

Self-efficacy of monitoring eating choices associated with fruit and vegetable
intake, BMI and autonomy in the MOVE'M study

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Abstract

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Epidemiology

Fruit and vegetable (FV) intake is inadequate in the US. Improving FV intake is associated with a reduced risk of chronic diseases and a lower BMI. Autonomy for food-related tasks and self-efficacy of monitoring dietary intake are factors that can potentially influence FV intake. In this study baseline data collected from the Move and Moderate in Balance (MOVE'M) study conducted Seattle worksites was used to evaluate the relationships between these variables (n=746). A single question with pictures of portion size examples was used to evaluate FV intake per day and BMI was measured. A mixed model regression analysis in STATA 11.1 was used to determine significant associations that included the random effects at the worksite level.

Autonomy of food-related tasks was not significantly associated with FV intake or BMI, although, there was a positive trend between autonomy score and FV servings. Fruit and vegetable servings were not significantly associated with BMI, but there was an inverse trend. In this data set 29.1% of subjects were in the normal BMI category, 29.9% were overweight and 41.1% were obese. Only 12.5% of subjects consumed more than 5 FV servings per day. Self-efficacy related to regularly monitoring eating choices was significantly associated with autonomy score ($p = 0.007$) FV intake ($p < 0.001$) and BMI ($p = 0.02$). A 4 point increase in autonomy score is significantly associated with a 0.2 point improvement in the self-efficacy score. Every 1 point improvement in the self-efficacy score is significantly associated with a $\frac{1}{4}$ increase in FV servings per day and a 1.02 unit drop in BMI. In conclusion, greater self-efficacy related to monitoring eating choices is significantly associated with greater autonomy in food-related tasks, higher FV intake and lower BMI. Enhancing self-efficacy related to monitoring eating choices may be an important goal for future public health interventions aimed at improving diet quality and BMI.

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Section One: Background and Rationale

Fruit and Vegetable Intake

The United States Department of Agriculture (USDA) recently released the newest version of the Dietary Guidelines for Americans in 2010 and a new nutrition guide, MyPlate, in 2011 that displays healthy eating recommendations. The MyPlate icon depicts what a healthy plate should include at each meal, and half of the plate is filled with fruits and vegetables (MyPlate, 2012).

The 2010 Dietary Guidelines for Americans includes a specific section on the foods and nutrients that should be consumed by Americans, and the recommendations at the top of the list include increasing fruit and vegetable intake and widening the variety of vegetables consumed (Dietary Guidelines, 2010). These recommendations are developed to encourage consumption of adequate amounts of nutrients to promote the overall health of the population.

Fruit and vegetable intake has been monitored for decades and the majority of the US population has never met the recommended levels (Casagrande, Wang, Anderson, & Gary, 2007). The Dietary Guidelines for Americans recommends at least five servings of fruits and vegetables a day for adults. Each serving, with exceptions for salad and dried fruit, is equivalent to a half cup of fruits or vegetables, and the five servings a day is the average number of servings needed to meet minimum nutritional needs (Dietary Guidelines, 2010). In a study examining data collected from the National Health and Nutrition Examination Survey (NHANES) administered by the US Centers for Disease Control and Prevention (CDC) from 1988-1994 and 1992-2000 the percent of Americans who consumed two or more servings of fruit and three or more servings of vegetables a day remained steady at 11% (Casagrande et al., 2007). There was no increase in the percent of the population that had adequate fruit and vegetable intake despite a huge public

health initiative program to encourage increased intake that began in 1991 known as the 5 a Day for Better Health program (Guenther, Dodd, Reedy, & Krebs-Smith, 2006).

Various studies measuring fruit and vegetable intake have determined that over the past decade intake has remained inadequate. In a study examining BRFSS data collected between 1994 and 2005 the conclusion was reached that the proportion of men and women consuming five or more servings of fruit and vegetables a day remained largely unchanged over time with 20.6% of men meeting the recommendation in 1994 and 20.3% meeting it in 2005 (Blanck, Gillespie, Kimmons, Seymour, & Serdula, 2008). In 1994 28.4% of women met the recommendation and in 2005 only 29.6% consumed five or more fruit and vegetable servings a day (Blanck et al., 2008). The most recent data collected by the CDC through BRFSS in 2009 on state-specific fruit and vegetable intake found that nationwide only 23.5% of the population consumed five or more servings of fruits and vegetables a day (CDC, 2009). These studies demonstrate that the majority of the American population is not currently meeting the recommendations for fruit and vegetable intake.

Investigating fruit and vegetable intake in relation to obesity and chronic disease within the literature provides a definitive picture of why further investigations of these associations are necessary. It also provides impetus to continue to examine what factors influence fruit and vegetable intake in order to determine the most effective methods for increasing the amount of servings consumed per day. A thorough literature search examining fruit and vegetable intake and obesity was conducted through PubMed. The keywords fruit and vegetable intake and obesity or BMI were used to find articles. Articles involving children under the age of 18 or an

exclusively elderly population were removed. Studies conducted in underdeveloped countries were also removed. This left a total of 324 studies, study topics were then examined and those that were primarily looking at fruit and vegetable intake in an average population group in relation to obesity or BMI were read closely, this comprised approximately 8 studies. A similar method was used to conduct a review of fruit and vegetable intake in relation to the chronic diseases that are associated with the leading causes of death in the US, cardiovascular disease (52 studies initially) and cancer (989 studies initially). Information from leading non-profit and government agencies were also used in the review of the relationship between chronic disease and fruit and vegetable intake. In the end, 9 studies looking at cardiovascular disease and fruit and vegetable intake and 12 studies looking at cancer and fruit and vegetable intake were closely examined for this background discussion.

Fruit and Vegetable Intake and Obesity

The obesity epidemic in the US has taken center stage in national health improvement programs after the significant increase in obesity observed within the population that began in the 1980's (Flegal, Carroll, Kit, & Ogden, 2012). Obesity is defined as having a body mass index (BMI) greater than 30.0, which is calculated by dividing body weight in kilograms over height in meters squared. The newest NHANES data from 2009-2010 shows a leveling off of the obesity trend in the population, with the current values not significantly different from those collected in the last six years (Flegal et al., 2012). According to the 2009-2010 NHANES data 31.3% of the adult population (≥ 20 years) is of normal weight (BMI < 25.0), 33.0% are overweight (BMI 25.0-30.0), 35.7% are obese and the average BMI for both men and women is 28.7 (Flegal et al., 2012). Obesity trend data collected by the CDC through BRFSS found similar results in 2009

with 35.9% of the population falling in the normal BMI range, 36.2% were overweight and 27.2% were classified as obese (CDC, 2009). These numbers demonstrate the state of the epidemic in the US with the majority of adults falling in the overweight and obese categories.

A relationship between fruit and vegetable intake and weight management has been documented in the literature (Ledoux, Hingle, & Baranowski, 2011; Rolls et al., 2004; Tohill, Seymour, Serdula, Kettel-Khan, & Rolls, 2004). The potential mechanism behind the inverse relationship seen in the majority of the literature between fruit and vegetable intake and reduced body weight could be related to the higher water and fiber content of these foods, which may increase satiety (Ledoux, Hingle, & Baranowski, 2011). Another potential mechanism is that the displacement of energy-dense foods with low-energy dense fruits and vegetables leads to an overall reduction in daily energy intake (Ledoux et al., 2011). In one review article longitudinal studies demonstrated that fruit and vegetable consumption by overweight adults is associated with slower weight gain (Ledoux et al., 2011). In another review, no strong significant association between fruit and vegetable intake and body weight was evident. It should be noted that sixteen of the studies included in this review were of a cross-sectional design with one prospective study, and the overall trend did indicate an inverse relationship between the two variables (Tohill, Seymour, Serdula, Kettel-Khan, & Rolls, 2004). In a review of intervention studies primarily examining this relationship significant weight management and weight loss results were reported in conjunction with increased fruit and vegetable intake (Rolls, Ello-Martin, & Tohill, 2004). This study also found that fruit and vegetables can increase satiety and reduce hunger, while intake of vegetables in meals and mixed dishes naturally reduced overall energy intake (Rolls et al., 2004). Although the studies discussed above support the inverse trend between these two variables,

there are also studies that have not found a relationship, and very few studies examined fruit and vegetable intake and BMI as their primary study objective (Tohill et al., 2004). In one cross-sectional study a non-significant inverse trend between fruit and vegetable intake was evident, but this trend was inconsistent among men and women (Tohill et al., 2004).

Although the literature does not yet provide a clear picture of the relationship and exact mechanisms between fruit and vegetable intake and body weight, it does suggest a trend that supports the concept of increasing fruit and vegetable intake to maintain or achieve a healthy weight.

Fruit and Vegetable Intake and Chronic Disease

The leading causes of death in the US are heart disease, cancer, stroke and diabetes mellitus (Murphy, Xu & Kochanek, 2012). Fruit and vegetable intake may have an important protective effect on these chronic diseases that occupy the top spots for causes of death in this country. In a prospective study that followed two large groups of women and men for a period of approximately fourteen years fruit and vegetable intake was found to be protective against cardiovascular disease (Hung et al., 2004). A study examining coronary heart disease (CHD) found that for every increase in one serving a day of fruits and vegetables there was a four percent decrease in the risk of developing CHD, and green leafy vegetables and Vitamin-C rich fruits and vegetables conferred the greatest protective effect (Joshi et al., 2001). In a meta-analysis investigating the relationship between fruit and vegetable intake and CHD an increase in fruit and vegetable intake from less than three servings a day to more than five was related to a seventeen percent decrease in developing CHD, whereas an increase from less than three

servings a day to three to five servings a day was related to a small, barely significant protective effect; thus supporting the recommendation of five or more fruit and vegetable servings a day (F J He, Nowson, Lucas, & MacGregor, 2007). In a follow-up study on fruit and vegetable intake and cardiovascular disease (CVD) in NHANES participants there was a strong inverse relationship between fruit and vegetable intake and CVD, as well as all-cause mortality (Bazzano et al., 2002). In a meta-analysis of independent cohort studies five or more servings of fruit and vegetables a day significantly reduced the risk of developing both ischemic and hemorrhagic stroke (Feng J He, Nowson, & MacGregor, 2006). There is a wealth of evidence supporting the protective effect of fruit and vegetable intake against heart disease, the number one leading cause of death in the US.

A reduced risk of the development of the second leading cause of death in the US, namely cancer, has been associated with high fruit and vegetable intake (Steinmetz & Potter, 1996). In 1997 the World Cancer Research Fund and the American Institute for Cancer Research released a statement supporting the promotion of high fruit and vegetable intake for cancer prevention due to the supportive evidence of such a claim in the literature (WCRF, 1997). In a meta-analysis of case control studies a significant reduction in the development of esophageal, lung, stomach and colorectum cancers was associated with fruit and vegetable intake, while fruit intake was significantly associated with reduced lung and bladder cancer (Dagfinn Aune et al., 2011; Riboli & Norat, 2003). A review of 206 epidemiological human studies and twenty-two animal studies reported that fruit and vegetable intake was protective of several different cancer types, and the cohort and case-control studies demonstrated that high fruit and vegetable intake of five or more servings a day, as compared to low fruit and vegetable intake, resulted in a halving of the risk of

developing these cancers (Steinmetz & Potter, 1996). Although the studies described above have found a significant protective effect of fruit and vegetable intake for some specific cancers, this is not the case in several other cancer types. For example, in the relationship of fruit and breast cancer or vegetables and bladder cancer a protective effect has not been found (D Aune et al., 2012; Riboli & Norat, 2003). At the same time, prospective studies have shown inconsistent results or a weak association between these variables (Riboli & Norat, 2003). In its review of all of the available evidence the U.S. Preventive Task Force concluded that there was insufficient evidence for a fruit and vegetable recommendation for the prevention of cancer. Therefore, although the relationship between fruit and vegetable intake and overall cancer development is not yet fully elucidated, there is evidence to support that increasing fruit and vegetable intake may reduce the risk of developing certain cancers. This could have a significant impact on the cancer rates in the US as the majority of the population has very low fruit and vegetable intake.

Autonomy

Autonomy is a general term that denotes an individual's ability to function independently or to be independently responsible for a specified task or duty. In the context of this paper autonomy refers to an individual's degree of independence and responsibility for food-related tasks in their daily life, such as food preparation, grocery shopping and meal planning.

Gender Roles

Autonomy, in the sense of food preparation and planning, has largely been the domain of women in American culture. In the 2010 American Time Use Survey, for both men and women, food and drink preparation was the most often reported moderate activity level task during a 24 hour

period (Tudor-Locke, Johnson, & Katzmarzyk, 2010). Men reported that food-related tasks accounted for 12.8% of their moderate level activity while women reported that it comprised 37.4% of this activity type (Tudor-Locke et al., 2010). A study examining food-related time use trends, again using the American Time Use Survey, between the years of 1975 and 2006 found that over this 30 year period the time women spent on food-related activities has declined significantly by 40 minutes a day (Zick & Stevens, 2010). In 1975 women spent approximately 92 minutes a day on food-related activities and in 2006 they spent only 51 minutes a day, during this 30 year period there was no significant change in the time men spent on these activities (Zick & Stevens, 2010). This decrease in time spent on food-related activities corresponds with the rise of processed convenient foods and time spent eating meals away from the home. Throughout American history women have been viewed as the main food preparers, while men have typically avoided the task, despite the increase of women in employment settings this division of responsibilities still remains (Sellaeg & Chapman, 2008). Studies have also examined the relationship between men and women and knowledge on healthy food, men view women as the experts of the food domain when it comes to food preparation, meal planning and consumption of food for health (Gough, 2007). Research and cultural norms in the US clearly delineate the expected tasks of each gender in food-related activities, bestowing on women the majority of the autonomy in the household when it comes to food preparation, meal planning and grocery shopping.

Relation to Diet Quality

There are few studies currently available that examine the relationship between food-related autonomy and other health indicators. A systematic review of the literature was conducted using

key terms such as food responsibility, food related autonomy, autonomy of food tasks, meal planning, meal preparation and food shopping. Out of the 73 articles found using these key terms only 27 related to healthy eating choices and diet quality. Fourteen of these studies were examined in detail to provide the basis for the background below. A substantial proportion of the literature that examines autonomy is assessing the adolescent and young adult population because they are in the early stages of determining their autonomy status and the food-related tasks for which they will be responsible. A cross-sectional study of adolescents looking at the relationship between diet quality and participation in food preparation found that being female, having a lower socioeconomic status and regularly consuming family meals was significantly associated with greater involvement in meal preparation (Larson, Story, Eisenberg, & Neumark-Sztainer, 2006). This particular study also found that the adolescents who spent more time helping prepare food had diets that were significantly lower in fat and higher in fruit and vegetable intake, fiber, folate and vitamin A (Larson, Story, et al., 2006). On a college campus a study reported that young adults who frequently completed food preparation activities consumed less fast food and were more likely to meet healthy dietary guidelines for calories and fruit and vegetable intake (Larson, Perry, Story, & Neumark-Sztainer, 2006). College students were less likely to participate in food preparation activities if they were male, African American, or living in campus housing facilities (Larson, Perry, et al., 2006). Of the college students who were categorized as participating in a high frequency of food preparation activities, such as grocery shopping, making a grocery list and preparing meals, 31% consumed five or more servings of fruit and vegetables a day as compared to 3% of those who were in the low food preparation categories (Larson, Perry, et al., 2006). In the setting of a primary care clinic an intervention was conducted using self-help materials to encourage increased autonomy for food shopping, meal

planning and meal preparation, autonomy in these tasks was significantly associated with a reduction in the percentage of energy from fat in the diet twelve months after the intervention (S. A. Beresford et al., 1997). In a study examining the psychosocial predictors of fruit and vegetable intake there was a positive association between autonomous motivation and fruit and vegetable servings, leading the author to encourage further consideration of autonomy as a predictor of diet quality (Shaikh, Yaroch, Nebeling, Yeh, & Resnicow, 2008).

The association between meal preparation and improved diet quality has been discussed in the literature and is supported by the studies outlined above that examine autonomy of food-related responsibilities. Trends in the US suggest that over the past twenty years the population has increased the number of meals and snacks consumed outside the home (Guthrie, Lin, & Frazao, 2002; Kant & Graubard, 2004). The amount of calories in the diet from outside foods was 18% in 1977-78, and this proportion rose to 32% by 1994-96, with the majority of those away food calories coming from fast food establishments (Guthrie et al., 2002). In this particular study the upward trend of outside food consumption was not the only parameter investigated, the nutritional quality of outside food was also compared to home prepared meals. Outside meals and snacks tended to be higher in calories, total fat, saturated fat, sodium and cholesterol, and lower in fiber, calcium and iron (Guthrie et al., 2002). The clear delineation of diet quality in a comparison of home prepared meals to outside meals suggests that encouraging individuals to prepare meals at home may result in improved health outcomes in the population. One of these potential health outcomes would be an improvement in body weight and BMI. A study examining the impact of foods consumed away from the home on BMI found a positive association (Bezerra, Curioni, & Sichieri, 2012). A significant positive association was also

found in a study looking at the relationship between restaurant food intake and body fatness (McCrorry et al., 1999). These few studies examining autonomy and fruit and vegetable intake, diet quality or BMI, demonstrate that there is a potentially positive trend between food-related autonomy and these variables.

Self-efficacy

Self-efficacy is one of the most important indicators of behavior change, it describes whether or not an individual believes they will be able to accomplish adopting a new behavior or complete a task (Bandura, 1977). Perceived self-efficacy can be improved or strengthened with hands-on experience related to the behavior change or task (Larson, Story, et al., 2006). The level of self-efficacy an individual possesses describes how long they will continue to implement a behavior change or complete tasks when they are presented with obstacles (Bandura, 1977). Therefore, self-efficacy can be an important indicator of whether or not a behavior change will be implemented and continued over time, making it a useful measurement in studies examining behaviors. Self-efficacy has been studied in the literature in relation to numerous different behaviors and is now recognized as a significant predictor of behavior change.

Relation to Health Indicators

Self-efficacy is a well-known indicator of behavior change in psychology; however it has not been routinely applied to public health nutrition behaviors in the literature. In a systematic literature review using key words such as self-efficacy and monitoring eating choices 62 studies were found and nine were examined closely for the background section below. The studies that have recently investigated the relationship of self-efficacy and healthy nutrition related behaviors

have found that it is a significant mediator. In a review examining the psychosocial factors that influence fruit and vegetable intake, self-efficacy was the strongest mediator with a significant positive association found in 7 of 9 cross-sectional studies (Shaikh et al., 2008). In a study looking at the role of self-efficacy and planning on several different health related behaviors, including dietary behaviors, both self-efficacy and planning were significant mediators of adopting the healthy dietary behavior of consuming five or more fruits and vegetables a day (Schwarzer et al., 2007). In the development of a tool to assess indicators of fruit and vegetable intake there was a positive correlation between fruit and vegetable intake and self-efficacy (Townsend & Kaiser, 2005). A study investigating what mediators contributed to an increase in fruit and vegetable intake in the national 5 a day interventions found that self-efficacy and knowledge were significant mediators of the increased fruit and vegetable intake (Campbell et al., 2008). These studies demonstrate that there is a strong positive association between fruit and vegetable intake and self-efficacy.

Self-efficacy has also been studied in relation to weight loss and weight maintenance, in an intervention study for obese subjects the aim was to improve self-efficacy and self-regulation of healthy behaviors, such as increasing fruit and vegetable intake and cardiovascular exercise (Annesi, 2011). Improved self-efficacy significantly predicted increased fruit and vegetable intake and exercise, and increases in these variables were significantly associated with weight loss after 26 weeks (Annesi, 2011). In a study of middle-aged women in New Zealand those who knew that eating healthy was important and part of their core belief system had significantly lower BMI than those who had no motivation or desire to act on healthy behaviors (Leong, Madden, Gray, & Horwath, 2012). These examples establish that improving self-efficacy can

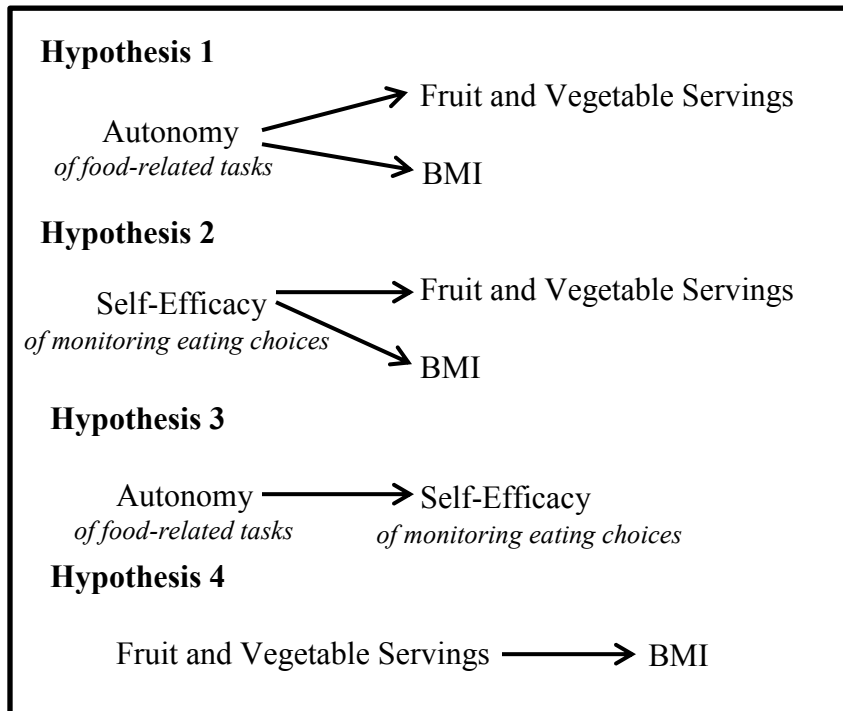
advance the adoption of healthy behaviors and ultimately lead to improved health in individuals and in the country by combatting the obesity and chronic disease epidemics.

The purpose of this study is to provide information regarding the potential relationships between food-related autonomy, self-efficacy for monitoring eating choices, fruit and vegetable intake, and BMI. Although there are few studies examining autonomy or self-efficacy and fruit and vegetable intake, diet quality or BMI, there is a potentially important association between these variables. This information can be used to inform future studies and public health research to determine whether autonomy and/or self-efficacy should be a target for interventions aimed at increasing fruit and vegetable intake and improving diet quality and health.

Section Two: Study Aims

Figure 1 below depicts the hypotheses that were investigated to provide information regarding the potential relationships between food-related autonomy, self-efficacy for monitoring eating choices, fruit and vegetable intake, and BMI.

Figure 1. Hypotheses Diagram of the MOVE'M Study



Autonomy: Fruit and Vegetable intake and BMI

Hypothesis 1 examined the relationships between food-related autonomy and fruit and vegetable intake and BMI. Based on the available information from the literature summarized above it is hypothesized that the subjects who shop for their food and plan and prepare meals consume significantly more servings of fruit and vegetables per day and have a lower BMI than those who are not highly autonomous in food-related tasks.

Self-Efficacy: Fruit and Vegetable Intake and BMI

Hypothesis 2 investigates the relationships between self-efficacy and fruit and vegetable intake and BMI, independent of autonomy. It is hypothesized that the subjects who reported a high level of self-efficacy, related to regularly monitoring eating choices, also consume significantly more servings of fruit and vegetables a day and have a lower BMI.

Autonomy and Self-Efficacy

Hypothesis 3 determines if there is a significant relationship between autonomy and self-efficacy related to monitoring eating choices on a regular basis. It is hypothesized that the subjects who have a high autonomy score and are responsible for the food-related tasks of the household will also have significantly higher self-efficacy related to regularly monitoring eating choices.

Fruit and Vegetable Intake and BMI

Hypothesis 4 examines the potential relationship between fruit and vegetable intake and BMI, independent of both autonomy and self-efficacy. It is hypothesized that there is a significant inverse relationship between fruit and vegetable intake and BMI.

Section Three: Methods

The data used in this study was collected from the baseline questionnaire of the Move and Moderate in Balance (MOVE'M) study. This study was a project to promote worksite health supported by the Fred Hutchinson Cancer Research Center in Seattle, Washington. A total of 31 small (15-75 employees) worksites in the greater Seattle area were recruited in a manner similar to what has been described in previous studies (S. A. A. Beresford et al., 2007). These worksites were recruited from within six King county zip code locations (98057, 98018, 98118, 98144, 98148, and 98168) that represent underserved areas of the community. The companies were recruited from a purchased list of specific standard industrial categories (SIC) to enhance blue-collar worksite representation. Successfully recruited companies included manufacturing (20%), personal services (19.35%), social services (19.35%), wholesale trade (13.33%), retail trade (9.68%), real estate (6.45%), engineering and related services (6.45%), business and financial services (3.23%) and construction (3.23%). These companies were small, family owned businesses, subsidiaries or distributors of larger countrywide businesses, locally grown community based organizations and national service agencies, they included worksites with a high sedentary rate. Their inclusion in the study delivered a total of 920 employees with an 81.6% survey return rate. A copy of the questionnaire is provided in appendix A.

The subjects in this data set are working adults in the greater Seattle area, 752 subjects completed the baseline questionnaire. Subjects who failed to answer all three of the questions pertaining to autonomy, self-efficacy and fruit and vegetable intake were dropped from the data set (n=6). This leaves the total number of subjects in this analysis at 746 subjects in 31 worksites.

The four measures investigated in this study are autonomy, fruit and vegetable intake, self-efficacy and BMI.

Autonomy

Autonomy was measured using a three part question where respondents ranked their responsibility by noting little or none, about half, or most or all for three different food-related tasks. The three food-related tasks are food shopping, planning meals and preparing meals. A score of zero is assigned to any little or none responses, a score of one is assigned to the about half responses and a score of two is given for each most or all response. The answers to the questions are then added to a total value, which is the subject's autonomy score. Autonomy scores can range from 0 – 6, with six being the highest level of autonomy. When autonomy is made into a binary variable of high and low-medium groups the high autonomy group contains all subjects that received a score of six for the autonomy question and the low-medium autonomy group contains all other subjects. This binary variable is used for demographic and mean comparisons only.

Fruit and Vegetable Intake

Fruit and vegetable intake is assessed with a single question that asks the subject how many servings of vegetables and fruits they eat a day, subjects can then check a box next a range of numbers from one up to eleven (with eleven denoting that it is the answer for eleven servings a day and up). Above this question is information describing servings sizes along with pictorial examples of both fruits and vegetables and fruit juice. This question has been found to be correlated (0.62) with the set of seven Food Frequency Questionnaire fruit and vegetable

questions as has been used in the National Cancer Institute 5 a day studies and been shown to be responsive to change (S. A. A. Beresford et al., 2010).

Self-Efficacy

Self-efficacy was measured using a question that provided five possible responses of extremely sure, very sure, somewhat sure, slightly sure and not sure after asking “How sure are you that you can stick to a plan to monitor your eating choices on a regular basis?” The answers were given a score of 1-5 with one corresponding to extremely sure and five corresponding to not sure. When self-efficacy is made into a binary variable of high and low groups the high self-efficacy group contains all subjects who answered either extremely sure or very sure to the question and the low self-efficacy group includes all other subjects. These groups were used for demographic and mean comparisons only.

BMI

BMI was measured in kilograms and centimeters by a study investigator at the Fred Hutchinson Cancer Research Center, there is measured BMI data on 650 of the baseline subjects. In STATA version 11.1 the height in centimeters was converted to meters and squared, BMI was calculated using the standard formula of weight in kilograms divided by height in meters squared. BMI was divided into groups according to the CDC guidelines, a BMI of less than 25 constitutes normal weight, a BMI between 25 and 29.9 denotes a subject that is overweight and subjects with a BMI of 30 and greater are in the obese category.

Data Analysis

Hypotheses 1-4 were tested using the MLE xt-mixed protocol in the statistical software program STATA version 11.1 (Texas Instruments). This mixed model protocol accounts for clustering of employee values within a worksite for the variable of interest and treats worksites as a random sample of a universe of worksites. In order to include categorical variables as potential confounders in the analysis, categories were grouped and the resulting variables were binary. Income and age were treated as continuous variables. Gender is a binary variable. Race and ethnicity were included in a single binary variable where non-Hispanic white subjects were compared to all other races and ethnicities in a variable named 'minority status.' Income, as mentioned before, was a linear variable in this analysis where the mid-point values were used as the linear scale for income. Education level was examined in a binary form where subjects are divided into two groups, those with a high school education or less and those with more than a high school education. Living situation was also included as a binary variable split into two groups, adults only households as compared to households with both adults and children. BMI was transformed to a log variable to be used in the statistical models.

In order to determine how these variables affect the main hypotheses questions a model was created where the initial analysis excludes all confounders. It is then tested with the inclusion of gender, age and minority status to look at these demographic variables within the context of the model. The model is then run with only the socioeconomic variables education and income as potential confounders, and finally with only living situation as a potential confounder. This model allows for the determination of which potential confounders should be included in the final model for each hypothesis. The results are then presented by multiplying the regression

coefficient and the upper and lower limits of the confidence interval by the interquartile range (IQR) of the exposure of interest.

Section Four: Results

Demographic Characteristics

There are 746 subjects from the baseline MOVE'M data set included in this study. The mean age is 41.5 years and there are slightly more female participants (53.8%) (Table 1). The majority of the subjects are white, college educated, and live with other adults in their household (Table 1).

Table 1. Demographic Characteristics in the MOVE'M study

	Total N=746	
	Mean	(SD)
Age (years)	41.5	(12.7)
	N	(%)^a
Gender^b		
Male	344	(46.2)
Female	400	(53.8)
Education		
Less than high school	27	(3.6)
High school graduate or equivalent	134	(18.0)
Some college/associates degree	219	(29.4)
Bachelor's degree	232	(31.1)
Graduate or professional degree	133	(17.9)
Living Situation^b		
Alone	96	(13.6)
With other adult(s) and children	280	(39.6)
With children only	45	(6.4)
With other adult(s) only	286	(40.5)
Income^b		
< \$25,000	46	(6.6)
\$25,000-\$49,999	171	(24.4)
\$50,000-\$74,999	160	(22.8)
\$75,000-\$99,999	118	(16.8)
\$100,000+	147	(21.0)
Prefer not to answer/Don't Know	59	(8.4)
Race		
White	511	(68.6)
Black or African American	71	(9.5)
Asian	75	(10.1)
Hawaiian or Pacific Islander	18	(2.4)
American Indian, Native American or Alaskan native	9	(1.2)
Other Race	60	(8.1)
Prefer not to answer	1	(0.1)
Ethnicity		
Hispanic	68	(9.2)

^a N's may not sum to 746 due to missing data, %'s may not sum to 100% due to rounding

Autonomy: Fruit and Vegetable intake and BMI

When the autonomy variable is divided into a high autonomy group (autonomy score = 6) and a low-medium autonomy group (autonomy score < 6) there are significant differences in gender, living situation and income. The high autonomy group that is responsible for the food-related tasks in the household contains significantly more females (71.6%) and fewer subjects living in households with other adults. In the high autonomy group the majority of subjects' income is less than \$75,000 a year (67.7%) and in the low-medium autonomy group the majority of subjects' income is higher than \$75,000 a year (57.5%). Interestingly, despite the fact there was a significant difference in gender between the high and low-medium autonomy groups, when an analysis was conducted examining the influence of gender individually in each hypothesis no significant results were found.

	Un-adjusted model ^a		Adjusted model ^a	
	Estimated Change	(95% CI)	Estimated Change	(95% CI)
Obesity Related Variables				
Fruit and Vegetable Servings ^b	0.155	(-0.084, 0.394)	0.140	(-0.118, 0.398)
BMI ^c	1.00	(-0.977, 1.03)	1.00	(-0.977, 1.03)

^a Multiplied by autonomy score IQR.

^b Adjusted for gender, income, education and minority status.

^c Adjusted for age and minority status.

The average fruit and vegetable intake in this study was 2.8 servings per day with a 95% confidence interval of (2.7, 2.9). The average number fruit and vegetable servings in both the high and low-medium autonomy groups were also 2.8 servings per day with a 95% confidence interval of (2.6, 3.0). Therefore it is not surprising that a significant relationship was not found between autonomy score and fruit and vegetable servings in the mixed-model regression analysis

(Table 2). The significant confounders of this relationship include gender, minority status, education level and income. Although there was not a significant relationship, there was a trend showing that as the autonomy score increased fruit and vegetable intake also increased (Table 2). This non-significant trend suggested that for every 4 point increase in autonomy there was a corresponding increase of 0.14, or about 1/8 of a fruit and vegetable serving (Table 2). This association was weakened if the subject was female and/or non-Hispanic White and it was strengthened as income and education increased.

BMI was also not significantly associated with autonomy status, and it was significantly confounded by age and minority status (Table 2). As expected, as age increased BMI also increased.

Self-Efficacy: Fruit and Vegetable Intake and BMI

Both men and women had an average self-efficacy score related to monitoring eating choices of 2.6 out of 5, the same score as the overall subject pool. Exactly 50% of the subjects in this study were in the high self-efficacy group (self-efficacy score ≤ 2). There was a significant difference between the two self-efficacy groups in education level and race. In the low self-efficacy group (self-efficacy score > 2) 76.0% of the subjects had a college education, and in the high self-efficacy group 84.5% of the subjects were college educated. The low self-efficacy group also had a greater percentage of subjects self-identified as Asian with 13.2% compared to 5% in the high self-efficacy group. The high self-efficacy group consisted of a greater percentage of subjects self-identified as white (73.7%) and Black or African American (12.0%) as compared to the low self-efficacy group (68.1% and 5.85%, respectfully).

	Un-adjusted model ^a		Adjusted model ^a	
	Estimated Change	(95% CI)	Estimated Change	(95% CI)
Obesity Related Variables				
Fruit and Vegetable Servings ^{b, *}	-0.252	(-0.377, -0.127)	-0.261	(-0.390, -0.133)
BMI ^{c, *}	1.02	(1.00, 1.04)	1.02	(1.00, 1.04)

^a Multiplied by self-efficacy IQR

^b Adjusted for gender, minority status and income

^c Adjusted for age and minority status

* Significant association ($p \leq 0.05$)

The high self-efficacy group consumed an average of 3.1 fruit and vegetable servings per day and the low-medium self-efficacy group consumed an average of 2.5 servings per day. In the mixed-model regression analysis self-efficacy score related to monitoring eating choices is significantly associated with fruit and vegetable servings ($p < 0.001$). For every point that the self-efficacy score improves there is a significant $\frac{1}{4}$ increase in fruit and vegetable servings (Table 3). This relationship is significantly influenced by gender, minority status and income; increased income is associated with an increase in fruit and vegetable intake.

In the high self-efficacy group 31.8% of subjects were in the normal BMI category, 29.8% were overweight and 38.4% were obese. In the low self-efficacy group 25.6% of subjects were in the normal BMI category, 27.9% were overweight and 45.6% were obese. In the mixed-model regression analysis self-efficacy score is significantly associated with BMI, as the self-efficacy score related to monitoring eating choices improves by one, BMI significantly decreases by 1.02 kg/m^2 ($p = 0.02$, Table 3). This significant association is influenced by age and minority status (Table 3). The characteristic of increased age is associated with increased BMI.

Autonomy and Self-efficacy

The high autonomy group had slightly better average self-efficacy score, related to monitoring eating choices, of 2.5 and a 95% confidence interval of (2.4, 2.6) compared to the low-medium autonomy group which had a score of 2.6 and a 95% confidence interval of (2.5, 2.7).

Un-adjusted model^{a, *}		Adjusted model^{a, b, *}	
Estimated Change	(95% CI)	Estimated Change	(95% CI)
-0.199	(-0.342, -0.055)	-0.197	(-0.339, -0.056)

^a Multiplied by autonomy IQR

^b Adjusted for age and education

* Significant association ($p \leq 0.05$)

In the mixed-model regression analysis self-efficacy score related to monitoring eating choices is significantly associated with autonomy score; for every 4 point increase in the autonomy score the self-efficacy score improved by 0.2 points ($p = 0.007$, Table 4). This significant association was influenced by age and education level (Table 4). A college education appears to be associated with a higher level of self-efficacy in this analysis.

Fruit and Vegetable Intake and BMI

Only 12.5% of the subjects in this study consumed five or more servings of fruit and vegetables per day with an average intake of 2.8 servings per day. Men consumed an average of 2.6 servings a day and women consumed an average of 3.0 servings per day. The majority of the subjects in this study did not meet the minimum fruit and vegetable intake recommendation. In this study 29.1% of the subjects had a normal BMI, 29.9% were overweight and 41.1% were obese.

Table 5. Change in BMI by fruit and vegetable servings in the MOVE'M study			
Un-adjusted model ^a		Adjusted model ^{a, b}	
Estimated Change	(95% CI)	Estimated Change	(95% CI)
-0.992	(-0.972, 1.01)	-0.988	(-0.968, 1.01)

^a Multiplied by fruit and vegetable servings IQR

^b Adjusted for age and minority status

In the mixed-model regression analysis fruit and vegetable servings were not significantly associated with BMI, although, the trend suggests that as fruit and vegetable servings increase BMI decreases (Table 5). The confounders of this relationship are age and minority status.

Section Five: Discussion

Fruit and vegetable intake has been associated with a reduced risk of the leading causes of death in the US and a decreased BMI (Hung et al., 2004; Ledoux et al., 2011; Murphy et al., 2012). In the face of the obesity epidemic, and the rise of preventable chronic diseases, encouraging the public to eat healthy and increase their intake of fruit and vegetables is of paramount importance. The goal of this study was to examine factors that may influence fruit and vegetable intake and BMI in order to inform future research and public health interventions, because a small change made by individuals can have a huge impact at the population level.

Fruit and vegetable intake in the US has not reached the minimum recommended level, and in Washington State only 25.1% of residents consumed five or more servings of fruit and vegetables a day in 2009, which is higher than the 12.5% of subjects in this study (Casagrande et al., 2007, CDC 2009). The average number of servings of fruit and vegetables in this study of 2.8 per day is similar to the average intake found in similar studies in the literature. In Seattle worksites that participated in the 5 a day intervention campaign, baseline intake of fruit and vegetables was a little above two servings a day (S. A. A. Beresford et al., 2010). In a study examining the baseline fruit and vegetable intake of fifteen different centers in the 5 a day intervention program the authors found an average intake of 3.6 servings per day using the seven question food frequency questionnaire, which has been known to provide a higher average servings number (Thompson et al., 1999). The baseline mean fruit and vegetable intake in the Treatwell-5-a-day study ranged from 2.84-2.95 servings per day (Sorensen et al., 1999). These numbers reflect the low fruit and vegetable intake that is prevalent throughout the country despite national campaigns to increase consumption. Also in accordance with the current

literature, the women in this study had a higher average fruit and vegetable intake at 3.0 servings a day, compared to the men's intake of 2.6 servings a day (Thompson et al., 1999).

Autonomy status of food-related tasks and fruit and vegetable intake has not been extensively studied in the literature, however the current overall trend suggests that higher autonomy may be positively related to some aspects of diet quality (S. A. Beresford et al., 1997; Larson, Perry, et al., 2006; Shaikh et al., 2008). The high autonomy group in this study contains more women than men (71.6%); which was expected due to the gender roles associated with food responsibility. Remarkably, even though women tend to consume more servings of fruit and vegetables on average, the high autonomy group has the same average fruit and vegetable intake as the low-medium autonomy group. Interestingly, the majority of the subjects in the high autonomy group have a household income below \$75,000 per year, whereas the majority of the low-medium autonomy group has a household income above \$75,000 per year. The higher earning low-medium autonomy group may inherently have less autonomy for food-related tasks such as meal planning and meal preparation if they consume the majority of their meals outside the home, a trend that is increasing in frequency in the US (Guthrie et al., 2002). Earning a greater income may allow the low-medium autonomy group a greater ability to afford more restaurant meals as compared to the high autonomy group.

There was no difference in the average fruit and vegetable servings between the autonomy groups in this study. Other studies in the literature have found a positive trend between autonomy and fruit and vegetable intake. In a study looking at baseline characteristics of several 5 a day study centers there was a strong positive trend between food shopping responsibility and fruit

and vegetable intake (Thompson et al., 1999). When investigating the potential psychosocial mediators that led to the increase in fruit and vegetable intake observed in the 5 a day studies some of the study centers had a positive association between autonomy and fruit and vegetable intake, although overall autonomy was not considered to be a significant mediator (Campbell et al., 2008). In the analysis in our cross-sectional study, although there was no significant relationship, the trend suggests that higher autonomy is associated with higher fruit and vegetable intake. For every 4 point increase in the autonomy score there was an associated 1/8 increase in fruit and vegetable servings. This positive trend is in accordance to the findings in the literature.

Although autonomy has not yet been found to significantly influence fruit and vegetable intake, self-efficacy has been regularly observed as a significant mediator of fruit and vegetable intake (Campbell et al., 2008; Shaikh et al., 2008). In this analysis we found that higher self-efficacy related to monitoring eating choices was significantly associated with higher fruit and vegetable intake ($p < 0.001$). For every one point improvement in self-efficacy score there was a significantly associated $\frac{1}{4}$ increase in fruit and vegetable servings. This relationship between fruit and vegetable intake and self-efficacy is expected as self-efficacy is one of the strongest predictors of dietary behaviors, and in this case we asked about regularly monitoring eating choices. Those who answered this question with a high self-efficacy score may already be monitoring their eating choices and consuming more fruit and vegetables. This relationship was influenced by gender, minority status and income. A higher income level was associated with greater fruit and vegetable intake, this is expected as low income subjects may consume fruit and vegetables less often due to high fruit and vegetable prices (Webber, Sobal, & Dollahite, 2010).

Although an increase by only $\frac{1}{4}$ of a fruit and vegetable serving seems like quite a small increase, this could potentially have a large impact at the population level.

Self-efficacy of monitoring eating choices was also significantly related to autonomy for household food tasks ($p = 0.007$). Every 4 point increase in the autonomy score was significantly associated with a 0.2 point improvement in the self-efficacy score. It was expected that the subjects who had more control over the food-related tasks in the household would also have higher self-efficacy related to monitoring their eating choices; and this was supported by the analysis. This relationship has not been distinctly examined in the literature and these results add to the knowledge regarding the relationship between these variables. Determining how these variables relate to each other and to health indicators such as fruit and vegetable intake and BMI provide valuable information for future research and public health programs.

With the continuing obesity epidemic it is important to determine what factors influence BMI. In this data set there was a greater percentage of subjects in the obese category as compared to the percentages for Washington State. In 2009 Washington had 37.5% of residents in the normal BMI category, 35.5% were overweight and 26.9% were obese (CDC, 2009). In this study 41.1% of subjects were obese and 29.9% were overweight and only 29.1% were in the normal weight range. The BMI values used for this study were physically measured and the CDC data is self-reported, which may in part account for the large difference as it is well known that individuals tend to underreport their weight. At the same time, BMI can be affected by a number of different factors, including race, ethnicity, age, income level, and type of work. For example, in a study examining data from the 1999-2008 NHANES survey non-Hispanic Black women and men

tended to have a higher prevalence of obesity (Flegal et al., 2012). In this study of NHANES data age was also considered to be a significant confounder, as BMI tends to increase with age (Flegal et al., 2012). Work environment can also influence BMI, those who work in an environment requiring physical labor or encourage physical activity are associated with a lower BMI compared to those who work in a more sedentary environment (Linde et al., 2012). The SIC codes that were used to select worksites in this study have a high propensity for representing sedentary work environments. The worksites selected for the MOVE'M study were specifically examined because of they were in underserved zip codes in the Seattle area. This selection method could partially explain why this data set contains a higher percentage of obese subjects than what is generally found within the state. In a study examining obesity rates by zip code in King County, higher obesity rates were found in the zip codes that were the ones sampled for the MOVE'M study (Drewnowski, Rehm, & Solet, 2007). In the literature there is evidence that BMI is inversely associated with fruit and vegetable intake, this trend was found in our analysis, however it was not significant (Heo et al., 2011). For each 2 serving increase in fruit and vegetables we found a non-significant predicted decrease of 0.992 BMI units. It is possible that in the context of having data that was skewed towards the obese end of the spectrum could have weakened an potential relationship between fruit and vegetable intake and BMI in this study.

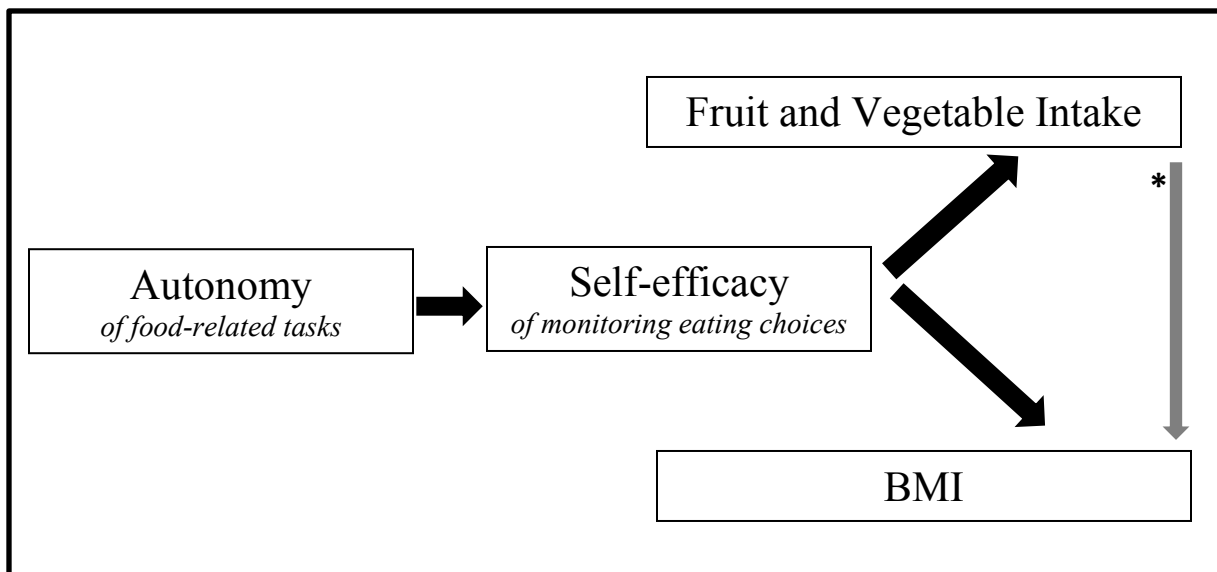
Self-efficacy related to monitoring eating choices was significantly associated with a lower BMI ($p = 0.02$). A one point improvement in the self-efficacy score was associated with a 1.02 unit decrease in BMI. Both age and minority status had a significant influence on this relationship, which is expected as BMI has been shown to be affected by these characteristics (Flegal et al., 2012). In a study that focused on middle-aged women the subjects with intrinsic motivation to

adopt healthy eating patterns were more likely to have a lower BMI, this is a measure similar to self-efficacy related to monitoring eating choices (Leong et al., 2012). In this study they also found that subjects with autonomous regulation of eating and food-related habits had a significantly lower BMI by 2% (Leong et al., 2012). In our analysis we did not find a significant relationship between BMI and food-related autonomy, and interestingly, found that higher autonomy was related to a slight increase in BMI (Table 1). Similarly, in a study looking at adolescents and their food behaviors it was found that those who participated in the grocery shopping actually consumed more fried foods and had a higher fat intake (Larson, Story, et al., 2006). Therefore, it is possible that the temptations at the supermarket could possibly contribute to a positive trend between autonomy for food shopping and BMI.

The limitations of this study include the nature of the questionnaire; all of our measures, except for BMI are self-reported. Self-reported fruit and vegetable intake can be unreliable, although in our questionnaire there were pictures of actual portion sizes to help subjects make a reliable estimate of intake. The wording of the self-efficacy question may have been confusing to subjects as it asked about sticking to a plan to monitor eating choices, however no description of a specific plan was provided. Another limitation is that our data set is not easily generalizable to the US population; in using worksite data from the Seattle area the data set included a majority of subjects that are non-Hispanic White, college educated and working in middle class jobs. Though this study has limitations, the overall findings are beneficial to the research community and to inform future public health interventions.

Although food-related autonomy was not significantly related to the fruit and vegetable intake and BMI in this study, it was significantly related to self-efficacy of monitoring eating choices. This finding provides new insight into the association between these two variables and demonstrates that they may work together to influence changes in health related behaviors. The conceptual diagram below demonstrates how these variables may work together based on the findings in this study and the current status of the literature regarding these variables.

Figure 2. Conceptual diagram of Behavioral Processes Supported by the MOVE’M study.



* No relationship was found in this study; however a relationship is evident in the literature.

Clearly, increasing fruit and vegetable intake can have a positive effect on the health of the nation. Promoting intervention strategies that encourage and support increasing fruit and vegetable intake could potentially have an enormous impact on reducing obesity levels and the development of several chronic diseases. The literature does strongly support the significant findings in our analysis regarding the inverse relationship between self-efficacy of monitoring eating choices and BMI and the linear relationship between self-efficacy and fruit and vegetable intake. Self-efficacy is known to be an important influence on adopting new behavior changes.

Perhaps focusing on improving self-efficacy related to regularly monitoring eating habits would be a reasonable and productive goal in future interventions aimed at improving fruit and vegetable intake and BMI. At the same time, promoting autonomy of food-related tasks may help improve self-efficacy for monitoring eating choices and therefore lead to the desired increase in fruit and vegetable intake and reduction of BMI. Clearly, more research in this area would provide guidance in determining how these variables work together in order to inform future interventions and improve the health of the nation.

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