

**PREDICTORS OF EARLY ATTRITION AND SUCCESSFUL WEIGHT LOSS IN PATIENTS  
ATTENDING AN OBESITY MANAGEMENT PROGRAM**

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## **ABSTRACT**

Lifestyle weight management programs often experience high attrition rates. Existing literature mainly consists of research populations. Therefore, this study aimed to determine factors associated with early attrition and successful weight loss (WL) in a publically funded obesity management program. Factors influencing early attrition (<6 months) and successful WL ( $\geq 5\%$ ) were analyzed. Longer treatment time was related to greater absolute WL, but a lower rate of WL over time regardless of sex. Younger age and having certain health conditions were associated with both earlier attrition and lower WL success regardless of sex. Males with a lower education had greater early attrition compared to males with a higher education. Females who smoked had greater attrition compared to females that were non-smokers. Females of ethnic minorities had lower WL compared to White females. Because treatment time is related to WL, providing alternative treatment options to improve treatment adherence may improve weight loss success.

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## LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BE	Bariatric Educator
BMI	Body Mass Index
CI	Confidence Interval
CVD	Cardiovascular Disease
OHIP	Ontario Health Insurance Plan
REF	Referent
RR	Relative Risk
RMR	Resting Metabolic Rate
SEM	Social Ecological Model
SES	Socioeconomic Status
SD	Standard Deviation
SWL	Successful Weight Loss
T2D	Type 2 Diabetes
TTM	Transtheoretical Model
WL	Weight Loss
WMC	Wharton Medical Clinic
YRS	Years

## **1.0 GENERAL INTRODUCTION**

The prevalence of overweight and obesity in Canada has increased by 12.2% in the past few decades, as approximately 59% of the adult population lives with overweight, and 23% with obesity (1). This is concerning, as excess weight is associated with numerous comorbidities such as type 2 diabetes (T2D), hypertension, dyslipidemia and several forms of cancer (1–3). Weight loss as little as 5-10% of body weight is associated with numerous health benefits (2, 4) and accordingly, current weight management guidelines suggest weight loss for all overweight and obese individuals using a combination of lifestyle and behavioral therapy. However, lifestyle interventions have demonstrated limited success in weight reduction, as maintaining long-term weight loss success often requires difficult life-long changes in eating behavior and physical activity (5). Lifestyle interventions have frequently been supplemented with pharmacotherapy to improve weight loss in obese patients, but there are only a limited number of medications available and side effects have constrained their success (6, 7). Surgical approaches have been shown to be more effective in inducing long-term weight loss, however, the majority of patients with even severe obesity do not wish to undergo this procedure for various reasons such as costs or fear of complications (8). Given that lifestyle management is at the core of obesity treatment, there is a need to understand why patients discontinue lifestyle-based weight management interventions and the difficulties associated with attaining successful weight loss. Therefore, the objective of this study was to identify factors associated with both early attrition and successful weight loss in a publically funded lifestyle-based obesity management program.

## **2.0 REVIEW OF LITERATURE**

### **Introduction**

Obesity is a major health concern in Western society as it is a risk factor for many chronic diseases (4, 5, 9). Accordingly, individuals with obesity are often encouraged to lose weight, as modest weight reductions are associated with numerous health benefits (2, 10, 11). Currently, lifestyle interventions using a combination of dietary, exercise and behavioral approaches are used as the primary means of weight loss and the management of obesity. However, adherence to lifestyle interventions remains low and long-term success tends to be limited, as only a small percentage of patients are able to maintain a weight loss of at least 5% of their bodyweight (2). As weight loss continues to be a challenge for many individuals, lifestyle interventions have often been supplemented with surgical or pharmacological procedures to improve weight loss success (4, 8). However, many people opt out of surgery for unknown reasons and side effects from medications often limit adoption of these techniques (4, 8). Furthermore, although some patients are able to successfully lose weight, the majority of patients regain their weight post intervention. Therefore, it is important to understand why patients discontinue treatment, and to identify factors that may negatively impact weight loss success so that patients that are at risk can be offered additional support or alternative treatment options to improve treatment adherence and long-term WL success.

## **Successful Weight Loss**

Successful weight loss has previously been defined as losing 5% or more of initial body weight (12, 13). Weight loss success is quite important as a loss of body weight produces substantial changes in health risk factors (14). However, the high attrition rates observed in weight loss programs often lead to poorer weight loss outcomes and reduced treatment success (15). Although patients tend to discontinue treatment early, longer duration of weight control interventions has been related to greater weight loss (16) and improvements in long-term treatment outcomes. A longer treatment duration may be beneficial as individuals may develop the habits required to be successful in the long term (5, 17, 18). In addition, a greater WL may increase an individual's self-efficacy and motivation to continue their weight loss efforts (18). Currently, weight loss success in lifestyle weight management programs is quite low and may be related to the high attrition reported in many studies (13, 19, 20). Therefore, it is important to determine factors that differentiate those who are unsuccessful and individuals who successfully lose weight so that those at risk can be provided with additional support or alternative treatment options.

## **Factors influencing behavior change**

Successful WL continues to be a challenge in obesity treatment, as 85% of individuals who lose weight often regain it within 1 to 5 years (21). Weight loss is quite challenging, particularly in our obesogenic environment as food marketing, education, urban design, federal and state policies all work together to make behavior change a

difficult task (22). Therefore, to increase physical activity and healthy eating, health promotion efforts need to focus not only on the behavior choices of each individual, but also on the factors that influence these choices (23). Accordingly, various multilevel models are used to address individual behavior as behavior is often shaped by varying levels of influence, including biological (genes, cells and organs) and socioenvironmental (economics, culture, social networks, physical environment) factors (24, 25). By working with multiple levels of influence at the same time, it may lead to a greater impact on behavior change as opposed to working at an individual level. For example, increasing knowledge, skills and self-efficacy of low-income individuals may lead to adoption of healthy nutritional habits delivered through nutritional educational programs (22). Family and social support may be increased, in order to accommodate healthy behavior change (22, 24). At the institutional level, policies that support increased physical activity such as walking or biking to work or school may increase physical activity levels (23, 24). By understanding that individual's behaviors are shaped by both individual and external levels of influence, it may lead to improvements to this obesogenic environment and increase WL success. Therefore, effective interventions require more supportive environments in addition to lifestyle change to address this obesogenic environment. By understanding multiple factors that influence behavior, it may lead to the development of new interventions that are more effective and address this increasing prevalence of obesity.

## **Attrition rates in existing literature**

Currently, high attrition rates are a common problem in lifestyle weight management programs, as studies have reported varying attrition rates ranging from 10-80% depending on the type of treatment (20, 26). Previous research on attrition has attempted to use demographic data collected prior to treatment initiation to predict success of program completion (27–31). Demographic factors such as age, sex, ethnicity, education and smoking status have been previously suggested as correlates of attrition (20, 26). Although demographic variables have previously been examined in clinical trials, differences in sample size, type of program, length of treatment and exclusion criteria limit the generalizability of the findings to the general population seeking weight management (30, 32–37).

## **Demographic variables associated with attrition and successful WL in existing literature**

### ***Age***

Existing literature has examined the relationship between age and attrition and demonstrated mixed results, as some studies have reported greater attrition in younger individuals (30, 38) whereas age was not associated with attrition in others (39, 40). For example, one study reported greater attrition in younger patients attending a 16-week clinical weight loss program using meal replacements and severe caloric restriction (30). Similarly, younger age was associated with higher attrition in patients attending a fairly labor intensive 6-month program at a publicly funded weight management clinic in

Alberta (38). Conversely, two studies reported no relationship between age and attrition in patients attending a two year dietary intervention (40) or outpatient centre for obesity treatment (39). Both studies, however, only included a narrow age range of patients [ranges 25-50 (39) & 40-65 (40) yrs], which could limit their ability to observe age differences.

Younger age has been more commonly related to lower weight loss success in existing research studies (7, 41), which is in line with studies that indicate greater attrition in younger adults. Possible reasons may include greater health-related concerns amongst older adults who may be more motivated to improve health and reduce comorbidities. Further, younger individuals may have greater attrition due to greater family responsibilities or work obligations, which may make it difficult to attend or comply with treatment (7). Thus, older individuals may more regularly attend treatment, have better compliance and sustain superior weight loss. Although more research is needed, if older age is associated with lower attrition and greater WL success, particular focus might be needed for younger individuals in order to improve attrition and WL success.

### **Sex**

Participant sex and attrition has also been investigated by several studies with conflicting findings (7, 26, 30, 33). Out of four studies examining the relationship between sex and attrition, only one study reported that females had greater attrition in comparison to males in a 16 week clinical weight loss program (30). Sex differences are likely to contribute to attrition for different reasons as males may discontinue treatment

for job related reasons, whereas females may discontinue for familial commitments (42). In contrast, three other studies (7, 26, 33) reported no differences in attrition by sex. However, many of the existing studies tend to have a small number of male patients [n = 37 to 44], which may have limited their statistical power to detect any true sex specific differences.

Existing studies examining the relationship between sex and weight loss have demonstrated greater weight loss in males compared to females (43, 44), however, many have simply adjusted for sex (7, 20, 45). Although many studies tend to combine or adjust for sex when reporting WL (7, 20, 45), two studies (43, 44) have demonstrated lower WL in females compared to males. Females may have lower absolute WL as they may have lower energy expenditure and greater energy intake (43), which may lead to the lack of observed WL in females. Additionally, men and women likely have different motivators and barriers for weight management (46), which may also contribute to differences in WL success. For example, men were motivated to lose weight for health reasons and productivity at work, but barriers often included lack of motivation and weight gain (47). In females, common barriers included changing food habits, health problems, lack of self-control and insecurity but females were motivated by having clear self-defined goals and by receiving support from family and friends (48). As participant's sex likely has an influence on both attrition and WL, more research examining sex and its association with attrition and WL is warranted.

## ***Ethnicity***

Ethnicity has previously been linked to attrition in two studies (35, 49), but two other studies reported no effect of ethnicity on attrition (7, 30). However, the bulk of the evidence has focused on mainly only White and Black populations (7, 30, 35, 49). For example, one study reported no differences in attrition rates between Black and White patients attending a clinical weight management program (30). Conversely, in another study, being Black was associated with greater attrition in a paid community wellness facility (35). Because certain ethnic minorities are often related with lower socioeconomic status (SES) (50), individuals of these ethnic minority groups may not be able to as easily afford the reoccurring costs associated with lifestyle management treatment. Additionally, since a majority of the studies only include a small proportion of patients from minority groups, it is plausible that the studies were underpowered.

In two studies (7, 51), being of an ethnic minority has also been related to lower WL when compared to White individuals. Individuals of ethnic minorities may have lower resting metabolic rates compared to White individuals, which may account for the differences in weight loss (7). In addition, some cultures welcome a larger body as it is associated with health and vitality, whereas being lean is associated with poor health and vulnerability to illness (52). Therefore, cultural factors may be important to consider as they may influence an individuals' view of desirable weight and body shape, which may hinder weight loss efforts (53). Currently, studies lack ethnic diversity, which limits interpretation of findings to individuals of non-White and non-Black ethnicities. Thus,

understanding the relationship of ethnicity on weight loss and attrition may contribute to the development of useful interventions and address the problem of obesity.

### ***Education***

Lower education has previously been associated with greater attrition in two studies (7, 49) but not two others (26, 54). For example, education was not associated with attrition in patients attending a dietary clinical trial (26) or in patients randomized to psychological lifestyle interventions (54). However, both studies included challenging components such as recording detailed food diaries or consuming a diet of specific macronutrient compositions (54, 55), which may be difficult for individuals with a lower education. Conversely, Elfhag et al. (49) reported greater attrition in patients with lower education in a similarly taxing intervention that required participants to attend a mandatory number of group sessions, attend lessons on nutrition, and record food intake and physical activity. Current studies examining the relationship between education and attrition have required patients to adhere to very specific dietary and treatment protocols, and may not be delivered in a manner that is appropriate for individuals with lower education. Thus, complicated treatment protocols may be difficult for individuals with lower education to comply and may lead to greater attrition. Lower educational level was also associated with lower WL success in one study (49). As education is associated with income (56), individuals with lower income may not be able to afford the types of 'healthy' foods that are often recommended in weight management programs, making WL success more difficult. Therefore, future research is warranted to clarify the relationship between education and weight loss.

## **BMI**

Studies have previously examined the relationship between initial BMI and attrition from weight management programs (27, 57, 58) and reported conflicting findings. Initial BMI was not associated with attrition (57, 58) in two weight management studies, however, both studies only included individuals with a BMI of class II obesity or lower. Conversely, another study with the same BMI restrictions (27) demonstrated greater attrition in those with a higher BMI, compared to those with a lower BMI. The overall data seem to suggest that initial BMI is not related with attrition but it is not known if this applies for individuals with higher obesity levels.

Similarly, BMI was not related with weight loss in several studies (7, 49, 59), however, one study reported greater weight loss in individuals with a lower BMI (19). Weight control can be particularly difficult for individuals with a greater BMI, as excess body fat is associated with impaired physiological mechanisms such as leptin resistance. As leptin resistance is associated with reduced satiety, those with a greater BMI may eat more (60) which in turn may hinder weight control efforts in individuals attempting weight management and lead to lower WL. In addition, individuals with a greater BMI may experience metabolic alterations such as an increased energy expenditure, which is often observed with weight gain (61). This increased energy expenditure may promote increased food intake and a sense of hunger (61), which may make WL difficult. The majority of the existing research (7, 49, 57–59) indicates that initial BMI is not related to greater attrition or WL in patients attending a lifestyle intervention. As a majority of the current research only includes individuals below class II obesity, future research is

needed to investigate the influence of higher BMI classes on attrition and weight loss in order to improve lifestyle weight management.

Currently, most of the available literature seems to demonstrate low WL success and high attrition rates in lifestyle interventions. However, the majority of existing research has been performed on participants of research populations using strict inclusion criteria. These studies often lack ethnic diversity, are catered for individuals with a higher education and exclude individuals with higher BMI (7, 30, 59). Additionally, patients in clinical research studies may be more motivated as they are often provided with incentives for participation, are enrolled in weight loss programs in which they are required to pay for treatment or are screened prior to inclusion (35, 38, 45). Currently, the majority of this research is conducted in populations that are recruited for clinical trials. Therefore, those who attend publically funded physician-referred lifestyle management program for obesity treatment are likely to be different from those included in clinical weight loss trials as they may consist of a 'real-world' population as compared to clinical trials (30). Thus, it is important to understand what factors predict early attrition and weight loss success in a real world setting. By identifying the most important factors related to patient attrition in lifestyle based weight management programs, we may improve the effectiveness of the program and provide those at risk with the support they need to benefit from treatment (20, 30, 32). Additionally, those at risk could also be offered a more tailored approach with additional support or assistance to ensure treatment success (20, 30, 32).

Therefore, the aim of this research is to determine if pre-treatment characteristics such as age, initial BMI, education, smoking status and health conditions are associated with weight loss and attrition in a publically funded obesity management program.

### **3.0 MANUSCRIPT**

#### **Predictors of Early Attrition and Successful Weight Loss in Patients Attending an Obesity Management Program**

Running Head: Factors associated with early attrition and successful WL

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## ABSTRACT

**Background:** High attrition rates are commonly seen in weight management programs. Our objective was to identify factors associated with early attrition and successful WL in an obesity-management program.

**Methods:** Participants were 5415 patients enrolled for at least 6 months. Correlates of early attrition (<6 months) and successful weight loss ( $\geq 5\%$ ) were analyzed.

**Results:** In both sexes, those in treatment for longer than 6 months had greater absolute WL but a more gradual rate of WL ( $P < 0.0001$ ) over time. Middle and older aged individuals had lower early attrition (RR Range:0.74-0.92,  $P < 0.05$ ) and greater WL success (RR Range:1.40-1.65,  $P < 0.05$ ) than younger individuals, irrespective of sex. Males with hypertension and females with depression had greater early attrition (RR Range:1.09-1.20,  $P < 0.05$ ) and lower WL success (RR Range:0.48-0.57,  $P < 0.05$ ) than those without any conditions. Females with hypertension, depression or a prior history of cancer had 9-27% greater attrition than females without health conditions. Males with lower education had greater early attrition (RR:1.11[1.03-1.19],  $P = 0.002$ ) than males with higher education, but education was not related to WL. Females who smoked had greater early attrition (RR:1.06[1.01-1.11],  $P < 0.05$ ) compared to females who were non-smokers, but smoking status was not related to WL. Ethnicity was not related to early attrition, however, females of ethnic minorities had lower WL compared to White females (RR Range:0.58-0.74,  $P < 0.05$ ).

**Conclusion:** As WL and attrition are related, particular attention should be given to individuals at risk, so that they can be offered alternative treatment options, which may improve patient retention and improved weight related outcomes.

**Keywords:** weight loss; drop out; overweight; obese; intervention; clinical

### 3.1 INTRODUCTION

High attrition is a common problem in weight loss interventions with attrition rates ranging from 10% to more than 80% depending on the type of intervention (20, 27). Current literature identifies several characteristics that may predict attrition in weight loss programs such as age, sex, education, ethnicity and smoking status (20, 30, 32, 34, 45). However, the majority of the existing weight loss intervention literature focuses on research populations recruited using strict inclusion and exclusion criteria along with extensive baseline testing (35, 36, 38, 45). For example, some studies report having patients pay for treatment (55) or complete at least 6 months of primary care in order to be considered for inclusion (38). Studies also report excluding patients if they were unable to attend all baseline assessment or treatment sessions, or had existing obesity co-morbidities such as type 2 diabetes or hypertension (45). Thus, patients recruited in these studies may be more motivated to complete treatment and are likely healthier than the general population with obesity. Due to the strict inclusion and exclusion criteria in research studies, the findings may not be generalizable to patients referred to weight management programs without these extra requirements (20, 30, 37, 62). Understanding factors that influence early attrition and weight loss success in overweight and obese individuals seeking medical treatment is important, as it may lead to the implementation of alternative strategies which may improve retention and ultimately health- and weight-related comorbidities. Therefore, our study aimed to examine factors related with early attrition and weight loss success in patients seeking medical weight management.

## 3.2 METHODS

### Participants

The Wharton Medical Clinic (WMC) is a multidisciplinary obesity management clinic with several locations across Ontario, Canada (Toronto, Burlington, Hamilton, Stoney Creek and Etobicoke). The WMC assesses and provides weight management treatment for patients with overweight, obesity or type 2 diabetes using principles outlined in the Canadian clinical practice guidelines for the treatment of obesity (4). Patients are referred to the clinic by their family physician and all visits are available free of charge to patients as services are covered by the Ontario Health Insurance Plan (OHIP). The clinic provides patients with a broad range of services such as physician assessments, blood pressure monitoring, ECG readings and other diagnostic tests. Patients are treated by a multidisciplinary team of behavioral therapists, dietitians, nutritionists, physicians, and bariatric educators (BE). Patients have the option to attend additional information sessions regarding diet, exercise and other related topics on weight management and health. Individualized meal plans are provided for patients who have regular follow-ups with their BE and physician on an appointment basis. Participants provided written informed consent for the use of their electronic medical data for research purposes and were informed that participation or lack of participation would not affect their medical treatment. The methods used in this study were approved by York University Ethics Review Board.

### **Attrition and Group Allocation**

Data was extracted from electronic medical records in December 2014 and included a total of 9498 participants who were at least 18 years of age (range 18-89 yrs). Participants were excluded from the analysis if they had missing or implausible values for age (n=85), weight (n=6), or initial visit date (n=1). Participants were also limited to those who had enrolled at least 6 months prior to the data extraction date (June 2014) to allow for the correct categorization of patient attrition and weight loss outcomes. The final sample size was 8196 (86.3%). For baseline characteristics, participants were divided into five mutually exclusive groups based on the amount of time they attended treatment and their overall weight loss (single visit, <6 months and <5% WL, <6 months and ≥5% WL, ≥6 months and <5% WL and ≥6 months and ≥5% WL). Early attrition was defined as leaving treatment before 6 months and being absent for more than 6 months since their last visit. Successful weight loss was defined as achieving a weight loss of ≥5% of their initial body weight. Weight loss and attrition analyses were restricted to participants with more than 2 visits (n=5415). Patients with fewer than 2 visits were excluded as they discontinued treatment prior to all baseline assessments and program commencement.

### **Statistical Methods**

Continuous variables were reported as means and SDs while categorical variables were presented as frequencies and prevalences. Differences in baseline characteristics between each of the five groups were examined using one-way analysis of variance

(ANOVA) with Bonferroni post-hoc tests for continuous variables and  $X^2$  tests for categorical variables. Kaplan-Meier survival analysis was used to illustrate patient attrition over treatment time. Independent *t*-tests were used to identify differences in both the absolute and the rate of weight loss between groups (<6 months and  $\geq 6$  months). Pearson's correlation was used to determine the relationship between weight loss and treatment time. Poisson regression analysis was used to determine if age, smoking status, education, initial BMI, ethnicity and certain health conditions (cardiovascular disease [CVD], hypertension, depression, type 2 diabetes [T2D], fatty liver and cancer) were independently associated with early attrition and successful weight loss ( $\geq 5\%$ ). Our initial model was stratified by sex ( $P < 0.05$ ) as there are clear sex differences that are reported in health and obesity research. Our model was also mutually adjusted for age category (young [18-44 yrs] vs. middle [45-64 yrs] & old [65-89 yrs]), initial BMI, ethnicity (White vs. Asian, White vs. Black & White vs. Other), education (college vs. high school), and smoking status (smokers vs. non-smokers). A second model included the additional adjustment for treatment time. Results were considered significant at  $P < 0.05$  and all analyses were performed using SAS 9.4.

### **3.3 RESULTS**

#### **Baseline characteristics**

The baseline characteristics of the study participants stratified by treatment time (single visit, <6 months or  $\geq 6$  months) and weight loss status (<5% or  $\geq 5\%$ ) are reported in **Table 1**. Participants were generally young (36.9%), White (85.0%) and female (74.8%). Within the entire sample, 2779 (34.0%) patients discontinued after a single

visit. Of the 3057 (37%) patients enrolled in treatment for greater than 6 months, 1242 (40.6%) participants achieved successful weight loss ( $\geq 5\%$ ). Patients who achieved 5% or greater weight loss were more likely to be White and have T2D but were less likely to have depression when compared to those without weight loss ( $P < 0.05$ ). Additionally, patients that remained in treatment longer than 6 months tended to be older and were less likely to smoke compared to those in treatment for less than 6 months ( $P < 0.05$ ).

### **Weight loss and treatment time**

Weight loss was positively related to treatment time ( $r = 0.38$ ,  $P < 0.0001$ ) and greater visit frequency ( $r = 0.43$ ,  $P < 0.0001$ ). Those in treatment for less than 6 months had lower absolute weight loss when compared to those in treatment for more than 6 months in males (2.8 [2.3] kg versus 6.1 [10.9] kg,  $P < 0.0001$ ) and females (2.1 [4.9] kg versus 4.4 [8.7] kg,  $P < 0.001$ ). However, patients in treatment for less than 6 months had a greater rate of weight loss in males (0.90 [1.80] kg/month versus 0.45 [0.76] kg/month,  $P < 0.0001$ ) and females (0.68 [1.73] kg/month versus 0.37 [0.64] kg/month,  $P < 0.0001$ ) when compared to those in treatment greater than 6 months.

### **Predictors of early attrition**

Both middle-aged (range 45-64 yrs) and older patients (range 65-89 yrs) had lower early attrition rates ( $P < 0.005$ ) than younger individuals (range 18-44 yrs) (**Figure 1A**). In comparison to White patients, Asians had higher early attrition rates ( $P = 0.002$ ) but no differences were observed in attrition rates of Black ( $P = 0.15$ ) or Other ethnicities ( $P = 0.07$ , **Figure 1B**). Patients who smoked had greater attrition rates when compared to

patients who did not smoke ( $P < 0.001$ , **Figure 1C**), whereas educational attainment was not related to attrition ( $P = 0.29$ , **Figure 1D**).

**Table 2** reports the relative risk of early attrition by sex with mutual adjustments for age, initial BMI, ethnicity, education and smoking status. Those who were middle-aged and older had lower early attrition (RR Range: 0.74-0.92,  $P < 0.05$ ) when compared to younger individuals, regardless of sex. Having hypertension (RR: 1.16-1.20,  $P < 0.0001$ ) was associated with greater attrition in both males and females. In females, having depression, fatty liver and a history of cancer predicted greater early attrition compared to females without any health condition (RR Range: 1.09-1.27,  $P < 0.05$ ), however, neither condition predicted attrition in males ( $P > 0.05$ ). Males with a lower education had greater early attrition (RR: 1.11 [1.03-1.19],  $P = 0.002$ ) when compared to males with a higher education, but education did not predict attrition in females. Ethnicity, smoking status, and the remaining health conditions were not related with early attrition in either males or females ( $P > 0.05$ ).

### **Predictors of successful weight loss**

**Table 3** reports the relative risk of achieving successful weight loss ( $\geq 5\%$ ) by sex with mutual adjustments for age, initial BMI, ethnicity, education and smoking status. Similar to observations with attrition, older age also predicted greater likelihood of achieving successful weight loss (RR Range: 1.40-1.65,  $P < 0.05$ ) when compared to younger individuals, in both males and females. In females, those who were Black (RR, [95% CI]: 0.58 [0.37-0.94],  $P = 0.03$ ) or belonged to 'Other' ethnicities (RR, [95% CI]: 0.66

[0.57-0.94],  $P=0.02$ ) had a lower likelihood of successful weight loss compared to White individuals. Females with depression were also less likely to attain a 5% weight loss (RR, [95% CI]: 0.48 [0.27-0.85],  $P=0.002$ ) but no differences were observed for all other health conditions ( $P>0.05$ ). In males, only hypertension was associated with lower (RR: 0.57 [0.40-0.81],  $P=0.001$ ) weight loss success. After adjusting for treatment time, there were no differences in weight loss success regardless of age, smoking status, ethnicity or health conditions ( $P>0.05$ ) in either males or females ( $P>0.05$ ).

### **3.4 DISCUSSION**

A majority of the existing research on attrition has been conducted in strictly controlled clinical trials, and may not be generalizable to patients who are referred by their physicians to weight management programs. We determined that greater time spent at the clinic was related to greater weight loss. We also identified that younger age and certain health conditions were associated with greater attrition and lower weight loss success in both males and females. Additionally, factors such as lower educational attainment and current smoking status predicted greater attrition but not weight loss, whereas belonging to ethnic minority groups was associated with lower weight loss success, but no differences in attrition. However, after adjusting for treatment time, none of these characteristics were associated with WL success. Therefore, treatment time is independently associated with WL and is important for WL success.

We observe that the duration of treatment was an independent predictor of weight loss. Increasing treatment duration has been consistently associated with

improved weight loss in previous literature (14, 63). Extending the length of treatment is important as it may provide patients with a greater opportunity to practice the behaviors necessary for long term weight loss success (63), allow patients to achieve greater weight loss (63), and allow for continued support (14) which may aid in reducing early attrition and improving weight loss success. Conversely, greater weight loss may be the motivating factor leading to longer treatment length, however, those with longer treatment time had a lower rate of weight loss. This finding is consistent with the literature examining long-term weight loss (14, 63). Longer treatment and life-long strategies are important given that obesity is a chronic condition. Therefore, it is important for participants to remain in treatment longer in order to receive continued support and have the opportunity to develop skills necessary for successful weight maintenance.

Our study reported that age is associated with greater program attrition and less weight loss, which is in accordance with some studies (30, 38) but in contrast with others that report no influence of age on attrition (39, 40, 54). The studies that did not observe associations between age and attrition had smaller age ranges consisting of mainly younger and middle-aged participants (39, 40, 54), as opposed to our study that also included older adults. These age-related differences in attrition may be explained by several factors. It is hypothesized that younger individuals may not be able to attend treatment as frequently as older individuals as they may have the extra burden of childcare (30), have less financial stability (30), may not be able to take time off work (30), or may be less motivated to improve their health (7). In some settings, patients

seeking medical treatment from weight management clinics may also be faced with additional barriers such as long wait times or distance to the clinic, which may make it harder to attend treatment. As attrition and weight loss are related, the lower weight loss success in younger patients as compared to older individuals may also be due to their greater attrition rates. Indeed, there were no age related differences in weight loss after adjusting for differences in treatment time. These findings suggest that there may be a need to adopt specific strategies to cater to younger individuals, in order to improve treatment attendance and weight loss success.

Previous literature on attrition and weight loss often exclude participants who have existing obesity-related health conditions (54, 64, 65) such as T2D (57), depression, or a history of cancer (66) while others have made no mention of participant health conditions (35, 39, 41). In our study, having certain baseline comorbidities such as depression or hypertension are associated with both greater early attrition and lower WL success depending on sex. Our findings are consistent with previous studies (7, 28, 57), but contradict several others that do not observe comorbidities to be associated with differential attrition or weight loss (40, 67). Although patients with existing health conditions may have greater motivation to lose weight, they may also be more likely to discontinue treatment early due to ongoing health concerns or due to other health related impairments such as a reduction in quality of life, which may lead to early attrition and lower weight loss success (68). Additionally, certain health conditions such as depression or a history of cancer may interfere with weight management as they are often associated with symptoms such as lethargy and lack of motivation, making it

harder to attend treatment and lose weight (28). It is also possible that patients may experience other negative symptoms associated with depression such as uncontrolled eating or substance abuse, which may make weight loss more difficult (28). Other factors such as the use of medications are also important to consider as they can be associated with weight gain (69) or weight loss (70, 71). These inconsistent observations for attrition and weight loss suggest that participants may require alternative treatment options to ensure weight loss is maintained over the long term. Thus, adherence to treatment may require more flexible treatment options and the need for a more tailored approach in order to improve WL success and reduce early attrition.

Lower educational attainment was related to greater early attrition in males, but was not related with weight loss success in either sex. Our findings are consistent with some previous research studies (49, 65) which report an association between education and attrition, but contradict others which report no relationship between education and attrition (54, 55). Education may be related to greater early attrition as education is often a marker for SES (65). Therefore, as observed with younger age, patients with lower education or SES may have greater attrition due to inflexible work hours (49, 65), cost of transportation, parking or the reliance on public transportation which may make it more difficult to attend treatment. Although education was associated with greater early attrition, education level did not influence weight loss success in our study. This may be due to the high level of support provided to patients, which may help them overcome common barriers and prevent relapse. Also, the program at WMC is

purposefully designed so that it will be understandable and accessible to those with more modest English language facility and health literacy. Patients are also in regular contact with their physician, which is important in building a trusting and collaborative physician-patient relationship which has been reported to help overcome obstacles to weight loss (41). Thus, while low educational attainment does not appear to limit weight loss success, it may still be associated with greater attrition. Additional accommodations may therefore be necessary to reduce early attrition in patients with lower education.

With regard to smoking status and attrition, the current literature has reported mixed findings (7, 28, 38, 40, 55, 65). Two studies (7, 38) demonstrated no relationship between smoking status and attrition in patients randomized to receive pharmacotherapy, behavior therapy or combined therapy for weight loss (7) or a clinical weight management program (38), which contradicts our findings that demonstrated greater early attrition in patients who smoke. In studies that observe no differences in attrition by smoking status, patients were frequently contacted if they missed program visits (38) or individuals were required to attend 30 behavioral therapy sessions over 52 weeks (7) prior to inclusion, which may have improved treatment compliance and made it harder to discern differences between groups. In our study, patients who smoke may be more likely to discontinue treatment as physicians may constantly remind patients of the negative effects of smoking, which might discourage patients from attending weight management treatment. Additionally, because smoking cessation is often associated with weight gain (72), it may more generally discourage patients from attending weight

management treatment. However, although smoking status was related with greater attrition, it was not related with differences in weight loss in our study. Taken together, these findings suggest that these individuals did not attempt to stop smoking or that the treatment provided was adequate in combatting post-cessation weight gain. Thus, particular attention should be focused on reducing early attrition in patients who smoke.

Finally, relatively few studies have been adequately powered to examine differences in attrition between ethnicities. For example, one study reported greater attrition in Black patients when compared to White individuals who were attending a clinic based weight loss program (35), but two studies (7, 57) reported no association between ethnicity and attrition. Likewise, our study did not find an association between ethnic groups in patients who were White, Black, Asian or of the Other ethnicities. One reason may be due to the ethnic diversity of the clinic staff at WMC. Because the staff at the clinic are from the same diverse ethnicities, it may make the patients may feel more comfortable and thus, patients may remain in the program longer. Although ethnicity did not influence attrition, females of ethnic minorities had lower weight loss success compared to White females Our findings are consistent with the findings of Fabricatore et al. (68) who reported lower WL success in Black individuals when compared to White individuals. Individuals of ethnic minorities may have lower WL success, as the majority of the staff at the clinic are generally trained in North American foods using Canadian guidelines, making it more difficult to provide nutritional guidance for ethnic foods. In addition, it may also be due to physiological differences such as resting metabolic rate

(68) or language barriers (73). Given the differences in weight loss success amongst ethnic groups, it is important to provide a culturally tailored environment, which is supportive to those of various ethnic backgrounds.

Our analysis has several strengths and limitations. To our knowledge, this is the first study with such a large ethnically diverse clinical sample. This large sample allowed us to stratify our findings by sex as opposed to statistical adjustment, which is important given the clear sex differences that are commonly observed in health and obesity research. Our sample also consisted of patients that are often excluded from clinical trials. Despite these strengths, our study also has several limitations. Due to the observational study design, our findings cannot imply causation. Furthermore, there are many other factors that we did not assess which may have an effect on attrition and weight loss, such as eating behaviors (weight cycling, binge eating), logistics (travel distance, income, environment), personality and physical health.

### **3.5 CONCLUSION**

In conclusion, our study determined that in a physician-referred clinical weight management population, longer treatment time is the only independent predictor of weight loss. Additionally, younger age and having certain health conditions also predicted greater early attrition and lower weight loss success in both sexes. Other factors such as education and smoking status were only related with early attrition, whereas individuals of ethnic minorities had no differences in attrition but were still less likely to lose weight. Given that weight loss and attrition are generally related, using a

range of strategies to minimize early attrition in groups at risk may be important as it may improve program adherence and treatment success.

**Table 1: Baseline characteristics of patients by treatment time and weight loss status**

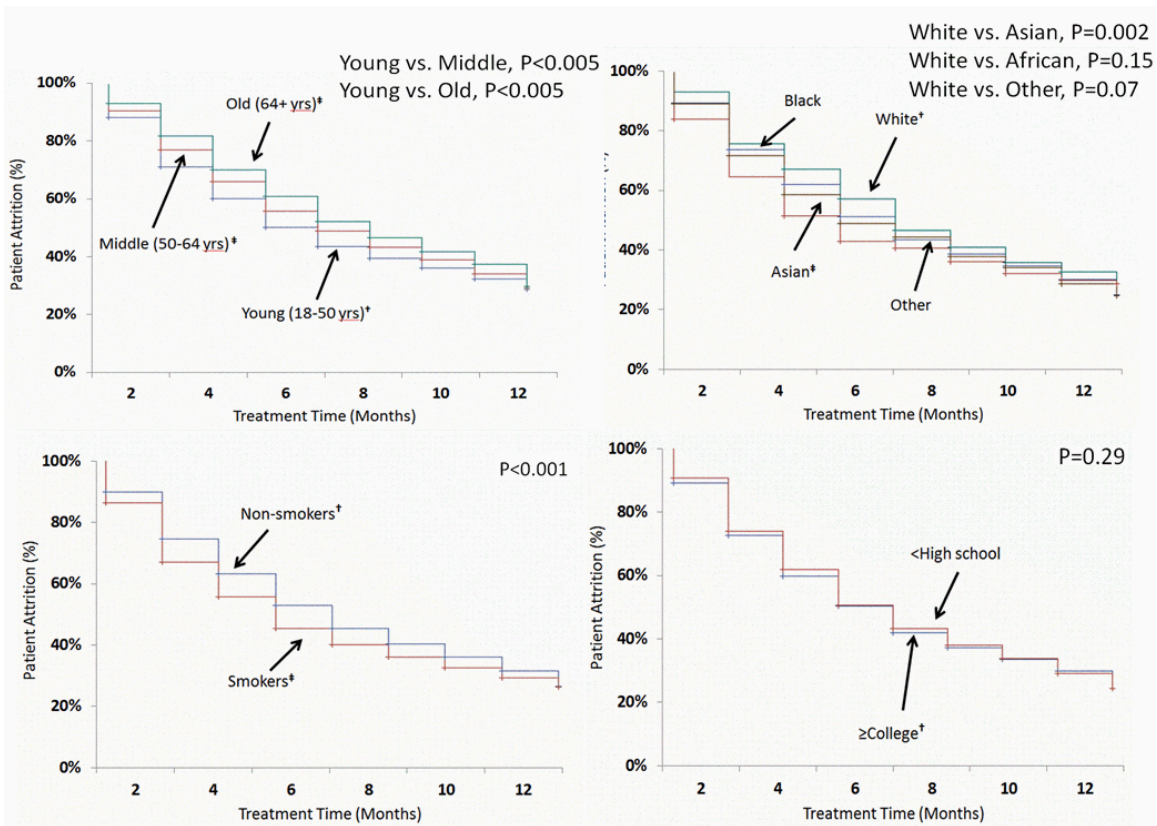
Participant Characteristics	Single Visit	<6 Months		≥6 months	
	No Weight Loss	WL < 5%	WL ≥ 5%	WL < 5%	WL ≥ 5%
N = 8196	2779	1990	370	1815	1242
Female, %	76.2 <sup>cde</sup>	77.2 <sup>cde</sup>	72.7 <sup>ab</sup>	71.7 <sup>ab</sup>	72.7 <sup>ab</sup>
Age, years	45.9 (13.0) <sup>bcd</sup>	48.1 (12.9) <sup>acde</sup>	49.2 (12.6) <sup>abde</sup>	52.2 (12.7) <sup>abce</sup>	54.4 (12.5) <sup>abcd</sup>
Initial Weight, kg	112.6 (25.0)	110.6 (23.9) <sup>e</sup>	112.3 (24.6)	112.7 (27.0)	114.7 (25.5) <sup>b</sup>
Weight change, %	-	1.0 (2.3) <sup>cde</sup>	8.8 (7.6) <sup>bde</sup>	-0.23 (4.2) <sup>bce</sup>	12.8 (9.1) <sup>bcd</sup>
Initial BMI, kg/m <sup>2</sup>	40.3 (7.6) <sup>e</sup>	39.8 (7.2) <sup>e</sup>	39.9 (7.8)	40.5 (8.2)	41.2 (7.9) <sup>ab</sup>
Final BMI, kg/m <sup>2</sup>	-	39.4 (7.2) <sup>cde</sup>	36.7 (6.6) <sup>bd</sup>	40.6 (8.4) <sup>bce</sup>	36.6 (7.2) <sup>bd</sup>
< High school	40.3 <sup>bd</sup>	36.4 <sup>a</sup>	36.7	36.6 <sup>a</sup>	39.4
<i>Ethnicity</i>					
White, %	83.8 <sup>ce</sup>	85.0 <sup>ce</sup>	89.3 <sup>abd</sup>	82.7 <sup>ce</sup>	89.8 <sup>abd</sup>
Asian, %	3.4 <sup>e</sup>	2.1 <sup>ce</sup>	2.4 <sup>ad</sup>	3.2 <sup>ce</sup>	1.3 <sup>abd</sup>
Black, %	2.5	2.9	2.8	3.2 <sup>e</sup>	1.6 <sup>cd</sup>
Other, %	10.2 <sup>ce</sup>	10.0 <sup>ce</sup>	5.5 <sup>abd</sup>	10.9 <sup>ce</sup>	7.3 <sup>acd</sup>
Current smokers, %	20.5 <sup>bcd</sup>	14.8 <sup>ade</sup>	12.7 <sup>a</sup>	10.6 <sup>ab</sup>	10.1 <sup>ab</sup>
Treatment time, months	-	3.1 (1.0) <sup>de</sup>	3.6 (1.1) <sup>de</sup>	19.5 (15.9) <sup>bc</sup>	19.9 (15.2) <sup>bc</sup>
<i>Baseline comorbidities</i>					
CVD, %	5.5	3.8	3.4 <sup>d</sup>	6.7 <sup>c</sup>	4.2
Hypertension, %	32.7 <sup>c</sup>	35.3 <sup>cd</sup>	38.6 <sup>abd</sup>	34.1 <sup>bc</sup>	35.6
Depression, %	16.5 <sup>bcd</sup>	9.2 <sup>ace</sup>	3.4 <sup>abd</sup>	7.6 <sup>ac</sup>	4.5 <sup>ab</sup>
Type 2 diabetes, %	25.8 <sup>bde</sup>	21.2 <sup>acde</sup>	26.1 <sup>bde</sup>	29.1 <sup>abc</sup>	30.8 <sup>abc</sup>
Fatty liver, %	14.8 <sup>bcd</sup>	24.9 <sup>ade</sup>	25.0 <sup>ad</sup>	20.6 <sup>abc</sup>	22.7 <sup>a</sup>
Cancer, %	4.8 <sup>de</sup>	5.6 <sup>e</sup>	3.4 <sup>d</sup>	1.9 <sup>ac</sup>	2.1 <sup>ab</sup>
<p>WL = weight loss; BMI = Body Mass Index; CVD = Cardiovascular disease; CVD outcomes = heart attack, heart failure, thrombosis, stroke, hyperlipidemia;            Values are in mean (SD) or prevalence (%) where indicated.  <sup>a</sup> significantly different from single visit (P&lt;0.05).  <sup>b</sup> significantly different from &lt;6 months with WL &lt;5% (P&lt;0.05).  <sup>c</sup> significantly different from &lt;6 months with WL ≥5% (P&lt;0.05).  <sup>d</sup> significantly different from ≥ 6 months with WL &lt;5% (P&lt;0.05).  <sup>e</sup> significantly different from ≥ 6 months with WL ≥5% (P&lt;0.05).</p>					

**Table 2: Mutually adjusted relative risk predicting likelihood of early attrition by sex**

Participant Characteristics	Male		Female	
	RRs (95% CI) <sup>1</sup>	P-Value	RRs (95% CI) <sup>1</sup>	P-Value
<i>Age</i>				
Young, 18-49 yrs	REF†	-	REF†	-
Middle, 50-64 yrs	0.92 (0.86-0.99)	0.04	0.91 (0.87-0.94)	<0.0001
Old, 65+ yrs	0.74 (0.66-0.84)	<0.0001	0.87 (0.83-0.93)	<0.0001
Initial BMI, kg/m <sup>2</sup>	1.06 (1.01-1.11)	0.008	1.03 (1.01-1.07)	0.01
<i>Ethnicity</i>				
White	REF†	-	REF†	-
Asian	1.08 (0.88-1.34)	0.41	1.10 (0.95-1.28)	0.16
Black	0.91 (0.74-1.12)	0.40	1.06 (0.94-1.18)	0.32
Other	0.94 (0.84-1.05)	0.29	0.97 (0.92-1.03)	0.45
<i>Education</i>				
≥ Some College or University	REF†	-	REF†	-
≤ High school	1.11 (1.03-1.19)	0.002	1.00 (0.97-1.04)	0.78
<i>Smoking Status</i>				
Non-smokers	REF†	-	REF†	-
Current Smokers	0.96 (0.87-1.06)	0.44	1.06 (1.01-1.11)	0.006
<i>Health Outcomes</i>				
CVD	0.80 (0.56-1.14)	0.23	0.87 (0.71-1.06)	0.17
Hypertension	1.20 (1.10-1.30)	<0.0001	1.16 (1.10-1.22)	<0.0001
Depression	1.04 (0.71-1.50)	0.85	1.09 (1.01-1.19)	0.03
T2D	0.87 (0.74-1.03)	0.11	0.97 (0.91-1.05)	0.59
Fatty Liver	1.06 (0.91-1.23)	0.46	1.14 (1.06-1.22)	0.0002
Cancer	1.20 (0.95-1.51)	0.11	1.27 (1.18-1.35)	<0.001
BMI = body mass index; T2D = type 2 diabetes; CVD = cardiovascular disease †REF indicates referent group. <sup>1</sup> Adjusted for age, BMI, education, ethnicity and smoking status where appropriate				

**Table 3: Mutually adjusted relative risk predicting likelihood of achieving successful weight loss by sex**

Participant Characteristics	Male		Female	
	RRs (95% CI) <sup>1</sup>	P-Value	RRs (95% CI) <sup>1</sup>	P-Value
<i>Age</i>				
Young, 18-49 yrs	REF†	-	REF†	-
Middle, 50-64 yrs	1.40 (1.12-1.77)	0.003	1.42 (1.23-1.64)	<0.0001
Old, 65+ yrs	1.50 (1.14-1.98)	0.004	1.65 (1.39-1.96)	<0.0001
Initial BMI, kg/m <sup>2</sup>	0.93 (0.88-0.98)	0.008	0.95 (0.92-0.99)	0.01
<i>Ethnicity</i>				
White	REF†	-	REF†	-
Asian	0.74 (0.40-1.38)	0.35	0.74 (0.46-1.19)	0.22
Black	1.03 (0.57-1.88)	0.91	0.58 (0.37-0.94)	0.03
Other	0.78 (0.53-1.13)	0.18	0.74 (0.57-0.94)	0.02
<i>Education</i>				
≥ College	REF†	-	REF†	-
≤ High school	0.89 (0.74-1.06)	0.21	1.05 (0.94-1.18)	0.36
<i>Smoking Status</i>				
Non-smokers	REF†	-	REF†	-
Smokers	0.89 (0.67-1.18)	0.42	0.82 (0.67-1.00)	0.05
<i>Health Outcomes</i>				
CVD	0.65 (0.30-1.45)	0.30	0.64 (0.35-1.14)	0.13
Hypertension	0.57 (0.40-0.81)	0.001	0.97 (0.80-1.18)	0.80
Depression	0.37 (0.06-2.45)	0.30	0.48 (0.27-0.85)	0.01
T2D	1.02 (0.78-1.36)	0.85	0.94 (0.76-1.16)	0.57
Fatty Liver	0.98 (0.62-1.53)	0.92	0.97 (0.72-1.32)	0.86
Cancer	0.72 (0.22-2.36)	0.59	0.49 (0.22-1.09)	0.08
BMI = body mass index; T2D = type 2 diabetes; CVD = cardiovascular disease				
†REF indicates referent group.				
<sup>1</sup> Adjusted for age, BMI, education, ethnicity and smoking status where appropriate				



**Figure 1. Kaplan-meier curve of patient attrition at WMC by: A) Age, B) Ethnicity, C) Smoking Status and D) Education**

† indicates referent group. ‡ significantly different from referent group ( $P < 0.05$ )

## 4.0 GENERAL DISCUSSION

Obesity is a chronic disorder which requires long term weight management (55). However, existing research has demonstrated limited success in weight loss, as it is reported that 85% of patients who lose weight eventually regain the weight (5, 12, 74). Because treatment attendance is related to long-term success (63), understanding why patients discontinue lifestyle weight management treatment prematurely is important as it may allow for the identification of targets for improving treatment adherence. Having individuals attend lifestyle weight management treatment longer will likely improve their ability to develop the skills necessary required for long-term weight maintenance. Although many studies have tried to examine reasons for treatment discontinuation, a reliable set of predictors has not yet been established (39, 40, 55).

### *Behavior modification*

Weight loss is a complicated process as it also involves behavior change in addition to changes in diet and physical activity (5). It has been suggested that those who are able to maintain their weight loss for more than a year have developed the skills and behaviors necessary for continued weight maintenance (14). However, individuals in weight management may have varying readiness to change their behavior, which may have an impact on weight loss (75). Weight loss success has previously been related with greater behavior change as those who had made five or more behavioral improvements had greater weight loss success compared to those with fewer changes (21). Accordingly, the transtheoretical model (TTM) can be used to explain the five

sequential stages (pre-contemplation, contemplation, preparation, action and maintenance) of behavior change that individuals' progress through when modifying or trying to engage in a new behavior (76). As behavior change is highly self-driven and voluntary, individuals who are successful in weight loss may be further in their stage of change (action or maintenance) compared to those who are not successful. In addition, those who lose weight may be more motivated or have greater sense of control required to combat weight regain. Thus, TTM is a useful theoretical model that can be used in combination with diet and physical activity as it may aid in the improvement the behaviors necessary for weight loss success.

#### *Built Environment*

Weight management programs are important in providing patients with the resources and support they need for weight loss success (38, 77). Even though lifestyle weight management programs offer ample support during treatment, long-term weight loss still continues to be a challenge after program cessation (5, 12). This can be attributed at least in part to our built and social environment, as it favors excessive food intake and discourages physical activity which may be a large contributor to obesity and obesity-related chronic diseases (78). This obesogenic environment has large quantities of readily available calorically dense food, served in ever increasing portion sizes (79). For example, fast food restaurants often offer 'super sizing' of menu items and larger portion alternatives for a greater monetary value, which promotes higher calorie intake and increases risk for obesity (80).

Obesity is related to lower SES as those with lower income and education have shown to have higher rates of obesity (81). Although dietary intake is considered to be an individual choice, the lack of access to healthy foods in low-income neighborhoods may influence food choices. Low-income neighborhoods often lack supermarkets and have an abundance of fast-food restaurants (82), which is likely associated with a lower quality of food intake (81, 82). Similarly, greater distance to a supermarket was also associated with lower quality of food intake in low-income women (83). In addition, healthier food options are often more expensive and thus less readily available to low income populations (84). Thus, although, dietary intake is considered to be an individual choice, the environment and SES likely play a large role in influencing the ability to incorporate healthy foods into one's diet.

Low levels of physical activity are also often related to greater risk for obesity (2, 5). Currently, driving is used as the primary means of transportation for work, school, shopping and leisurely activities in North American countries (85). This high dependence on motorized vehicles for transportation has decreased energy expenditure, further contributing to physical inactivity and the obesity epidemic (85). Research has demonstrated that ownership of a vehicle was associated with both increased risk of weight gain and greater likelihood of developing obesity in China and the US (85, 86). Lastly, modern conveniences such as self-propelled lawn movers, remote controls and computers now provide opportunities to further reduce daily energy expenditure (78). Thus, our current environment tends to favor physical inactivity, as the reliance on

technology and transportation has reduced energy expenditure, likely contributing to the obesity epidemic.

In conclusion, since obesity is a chronic problem, it will likely require a multifaceted life-long solution. Lifestyle interventions using a combination of diet and physical activity are used as a primary means of obesity treatment. However, current lifestyle interventions have limited success caused by poor program adherence and low long-term weight loss success. In addition, our current built environment favors excessive food intake and discourages physical activity, which makes weight management more difficult. As longer treatment duration is associated with greater WL, using a range of strategies to minimize attrition in those at risk may improve WL success. Therefore, it is important that individuals continue to attend treatment in order to receive the support the need to benefit from treatment and successfully manage their weight.

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# APPENDICES

## APPENDIX A: Ethics Approval



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<b>Certificate #:</b>	<b>2014 - 380</b>
<b>Approval Period:</b>	<b>12/18/14-12/18/15</b>

### Memo

To: Professor Jennifer Kuk, Kinesiology and Health Science, Faculty of Health,  
[jennkuk@yorku.ca](mailto:jennkuk@yorku.ca)

From: Alison M. Collins-Mrakas, Sr. Manager and Policy Advisor, Research Ethics  
*(on behalf of Denise Henriques, Chair, Human Participants Review Committee)*

Date: **Thursday, December 18, 2014**

Re: Ethics Approval

Common factors associated with patient attrition and weight loss: A follow up study of patients of weight management clinic

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I am writing to inform you that the Human Participants Review Sub-Committee has reviewed and approved the above project.

Should you have any questions, please feel free to contact me at: 416-736-5914 or via email at: [acollins@yorku.ca](mailto:acollins@yorku.ca).

Yours sincerely,

Alison M. Collins-Mrakas M.Sc., LLM  
Sr. Manager and Policy Advisor,  
Office of Research Ethics