interventions (71,72), may be a potential improvement for subsequent studies and was suggested by study participants. Furthermore, unlike in the present study, researchers may decide to collect the self-assessment audits pre- and post-intervention as part of the data analysis. Two validated questionnaires that could be included are: 1) the 20-item Weight Efficacy Lifestyle Questionnaire (87) and 2) the 28-item Mindful Eating Questionnaire (88).

One aspect of the intervention that did not consistently demonstrate good feasibility and acceptability among participants was the walking program. Although initially the walking component was designed as a mandatory component of the intervention, mainly to foster social support, at the request of some participants we agreed to be flexible with this component due to the potential risk of losing participants from our already small sample size. This flexibility included participants either meeting the walking expectation independently from the group or performing an alternative form of physical activity. If the latter was chosen, participants were asked to perform the activity in a consistent manner (e.g. same duration, frequency and intensity per week). As a consequence of this, the average attendance rate for the group walking component was only 34% and those participants who did not participate in the group program did not benefit from the added social support from their peers and study personnel. In a larger study, this may be discernable as a confounding factor as self-efficacy and social support

are reciprocal mediators to behaviour change (76), including physical activity or dietary changes.

Although the walking component of the study was not implemented as initially intended, findings from the post-intervention interviews and behavioural survey suggest that overall the nutrition education component of the intervention was acceptable, feasible, and practical for the majority of participants. In addition, analysis revealed that that the nutrition education component created opportunities that supported targeted behavioural theory constructs (e.g. social support, self-efficacy, self-assessment, knowledge, skills and reinforcement, etc) known to predict positive change in nutrition behaviours (69-72,79,85,86,89). Collectively, the aforementioned modifications to the program methodology as part of this formative evaluation have likely resulted in improved acceptability and adoption of the program as well as preserved our small sample size from further participant loss.

5.2 Impact evaluation

Over the course of this six-month pilot study, an overall average diet quality improvement of 9.9 points (59.5 to 69.4 points) was observed. Although this improvement was not statistically significant, it was indicative of a commitment to diet enhancements from the baseline score, which was comparable to the average diet quality of Canadians (58.8) (38) and Americans (58.2) (42). Notably, the completers in this study had a non-significant, yet marginally greater diet quality score (59.5) than the non-completers (52.1), and the completers were also found to be heavier at baseline. This may lead one to speculate that at baseline, the completers may have been more committed to the attainment of a healthier lifestyle for the potential projected weight loss

of this pilot study. Other potential contributors to lower diet quality scores may have been socioeconomic status (7); however, this was beyond the scope of this paper and with our small sample size, would be impossible to determine. Nevertheless, the baseline diet quality of the completers (59.5) was in the 'needs improvement' range of the CHEI nominal rating (38) which is similar to other HEI-related interventions (69,70,73).

With respect to dietary adequacy at baseline, the participants met the recommendations for the meats and alternatives food group according to EWCFG (40); however, they did not meet the recommendations for grains and milk and alternatives, and consumed less than 50% of the suggested servings for vegetable and fruit intake. This latter finding is consistent with CCHS dietary findings for the general population (33). Furthermore, dietary fibre intake was 0.86 g/100 kcal which was consistent with the intake of obese Canadian women according to Langois et al.'s (12) report. Lastly, the average intake of fat and saturated fat were greater than the mean intake of Canadians for age and gender in CCHS reports (33,35), as well as higher than the intakes of obese Canadian women (12). In contrast to Langlois et al.'s (12) report, the intake of the obese women in this study was reported to be less (1891 kcal) than that of obese Canadian women (2160 kcal) at the population level. Taken together, these findings suggest that participants' diets at baseline required nutritional improvement in order to meet dietary guidelines and recommendations.

Reverting to the CHEI 9.9 point overall diet quality improvement, the three components that provided the greatest contributions were 'other foods' (2.9 points), total fruits and vegetables (2.2), and saturated fat (2.0), with only the change in fruits and vegetable intake being statistically significant. In young adults, researchers have reported

an association between food preparation skills and improved intakes of fruits and vegetables (90); therefore, the cooking component may have been a mediator to this diet quality component. Together, the improvements in these three aforementioned components were also confirmed by the post-intervention behavioural survey where the participants' reported an increased self-efficacy towards improving these components of their diets. An overall diet quality improvement of this magnitude is similar to that previously reported by Carpenter et al. (69) who observed a 7.6 point overall improvement in the modified-HEI score following a six-month (20 session) behavioual skill-building program. As in the present study, two of the greatest contributors to the improvement in their overall score were the fruit score (2.2 points) and saturated fat score (1.2 points), although no p-values were reported (69). The slightly higher overall diet quality improvement observed in the present study may be attributed to the fact that the CHEI was used as a nutrition education and skill-building framework, which incorporated cooking classes as part of this intervention. This methodology provides the knowledge and the 'how-to' components that would support dietary enhancements as measured by the CHEI. Regardless of the fact that the overall increase in CHEI score was not significant, the observed increases in fruits and vegetables, and reductions in saturated fat and 'other foods' are known to reduce the risk of chronic disease development, and are known contributors to health and a healthier body weight (40).

Despite the observed diet quality improvement, we did not observe a significant reduction in body weight (-1.2 kg; BMI = -0.4 kg/m^2) even with a mean reduction in energy intake of 250 kcal/d. These findings are in contrast to a weekly behavioural weight control program conducted by Sallit et al. (70) who reported an increase in HEI

score of 15.5 points which resulted in a significant 4.6 kg (BMI -1.6 kg/m^2) weight loss at 12 weeks post-intervention. These findings suggest that diet quality improvements can lead to statistically significant weight loss and the reason it was undetected in the present study may be due to the smaller sample size, less intense meeting frequency, and the fact that weight loss was not a primary focus of this intervention as it was in the Sallit et al. (70) study. Regardless, increasing the CHEI score by 9.9 points may have clinical significance in that a 1-point improvement in diet quality has been suggested to reduce the risk of abdominal obesity in men by 1.4% and women by 0.8% (65). Due to the fact that an assessment of abdominal adiposity was not conducted on participants in the present study, we cannot comment on whether the weight reductions in some of our participants were attributed to reductions in abdominal adiposity. Regardless, the above evidence does suggest that improvements in diet quality may significantly reduce the risk of obesity.

In addition to the aforementioned potential clinical significance of the diet quality improvement, our program was successful in shifting the average diet quality score from the lower end of the 'needs improvement' range (59.5 points) to the middle of the range (69.4). In four interventions that demonstrated some improvement in overall diet quality, all of them found similar post-intervention scores regardless of study duration or protocol (69-72). It is also noteworthy that by the end of the present six-month pilot intervention, no participant remained in the 'poor diet quality' (< 50 points) range and one participant even achieved a 'good quality diet' (> 80 points) (Figure 3) as defined by Garriguet (38). Combined, this too may have clinical significance as it has been reported that the odds of obesity were significantly greater for men and women consuming a 'poor quality diet'

(OR 1.9 and 1.7 respectively) or a 'needs improvement' quality diet (OR 1.6 for both men and women) compared with those consuming a 'good quality diet' as measured by the HEI (64). In addition, the shift in the average diet quality score toward a higher diet quality implies that participants are closer to achieving current recommended dietary guidelines known to reduce the risk of developing a variety of chronic diseases (37,60,61). Although the improvement in participants' diet quality was not statistically significant in the present study, our intervention model was successful in enhancing key dietary components known to be beneficial in reducing the development of chronic disease and hence may provide protection to our participants in the future.

Breaking the overall CHEI score into sub-components, a 4.6 point increase in diet adequacy was observed, which included increases in total fruits and vegetables, green and orange vegetables, whole fruits, whole grains, and milk and alternatives (Table 6). With respect to fruit and vegetable intake, the improvements were reiterated by participants in the post-intervention behavioural survey where the majority of participants reported having the skills to prepare meals and snacks with fruits and vegetables, and self-efficacy for the ongoing incorporation of daily fruits and vegetables and whole fruit more often than juice into their diet. These finding are consistent with previous literature whereby food preparation skills (90), and enhanced knowledge and self-efficacy (79,89) have been associated with greater intakes of fruits and vegetables, including green and orange vegetables. This increase in fruit and vegetable score, by approximately 2 servings/d (total = 5 servings/d), is similar to that previously reported in some studies (69,72) that focused on diet quality, but not in others (71,73). The aforementioned diet quality studies that reported increased intake in fruit and vegetable consumption may be related

to their methodological focus on teaching cognitive and behavioural strategies to enhance diet quality (69) and enhancing self-efficacy (72), both of which are consistent with the change in fruit and vegetable intake following a behavioural diet counseling program (89). Lapointe et al. (91) observed a similar increase in their six-month high fruit and vegetable, positive messaging intervention. The significance of this increase in our intervention is that previous research has demonstrated a decrease in obesity prevalence from 27% to 20% when fruit and vegetable intake is increased from 3 to 5 servings/d (1). Although we recognize that our participants are still not meeting the current recommendations for fruit and vegetable consumption according to EWCFG (40), they are closer to their recommendations, and with enhanced self-efficacy in this area, the dietary change is suggested to be more sustainable (76,77). Moreover, an increase in dark green and orange vegetables (+1 serving/d) likely indicates that participants are getting more beta-carotene and folate in the diet, which have been suggested to reduce the risk of cancer and cardiovascular disease (40,60).

In addition to the increase in fruit and vegetable consumption, we also observed a non-significant increase in whole grain consumption (+1 serving/d) to a final daily intake of 2.5 servings/d. The post-intervention behavioural survey confirmed these findings with participants reporting an improved self-efficacy to choose whole grains more often and an enhanced awareness of types of carbohydrates and fibre content of foods.

Together, the increase in fruit and vegetable and whole grain consumption contributed to a nearly 7 g/d increase in dietary fibre intake, bringing the mean daily intake of fibre to 22.9 g/d. This means that our participants were closer to meeting the current AI for dietary fibre (25 g/d) (37) and in fact, they exceeded the mean intake of obese Canadian

women (17g/d) according to CCHS data (12). Furthermore, the mean intake falls within the range of 20-27 g/d which has been reported by nutrition professionals to be beneficial for weight loss and satiation (92). Finally, although correlation analysis revealed no associations between CHEI component scores in total fruits and vegetables or the change in dietary fibre (g/d) and BMI, the increase in whole grains was inversely correlated with BMI. Overall, our data suggests that the majority of our participants are consuming a fibre intake that may aid in weight management while reducing the risk of cardiovascular disease development.

Conversely to some of the observed positive enhancements in diet adequacy, we also found an unintended reduction in the unsaturated fat component. This decline was in spite of dedicating an entire educational class to fats, in addition to using and promoting the intake of foods with high unsaturated fat content in each of the cooking classes (e.g. fish, nuts, cooking oils, olives etc). While the non-significant 1.1 point reduction equates to a negligible reduction (i.e. <1 teaspoon of oil or margarine), it does mean that our participants are now further from their recommended unsaturated fat intake level of 30-45 g/d of unsaturated fats (i.e. 2-3 tablespoons of oil) (40,60). This finding also suggests that the reduction in total fat intake from 36% to 31% of TEI was due to both a reduction in saturated and unsaturated fat intake. Given that the unsaturated fat component is a new measurement in HEI-2005 and CHEI, no comparisons can be made with other diet quality interventions; however, the reduction in total fat and saturated fat in the present study is comparable to other diet quality interventions (69,71,73). While a reduction in overall fat intake is beneficial in terms of chronic disease development and moves our participants to within the AMDR for fat (37), our intention was to promote unsaturated

fat use in hopes that it would replace saturated fat intake. This could suggest that there are inherent issues within the nutrition education lesson plan with respect to the education and skill-building components surrounding unsaturated fats. Furthermore, this could explain the mixed messages reported in the post-intervention behavioural survey with respect to an enhanced self-efficacy to choose unsaturated fats more often with no improved knowledge or awareness on how to incorporate them into their diet.

The remainder of the diet quality improvements resulted from an increase in the moderation sub-component score (+5.3 points), which measures diet quality in terms of reduced intakes of saturated fat, sodium and 'other foods'. Given that the focus of the present intervention was to promote comprehensive diet quality enhancements, rather than restricting certain foods or nutrients, it was somewhat surprising that the overall increase in diet quality score was equally attributed to changes in both adequacy (i.e. meeting current EWCFG recommendations) and moderation sub-components. While the educational sessions did not focus on restrictive messaging, it is likely that the reduction in moderation components was due to a replacement of less healthy food options with healthier ones, which essentially is the basis for diet quality enhancement. In this present study, a non-significant reduction in saturated fat of nearly 2% of TEI indicates that on average, participants were closer to meeting the current recommendation of less than 10% of TEI from saturated fat (61) - a finding that compares well with previous studies employing diet quality improvement strategies (69,71,73). In absolute amounts (g/d), the 8 g/d decline in saturated fat intake means that our participants were consuming less than the average saturated fat intake reported in CCHS for women 19-50 years (35). In addition, a non-significant improvement in the 'other foods' score was reflective of a 5%

reduction in TEI from foods that are high in sugar and/or fat, which may have attributed not only to the reduction in saturated fat, but to the non-significant decrease in energy intake of 250 kcal/d. While these changes did not correlate with weight change in our pilot study, reductions in saturated fat and dietary sugars by our participants are clinically important for reducing the risk of chronic diseases (37).

A review of the post-intervention overall diet quality score (69.4 points) revealed that the highest and lowest contributors were generally reflective of the aims of our study. In Garriguet's (38) 'Diet Quality in Canada' report, the greatest contributors to the total diet quality score were total grains, meats and alternatives, and unsaturated fats. In the present study, unsaturated fat was not one of the greatest contributors. Instead, the greatest contributors to our overall post-intervention CHEI score were meats and alternatives, milk and alternatives, whole grains and total grains. Conversely, the lowest contributors to the overall score in Garriguet's (38) analysis were green and orange vegetables, whole grains, and whole fruits, whereas in the present intervention, the lowest contributors were unsaturated fat, 'other foods', total fruits and vegetables, and sodium. While the fact that fruits and vegetables were one of the lowest contributors may appear discouraging, the participants did demonstrate a significant improvement in this score over the course of the intervention. These findings are quite promising as our highest contributors were within the adequacy components, meaning that participants were closer to meeting EWCFG recommendations and two of the lowest contributors were moderation components (less sodium, saturated fats and other foods). Taken together, these findings reflect the program's ability to optimize the quality of our participants' diets.

Upon further assessment of the post-intervention diet, the macronutrient distribution of carbohydrate, fat, and protein were 52%, 31%, and 17% of TEI respectively, which are all within the current AMDR recommendations (37). In addition, these distributions were similar to ranges typically targeted by many restrictive intervention approaches or control diets which participants are often unable to achieve (15-18,20-22,24,25,29). This was interesting because these low-fat, high-carbohydrate diets are typically focused on dietary restriction, while the present intervention followed an ad libitum approach, promoting diet quality with little to no mention of diet quantity and no restrictive or prescriptive targets. It is possible that the similarities in macronutrient distribution may be explained by the fact that we used the CHEI as our intervention framework which is based on current dietary guidelines that typically support a higher carbohydrate, lower fat energy distribution. Regardless, these findings suggest that a 'true' ad libitum approach, where participants were free-living and able to freely choose the amount and type of food that they desired, can be as effective and enable participants to make positive macronutrient changes without restrictive messaging and 'negative' feelings about intake control. Overall, these findings lend support to the use of a more 'positive' messaging approach (i.e. promoting healthy food options in place of unhealthy ones) for nutrition education to promote a healthier diet.

Finally, although weight loss was not a primary focus of the present study, it was somewhat disappointing to report that the overall diet quality and anthropometric findings were not significant. While this is likely due to the small sample size of this pilot study, it was promising that the majority of the participants lost some weight, in the range of approximately 2-4% of total body weight or 1-2 kg/m^2 BMI units (Figure 4).

This modest reduction in weight is likely in part attributed to the non-significant energy reduction of 250 kcal/d. Interestingly, this reduction occurred through self-motivated alterations in diet consumption, by encouraging participants to select food items based on their own preferences and not by restrictive messaging. Regardless, previous studies have reported weight loss with energy deficits in the range of 250-500 kcal/d (25-27,31). This reduction may prove clinically significant to our participants in that Hill (93) suggested that small changes in energy balance of approximately 100 kcal/d can stop weight gain and enhance self-efficacy towards further dietary or activity-related changes. While the 250 kcal/d energy reduction did not correlate with BMI in the present study, this small change may be indicative that these participants were progressing towards a more healthful weight as has been promoted by dietitians (13) and researchers alike (78,93). In addition, this progression towards a healthier weight, in combination with the positive dietary changes in participants as a result of this program, may have ongoing longer-term benefits in reducing participants' inherent risk of chronic disease development.

5.3 Strengths

This is the first Canadian-based study to use the CHEI as an intervention framework and an outcome measurement and only the second to use a diet quality index in this capacity. This provided a comprehensive diet approach using a variety of readily available, common foods and it enabled the research team to provide participants with consistent information and individualized feedback upon which they could develop their personal goals and assess their dietary changes throughout the program. This positive messaging approach, by promoting healthier foods and enhancing skills to purchase or

prepare healthier foods, in the absence of dietary restriction, resulted in non-significant, but clinically relevant findings. These included an overall improvement in diet quality, a modest decrease in energy intake and weight loss or maintenance in the majority of our obese participants.

This intervention provided a supportive environment that enabled participants to discuss their success, or barriers to success, for making healthier diet choices. Participants reported enhanced awareness, knowledge, and self-efficacy in a variety of diet quality components which was evidenced by diet quality improvements and the progression towards meeting their current recommendations for food groups and a variety of nutrients. Furthermore, the majority of tools and resources that were provided were not only reported to be useful throughout the program, but also provided a future reference that could aid in the sustainability of their diet quality improvements. Together, this pilot intervention offered an alternative approach to restrictive dieting that encompassed a focus on healthier eating, great flexibility, and practical strategies that enhanced overall diet quality and moved participants towards current dietary recommendations known to be beneficial for weight loss and health.

5.4 Limitations

Among the limitations of this pilot study, the greatest one was the small sample size, despite an extensive recruitment period aiming to enroll 20-30 participants. Recognizing that the small sample size would not provide the statistical power to accurately evaluate outcome measures, it was important to conduct a formative evaluation of the intervention framework to assess its feasibility, acceptability, and practicality. Second, regarding the food records and subsequent dietary assessment, the

limitations associated with implausible food intake reports are common among obese people (94,95); however, this may have minimal impact on the CHEI score as Garriguet (94) has estimated that under-reporting in the CCHS data was equal to 10% of energy intake and when this was assessed within the CHEI, he has suggested that this may only account for a 1-2 point difference (out of 100) in the overall score. Third, the methodology for calculating the CHEI, based on Garriguet's Canadian adaptation (38) of the HEI-2005, involves manual tallying of food groups according to EWCFG, which may pose limitations for larger studies and limit the reproducibility of the findings. To minimize the variability in these tabulations in the present study, the same study personnel completed the food record analysis and CHEI calculations pre- and post-intervention. Fourth, we did not conduct a thorough assessment of participants' weight history which may have been a confounding variable to a participant's success or lack of success. This is important because if a participant was gaining weight prior to beginning the program, weight stabilization due to the program would have been seen as more of a success. Additionally, the group walking program was not implemented as a mandatory program as initially intended, which limited our ability to control physical activity and to make any conclusions regarding the social support that may have been fostered. Finally, with respect to the post-intervention behavioural survey, we acknowledge that to truly determine the effectiveness of the program, these data should be collected and compared pre- and post-intervention. The development of this tool was done mid-intervention, as a result of repeated discussions with the participants' which suggested that the use of the CHEI and post-intervention interviews alone would not capture valuable information about the pilot program, concerning awareness, skill-building and perceived self-efficacy.

While we specifically asked participants to self-report changes made 'due to their involvement in the program', we acknowledge that it would have been better to do a pre-post assessment. Furthermore, the self-efficacy portion of the behavioural survey did not specifically address barriers that could impede the achievement of a high quality diet. The reason for this is because of the comprehensiveness of our intervention to address multiple components of the diet, whereby addressing barriers for every dietary change (e.g. fruits and vegetables, whole grains, fat, sodium, etc) could have resulted in a high response burden for our participants.

6.0 FUTURE DIRECTIONS AND RELEVANCE TO PRACTICE

6.1 Opportunities for improvement

Logistically, many improvements were made throughout the course of the six-month pilot study; however, some changes remain outstanding. We believed that by dedicating one nutrition session to fats and incorporating unsaturated fats into the cooking lessons and recipes (e.g. olive oil, salad dressing, olives, nuts and seeds) that unsaturated fat intake in the diet would have increased. However, the unsaturated fat score did not increase and the comments on the post-intervention behavioural survey suggest that participants did not consistently report an increase in their awareness, knowledge or skills regarding how to incorporate more unsaturated fat into their diets despite the efforts made as described above. This suggests that we need to review this portion of the intervention framework. Furthermore, given that the menu planner was not recognized as one of the useful resources provided to the participants, potentially more time should be dedicated to the purpose and specific application of this tool. This could include time in group discussions, personal assessment time with the RD or research team member, or as a 'homework assignment'. Additionally, the post-intervention interview will be modified to make more of the questions open-ended and less directive. Finally, a post-intervention follow-up would be beneficial to assess if diet changes are sustained.

6.2 Relevance to practice

Obesity and lower quality diets are a great public health issue and we believe that this type of program, based on the CHEI framework, can have positive implications for individuals within a community-based practice approach. Restrictive diets are a common

approach to weight loss but may promote restricting the wrong foods which can result in a lower diet quality. Messaging to promote a healthful diet and quality nutrients, specifically incorporating the 'how-to', skill-building techniques through cooking classes, grocery store tours or opportunities for taste testing are imperative. An ad libitum, lifestyle program promoting diet quality enhancements through education and skill-building can be incorporated into a community program relatively easily. Participants can continue to purchase food from their local grocery store based on the premise of understanding how to select and prepare foods that are healthier choices at their own free will, with no dietary controls or prescriptive plans. As there is a high rate of reversion in most restrictive weight loss approaches, this non-dieting, positive messaging approach, with no mention of portions or serving size counts, allows obese persons to adapt the nutrition concepts or menu / recipe ideas into his/her current lifestyle which makes a weight management approach potentially more sustainable. By our data, although statistically significant findings were not supported, we believe that there are a variety of clinically significant findings which warrant a larger intervention trial.

6.3 Concluding remarks / summary

Restrictive, prescriptive diet patterns have not consistently been shown to be efficacious as a weight loss strategy for obese people. This intervention offers a potential weight loss alternative that promotes a healthier lifestyle through nutrition education and skill-building sessions aimed at enhancing self-efficacy of obese persons towards a higher diet quality. In this pilot intervention, we found that participants believed that this ad libitum, non-restrictive intervention, which applied a CHEI framework, was beneficial and practical for enhancing their knowledge, skills and self-efficacy towards healthier

dietary behaviours. Furthermore, we observed a non-significant diet quality improvement of 9.9 points to a post-intervention CHEI score of 69.4 points out of 100. Although diet improvement had no statistically significant impact on the post-intervention body weight (-1.2 kg in body weight) or BMI (– 0.4 kg/m^2), the diet changes observed (i.e. increase in fruits and vegetables, green and orange vegetables, and fibre, and reduced saturated fat and 'other foods'), regardless of non-statistical significance, may be clinically important to our participants as these dietary changes are known to contribute to health and reduce the risk of developing some chronic diseases. Overall, the CHEI as an intervention framework appears to be feasible to implement on a larger scale study where greater power may result in significant changes in outcomes.

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Appendix I. Components of the HEI-2005

Component	Maximum points	Standard for maximum score[1]	Standard for minimum score of 0[1]
Total Fruit (includes 100% juice)	5	≥0.8 cup equiv. per 1,000kcal	No Fruit
Whole Fruit (not juice)	5	≥0.4 cup equiv. per 1,000kcal	No Whole Fruit
Total Vegetables	5	≥1.1 cup equiv. per 1,000kcal	No Vegetables
Dark Green and Orange Vegetables and Legumes[2]	5	≥0.4 cup equiv. per 1,000kcal	No Dark Green and Orange Vegetables and Legumes
Total Grains	5	≥3.0 oz equiv. per 1,000kcal	No Grains
Whole grains	5	≥1.5 oz equiv. per 1,000kcal	No Whole Grains
Milk[3]	10	≥1.3 cup equiv. per 1,000kcal	No Milk
Meat and Beans	10	≥2.5 oz equiv. per 1,000kcal	No Meat or Beans
Oils[4]	10	≥12 gram per 1,000kcal	No Oil
Saturated Fat	10	≤7% of energy[5]	≥15% of energy
Sodium	10	≤0.7 grams per 1,000kcal[5]	≥2.0 grams per 1,000kcal
Calories from Solid Fats, Alcoholic beverages, and Added Sugars (SoFAAS)	20	≤20% of energy	≥50% of energy

[1]Intakes between the minimum and maximum levels are scored proportionally, except for Saturated Fat and Sodium (see note 5)

[2]Legumes counted as vegetables only after Meat and Beans standard is met.

[3]Includes all milk products, such as fluid milk, yogurt, and cheese, and soy beverages.

[4]Includes non-hydrogenated vegetable oils and oils in fish, nuts, and seeds.

[5]Saturated Fat and Sodium get a score of 8 for the intake levels that reflect the 2005 Dietary Guidelines, <10% of calories from saturated fat and 1.1 grams of sodium/1,000kcal, respectively.

Reference: 58

Appendix II. Components of the CHEI

Component	Maximum points	Standard for maximum points	Standard minimum points
Adequacy components:	60 points[1]		
Total vegetable and fruit	10	EWCFG recommendations[2]	No vegetables or fruit
Whole fruit (not juice)	5	21% of EWCFG recommendations for Vegetables and Fruit	No whole fruit
Dark green and orange vegetables	5	21% of EWCFG recommendations for Vegetables and Fruit	No dark green and orange vegetables
Total grain products	5	EWCFG recommendations[2]	No grains
Whole grains	5	50% of EWCFG recommendations for Grain products	No whole grains
Milk and alternatives	10	EWCFG recommendations[2]	No milk or alternatives
Meat and alternatives	10	EWCFG recommendations[2]	No meat and alternatives
Unsaturated fats	10	EWCFG recommendations 30-45 grams per day	No unsaturated fats or oils
Moderation components:	40 points		
Saturated Fat	10[3]	≤ 7% of TEI (10 points); 10% (8 points)	≥ 15% of TEI
Sodium	10[3]	≤ 1500 mg (10 points); 2300 mg (8 points)	≥ 4600 mg
Other foods	20[1]	≤ 20% of TEI	≥ 40% of TEI

[1] Points are calculated proportionally between minimum and maximum standards for all Adequacy components and for 'Other foods' component

[2] Recommendations according to EWCFG for age and gender

[3] Points are calculated proportionally between standards for 8 and 10 points, then proportionally for standards between 0 and 8 points

Reference: 38

Appendix III. Daily recommended number of servings based on EWCFG for adult females

	Age group (years)	
Females	**19-30 years**	**31-50 years**
Vegetables and Fruit	8	7
Grain products	7	6
Milk and alternatives	2	2
Meat and alternatives	2	2
Unsaturated fat (grams)	30	30

Reference: 60

Appendix IV. UWO Health Sciences Research Ethics Board – Letter of Approval

Western

Office of Research Ethics

The University of Western Ontario
Room 4180 Support Services Building, London, ON, Canada N6A 5C1
Telephone: (519) 661-3036 Fax: (519) 850-2466 Email: ethics@uwo.ca
Website: www.uwo.ca/research/ethics

Use of Human Subjects - Ethics Approval Notice

Principal Investigator:	Dr. D. Battram	**Review Level:**	Expedited
Review Number:	15967E	**Revision Number:**	5
Review Date:	March 09, 2010	**Approved Local # of Participants:**	30
Protocol Title:	Assessing the impact of a nutrition education and walking program on a diet quality in overweight individuals: A pilot study		
Department and Institution:	Nutrition & Food Services, Brescia University College		
Sponsor:			
Ethics Approval Date:	March 09, 2010	**Expiry Date:**	April 30, 2010
Documents Reviewed and Approved:	Revised study instruments, study methods, administrative changes and Letter of Information and Consent. Interview Script. Questionnaire.		
Documents Received for Information:			

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form.

During the course of the research, no deviations from, or changes to, the protocol or consent form may be initiated without prior written approval from the HSREB except when necessary to eliminate immediate hazards to the subject or when the change(s) involve only logistical or administrative aspects of the study (e.g. change of monitor, telephone number). Expedited review of minor change(s) in ongoing studies will be considered. Subjects must receive a copy of the signed information/consent documentation.

Investigators must promptly also report to the HSREB:

a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) all adverse and unexpected experiences or events that are both serious and unexpected;
c) new information that may adversely affect the safety of the subjects or the conduct of the study.

If these changes/adverse events require a change to the information/consent documentation, and/or recruitment advertisement, the newly revised information/consent documentation, and/or advertisement, must be submitted to this office for approval.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

Chair of HSREB: Dr. Joseph Gilbert
FDA Ref. #: IRB 00000940

Ethics Officer to Contact for Further Information			
☐ Janice Sutherland (jsutherl@uwo.ca)	☐ Elizabeth Wambolt (ewambolt@uwo.ca)	☑ Grace Kelly (grace.kelly@uwo.ca)	☐ Denise Grafton (dgrafton@uwo.ca)

This is an official document. Please retain the original in your files.

cc: ORE File

Appendix V. Anthropometric assessment form

Participant #: _____

Date: _____ **Date:**

_____

Week 0 **(Baseline or pre-intervention)**	**Week 25** **(Post-intervention)**
Height: _____cm	Height: _____cm
Weight: _____kg	Weight: _____kg
BMI (calculated): _____	BMI (calculated): _____
Rater's Initials: _____	Rater's Initials: _____

Appendix VI. Letter of information and informed consent

Brescia

Letter of Information

"Assessing the impact of a nutrition education and walking program on diet quality in overweight individuals: A pilot study"

Researchers:
Dr. Danielle Battram, PhD, Department of Food & Nutritional Sciences, Brescia University College, UWO
Cherie Dolmage, RD, MScFN candidate, Department of Food & Nutritional Sciences, Brescia University College, UWO

Why this study is being done?

As a society we know that the rate of obesity in our population is continuing to increase. While there are many factors that contribute to the development of obesity, an unhealthy lifestyle, such as an unhealthy diet and lack of physical activity, is perhaps the strongest contributing factor and in theory can be easily addressed through nutrition and physical activity programs. To date however, most programs have been relatively unsuccessful in maintaining weight loss long-term. The reasons for this are complex, but often these programs do not include opportunities to be physically active and they often focus only on the quantity of food eaten (how much is eaten) and often target a single nutrient (for example, fibre, carbohydrates, etc). This approach often leads to a restrictive diet, which may be affective in promoting weight loss in the short-term, but is difficult to maintain in the long-term and over a lifetime.

Therefore, the pilot study that you are invited to participate in focuses not on a restrictive approach to eating (the quantity of foods eaten), but instead focuses on the quality of the diet (the types of food eaten). Specifically, this pilot study is designed to examine whether or not a 6 month nutrition education and walking program aimed at improving the quality of the diet is 1) feasible and practical to implement, 2) improves the diet quality of its participants and 3) results in a modest weight reduction. This study will be conducted in 20-30 participants. In order to be eligible for participation in this study you must be a man or women i) between the ages of 18 – 50 years, ii) with a body mass index between 28.0- 45.9 kg/m^2 (body mass index is a tool used to classify weight. It is calculated by knowing your weight in kilograms and dividing by your height in metres squared), iii) who is inactive, meaning does not engage in more than 30 min of physical activity 3 times per week, iv) who is otherwise healthy or has not been diagnosed with a chronic disease (diabetes, heart disease, etc) or condition by your family

physician that will preclude you from participating in the walking program and v) who is currently participating in a weight reduction program that they are unwilling to withdraw from for the duration of this study.

What is asked of you as a participant?

Your involvement in this study will include a 6-month commitment. During these 6 months, you will be asked to participate in 9 nutrition education sessions aimed at increasing your knowledge and skills towards improving the quality of your diet. The nutrition education classes will be offered bi-monthly (Thursday evenings 7-8:30 pm) for the first 3 months and monthly thereafter. These sessions will include both information about improving diet quality and dietary patterns (for example, meal frequency, behavioural cues to eating, etc) and will provide skill building exercises, including goal setting, cooking classes, label reading and grocery store tours. The classes will be held at Brescia University College._Also, during this 6 month period, you will be asked to participate in a bi-weekly walking program. The walking program will be offered 3 times per week (Monday, Wednesday and Sunday at 6 pm) to which you will be required to attend 2 sessions per week. Each session will run for 40 min and will include a 5 min warm-up stretch, 30 min walk and a 5 min cool-down stretch. The walking program will be offered in conjunction with the Running Room in London and at Brescia University College.

At the start of the program you will be asked to: 1) have your height and weight measured to determine your body mass index, 2) have your waist circumference measured, 3) complete a demographic questionnaire concerning your education and income level, 4) complete a Physical Activity Readiness Questionnaire (PAR-Q)_and 5) complete two 3-day dietary intake records to determine your current diet quality and meal patterns. A dietary intake record is when you record all food, beverages and supplements consumed and includes 3 days of recording (*2 weekdays and 1 weekend day).* Detailed instructions will be provided to you. These procedures (1-4) will also be completed at the end of the study. In addition, at the end of the study you will be asked to participant in a focus group (1-1.5 hours) to discuss the aspects of the program that you liked the best and least and your general opinions about the study. The maximum number of participants in each focus group will be 10 people.

Are there any risks associated with participating in this study?

There are no known risks with participation in this study. Some participants may feel embarrassed by having their height, weight and waist circumference measured. To minimize this embarrassment, the measurements will be taken in a private office, with only yourself and the researcher present. Furthermore, measurements will be taken with your clothes on. Walking may help you to lose weight if you have been advised to do so by your doctor. While there are risks to starting any exercise program, the intensity of our walking program is low and controlled by you, therefore the risk to you in minimal. However, to ensure your safety, we ask that you complete a brief screening questionnaire. If you answer "yes" to any of the items in the questionnaire, we will require you to visit your family physician and will require written consent from him/her for you to participate in the study. If you answer "no" to all items, we still encourage you to consult your

physician, but do not require that you do so. Furthermore, all study personnel supervising the exercise sessions will hold a current CPR certificate.

Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time. If you agree to participate in this study, a study identification number will be assigned to you. From this point forwards, all personal identification information and contact information will be kept separate from all other data collected and kept secure in a locked cabinet and password protected computer. Furthermore, access to this information will be restricted to research personnel only.

As part of the evaluation, focus group members are asked to keep everything they hear confidential and not to discuss it outside of the meeting. However, we cannot guarantee that confidentiality will be maintained by group members. Finally, if the results of the study are published, your name will not be used and no information that discloses your identify will be released or published without your explicit consent to the disclosure. If you would like a copy of the results sent to you, please provide your contact information on a separate piece of paper and give it to the researchers.

What do I get out of participating in this study?

Throughout this study you will receive guidance about how to improve your current dietary intake and will be given opportunities to partake in physical activity. Throughout the study you will be provided with resources and opportunities to build skills to help you improve your diet and move toward a healthier lifestyle. The guidance provided to you by study personnel will be personally relevant as the program encompasses many activities in which you can analyse your specific dietary patterns and personal food environments.

Should you have any further questions about the study, please feel free to contact:

Cherie Dolmage, MScFN candidate **Dr. Danielle Battram**, PhD

Please be aware that "Representatives of The University of Western Ontario Health Sciences Research Ethics Board may contact you or require access to your study-related records to monitor the conduct of the research." If you have any further questions about your rights as a participant or the study protocol, you may contact the Office of Research Ethics (University of Western Ontario), at ethics@uwo.ca or (519) 661-3036.

Consent Form

I, _____ have read the letter of information and consent, have had the nature of the study explained to me and I agree to participate. All questions have been answered to my satisfaction.

_____ _____ _____

Date Participant's name (please print) Participant's signature

_____ _____ _____

Date Investigator's name (please print) Investigator's Signature

Appendix VII. Physical Activity Readiness Questionnaire

Reference: 83

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	**1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☐	**2. Do you feel pain in your chest when you do physical activity?**
☐	☐	**3. In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	**4. Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	**5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	**6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	**7. Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

→ **DELAY BECOMING MUCH MORE ACTIVE:**

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME _____

SIGNATURE _____ DATE _____

SIGNATURE OF PARENT or GUARDIAN (for participants under the age of majority) _____ WITNESS _____

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

Supported by: Health Canada Santé Canada

continued on other side...

Appendix VIII. Demographics questionnaire

Participant's ID#: _____

1. Sex: M F

2. Age: _____

3. Race or ethnic background (i.e. Chinese, Iranian, Canadian)? _____

4. How long have you resided or lived in Canada?

☐ Born here	☐ 11- 15 years
☐ < 5 years	☐ 16 – 20 years
☐ 5- 10 years	☐ > 20 years

5. Marital status: married not married

6. How many people live in your household? ____ adults _____ children ___ other

7. Highest level of Education:

☐ Graduate degree	☐ Some college/university
☐ Undergraduate degree	☐ High school degree
☐ College degree	☐ Some high school

8. Occupation:

☐ Student	☐ Full-time employed	☐ Retired
☐ Part-time employed	☐ Self-employed	☐ Unemployed

9. Which of the following best describes your family's annual income?

☐ < $21, 359 ☐ $21, 359 - $66, 343 ☐ > $66, 343 ☐ choose not to answer

10. Do you follow any special dietary guidelines? (vegetarianism, no pork etc)
Yes No
If yes, please specify: _____

11. In the past 6 months, have you tried to lose weight by any of the following means:

☐ gym / exercise class?

☐ diet books (eg. Zone, Atkins, Dr. Phil etc)

☐ structured weight loss program (eg. Weight Watchers, Herbal Magic etc)

☐ Other? _____

If yes, how many programs have you tried? ☐ < 2 ☐ 2-3 ☐ 4-5 ☐ > 5

12. How much physical activity do you get in a week? (walking, swimming, biking etc).

☐ < 30 min per week ☐ 61 – 90 min per week

☐ 30 – 60 min per week ☐ > 90 min per week

13. Do you smoke cigarettes? Yes No

Appendix IX. Diet quality audit

1. Do you choose whole grain or brown breads more often than white?

2. Do you think about having a fruit or vegetable with each meal?

3. Do you think about having yogurt or pudding as a snack instead of sweet treats most often?

4. Do you snack on nuts or seeds more often than chips?

5. Do you eat a green vegetable everyday? (e.g. broccoli, peas, spinach)

6. Do you buy whole grain crackers over other snack crackers most often?

7. Do you drink milk or soy beverage with most meals?

8. Do you eat fish twice per week?

9. Do you use an unsaturated oil, like olive or canola oil every day?

10. Do you eat an orange vegetable everyday? (e.g. carrots, squash, yam/sweet potato)

11. Do you eat whole grain cereals more often than other cereals?

12. Do you white meat more often than red meat?

13. Do you use beans or other legumes in place of meat for some meals?

14. Do you drink water, juice or milk more often than coffee, pop, Gatorade drinks or fruit punch?

15. Do you eat whole fruit more often than fruit juice?

Reflecting:
If you answered yes to more than 12 of the above questions → you seem to have a good quality diet → keep up the good work and make some changes where you can.

If you answered yes to less than 12 of the above questions → your diet needs improvement to make it a higher quality diet→ now that you are thinking about ways to make some improvements in your diet, think about how you can make some changes by breaking it into a smaller achievable **SMART goal!**

Appendix X. Post-intervention behavioural survey
Participant ID#: _____
Date: _____

PART I: Achievement of Behavioural Goals

Please refer back to your SMART goals and self-monitoring section of your binder to answer the following questions.

Question	Participant Answer
1. How many nutrition-related goals did you **set** throughout the program?	
2. Please list the nutrition-related goals that you **set** throughout the program.	
3. How many nutrition-related goals did you **achieve** during the program?	
4. Please list the nutrition-related goals that you **achieved** throughout the program.	
Please circle the most appropriate answer to each of the following questions about diet quality changes that you have made due to the program:	
3. All fruits and vegetables	Increased Decreased No Change
4. Whole fruits	Increased Decreased No Change
5. Green vegetables	Increased Decreased No Change
6. Orange vegetables (include peaches, cantaloupe, apricots, mangoes, nectarines here)	Increased Decreased No Change

7. Whole grain products	Increased	Decreased	No Change
8. Milk and Alternatives	Increased	Decreased	No Change
9. Meat and Alternatives	Increased	Decreased	No Change
10. Unsaturated Fats (olive oil, canola oil, safflower oil, corn oil, etc)	Increased	Decreased	No Change
11. Saturated fats (animal fats, butter, etc)	Increased	Decreased	No Change
12. Sodium / Salt	Increased	Decreased	No Change
13. High fat or High sugar snacks and desserts	Increased	Decreased	No Change

Please circle the most appropriate answer to each of the following questions about use of the information / tools provided during the program:			
14. EatWise Pyramid	Using now	Will use	No plans to use
15. Making a Healthy Lunch	Using now	Will use	No plans to use
16. Making a Healthy Breakfast	Using now	Will use	No plans to use
17. Menu Planner	Using now	Will use	No plans to use
18. Grocery List	Using now	Will use	No plans to use
19. Label Reading	Using now	Will use	No plans to use

Please circle the most appropriate answer about changes in your activity that you have made during the program:			
20. Walking	Increased	Decreased	No Change
21. Other physical activity (using stairs, gym, videos etc)	Increased	Decreased	No Change

22. Overall, what would you say is the greatest achievement you made in your lifestyle (either nutrition or physical activity-related) due to the program?

_____

_____

_____

23. Please list any other changes you made in your lifestyle due to the program. Do not include your nutrition-related goals as you have provided these above.

_____

_____

_____

_____

24. How likely are you to continue to set SMART goals in the future?

☐ Very likely ☐ Somewhat likely ☐ Not sure ☐ Somewhat unlikely ☐ Very unlikely

25. Is there a behavioural goal that you intend to set in the near future? YES NO

If yes, what is it? _____

_____

If no, why not? _____

_____

PART II: Self-efficacy Assessment

Please answer the following questions with regards to your self-efficacy or confidence in performing the following due to your participation in the program.

How confident are you that you can do the following:

	I know I can	I think I can	I'm not sure I can	I know I can't	Don't know
1. Eat fruits and vegetables every day					
2. Eat whole fruit more often than fruit juice					
3. Eat a dark green vegetable every day					
4. Eat an orange vegetable every day (or an acceptable orange fruit)					
5. Eat whole grains more often					
6. Eat milk or milk products every day					
7. Eat meat or meat alternatives every day					
8. Eat unsaturated fats more often than saturated fats					
9. Limit your sodium / salt intake					
10. Limit your snack foods or sugary foods					
11. Generally choose higher quality food options every day					
12. Eat breakfast every day					
13. Pack a healthy lunch most days of the week					
14. Plan a menu on a regular basis					
15. Read a food label					
16. Shop with a grocery list					
17. Continue to walk 2 days per week					
18. Maintain the goals you achieved in the program					
19. Continue to set goals					
20. Be mindful of the types of food you eat					
21. Be mindful of the amount of food you eat					

PART III: Knowledge, Awareness and Skill Assessment

1. Did the program increase your **awareness** about: (circle all that apply)
    a. The overall quality of your diet
    b. The types of carbohydrates you eat
    c. The amount of fibre you eat
    d. The types of fats you eat
    e. The types of proteins you eat
    f. The amount of water (or fluid) you drink
    g. The types of snacks you eat
    h. The amount of overall food you eat
    i. The amount of physical activity you do

2. Do you think the program increased your **knowledge** about: (circle all that apply)
    a. Eating an overall healthier diet
    b. Choosing higher quality carbohydrates
    c. Choosing higher quality fats
    d. Choosing higher quality proteins
    e. Preparing healthier meals and snacks (e.g. preparing meals and snacks with higher quality food choices)
    f. The importance of reading food labels
    g. The importance of planning a menu
    h. The benefits of shopping with a grocery list
    i. The benefits of being physically active
    j. Being mindful when you eat
    k. Being mindful of what you eat
    l. The importance of SMART goal setting

3. Do you feel that the program increased your **skills** in: (circle all that apply)
    a. Label reading
    b. Menu planning
    c. Preparing healthier meals and snacks (e.g. preparing meals and snacks with higher quality food choices)
    d. Choosing higher quality carbohydrates
    e. Choosing foods with a higher amount of fibre
    f. Choosing foods with unsaturated fats
    g. Preparing foods with unsaturated fats
    h. Choosing higher quality proteins
    i. Preparing meals and snacks with fruits and vegetables
    j. Setting SMART goals

4. What do you feel is the most significant thing you learned in this program?

    _____

    _____

We thank you for your information and participation in our Diet Quality Program.

Appendix XI. Post-intervention semi-structured interview guide

An exploratory interview will be undertaken at the end of the 6 month program to aid in understanding the strengths and weaknesses of the pilot study.

A few general thoughts about the interview:

1. Goal: To gather feedback on the six month diet quality pilot program from the adult participants who have completed the program (qualitative data).

2. Aim is to interview each participant over a 30-60 minute timeframe following the open ended questions in sequence and allowing some in-depth conversation through the use of the probing questions.

Moderator Preamble:

Thank you for coming in for the interview today. My name is _____ and I will be conducting the interview. Today we will be discussing the six month program that you recently completed regarding "the impact of nutrition education and skill building program on diet quality". This program was a pilot study, so I will be asking you questions about the strengths and weaknesses of the program in addition to any suggestions or opinions you had about the program in general. I will be recording this information so that I can listen and not have to take a lot of notes. The information that you provide will be grouped as themes and not identifiable to any one participant, so please feel free to be open and honest in your answers.

General Questions	"Probing Questions" (for use to extract more information and encourage discussion)	How the info will be used
Start with very general questions to engage with the participant and get him/her talking:		
What interested you in signing up for this research program?		To assess participants' motivation for partaking in the program
How did you find out about the research program?	A flyer? A person? A referral from a healthcare professional?	To know where and how to advertise the program
Was the location of the program easily accessible?		Accessibility of the program
Was the duration of the program appropriate?	Too long? Too short? Just right?	Feasibility of program
Did you find the information in the nutrition education lessons useful? (presentations, discussions, handouts including EatWise Pyramid, Tips for Drinking water, Glycemic index, Making a Healthy Lunch, 7-day Menu Planner, Grocery Shopping List)	Did you learn something new?	Usefulness of program education to improve diet quality
Did you find that the skill-building activities useful in changing your diet? (The skill building components in the nutrition class included: Cooking classes, Label reading, Grocery Store tour)	Please explain which were most useful (or least useful)	Usefulness of skill building components to improve diet quality

Did you find the behavioural assessment activities useful in changing your diet? (The behavioural components included: goal setting, self-monitoring and self-reflection through the use of the following audits: Diet Quality Audit, Mind-full Eating Questionnaire, Personal Behaviour Audit, Personal Environment audit, Self-Efficacy Questionnaire)	Please explain which were most useful (or least useful)	Usefulness of behavioural components to improve diet quality
Did you find the organized walking program helpful?	Why or why not?	Usefulness of the walking component
Did participating in the walking program encourage you to continue to be active or get involved in other physical activities?		Self-efficacy to partake in physical activities
What did you like the most about the program? What did you like the least about the program?		Acceptability of program components
Giving what you learned in the program, do you feel confident that you will continue to use what you learned?		Self-efficacy / maintenance
What other suggestions would you make to improve the program?		Formative research to improve program's offerings
Any final comments?	Any other information that you expected to be part of this program? Anything that you have questions about?	

Appendix XII. Instructions for calculating the CHEI

Reference: 38

STEPS FOR CALCULATING THE CHEI:

1) Both food records should be entered into 1 ESHA folder for each participant and an average intake (over 6 days) calculated. The average intake table will provide the information needed for the following CHEI categories: Unsaturated fats, Saturated fats, and Sodium.

2) To determine food group servings, **manual** counting is required. Using the information from the ESHA reports for the following CHEI categories: Total vegetables and fruits, Whole fruit, Dark green and orange vegetables, Total grain products, Whole grains, Milk and Alternatives and Meat and Alternatives.

HOW TO:

Calculate food guide servings (4 groups) for each of the 6 days and then take an average. A recording sheet has been provided for tracking purposes. Be sure to count the following foods twice: whole fruit, whole grain servings and dark green and orange vegetables. For example, an orange will count both in the Total vegetable and fruit category and in the Whole Fruit category. Follow EWCFG for orange and green vegetables, whole grains etc.

3) In order to get the information needed in the 'other foods', consult the ESHA report. You will need to locate the 'other foods' – these are foods and beverages that are not a part of the 4 food groups (guideline according to the 1992 Food Guide). Add up the remaining foods per day only in terms of calories. Average this caloric amount over the 6 days. Use the average ESHA report to find the average total caloric intake of the participant and divide this by the average number of calories from other foods. Calculate a percent.

For example, say you get an average total caloric intake of 2400 kcal and 750 kcal from other foods.

750/2400 x 100 = 31% (round to nearest whole number)

Component	Range of Scores	Scoring Criteria	Additional notes
ADEQUACY	**0 to 60 points**		
Total vegetables and fruits	0 to 10 points	Min: 0 Servings Max: Servings based on EWCFG for age and gender (e.g. 7 servings for men and women over 51 years of age)	Min. points are given if no vegetables and fruits are eaten (points=0). Max. points are given if the serving size for specific age and gender is met. For example, if a man of 55 years eats 7 servings or more of vegetables and fruits, the points given = 10. • For a male or female between the ages of 19 and 50 years, servings are given as ranges (7-8 or 8-10 servings respectively). In this case, if the minimum number of servings or more (≥ 7 for women, ≥8 for men) is eaten, award points = 10 For those that eat serving sizes between the minimum and maximum servings, a proportional point is awarded. For example, if a women (32 years) eats 5 servings, the points would be: 10 points/ max number servings (7 in this case) = 1.4 points per serving 5 servings x 1.4 = 7.0 points (round to 1 decimal)
Whole fruits	0 to 5 points	Min: 0 Servings Max: 21% of recommendation for total vegetable and fruit servings	Min. points are given if no whole fruits are eaten (points= 0). Max points: Must calculate what 21% of recommended total of vegetable and fruits would be. For example, a man 51 years of age is recommended to get 7 servings. 7 x 0.21 = 1.5 servings. Therefore for this individual, 5 points will be awarded only if this man eats 1.5 servings of whole fruit or more. • As for the ranges for men and women 19-50 years, again use 7 and 8 servings respectively to calculate the 21%.

			For those that eat servings sizes between the minimum and maximum servings, a proportional point is awarded. For example, if the man above eats 1 serving of whole fruit, then: 5 points / max servings (in this case 1.5) = 3.3 points per serving 1 serving x 3.33 points = 3.3 points (round to 1 decimal)
Dark green and orange vegetables	0 to 5 points	Min: 0 Servings Max: 21% of recommendation for total fruit and vegetable intake	Calculation is identical to that for whole fruit.
Total grain products	0 to 5 points	Min: 0 Servings Max: Servings based on EWCFG for age and gender (e.g. 7 servings for men over 51 years of age)	Calculation is identical to that for Total vegetable and fruits.
Whole grains	0 to 5 points	Min: 0 Servings Max: 50% of recommendation for total grain product intake	Calculation is identical to that for whole fruit and dark green and orange vegetables. One change is that 50% intake needs to be calculated, not 21%.
Milk and Alternatives	0 to 10 points	Min: 0 Servings Max: Servings based on EWCFG for age and gender (e.g. 3 servings for men over 51 years of age)	Calculation is identical to that for Total vegetable and fruits and total grain products.

Meat and Alternatives	0 to 10 points	Min: 0 Servings Max: Servings based on EWCFG for age and gender (e.g. 3 servings for men over 51 years of age)	Calculation is identical to that for Total vegetable and fruits and total grain products.
Unsaturated fats	0 to 10 points	Min: 0 Max: 30 to 45 grams	Min. points are given if no unsaturated fats are eaten (points = 0). Max. points are given if ≥ 30 g are eaten (points = 10). For those that eat amounts between the minimum and maximum servings, a proportional point is awarded. For example, say 22 grams is eaten. 10 points / max serving (30 grams) = 0.3 points per gram 22 grams x 0.3 points = 6.6 points (round to 1 decimal)
MODERATION 0 to 40 points			
Saturated fats	8 to 10 points 0 to 8 points	Min: 7% to 10% of total energy intake Max: 10% to 15% of total energy intake	10 points awarded if saturated fat intake = 7% of total energy intake or less 9 points awarded if saturated fat intake = 8-9% of total energy intake 8 points awarded if saturated fat intake = 10 % of total energy intake 8 points awarded if saturated fat intake = 10% of total energy intake 6.4 points awarded if saturated fat intake = 11% of total energy intake 4.8 points awarded if saturated fat intake = 12% of total energy intake 3.2 points awarded if saturated fat intake = 13% of total energy intake 1.6 points awarded if saturated fat intake = 14% of total energy intake 0 points awarded if saturated fat intake = 15% of total energy intake or more

Sodium			AI for men and women 50 years or under = 1500 mg/d AI for men and women 51 years and over = 1300 mg/d UL for men and women all ages = 2300 mg/d
	8 to 10 points	Min: AI to UL	10 points awarded if sodium intake is below AI for age and gender 9 points awarded if sodium intake is between AI and UL for age and gender 8 points awarded if sodium intake is at the UL (2300 mg/d)
	0 to 8 points	Max: UL to 2 times UL	8 points awarded if sodium intake is at the UL (2300 mg/d) 0 points awarded if sodium intake is at 2 times the UL (4600 mg/d) To calculate the proportional points: $\frac{8}{2300} = \frac{x}{\text{amount of sodium intake (> 2300 to < 4600 mg/d)}}$ x = the number of points awarded (rounded to 1 decimal)
Other food	0 to 20 points	Min: ≤ 5% of total energy intake Max: ≥ 40% of total energy intake	20 points are awarded if other food is ≤ 5% of total energy intake 19.4 points are awarded if other food is 6% of total energy intake 18.9 points are awarded if other food is 7% of total energy intake 18.3 points are awarded if other food is 8% of total energy intake 17.7 points are awarded if other food is 9% of total energy intake 17.2 points are awarded if other food is 10% of total energy intake 16.6 points are awarded if other food is 11% of total energy intake 16.0 points are awarded if other food is 12% of total energy intake 15.4 points are awarded if other food is 13% of total energy intake 14.9 points are awarded if other food is 14% of total energy intake

			14.3 points are awarded if other food is 15% of total energy intake 13.7 points are awarded if other food is 16% of total energy intake 13.2 points are awarded if other food is 17% of total energy intake 12.6 points are awarded if other food is 18% of total energy intake 12.0 points are awarded if other food is 19% of total energy intake 11.5 points are awarded if other food is 20% of total energy intake 10.9 points are awarded if other food is 21% of total energy intake 10.3 points are awarded if other food is 22% of total energy intake 9.7 points are awarded if other food is 23% of total energy intake 9.2 points are awarded if other food is 24% of total energy intake 8.6 points are awarded if other food is 25% of total energy intake 8.0 points are awarded if other food is 26% of total energy intake 7.5 points are awarded if other food is 27% of total energy intake 6.9 points are awarded if other food is 28% of total energy intake 6.3 points are awarded if other food is 29% of total energy intake 5.7 points are awarded if other food is 30% of total energy intake 5.2 points are awarded if other food is 31% of total energy intake 4.6 points are awarded if other food is 32% of total energy intake 4.0 points are awarded if other food is 33% of total energy intake 3.5 points are awarded if other food is 34% of total energy intake 2.9 points are awarded if other food is 35% of total energy intake 2.3 points are awarded if other food is 36% of total energy intake 1.8 points are awarded if other food is 37% of total energy intake 1.2 points are awarded if other food is 38% of total energy intake 0.6 points are awarded if other food is 39% of total energy intake 0 points are award if other food is ≥ 40% of total energy intake

Food Group recording sheet:

	Total vegetables and fruit	Whole fruit	Dark green and orange vegetables	Total grain products	Whole grains	Milk and Alternatives	Meat and Alternatives
Day 1							
Day 2							
Day 3							
Day 4							
Day 5							
Day 6							
Average							