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Lifestyle habits and obesity progression in overweight and obese American young adults: Lessons for promoting cardiometabolic health

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Abstract

Obesity among young adults is a growing problem in the United States and is related to unhealthy lifestyle habits such as high caloric intake and inadequate exercise. Accurate assessment of lifestyle habits across obesity stages is important for informing age-specific intervention strategies to prevent and reduce obesity progression. Using a modified version of the Edmonton Obesity Staging System (mEOSS), a new scale for defining obesity risk and predicting obesity morbidity and mortality, this cross sectional study assessed prevalence of mEOSS in 105 overweight/obese young adults and compared young adults' lifestyle habits across the mEOSS stages. Descriptive statistics, chi-square tests, and one-way analyses of variance (ANOVA) were performed. About 80% of participants (n=83) fell into the mEOSS-2 group and had obesity-related chronic disorders such as diabetes, hypertension and/or dyslipidemia. There were significant differences in dietary quality and dietary patterns across the mEOSS stages. Findings highlighted the significance of obesity prevention and early treatment for overweight and obese young adults to prevent/stop obesity progression.

Keywords

obesity progression; lifestyle habits; cardiometabolic health; young adults

Introduction

Currently, 69.2% of Americans are overweight or obese (Center for Disease Control and Prevention, n.d). Alarmingly, obesity prevalence particularly among young adults continues to grow rapidly (Flegal *et al.*, 2010; Ogden *et al.*, 2012). It is well recognized that obese individuals are especially vulnerable to chronic diseases such as type 2 diabetes (T2D) and

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cardiovascular diseases (CVDs) (Devereux & Alderman, 1993; Grundy *et al.*, 2005; Kramer *et al.*, 2013). However, some researchers argue that obesity traditionally measured by Body Mass Index (BMI) is not an accurate measure of obesity related morbidity or mortality risk (Hu, 2007; Padwal *et al.*, 2011) because more than two-thirds Americans are overweight and obese (Center for Disease Control and Prevention, n.d) and only a subgroup of these individuals actually develop a chronic disease (Brochu *et al.*, 2001). These researchers suggest the existence a phenomena called "healthy obesity," individuals who are obese by BMI definition but have no metabolic aberrations (Kramer *et al.*, 2013).

Healthy eating and adequate physical activity may contribute to "healthy obesity" as preventive factors to delay and prevent obesity and chronic disease progression (Brochu *et al.*, 2001; McCullough *et al.*, 2002). The Edmonton Obesity Staging System (EOSS) is a new approach to define overweight and obesity progression based on comorbidities and functional status (Kuk *et al.*, 2011; Padwal *et al.*, 2011; Sharma & Kushner, 2009). Due to the growing prevalence of obesity in young adults ages 18-29 (Ogden *et al.*, 2012), there is a strong need to develop lifestyle interventions that are tailored to meet young adults' education needs and address their current health conditions. This age group, however, is understudied. To provide effective counseling to prevent and delay obesity progression, researchers and clinicians need to be informed about patterns of age-related risk behaviors associated with obesity progression in young adults.

Literature Review

The EOSS is a new scaling tool to measure obesity progression (Kuk *et al.*, 2011; Padwal *et al.*, 2011; Sharma & Kushner, 2009). The EOSS consists of five stages (stage 0 to stage 4); stage 0 refers to "healthy obesity": no metabolic abnormality. When individuals have preclinical conditions (e.g., prediabetes), they fall into EOSS-1. When individuals have co-morbidities such as type 2 diabetes, hypertension or dyslipidemia, they are categorized as EOSS-2 (Padwal *et al.*, 2011). People in EOSS-0 to EOSS-2 experience no or minimal physical and functional limitations due to their obesity. Additionally, individuals in these stages have no obesity-related problems maintaining a normal routine (Kuk *et al.*, 2011; Padwal *et al.*, 2011). When obese individuals have end-organ damage (e.g., myocardial infarction, heart failure, stroke), they are classified as EOSS-3, and when they have severe or potentially end-stage disabilities along with severe physiological /psychological limitations, they are classified as EOSS-4 (Kuk *et al.*, 2011; Padwal *et al.*, 2011). Since the EOSS more accurately predicts how obesity relates to mortality risk, researchers and clinicians should consider using this nuanced scale to assess obesity progression in order to design effective obesity treatment/counseling (Kuk *et al.*, 2011; Padwal *et al.*, 2011; Sharma & Kushner, 2009).

The growing prevalence of obesity among young adults may be tied to their unhealthy lifestyle habits, including unhealthy eating and inadequate physical activity (Nelson *et al.*, 2008; Unwin *et al.*, 2013). Young adults often consume calorie dense foods such as fast food, late night meals, and sugar sweetened beverages (SSBs)(Bleich *et al.*, 2011; Nelson *et al.*, 2008), and their exercise is inadequate to prevent unintended weight gain (Centers for Disease Control and Prevention, 2014; Cha *et al.*, 2013; Tudor-Locke *et al.*, 2011).

Although more young adults reported the achievement of recommended exercise (150 minutes per week in moderate-intensity aerobic exercise, equivalent to 8 Metabolic Equivalent of Task [MET]- hour/week) than older adults (Health gov, 2008), their basal physical activity (daily routine activity) was lower than mature adults (Cha *et al.*, 2013; Tudor-Locke *et al.*, 2011). That is, many young adults who report meeting an exercise goal (≥ 8 METs-hour/week) may not reach a "daily activity goal" (i.e., 9,000-11,000 steps per day which is equivalent to 23 METs-hour/week)(Tudor-Locke *et al.*, 2011). Their exercise is inadequate to ensure normal weight maintenance or a weight loss. A lifestyle intervention for young adults needs to target age-related risk behaviors based on the assessment of their current behaviors.

Purpose

This study assessed overweight and obese young adults' lifestyle across EOSS stages to provide practical information for researchers and clinicians to tailor lifestyle interventions for overweight and obese young adults that are specific to their age, dietary and physical activity patterns, and obesity stage. This study examined the prevalence of overweight/obese young adults in each stage of the modified Edmonton Obesity Staging System (mEOSS) and lifestyle factors (dietary habits, nutritional quality, and physical activity) that influence obesity progression. Specifically, we: 1) examined the prevalence of overweight/obese young adults in each stage of the mEOSS, and 2) compared the dietary habits, nutrition quality, and physical activity between the stages to define age-specific nutrition and exercise areas targeted to stop obesity progression.

Methods

Design

This was an ancillary study to Diabetes Prevention Program for Young adults (DPP-Y) that assessed the needs for an age specific diabetes prevention program for young adults (Cha *et al.*, 2013). A cross-sectional, descriptive correlational study design was used.

Participants

Between 2011 and 2012, 106 young adults were recruited from the metro Atlanta area using recruitment flyers posted in 8 participating colleges' and universities' campus bulletin boards, 4 universities' student health centers, and 1 diabetes clinic, e-mail invitations via a student email listserv (1 university), and peer and self-referral. Eligible participants were young adults aged 18-29 years, overweight/obese (BMI ≥ 25), and physically inactive (leisure time physical activity < 90 minute/ week in a usual week).

Ethical Considerations

The Institutional Review Boards of all participating institutions approved this study. Written informed consent from all study participants was obtained, and participants' data were de-identified prior to data analysis to protect participants' confidentiality.

Data collection

Participants completed a self-reported survey packet to assess socio-demographics, dietary habits, and dietary quality and an interviewer administered the survey to assess physical activity.

Demographic information such as age, ethnicity, years of school, and smoking habits was assessed using the Socio-Demographic Questionnaire (SDQ).

Anthropometric and metabolic data were collected by trained research nurses in a university Clinical Research Unit. Blood pressure was assessed to comply with the American Heart Association standard guidelines (Moser, 2005). Fasting blood glucose, HbA1C (A1C), lipids (total serum cholesterol, triglyceride, direct high-density lipoprotein cholesterol [HDL], direct low-density lipoprotein cholesterol [LDL]) were assessed using an antecubital vein blood sample taken after at least 8 hours of fasting. After the blood draw, the samples were transported to a nationally accredited lab for data analysis using enzymatic method.

Two methods were used to define overweight and obese conditions. First, BMI (Kg/m^2) was calculated using weight (Kg) and height (cm) as measured by a trained research nurse. Then, the modified Edmonton Obesity Staging System (mEOSS), which considers cardiometabolic risk and BMI together (Padwal *et al.*, 2011; Sharma & Kushner, 2009), was used to define the stages of overweight and obese conditions after two small modifications by the authors. HbA1C was added to define hyperglycemic conditions (EOSS-1: prediabetes; EOSS-2: diabetes) because the American Diabetes Association includes HbA1C as a diagnostic measure of prediabetes and diabetes as of 2011(American Diabetes Association, 2011; Grundy, 2012). Also, the cut point of cholesterol guidelines using the ATP III were modified, See Table 1 (Grundy *et al.*, 2005; Grundy, 2012; Padwal *et al.*, 2011). Thus, a HDL of ≥ 50 mg/dL for women and a HDL of ≥ 40 mg/dL for men were used as the new cut points (10-year risk for cardiovascular diseases Framingham Point Score =0) for EOSS-0 (Grundy *et al.*, 2005; Grundy, 2012). Table 1 shows the cut point of each metabolic risk factor in accordance with the ATP III definition and mEOSS (Grundy *et al.*, 2005; Padwal *et al.*, 2011).

Dietary habits and quality were assessed with a self-reported 152-item Youth/Adolescent Food Frequency Questionnaire (YAQ) (Rockett *et al.*, 1997). Based on participants' responses, dietary patterns (e.g., frequency of fried foods, skip breakfast), nutrition components, sources of calorie intakes, and serving sizes were calculated by the Harvard University School of Public Health Nutrition Department. Then, the Dietary Quality Index Revised score for young adults (DQIR-Y) (Cha *et al.*, 2014; Newby *et al.*, 2003), adjusted to reflect the most recent dietary guidelines for young adults ages 18-30 in the 2010 Dietary Guideline for Americans (U. S. Department of Agriculture and U. S Department of Health and Human Service, 2010), was calculated to assess overall dietary quality. The detailed scoring guide of the DQIR-Y is presented in Table 2 as well as in another publication (Cha *et al.*, 2014).

Physical activity was measured using the 7-item Modifiable Activity Questionnaire (MAQ), the primary physical activity measure used in the Diabetes Prevention Program (Kriska,

1997; Kriska *et al.*, 2006). Leisure activity, occupational activity and inactivity in the past year were assessed by trained research staff to calculate Metabolic Equivalent of Task (MET)-hour per week (Kriska *et al.*, 2006). Based on the MET-hour per week, the participants were divided into four groups: 1) physical activity group (≥ 23 METs-hour per week), 2) physical inactivity group 1 (> 8 MET-hour per week and < 23 METs-hour per week), 3) physical inactivity group 2 (> 0 MET-hour per week and < 8 METs-hour per week), and 4) no activity group (MET-hour per week = 0) (Tudor-Locke *et al.*, 2011).

Data Analysis

Data analysis was conducted with IBM SPSS 20.0 (IBM SPSS statistics). Prior to data analysis, data patterns (missing data) were examined. One participant reported a very small calorie intake (326.70 Kcal per day). We included the person since the overall findings were not changed with/without this participant, and our primary goal was to examine dietary patterns and nutrient components rather than overall calorie intake in overweight and obese young adults. A participant who did not complete blood work was excluded. Thus, final data analyses were conducted with 105 participants. To answer our specific aims 1 and 2, descriptive statistics, a series of Chi-square tests, and one-way analyses of variance (ANOVA) were performed.

Results

Sample characteristics

The majority of participants were female (78.1%) and non-Hispanic African Americans (66.7%). About a half of the participants (n=48, 45.71%) met the BMI criteria for class II obesity or higher (BMI ≥ 35). The mean age and years of education were 24.0 years old, and 15.1 years, respectively. About 12% of the participants (n=13) were born outside of the U.S. Two-thirds of participants reported they had never smoked (n=78, 75.0%) (See Table 3).

Obesity progression and cardiometabolic risk

About 80% of participants (n=83) were categorized as mEOSS-2, presenting with obesity-related chronic disorders (hypertension, diabetes or dyslipidemia). However, none were aware of their conditions prior to their enrollment in the study. Metabolic aberration seemed to occur individually depending on predisposing conditions of young adults rather than in a cluster of risk factors (i.e., metabolic syndrome). The highest prevalence of metabolic risk was visceral obesity (88.8%) followed by low HDL (76.2%), higher A1C (26.7%), and elevated blood pressure (25.7%) (See Table 4).

Lifestyle Habits

Physical activity—The average self-reported physical activity was 16.3 MET-hour/week (median: 6.1 METs-hour per week). About two-thirds of young adults reported less than 8 METs-hour per week and 14.3% of participants reported no physical activity during the past year (see Table 3).

Dietary habits and nutrient intakes—Overall dietary quality was poor (mean score= 62.1, SD= 11.52) although calorie intake met 2010 dietary recommendations. In particular,

mEOSS-1 and mEOSS-2 groups reported lower dietary quality scores than mEOSS-0 group. There was a significant difference in the dietary quality between mEOSS-1 and mEOSS-0 groups (p=.037).

Most of the participants reported their intakes of calorie and sodium comparable to the recommendations from the 2010 Dietary Guidelines for Americans (DGA) although a wide range of calorie and sodium intake existed, 326.7 - 3287.8 Kcal/day (calorie intake) and 416.3-4285.4 mg/day (sodium consumption). Added sugar consumption, however, was almost two times higher than the American Heart Association (AHA) recommendations, but they were within the DGA recommendations (5-15% of total calorie intake).

On average, the participants met the 2010 DGA recommendations for carbohydrate, protein, and total fat intakes. However, EOSS-0 group consumed less saturated fat (9.1 ± 1.8% of total calorie intake) and more protein (17.9 ± 4.0% of total calorie) than the other two groups. Fruit and vegetable consumptions did not meet recommended levels, but the EOSS-0 group reported the consumption closest to the recommendation. The average reported dietary fiber (16.8 g / 1753.5Kcal) was much less than the recommendation (14g / 1000Kcal), and all participants consumed trans fat (2.3 ± .9 g/day) (see Table 5).

Concerning dietary patterns, 14.3% of participants skipped breakfast, and 21.2% of young adults consumed late-night snacks more than 3 times per week. About 12% of young adults consumed fried food more than 4 times per week outside of the home. Approximately 30% of young adults added sugar to their foods or beverages, and sugar sweetened beverage (SSBs) consumption was very popular (90.5%). The majority of the participants drank fruit juice (n=90, 85.7%), and the preferred milk options were 2% milk or whole milk (54.3%) and chocolate milk (23.8%). Only 24.7 % of the participants drank skim milk or 1% milk. As expected, regular and diet sodas were very commonly consumed; 78.1% (n=82) of participants consumed regular or diet soda, and 12.4% of them drank more than one can of regular or diet soda per day. In particular, the young adults categorized in mEOSS-2 consumed diet soda about twice more than the mEOSS-1 and 8.5 times more than the mEOSS-0. Detailed information on these dietary patterns by mEOSS group is presented in Table 6.

Discussion

This study successfully delineated key target lifestyle elements in overweight and obese young adults in order to prevent obesity progression and promote cardiometabolic health. For instance, the mEOSS-1 group was more vulnerable to cardiometabolic risk than the mEOSS-0 group although their BMI was significantly lower than the mEOSS-0 group (p=. 036, see Table 3). This may be because of their poorer dietary habits compared to mEOSS-0. Thus evidence based intervention targeting age-linked behaviors (e.g, monitoring added sugar and saturated fat consumption) needs to be developed with practical advice (Knowles *et al.*, 2005).

In this study, there was no significant difference in the physical activity levels of the groups, but this finding may be due to the inclusion of less than 90 minutes leisure time activity per

week, unequal numbers in each EOSS group, and a threshold effect of physical activity on health outcome (Chen *et al.*, 2013; Fretts *et al.*, 2012). Accumulated evidence shows that physical activity not only improves energy balance but also increases insulin sensitivity, improves beta-cell function, and controls blood pressure and cholesterol (Chen *et al.*, 2013; Grundy *et al.*, 2005). Therefore, a study with a larger sample of overweight and obese young adults reporting a wide range of physical activity should be replicated for further exploration.

Our findings underscore the importance of prevention and early treatment of obesity in young adults. Since the main goal of the current study was to identify the lifestyle factors that increase metabolic abnormality, we applied lower cut points of HDL when defining the obesity staging system than Padwal and colleagues (Padwal *et al.*, 2011). If we applied a HDL of ≥ 60 mg/dL, a prevention score (−1 of Framingham Point Score) to reduce 10-year risk for cardiovascular diseases, proposed by Padwal, no participants would have been classified into the “healthy obesity” EOSS-0 group. That is, “healthy overweight and obesity” may exist for a much shorter period in overweight (overweight: BMI of 25.00-29.99) and low-risk obese individuals (Class 1 obesity: BMI of 30.00-34.99) with healthy lifestyles than researchers previously believed. Longer obesity periods and/or morbidly obese conditions (BMI ≥ 35) make individuals very vulnerable to obesity progression regardless of their lifestyle habits. Thus, obesity prevention and early proactive obesity treatment (e.g., bariatric surgery, weight loss regime) may be the best way to promote cardiometabolic health regardless of current metabolic aberration (Kramer *et al.*, 2013; Kwok *et al.*, 2014).

The reduction of SSBs and diet sodas needs to be emphasized in overweight and obese young adults (Malik *et al.*, 2010; Van Horn *et al.*, 2010). As Table 5 shows, about 91% of the participants drank SSBs, a much higher rate than was reported in a previous study (72%) (Bleich *et al.*, 2011). SSBs are a major source of added sugar (about 30-50% of added sugar) and additional calories without essential nutrients (Hedrick *et al.*, 2012; U. S. Department of Agriculture and U. S Department of Health and Human Service, 2010). As Table 6 shows, the mEOSS-2 group drank diet soda more frequently than other groups. Diet soda may be an alternative to regular soda to avoid additional calorie intake; however, there is a growing concern that diet soda increases the risk for the development of T2D and CVDs later in life (Gardener *et al.*, 2012). Moreover, this risk is even greater for overweight and obese individuals (Gardener *et al.*, 2012). A nutrition education program focusing on the selection of the “right” beverage as well as healthier food choices needs to be developed to help overweight and obese young adults.

Finally, modifications of dietary habits based on young adults’ current dietary patterns need to be a key area of nutrition education for young adults. For instance, the mEOSS-1 and mEOSS-2 groups showed a higher prevalence of late night snack consumption than mEOSS-0 group. In particular, the mEOSS-2 group frequently ate fried food and skipped breakfast (see Table 6). Thus, increased education about eating a balanced and good quality diet is necessary in this population.

Limitations

The authors acknowledge several limitations to this study. While the Youth/Adolescent Food Frequency Questionnaire (YAQ) is a valid and reliable instrument to assess dietary habits in youth (Rockett *et al.*, 1997; Rockett *et al.*, 1995), issues related to a self-reported food frequency questionnaire may cause study limitations. For instance, the YAQ may not include all food items (e.g., sport drinks) consumed frequently by young adults, which may have led to underreporting of food consumption and underestimation of caloric intake. Also, the questionnaire challenges participants to recall what they ate in the past year, which is a very long recall period for an activity that one does daily. This recall bias is also applicable to the self-reporting of physical activity. The use of an objective measure of physical activity (e.g, accelerometer) needs to be considered for future studies.

Poor portion size estimation skills of young adults may also generate inaccurate study findings. Since assessing participants' portion size estimation skills was not a research aim for this study, we have very limited knowledge about whether participants correctly understood the serving sizes referenced in the questionnaire. To overcome these limitations, future research needs to use additional dietary assessments such as a 24-hour dietary recall or an instrument using food photographs in order to capture more accurate dietary habits in overweight and obese young adults (Jia *et al.*, 2012).

Another limitation of this study is related to the limitations of the EOSS, an evolving tool to assess obesity risk and its progression (Padwal *et al.*, 2011; Sharma & Kushner, 2009). However, we endorse the developers' conclusion that "the EOSS is a meaningful framework to guide obesity treatment/counseling decisions" (Sharma & Kushner, 2009, p.294) although we acknowledge a need to replicate the study with a larger sample size. Finally, our convenient sampling method, small sample size, and female (78.1%) and African American (66.7%) dominant sample reduces the external validity of our findings. To overcome this limitation, a study using a national representative sample is warranted.

Conclusions

Overweight and obese young adults can promote their cardiometabolic health with healthy lifestyles. To take action, young adults need practical and strategic dietary advice about beverage choices, diet quality, and macronutrient and micronutrient sources. In addition, increasing overall activity and minimizing sedentary behavior needs to be emphasized for young adults to achieve physical activity goals. The findings of the current study highlighted the great need for obesity prevention and early treatment through lifestyle modification for overweight and obese young adults to prevent and stop obesity progression.

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Table 1

Classification and cut points for assigning modified Edmonton Obesity Staging System (mEOSS) in this study

	mEOSS-0	mEOSS-1	mEOSS-2
Overall definition	No apparent metabolic risk factors	Presentence of obesity-related subclinical risk factors (e.g., prediabetes/ pre-hypertension, borderline dyslipidemia)	Presence of established obesity-related chronic diseases (e.g, Hypertension, T2D, dyslipidemia)
Metabolic risk factors			
Fasting glucose	<100mg/dL	100-125 mg/dL	≥126 mg/dL
†A1C (%)	< 5.7 %	5.7-6.4 %	≥ 6.5 %
Blood pressure (mmHg)	<130/85; if individual have diabetes	For individuals classified as having diabetes, SBP 125-129.9 or DBP 75-79.9. Otherwise, SBP 130-139.9 or DBP 85-89.9	If individual is taking antihypertensive drug; if individual have diabetes, 130/80; otherwise, ≥140/ 90
Total cholesterol (mg/dL)	< 200 mg/dL	200-239 mg/dL	≥ 240 mg/dL
LDL cholesterol (mg/dL)	< 130	130-159 mg/dL	≥160 mg/dL
fHDL cholesterol §	≥ 40 mg/dL in men; ≥ 50 mg/dL in women		< 40 mg/dL in men; <50 mg/dL in women
Triglyceride	< 150 mg/dL	150-199 mg/dL	≥ 200 mg/dL

†Metabolic risk cut-offs were adapted from Edmonton Obesity Staging System (EOSS) and ATP III. HbAlC was included as metabolic risk factors in this study since it is accepted as a diagnostic measure of prediabetes and type 2 diabetes by American Diabetes Association since 2010.

Table 2

Scoring guides of Dietary Quality Index Revised for Young adults (DQIR-Y)

Component	DQIR-Y Scoring [§]	Scoring guides [§§]	Possible ranges
Grains	7 servings	10:1 point less for each 10% less than intake required for full score	0-10
Vegetables	3 servings	Same as above	0-10
Fruit	2 servings	Same as above	0-10
Total fat	≤ 30% of total calories	≤ 30%=10; 31- 44 %=5; ≥ 45%=0	0-10
Saturated fat	≤ 10% of total calories	≤ 10% =10; 11-14 % =5; ≥15% =0	0-10
Cholesterol	< 300 mg	< 300 mg =10; 300-449 mg=5; ≥ 450 mg=0	0-10
Calcium	1000 mg	10:1 point less for each 10% less than intake required for full score	0-10
Iron	18mg for women; 8mg for men	10:1 point less for each 10% less than intake required for full score	0-10
Diet Modification			
Added sugar	5-15% of total calories	≤ 5 % =2.5; 5.01%-10.0% = 1.5; 10.01%-15.0% = 1; > 15.0 % of total calories= 0	0-2.50
Sodium	≤ 1500-2300 mg;	≤ 1500 mg= 2.5; 1501-2300 mg= 1.5; ≥ 2301 mg= 0	0-2.50
Food group of diet diversity		Representative foods	
Grains	Non-whole grain breads	White bread, roll	0-2.50
	Quick breads	Muffin, English muffin, pancakes	
	Pasta	Lasagna, macaroni, spaghetti, pasta	
	Whole -grain breads	Dark bread, graham crackers, wheat thins	
	Cereals	Cold cereal, hot cereal	
	Rice	Rice	
	Other grains	Corn bread, tortilla, kasha, popcorn	
Vegetables	Deep yellow or orange	Carrot, sweet potatoes	0-2.50
	Deep green	Broccoli, spinach, green/kale	
	Tomato product	Fresh tomato, tomato sauce	
	Potatoes	French fries, potatoes-baked, boiled, mashed	
	Beans	Tofu, beans	
	Starch	Corn, peas or lima beans	
	Other	Beets (not greens), mixed vegetables, pepper	
Fruits	Citrus, berries and melons	Cantaloupe, orange, strawberries	0-2.50
	Juices	Orange juice, apple juice	
	Other	Raisins, banana, apples, pears	
Meat & Dairy	Beef/ pork (Red meat)	Beef, pork, organ meats, lunch meats	0-2.50
	Poultry	Chicken, turkey	
	Milk	Milk (skim,1%, 2% & whole milk), chocolate milk	
	Cheese	Cheese, cream cheese, cottage cheese	
	Eggs and soup	Eggs	
	Fish	Tuna, fish stick, fresh fish, shrimp, lobster, scallops	
	Yogurt	Yogurt	
Total Score			0-95.00

§Based on 1800-2200 Kcal for 2010 Dietary guideline for Americans ages 19-30 and mypyramid.gov.

§§Scoring by Newby *et al.* 2003, U.S. Department of Agriculture and U. S Department of Health and Human Service 2010

Table 3

Sample Characteristics and physical activity by mEOSS stages (n=105)

	Total	mEOSS-0 (n=9)	mEOSS-1 (n=13)	mEOSS-2 (n=83)	p-value
		Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
Age	24.0 ± 3.5	23.1 ± 2.7	23.2 ± 4.5	24.3± 3.1	.400
BMI	36.8 ± 8.1	34.8 ±7.0	31.4 ± 3.3	37.68±8.32	.022
Year of Education	15.1 ± 2.6	15.6 ± 2.0	14.4 ± 2.9	15.56 ± 2.72	.972
Median of physical Activity (MET/h-week)	6.22	5.6	5.9	6.7	
		n (%)	n (%)	n (%)	n (%)
Male vs. Female	23(21.9) vs. 82 (78.1)	0(0.0) vs. 9(100.0)	4(30.8) vs. 9(69.2)	19(22.9) vs. 64 (77.1)	.198
African Americans(AA) vs. Non-AA	70 (66.7) vs. 35(33.3)	6(66.7) vs. 3(33.3)	8(61.5) vs. 5 (38.5)	56 (67.5) vs. 27(32.5)	.930
[§] Smoking:					
Never smoked	78(75.0)	5 (55.6)	11 (84.6)	62 (74.7)	.266
Former smoker	15(14.4)	3 (33.3)	1 (7.7)	11(13.3)	
Currently smoker	11(10.6)	1 (11.1)	0 (0.0)	10(12.0)	
Physical Activity n (%)					
No activity (MET/h =0)	15(14.3)	2 (22.2)	3(23.1)	10 (12.0)	.248
Physically inactive (0.1-7.9 MET/h-week)	47(44.8)	4(44.4)	5(38.5)	38 (45.8)	
Physically inactive (8-22.9 MET/h-week)	17(16.2)	0(0.00)	4 (30.8)	13(15.7)	
Physically active (23 ≥ MET/h-week)	26(24.8)	3(33.3)	1 (7.7)	22(26.5)	

[§] one person was missing

Table 4

Prevalence of metabolic risk across mEOSS stages

		Total (N=105)	mEOSS-0 (n=9)	mEOSS-1 (n=13)	mEOSS-2 (n=83)
		n (%)	n (%)	n (%)	n (%)
Obesity	(BMI ≥ 30)	83 (79.1)	6 (66.7)	9(69.2)	68 (80.0)
BMI ranges		26.2-58.6	27.4 - 46.1	26.9 - 40.5	26.2 - 58.6
Waist circumference	Men≥102 cm; women≥88cm	85 (81.0)	8 (88.9)	6(46.2)	71 (85.5)
Fasting glucose	100-125	7 (6.7)	0 (0.0)	1 (7.7)	6 (7.2)
	≥ 126 mg/dL	1 (1.0)	0(0.0)	0	1 (1.2)
A1C	5.7% - 6.4%	25(23.8)	0(0.0)	5 (38.5)	20 (24.1)
	≥ 6.5%	3(2.9)	0(0.0)	1(7.7)	2 (2.4)
Blood pressure	Prehypertension (130/85)	13(12.4)	0(0.0)	5(38.5)	8 (9.6)
	Hypertension (≥ 140/90)	14(13.3)	0(0.0)	0(0.0)	14 (16.9)
Total cholesterol	200-239 mg/dL	10 (9.5)	0 (0.0)	3(23.1)	7 (8.4)
	≥ 240 mg/dL	0 (0.0)	0(0.0)	0(0.0)	0(0.00)
LDL	130-159 mg/dL	19 (18.1)	0(0.0)	2(15.4)	17 (20.5)
	≥ 160mg/dL	5(4.8)	0(0.0)	0(0.0)	5 (6.0)
Triglyceride	150-199mg/dL	3(2.9)	0(0.0)	0(0.0)	3(3.6)
	≥ 200 mg/dL	7(6.7)	0(0.0)	0(0.0)	7 (8.4)
HDL	< 40mg/dL in men (n=23); <50mg/dL in women (n=82)	78(74.3)	0 (0.0)	0(0.0)	78(94.0)

Table 5

Dietary quality and nutrient intakes

	2010 Dietary guidelines for Americans	mEOSS-0 (n=9)	mEOSS-1 (n=13)	mEOSS-2 (n=83)	p-value
		Mean± SD	Mean± SD	Mean± SD	
Dietary quality (DQIR-Y)	N/A				
Total score	Range: 0-95	68.6 ± 6.6	58.2 ±10.7	62.0 ±11.8	.110
Food diversity sub-score	Range: 0-10	5.5 ± 2.0	4.5 ± 1.7	4.8 ± 1.8	.428
Total Calorie (Kcal)	1800-2600 Kcal	1682.0 ± 590.9	1759.1 ±715.1	1758.7 ± 567.7	.932
Total added sugar (g/day)	< 25 g for women; 37.5 g for men	48.6±27.4	63.9 ± 32.2	58.0 ± 28.2	.461
Total dietary fiber (g/day)	(14g/1000Kcal)	19.0 ± 5.6	14.9 ± 6.5	16.9 ± 8.0	.473
Total Sodium (mg/day)	≤ 1500-2300 mg	1917.5 ±720.8	2055.2 ± 895.9	2126.5 ± 787.0	.739
Cholesterol	<300 mg	251.5 ± 130.2	215.4 ± 113.6	227.7 ± 104.2	.736
Trans fat	0 mg	1.8±.7	2.6±1.2	2.3±.8	.114
Calcium	1000 mg	898.3 ± 425.0	723.3 ± 272.6	742.9 ± 316.3	.366
Magnesium	310 mg for women; 400 mg for men	284.9±89.4	226.0±83.7	248.4 ± 97.7	.366
Vitamin D	600 IU	263.3±226.0	204.2±170.2	185.6±164.2	.423
Fruit	2 cups	1.2 ± 0.6	1.1 ± 1.0	1.5 ± 1.2	.490
Vegetables	3 cups	3.0 ± 1.3	2.0 ± 1.4	2.1 ± 1.4	.175
% of energy sources					
% of carbohydrate	45-65%	54.8 ±5.4	54.2 ± 5.9	53.3 ± 6.5	.763
% of added sugar	< 5-15%	11.2 ± 3.1	14.7 ±4.7	13.2 ± 5.3	.305
% of protein	10-35%	17.9 ±4.0	14.2 ±2.1	15.9 ±3.2	.028
% of total fat	20-35%	27.7 ± 3.6	32.7 ± 4.7	31.4 ±5.3	.064
% of saturated fat	< 10% of total calorie	9.1 ± 1.8	11.4 ± 1.7	10.4 ±2.4	.065

Table 6

Dietary patterns

Beverage consumption (serving/ day)	**mEOSS-0 (n=9)**	**mEOSS-1 (n=13)**	**mEOSS-2 (n=83)**	**p-value**
	Mean± SD	**Mean± SD**	**Mean± SD**	
Sugar sweeten Beverages (soda, sweetened tea, or Punch)	.5 ± .8	1.2 ±1.4	.8 ± .8	.208
Diet Soda	.02 ± .05	.08± .2	.2 ±.5	.524
Milk	.6 ±.8	.4 ± .3	.4 ±.4	.214
Chocolate Milk	Not drink	.02± .05	.05±.1	.400
Coffee	.4 ±.5	.2 ±.3	.2 ±.3	.132
Tea	.4 ±.4	.08 ± .2	.2 ±.3	.062
Alcohol	.3 ± .3	.09±.1	.2 ±.2	.043
Dietary Habits	n (%)	n (%)	n (%)	p-value
No breakfast	1 (11.1)	0(0.0)	15 (18.1)	N/A
Frequency of fried food at home	n (%)	n (%)	n (%)	p-value
-never	8 (88.9)	5(38.5)	36 (43.4)	.064
-1-2 times/week	1 (11.1)	6(46.2)	42 (50.6)	
- ≥ 3 times/ week		2(15.4)	5(6.0)	
Frequency of fried food out	n (%)	n (%)	n (%)	p-value
-never/ less than once per week	4 (44.4)	5 (38.5)	19 (22.9)	.267
-1-3 times/week	5 (55.6)	5 (38.5)	54 (65.1)	
- ≥ 4 times/ week	0(0.0)	3 (23.1)	10(12.0)	
# of times eat late snacks out [§§]	n (%)	n (%)	n (%)	p-value
- never	6 (66.7)	4 (30.8)	33 (39.8)	.252
-1-2 times/week	3 (33.3)	4 (30.8)	32 (38.6)	
- ≥3 times/ week	0 (0.0)	5 (38.5)	17 (20.5)	

In beverage consumption, 0.14 serving per day refers to 1 serving per week

One person was missing