Individual Resting Metabolic Rate and Nutrition Education: Does This Knowledge Lead individuals into Making Healthier Lifestyle Choices?

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INDIVIDUAL RESTING METABOLIC RATE AND NUTRITION EDUCATION: DOES THIS KNOWLEDGE LEAD INDIVIDUALS INTO MAKING HEALTHIER LIFESTYLE CHOICES?

by

MELISSA UPDYKE

(Under the Direction of Dr. Amy Jo Riggs)

ABSTRACT

Introduction Promoting healthier lifestyle choices to college aged individuals is important since the choices they make during early adult years will affect them later in life. Roughly 27% to 35% of college students are overweight (BMI 25-29.9 kg/m²) or obese (BMI ≥30 kg/m²) and only 20% participate in regular moderate activity. Purpose The purpose of this study was to examine whether college students make healthier lifestyle choices after receiving information on individual resting metabolic rate and nutrition education. Subjects Forty Georgia Southern students (20 males and 20 females), between the ages of 19 and 24 years participated in the study. Methods Self reported anthropometrics were obtained. Participants were randomly assigned to one of four groups; Control, Resting Metabolic Rate (RMR), Education, or Combination. Resting metabolic rate measurements were taken on all subjects at baseline and again at six weeks. The RMR Group and Combination received information on what RMR means, what affects it, and ways to increase it. A nutritional education seminar was given to the Education Group and Combination Group at baseline. A food frequency questionnaire, physical activity questionnaire, and barriers towards exercise scale were given to the participants at baseline, two, four, and six weeks. Results The Resting Metabolic Rate Group and the Combination Group consumed a significantly higher number of servings of fruits and vegetables
(p=.007; p=.002 respectively) than the Control group. The Combination group was also
significantly higher than the Education group (p=.036). There were no significant differences for
physical activity or barriers towards exercise over the study or between the four different groups.

**Conclusion** More appropriate interventions need to be developed to help lower the incidence of
overweight and obesity in college-aged individuals.

INDEX WORDS: Resting metabolic rate, Nutrition, College, Physical activity, Exercise barrier
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B.S., Georgia Southern University, 2009

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Electronic Version Approved:

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DEDICATION

I would like to dedicate my thesis to my wonderful family and boyfriend. Throughout this process, they have been my biggest supporters. They have provided me with the strength and encouragement to make this all possible. I am so very thankful to have had such an amazing support group behind me during this journey.
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Chapter 1

Individual Resting Metabolic Rate and Nutrition Education: Does this knowledge lead individuals into making healthier lifestyle choices?

The transition into a college lifestyle is a critical time for weight management in this population (Ford & Torok 2008). The “Freshman 15” is generally defined as the 15 pounds students typically gain during their freshman year of college. However, since obesity is occurring at an earlier age in American adolescents, this may eventually turn into the freshman 30 or 45 (Ford & Torok 2008). Roughly 27% to 35% of college students are overweight (BMI 25-29.9 kg/m²) or obese (BMI ≥30 kg/m²) (Hajhosseini et al., 2006), and only 20% participate in regular moderate activity (Kilpatrick, Hebert, & Bartholomew, 2005). Furthermore, Kilpatrick et al. (2005) indicate that almost half of all college students report a decline in their level of physical activity following graduation. The CARDIA study revealed an average weight gain of more than 0.7 kg per year over a duration of ten years in Caucasian adults aged 18-30 years (Hajhosseini et al., 2006). Hivert, Langlois, Berard, Cuerrier, and Carpentier (2007) state that significant weight gain begins during the early 20’s, and carries on throughout adulthood. It is now recognized that subpar eating behaviors coupled with inadequate physical activity in adolescence are directly associated to serious health consequences later in life including osteoporosis, obesity, hyperlipidemia, and diabetes (Franko, Cousineau, Trant, Green, & Rancourt, 2008).

Resting metabolic rate is defined by Comana (2001) as “the minimal energy requirement needed to sustain all the body’s functions in a resting state.” Resting metabolic rate, physical activity and thermic effect of food are the three major components that make up total energy expenditure (EE). Resting metabolic rate makes up the largest component ranging from 60%-
80% of total EE (Gropper, Smith, & Groff, 2009). Factors that influence metabolic rate include
body size and body composition, age, gender, and climate (Comana, 2001). Hajhosseini et al.,
(2006) were the first to examine changes in resting metabolic rate (RMR) in college freshman.
Freshmen (n=27) were followed for 16 weeks and no significant difference were found between
RMR; however, there was a slight decrease at the end of the study. Past research has examined
RMR changes on different diets and exercise regimens. Stiegler and Cunliffe (2006) examined
different studies that involved exercise interventions and RMR, diet interventions and RMR, and
combined diet and exercise intervention and RMR. Overall, more significant differences were
found in studies that looked at the combined efforts of diet and exercise interventions rather than
studies that investigated diet or exercise alone.

Because college students are typically in good health, lack major medical problems, and
are young, little research has been focused on this population. In addition, most college students
are unaware of the role that nutrition and physical activity play in their future health. (Richards,
Kattelmann, & Ren 2006).

With the growing obesity epidemic, more research has been conducted in hopes to
reverse this trend. Because obesity is affecting young adults, research now is focusing more on
the younger generations (Huang et al., 2003). Resting metabolic rate has been investigated in
different aspects, since it could be a contributing factor to obesity (Hajhosseini et al., 2006;
Stiegler and Cunliffe 2006). Interventions that encourage an increase in healthier dietary
behaviors, like choosing more fruits and vegetables in college students, have been conducted and
show promising results (Franko et al., 2008; Peterson et al., 2010; Kolodinsky et al., 2007;
Richards et al., 2006). In addition to interventions being conducted in the college population,
prevention programs for young adults are being developed in hopes to prevent weight gain
Interventions have also been conducted to increase physical activity in young adults. This includes increasing stair usage (Ford and Torok 2008) and assessing what really motivates college students to engage in exercise and physical activity (Kilpatrick et al., 2005).

Peterson, Duncan, Null, Roth, and Lynn (2010) said that “Healthy people 2010 aims to increase the proportion of college students who receive information on dietary practices, nutrition, and disease prevention” (p. 425). A recent report from the Center for Disease Control and Prevention underscored the presence of well-structured prevention programs among college students (Hivert et al., 2007). It is clear that interventions for healthy lifestyles are needed among college students. Little research has been done on what motivates college students to increase their physical activity and make healthier food choices. Most studies only focus on the educational aspect, showing the benefits of choosing healthier food options and increasing physical activity (Franko et al., 2008; Peterson et al., 2010; Richards et al., 2006; Ford and Torok 2008). To date, there are no research studies that have conducted an intervention program using RMR knowledge as a tool for lifestyle change.

**Problem Statement**

The purpose of this study was to examine whether college students make healthier lifestyle choices after receiving information on individual resting metabolic rate and nutrition education.
**Rationale**

Promoting healthier lifestyle choices to college aged individuals is important since the choices they make during early adult years will affect them later in life. Some research has concluded that approximately 26% of college students are overweight or obese (Huang et al., 2003). Research has supported nutrition education as a way to increase fruit and vegetables in college students (Richards, Kattelmann, & Ren 2006; Franko et al., 2008). Research has also shown that students can be motivated to increase their physical activity by motivational signage (Ford & Torok, 2008). Interventions have also been conducted on this age group in regards to motivating them into making healthier lifestyle choices by educating subjects on the benefits of exercise and the consumption of fruits and vegetables (Franko et al., 2008; Peterson et al., 2010; Richards et al., 2006; Ford and Torok 2008). However, no research studies have been conducted on whether informing an individual of their resting metabolic rate will lead them into making healthier lifestyle choices. Since the rate of overweight and obesity is rising in college students, additional research needs to focus on different ways to promote healthier lifestyle choices in this particular population.

**Research Questions**

The research questions for this study include: 1) Does nutritional education encourage an individual to make healthier food choices? 2) Does knowledge of resting metabolic rate lead to increased physical activity? 3) Does knowledge of resting metabolic rate coupled with nutrition education lead to healthier food choices and increased physical activity? 4) Does knowledge of resting metabolic rate coupled with nutrition education decrease perceived barriers towards exercise
Chapter 2

Literature Review

Since obesity has become a growing problem, research has focused on assessing it and different interventions in the hopes of making a difference. In the United States, obesity has become an epidemic among all age groups. The incidence of obesity for individuals aged 18 to 29 years old increased from 12.1% to 14% from 1997 to 2001 (Huang et al., 2003)

Body Weight and Composition

In 2003, Huang et al., assessed overweight, obesity, dietary habits, and physical activity in college students. Subjects included 738 college students aged 18 to 27 years that completed a cross-sectional survey which included the Berkley fruit, vegetable, and fiber screener to assess dietary intake, and three questions from the Youth Risk Behavior Survey to assess physical activity. Body Mass Index (BMI) was also collected. Results found that 21.6% were overweight and 4.9% were considered obese. For dietary intake, the students reported consuming 4.2+/−2.0 servings of fruits and vegetables per day and 18.0 +/− 5.6g of fiber per day. Results also found that students engaged in 2.8+/− 2.1 days of aerobic exercise in the week prior to being assessed. It has been observed that there are an increased number of overweight and obese college students. In addition, college students aren’t meeting the required amounts of fruit and vegetable servings per day, nor meeting the required amount of physical activity per week.

Lowry., et al (2000) examined a large sample (n=4609) of undergraduate college students and evaluated their dietary and physical activity behaviors related to their weight management goals and practices. Data was analyzed from the 1995 National College Health Risk Behavior
Survey (NCHRBS). Self-reported height and weight values were used to assess Body Mass Index (BMI). Thirty five percent of the students were overweight or obese; however, 41.6% considered themselves to be slightly or very overweight. The students were asked questions regarding their physical activity, consumption of fruits and vegetables, consumption of high fat foods, weight management practices and goals and their body weight perception. Around 37% of students participated in vigorous physical activity three or more days per week and only 19.5% of students participated in moderate physical activity for at least 30 minutes five or more days a week. Seventy-eight percent reported consuming less than two servings of high fat foods, and 26.3% ate five or more servings of fruits and vegetables per day. Almost half of the students reported they were currently trying to lose weight at the time of the survey. Their weight loss efforts included exercise (53.6%) and diet (30.8%). This study examined the need for more interventions and efforts to increase physical activity and healthy dietary behaviors in college students.

Hoffman, Lee, Policastro, Quick and Lee (2006) examined the myth of the “freshman 15” by examining body weight and body composition changes in first year college men and women. Sixty-seven students completed the study with 48% male (n=32) and 52% female (n=35). Measurements included height, weight and body fat percentage. Height was measured using a fixed measuring tape and weight by a Tanita BF-578 scale which also had a bioelectrical impedance to measure body fat. The measurements were taken during the last three weeks in September and again in the last two weeks of April. The mean BMI was 22 kg/m² and had a mean increase of .45 kg/m² by the second set of measurements. For men, there was an increase in weight of 1.32 kg and for women 1.28 kg. Body fat also increased with a mean for men being
1.20 kg and women 0.20 kg. There was a mean increase in all the parameters; however it did not give support to the myth of the “Freshman 15”.

**Resting Metabolic Rate**

Hajhosseini et al., (2005) studied the popular belief of the “freshman 15” by examining first year college students and weight gain. This was the first study to document changes in RMR for freshman college students; therefore, making this study unique. The purpose of this study was to document changes in RMR, body composition, and body weight in first year college students. A sample size of 5 males and 22 females was used. The study lasted 16-weeks, and during that time subjects met with the researchers on three separate occasions. The first day of data collection included weight, height, body composition measurements, and RMR. In addition, a 3-day dietary recall and food frequency questionnaire were collected. Halfway through the study, anthropometric measurements were taken again and another 3-day food record was turned in. The final visit was between weeks 14 and 16 where anthropometric measurements and questionnaires were completed again. Before RMR was calculated, subjects were asked to fast and avoid any physical activity for at least two hours prior to their scheduled appointment time. BodyGem was used to measure RMR, a stadiometer to measure height, calibrated scale to measure weight, and bioelectrical impedance analysis (BIA) to measure body fat. BMI was calculated from height and weight measurements. The three 3-day dietary records included two weekdays and one weekend day. Participants were asked to be as specific as possible in regards to portion size, method of cooking, brand, and which items were eaten in a restaurant. The results were analyzed using USDA food guide pyramid and the Food Processor Nutrition and Fitness software. For the statistical analysis, t-test for paired comparisons and general linear model were
performed to compare means between visits. The mean body weight and BMI significantly increased at the end of the study (P=0.001; P=0.002, respectively). Although RMR decreased during the study, the change was not significant (p=.31). However, there was a significant association between the changes in RMR and changes in body weight (p<.02), which suggests that 20% of the RMR’s decrease was associated with the increase in weight.

A review of literature from Stiegler and Cunliffe (2006) examined the role of different diet and exercise regimens on individuals resting metabolic rate and fat-free mass. Different diet intervention studies, exercise intervention studies, and a combination of diet and exercise studies were reviewed. In these interventions, the most desirable outcomes were a loss of fat mass and an increase of fat free mass, since those were the variables that would affect the subject’s resting metabolic rate. There were differences seen in all of the categories, but when diet and exercise were combined, the greatest outcomes were seen.

Fat free mass (FFM), a component of what determines an individual’s resting energy expenditure (REE), can decrease in calorie restricted diets. With the loss of FFM, REE typically decreases. Hunter., et al (2008) set out to determine the effects of a calorie restricted diet and exercise has on body composition and REE in African American (AA) and European American (EA) women. Forty-eight AA and 46 EA women were randomly assigned to one of three groups. All of the subjects underwent a weight loss intervention that put them in the normal body mass index (BMI) category (18.5-24.9). A diet of 800 kcal/day was provided to the participants until they reached the normal BMI status. The aerobics training (AT) group participated in treadmill walking/jogging three times a week, the resistance training (RT) group participated in weight lifting exercises, and the no exercise training (NT) group did not participate in any exercise. The study length differed for each individual since it was partly based upon the individual reaching a
normal BMI status; however it was averaged around 25 weeks. Body composition, REE, maximal oxygen uptake, and muscular strength were all measured prior to the study and after the subjects reached a normal BMI. The RT group had significantly higher amounts of FFM at the end of the study compared to both the AT and NT groups (p<.05). Also, the RT group maintained REE, whereas both the AT and NT groups declined. The EA lost significantly more FFM than the AA women at the end of the study (p<.05). Results from this study support the effectiveness of resistance training in maintaining FFM and REE.

A decrease in resting metabolic rate (RMR) can be seen in weight loss. This may also contribute to weight regain due to the lowered energy expenditure. Schwartz and Doucet (2009) reviewed 90 publications, with a total of 2996 subjects, on the effects weight loss has on RMR. During these weight loss interventions the subject’s had an average decrease in RMR of -15.4 +/- 8.7 kilocalories per kilogram of body weight. During shorter interventions, lasting from two to six weeks, the drop in RMR was significantly greater than studies lasting greater than six weeks (-27.7 +/- 6.7 vs. -12.8 +/- 7.1 kcal/kg) (p<.001). A greater drop in RMR was also seen in the studies that focused solely on calorie restriction compared with diet and exercise interventions. During weight loss, a slight decline in RMR might unavoidable. However, weight loss interventions should include both calorie restriction combined with exercise to maximize the RMR maintenance.

**Nutrition and Prevention of Weight Gain**

Franko et al., (2008) took an internet based approach in the attempt to motivate college students in making healthier food choices and increasing physical activity. Students were
randomly assigned to one of three groups, experimental I, II, or placebo group. Both experimental groups received two 45 minute web sessions from mystudentbody.com-nutrition that mainly focused on nutrition with a small portion on physical activity. The experimental II group had extra access to the website. The placebo group had an interactive anatomy course. All subjects completed questionnaires that obtained information about diet and exercise at baseline, post-test, and again at three and six month follow-ups. Both experimental groups increased their fruit and vegetable intake at post-test (P<0.01) and were more likely to advance a stage in readiness to change fruit and vegetable intake at post-test (p<0.0001). Experimental group II had significantly greater nutrition knowledge scores at post-test compared to control (P<0.05). Both experimental groups had greater self-efficacy and encouragement scores compared to control (P<.05), and scored lower on the barriers to exercise portion and higher on the benefits to exercise portion of the exercise benefits/barriers questionnaire (P<0.05). There was, however, no significant difference in physical activity for any group at any period of time. This study demonstrated that an internet based education program can motivate college students into making healthier lifestyle choices (Franko et al., 2008).

Peterson et al., (2010) focused on a short term intervention that involved a preintervention/postintervention written survey. The survey was administered in a dining hall to evaluate student’s perceptions on availability of healthy foods. Students were also asked to complete a food frequency questionnaire. Participants were between the ages of 18 and 23 years old, had a meal plan with the residence dining hall, and consumed at least three meals per week at the dining hall. The actual three week intervention started a month after the pre-surveys were collected because they didn’t want March (National Nutrition Month) to have any influence on the students. For the intervention, healthy choice indicators at point-of-selection were used to
increase awareness of healthy foods available in the dining hall. Ten healthy foods were targeted to try and increase selection with using a colorful logo of “The Right Stuff.” The signs used humor and benefit-based messages to draw attention to them and were hung in front of the ten targeted foods that were on the survey. A large sign at the entrance was also used to promote the “Right Stuff” and encourage selection of those ten healthy foods. Following the intervention, a post survey was sent through e-mail. Reminder e-mails were also sent out on three different occasions to remind participants to do the survey. There were 288 students that took the pre-survey, but only 104 completed the study. Eighty-three students indicated that healthy choices were easily identified at least some of the time. There was a decrease in consumption of fast food (P=0.009), junk food (P=0.001), and soft drinks (P<0.001). Self-reported use of cottage cheese (P<0.001) and low fat dressings (P=0.04) increased significantly but the analysis of fresh fruit did not reach significance. Also, no significant results were found in self-reported changes in intake of steamed vegetables, chicken breast, or salad.

College students, most of the time, are exposed to food choices that are low in nutrient density, but high in calories. They often find themselves choosing foods in settings that don’t include nutritional facts. Kolodinsky et al., (2007) examined self-reported eating habits, and examined whether those dietary choices were related to knowledge of dietary guidelines. There were 200, first year students that had a meal plan, surveyed. The subjects completed an online survey that examined self-reported eating behaviors and nutrition knowledge. Survey questions were tailored to the recommended daily intake of the subjects based upon the amount of physical activity they self-reported. Another section of the survey was based upon the Department of Agriculture Diet and Health Knowledge Survey. Results showed that the subjects with increased knowledge related to the dietary guidelines were more likely to choose fruits and vegetables,
whole grains, lean protein and low fat dairy products. Among college students, it appears that better food choices are interrelated with the knowledge of dietary guidelines.

A relationship between fruit and vegetable consumption, and a decreased risk of chronic diseases has been identified. Promoting fruit and vegetable consumption to college aged individuals is a good prevention tactic to decrease risks of chronic diseases because college students are at the age where they are starting to make their own food choices. The purpose of this study was to increase vegetable and fruit consumption in college students. Four-hundred and thirty seven college students between the ages of 18 and 24 years participated in this four month intervention. Students were randomized into a control or experimental group. The experimental group received four stage based newsletters, a motivational interview, and a tailored follow-up email. Two food frequency questionnaires were administered at the beginning and end of the study to assess dietary intake of both groups. Three hundred and fourteen students completed the study (72% completion rate). A significant increase in fruit and vegetable intake was found in the experimental group (P=0.04). In conclusion, this study demonstrated that college aged students can be motivated to increase their fruit and vegetable consumption (Richards et al., 2006).

Hivert et al., (2007) conducted a seminar-based intervention program to prevent weight gain in college students. This research was conducted over two academic years, making it more extensive then past studies. The experimental group received the seminars while the control did not. At the beginning of the study, 45 minute seminars were given every two weeks. The first couple of seminars focused on weight gain and its complications, recommended dietary allowance (RDA) values, and the benefits of exercise. The seminars that followed were designed to introduce behavioral modification methods, such as problem solving, goal setting, and monitoring strategies. The primary objective was to examine the effect the intervention had on
weight and BMI at the end of the two years. Secondary objectives were to assess changes in waist circumference, lean body mass, blood pressure, plasma lipid profile, physical activity level, fitness level, and food intake. Anthropometrics were measured at baseline, three, six, 12, 18, and 24 months. After a 12 hour fast, subjects had their height and weight taken using a stadiometer and a calibrated scale. Waist circumference was measured and bioelectrical impedance analysis was used to obtain body composition. Blood pressure was measured at the beginning and end of the study. Blood lipid profiles, including plasma cholesterol, triglycerides, and high-density lipoprotein (HDL), were measured at baseline and the end of the study. The Canadian fitness survey was used to assess physical activity and was measured at baseline, 1 year and at the end of the study. Three-day food diaries were completed every year using FUEL software to analyze the results. Results concluded that the experimental group did not gain weight over the two year period, but rather lost a little weight. The control group; however, gained weight over the two year period (P= 0.04). Self reported physical activity was not significantly different between the two groups. There was no difference in total caloric intake but while, triglyceride levels increased in the control group; they decreased in the experimental group. In addition, alcohol consumption increased in the control group and decreased in the experimental group. These findings demonstrated that a seminar based approach in the prevention of weight gain appears to be effective for college students.

LaRose et al., (2010) conducted a pilot study that focused on weight gain prevention in young adults. The subjects participated in an eight-week program with an additional eight weeks of follow up where they received lectures on either small changes or large changes. There were 52 subjects aged 18-35 years old that had a BMI between 23 kg/m² and 32 kg/m². Exclusion factors included having a history of an eating disorder, participating in another weight control
program, or a weight loss of >5% within the past six months. Subjects were randomly assigned to one of two groups: Small Change group (SC), which focused on small changes (changes in energy balance of ~200 kcal/day) and Large Change group (LC), which focused on large changes (initial weight loss of 5-10 lbs to buffer against future weight gains). Eight weekly lectures were given to focus on the particular type of change. Once the eight-week program was completed, subjects attended two monthly meetings and were told to continue monitoring daily weight. Subjects were instructed on how to compare their current weight to their goal weight. Subjects reported their weight using a weekly automated call-in system and monitored it by using a color zone system. Measurements that were taken included demographics, weight, frequency of weighing, manipulation check questions, and acceptability/satisfaction questionnaires. At week eight and week 16, the large change group lost significantly more weight than the small change group (P<0.001; P=0.006 respectively). Both groups were satisfied with the approach that was presented to them. After the program was complete, 75% of the individuals in the SC group felt that their approach was the most effective, while 72% of the participants in the LC group thought their approach was most effective. The study suggests that a self-regulated approach may be useful framework for preventing weight gain in young adults.

Normand and Osborne (2010) examined the effects that dietary feedback on calorie and fat consumption among college students. The purpose of this study was to lower caloric and fat consumption in college students who dined in on-campus establishments. There were four undergraduates, who lived and ate on campus that participated in this study. Each time the participants ate at the on-campus dining facility, their fat and calorie consumption was recorded by itemized receipts placed in a special box next to the register. Receipts were collected right before the dining hall closed. The subjects received a baseline graph of their total fat and calorie
consumption based upon their on-campus dining. Every two days, they received similar graphs depicting their calorie and fat intake along with a personalized food pyramid using MYPyramid from USDA. This was given to the students so they could compare their intake to what their recommended daily intake should be. The results for each participant were demonstrated via graphs. There was a reduction in calorie consumption and percent calories from fat during the intervention phase, for each participant. Food that was not eaten on-campus was not recorded; however, the participants continually purchased the same amount of meals during the study. This study showed that individual dietary feedback did have a reduction in total calorie and fat consumption.

College is a critical point to establish healthy lifestyle choices. Unfortunately, the number of overweight and obese college aged individuals is on the rise. Gow, Trace, and Mazzeo (2010) used an internet based approach to prevent weight gain in college freshman using participant monitoring, feedback and education on healthy lifestyle choices. The intervention was six weeks in length, with a three month follow up. One hundred and fifty-nine participated in the intervention. They were randomly assigned to one of four groups: 1) weight and caloric feedback coupled with a six week online educational intervention (combined intervention), 2) weight and caloric feedback only, 3) online intervention only, 4) control. Each group consisted of around 40 participants. The weight and caloric feedback group required participants to weigh themselves once a week and report that weight, which would be graphed and sent back to them. The online intervention was delivered once a week for six weeks. Each session lasted around 45 minutes and covered topics like overweight and obesity, the role of the “toxic” college environment, nutrition, increasing physical activity and decreasing sedentary behaviors, being mindful of satiety and hunger signs, motivation, and body image. Different surveys were given post-intervention
including the International Physical Activity Questionnaire, Binge Eating Scale, Block Food Screener, Body Rating Scale, Three Factor Eating Questionnaire, Eating Behaviors Questionnaire, Eating Disorder Inventory, Eating Disorder Screening Questions and Smoking Items. A demographic questionnaire and anthropometric measures were also measured. One hundred and nine students completed the study. For Body Mass Index (BMI), the combined intervention group had a significantly lower BMI than the control group (P<.05). Post-hoc comparisons also showed a significantly lower BMI for the combination group than both the feedback group and the internet intervention group (P<.05). For a question off the Eating Behaviors Questionnaire regarding the number of cigarettes smoked per day, the control group was significantly lower than the feedback group (P<.05). There was not a significant difference for any of the other parameters. This study demonstrated the effectiveness of an internet based intervention on weight gain in college freshman.

**Physical Activity**

Daily physical activity and planned exercise have declined, and different methods to increase them need to be created. In effort to do this, Ford and Torok (2008) examined whether motivational signage would increase physical activity in college students. This three-phase observational study monitored stair and elevator usage in a four story classroom building. The first phase involved observing how many individuals took the stairs and elevator. During the second phase, motivational signs were placed at the bottom of the stairs and inside and outside of the elevators. The motivational signs were then removed during the third phase and the stairs and elevator were monitored again for usage. Stair usage was increased with the motivational signs from 23.6% in phase one to 28% in phase two. Also, stair usage was maintained in phase three at
28.6%. The results to this study suggest that physical activity can be increased on a college campus by motivational factors. (Ford and Torok 2008)

Approximately one-fifth of college students participate in regular, moderate activity. Most physical activity interventions only center on exercise and exercise programs, not sport participation. Kilpatrick et al. (2005) examined the motivation college students showed towards sport participation versus exercise. Gender differences between these motivating factors were also examined. College students (n=233) with a mean age of 22.2 +/- 4.8 years were recruited for this study. Amount of physical activity was obtained via a four single-item indicator that assessed frequency, duration, intensity, and adherence. Motivation for physical activity was measured via two modified versions of the Exercise Motivation Inventory-2. Results showed exercise participation was significantly (P<0.001) more frequent than sport participation (3.58 +/- 1.46 days/wk; 2.14 +/- 1.95 days/wk). There was no significant difference between duration and adherence for exercise and sport. There was a greater extrinsic motivator for exercise, such as appearance and weight. For sport, there were more intrinsic motivating factors, including enjoyment and challenge. When comparing the gender differences, males had a higher level of motivation for challenge, competition, social recognition, strength, and endurance than females did (P<0.001). Weight management was a higher motivator in females than in males. In conclusion, this study found that motivators for exercise and sport participation differ. Exercise motivators are more of an extrinsic motivator whereas sport participation is an intrinsic motivator (Kilpatrick et al., 2005).

In college aged individuals, physical inactivity is a problem that needs to be addressed. Jackson and Howton (2008) hoped to promote an increase in physical activity with the use of pedometers. Two-hundred and ninety students participated. The subjects were required to wear
the pedometer five days out of the week, for 12 weeks. Daily number of steps taken was
recorded by the students. Weekly steps taken per day for weeks one, six and 12 were averaged
by the researchers. The subjects were categorized based upon their body mass index (BMI)
classification. A significant increase in steps taken per day was seen between weeks one and six
(P<.001), and continued to rise through week 12 (p<.002). Of the three BMI classifications, the
underweight individuals took significantly lower amount of steps per day when compared with
the normal weight individuals (p<.03); however, it was not significant when compared to the
overweight/obese subject’s. Results of this study support the use of pedometers as a tool to
increase physical activity in college students.
Chapter 3

Methods

The purpose of this study was to examine whether college students make healthier lifestyle choices after receiving information on individual resting metabolic rate and nutrition education.

Subjects

Forty-seven subjects between the ages of 19-24 years were recruited from Georgia Southern University. Recruitment was done through flyers and classroom recruitment. Individuals with a major in the College of Health and Human Sciences were not allowed to participate in the study. Individuals that qualified to participate were randomly assigned to one of four groups: Control (n=9), Resting Metabolic Rate (n=12), Education (n=10) and Combination (n=9). The Georgia Southern University Institutional Review Board (IRB) approved the protocol, and all participants signed an informed consent.

Protocols

Control Group: The control group had their RMR measured at baseline and at the end of the study, but did not receive any results or information on this number. In addition, they did not receive nutrition education. However, they did complete all three questionnaires. The International Physical Activity Questionnaire, the Food Frequency Questionnaire, and the Barriers to Exercise Questionnaire were given at baseline, two weeks, four weeks, and six weeks.
**Resting Metabolic Rate Group:** This group had their RMR measured at baseline and at the end of the study. During baseline measurement, the subjects received information on what the number meant, ways to increase it, and factors that influence RMR. They did not receive nutrition education. In addition, they completed all three questionnaires. The International Physical Activity Questionnaire, the Food Frequency Questionnaire, and the Barriers to Exercise Questionnaire were given at baseline, two weeks, four weeks, and six weeks.

**Nutrition Education Group:** The Education group had their RMR measured at baseline and at the end of the study, but did not receive any results or information on this number. This group received nutrition education via a nutrition education seminar. They also completed all three questionnaires. The International Physical Activity Questionnaire, the Food Frequency Questionnaire, and the Barriers to Exercise Questionnaire were given at baseline, two weeks, four weeks, and six weeks.

**Combination group:** This group had their RMR measured at baseline and at the end of the study and also received nutrition education. During baseline measurement, subjects received information on what the number meant, ways to increase it, and factors that influence RMR. They attended a one hour nutrition education seminar during week one of the study. They also completed all three questionnaires. Again, the International Physical Activity Questionnaire, the Food Frequency Questionnaire, and the Barriers to Exercise Questionnaire were given at baseline, two weeks, four weeks, and six weeks.
Data Collection

Resting Metabolic Rate (RMR)

*Medgem*: This device was used to assess resting metabolic rate. Measurements were obtained first thing in the morning in a room where both the temperature and lights were controlled. Subjects were asked to refrain from eating or drinking (except water) for 12 hours, refrain from caffeine use and exercise for at least 12 hours, and refrain from nicotine use the morning of the measurement. Subjects reported to the Hanner building, room 2209, for the measurement to be completed. Once subjects arrived, they were asked to sit and relax for ten minutes before administering the test. Once relaxed, the subjects placed their individual nose clips on their nose and breathed nasally to ensure no air was leaking out. The subjects were then asked to breathe normally into their individual mouth piece that was hooked onto the MedGem. The test took approximately ten minutes to measure and the subjects were asked to sit as still as possible for that time period to allow for an accurate measurement. Once the measurement was completed, the researcher recorded the number displayed on the MedGem screen (Compher, Hise, Sternberg, & Kinosian, 2005). The MedGem has a validity of 0.94, when compared to the Delta Track VH (Stewart, Branson, & Goody, 2005).

**Anthropometric Measurements**: Height and weight was obtained on all subjects from self-reported values. From the height and weight measurements, Body Mass Index (BMI) was calculated using the following calculation, Weight in kg/height in meters$^2$ (Hajhosseini et al., 2006).
Questionnaires

**International Physical Activity Questionnaire (IPAQ):** The short version of the IPAQ, which is formatted to answer questions about activity in the last seven days, was used. The seven questions addressed frequency, intensity, and time. The subjects took the questionnaire online via survey monkey at baseline, two weeks, four weeks, and six weeks. The criterion-related validity is 0.35 and the test-retest reliability is 0.8 (Franko et al. 2008).

**Food Frequency Questionnaire (FFQ):** This questionnaire was used to assess food intake. Subjects took the questionnaire online via survey monkey at baseline, two weeks, four weeks, and six weeks. The 17-item questionnaire addressed intake of fruit, vegetable, fat, and fiber. Correlations from screener estimate and estimate of true intake range from 0.5 to 0.8 (Thompson, Midthune, Subar, Kahle, Schatzkin, & Kipnis, 2004).

**Exercise Benefits/Barriers Questionnaire:** This was used to assess barriers towards exercise. Subjects only took the barriers portion of the questionnaire, which included 14 items on a four point likert scale. Like the other questionnaires, this was taken online via survey monkey and was completed at baseline, two, four, and six weeks. The scale has a test-retest reliability of .77. (Sechrist, Walker, & Pender, 1987) and a validity of .80 (Ortabag, Ceylan, Akyuz & Bebis, 2010).

Nutrition Education

**Eating healthy on the go (dining out):** This part of the seminar included demonstrating healthier food options from popular food establishments around Georgia Southern. In addition to
educating on healthier options, calorie content of both healthy and unhealthy food items were discussed. Suggestions from the American Dietetic Association website, eatright.org, were emphasized. Different strategies to cut calories when dinning out were also discussed. In addition, participants learned about healthy side dishes. Because portion sizes tend to be too large at restaurants, subjects were educated on how to control portions when eating out (Andajani-Sutjahjo, Ball, Warren, Inglis & Crawford 2004).

**Eating healthy on a budget:** This section of the seminar was based on how students can eat healthier on a tight budget. Different tips of how to eat healthy were discussed (Andajani-Sutjahjo., et al 2004).

**Portion control:** This included portion distortion from the National Heart, Lung and Blood Institute that shows how portions have changed over the years. This part of the seminar was for the shock factor. Proper portion sizes were also shown. Food models and other items were used to educate the subjects on proper portion sizes on popular foods (Hivert, Langlois, Berard, Cuerrier, and Carpentier 2007).

**“Fad” diets:** This section did not focus on any particular fad diet, but discussed some of the main claims. Individuals learned how to spot false claims and how to make permanent behavior changes (Hivert., et al 2007)
**Healthy grocery shopping:** This part of the seminar included tips from eatright.org. Topics that were covered included how to stock the grocery cart with healthy food items and how and what to read on nutrition labels (Hivert., et al 2007)

**Study timeline**

**Baseline:** Subjects were randomly assigned to a group and informed on what their group assignment would involve. Informed consent was signed at the subject’s convenience during the researchers’ office hours. All of the subjects were contacted to make an appointment to get their resting metabolic rate measured in Hanner 2209. During RMR measurements, subjects in the Nutrition Education Group and Combination Group signed up for a nutrition seminar.

**Week 1:** Subjects in the Nutrition Education Group and the Combination Group attended the nutrition seminar.

**Week 2-6:** Subjects were notified on a weekly basis, using text messages, to remind them to take the three questionnaires online via survey monkey.

**Week 7:** All of the subjects were contacted to make an appointment to get their resting metabolic rate measured, for the last time, in Hanner 2209.

**Statistical Analysis**

Statistical analyses were conducted using IBM SPSS Statistics 19. A Two-Way ANOVA with repeated measures was used to measure physical activity (vigorous, moderate, walking, and
sitting for minutes per week), dietary intake (daily servings of fruit and vegetables, grams of fat, and grams of fiber) and barriers to exercise (Scores will range from 14 to 56). Furthermore, Fisher’s LSD was used as a follow-up to significant main effects. Significance was set at P<.05.
Chapter 4

Results

Subject Characteristics

The demographics of the participants are depicted in Table 1 and are individualized by the four different groups. Forty seven students initially began the study. However, three students failed to show up for their Resting Metabolic Rate (RMR) measurement, one student failed to attend the nutrition education seminar, and three could not come back for their final RMR measurement. Therefore, forty students (85%) completed the study. This study was divided up evenly between males (n=20) and females (n=20). Twenty-eight Caucasians (70%), 10 African Americans (25%), and two Hispanics (5%) made up the racial background of the study. There were no significant differences for the demographics between the four different groups.

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Control</th>
<th>RMR</th>
<th>Education</th>
<th>Combination</th>
<th>Total (n)</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>5</td>
<td>8</td>
<td>1</td>
<td>6</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>Females</td>
<td>4</td>
<td>4</td>
<td>9</td>
<td>3</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>Age (years)</td>
<td>20.5 +/- .60</td>
<td>19.7 +/- .25</td>
<td>19.8 +/- .38</td>
<td>20.4 +/- .53</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 depicts the participant’s body mass index (BMI) and the RMR measurements at the beginning and end of the study. There was no significant change in RMR over the six weeks for any group. Fifty-five percent of the participants had a normal BMI, and 45% were overweight or obese.
Table 2. BMI and Resting Metabolic Rate

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>RMR</th>
<th>Education</th>
<th>Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>74.09 +/-15.39</td>
<td>74.24 +/-20.33</td>
<td>68.77 +/-12.74</td>
<td>71.61 +/-12.80</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.69 +/- .09</td>
<td>1.73 +/- .09</td>
<td>1.67 +/- .05</td>
<td>1.73 +/- .09</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>25.88 +/- 5.23</td>
<td>24.11 +/- 4.41</td>
<td>24.58 +/- 4.46</td>
<td>23.64 +/- 3.32</td>
</tr>
<tr>
<td>RMR (pre-test)</td>
<td>1688.89 +/-183.60</td>
<td>1643.33 +/-287.47</td>
<td>1477.00 +/-249.80</td>
<td>1783.33 +/-379.04</td>
</tr>
<tr>
<td>RMR (post-test)</td>
<td>1621.11 +/-243.53</td>
<td>1585.83 +/-320.89</td>
<td>1487.00 +/-230.89</td>
<td>1682.22 +/-310.71</td>
</tr>
</tbody>
</table>

Food Frequency Questionnaire

Table 3 depicts the mean (+/- SD) fruit and vegetable servings, fiber grams, and percent of total energy from fat, throughout the study. The participant’s answers for the fruit and vegetable portion of the food frequency questionnaire were scored using the Multifactor Screen scoring procedures (“Multifactor screener,” 2010) that converted answers into total servings. A serving of fruit consists of one cup fresh or a half cup of dried and a serving of vegetables is one cup cooked or raw, and two cups of raw leafy greens ("Food groups," 2011). The test for sphericity showed that the assumption was violated (p<.01). Therefore, the Greenhouse Geisser adjustment was used. There was not a significant effect for the fruits and vegetables variable (p=.488) over the length of the study. Nor was there a significant effect within the groups for the four fruit and vegetable survey responses (p=.669). However, there was a significant effect between the four different groups (p=.008). The Fisher’s LSD post hoc tests showed the average fruit and vegetable consumption for the Resting Metabolic Rate Group and the Combination Group were significantly higher (p=.007; p=.002 respectively) than the Control group. The Combination group was also significantly higher than the Education group (p=.036).

Again, the Multifactor Screener scoring procedures were used to calculate grams of fiber ("Multifactor screener, 2010"). The test for sphericity showed that the assumption was violated (p<.01). Therefore, the Greenhouse Geisser adjustment was used. There was no significance for
the fiber variable through the six weeks (p = .386). No significant effect within the subjects for the four different fiber survey questions (p = .773) or between the four different groups was observed (p = .216).

The same scoring procedures were used one more time to turn the subject’s survey answers into percent of energy from fat. The test for sphericity was assumed (p = .086). Therefore, the Sphericity Assumed adjustment was used. Fat grams, throughout the study, didn’t show significance (p = .810) nor was a significant interaction within the groups found (p = .246). No significant difference was seen when comparing the four different groups to each other (p = .494).

<table>
<thead>
<tr>
<th>Table 3. Food Frequency Questionnaire Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrient</td>
</tr>
<tr>
<td>Fruits and Vegetables (# of servings)</td>
</tr>
<tr>
<td>Control</td>
</tr>
<tr>
<td>RMR *</td>
</tr>
<tr>
<td>Education</td>
</tr>
<tr>
<td>Combination*</td>
</tr>
<tr>
<td>Fiber (grams)</td>
</tr>
<tr>
<td>Control</td>
</tr>
<tr>
<td>RMR</td>
</tr>
<tr>
<td>Education</td>
</tr>
<tr>
<td>Combination*</td>
</tr>
<tr>
<td>Fat (% energy)</td>
</tr>
<tr>
<td>Control</td>
</tr>
<tr>
<td>RMR</td>
</tr>
<tr>
<td>Education</td>
</tr>
<tr>
<td>Combination*</td>
</tr>
</tbody>
</table>

*Significance = P < .05
Physical Activity Questionnaire

Table 4 represents the mean (+/− SD) activity level, including vigorous and moderate activity, walking, and sitting for each of the groups during the six weeks. The participant’s activity answers for vigorous, moderate and sitting were calculated into total minutes during the week. For the sitting variable, only the weekdays (Monday-Friday) were included in the total minutes.

**Vigorous activity:** The variable is defined in the International Physical Activity Questionnaire (IPAQ) as heavy lifting, aerobics, or fast cycling for greater than ten minutes. The test for sphericity showed that the assumption was violated (p<.01). Therefore, the Greenhouse Geisser adjustment was used. The vigorous activity variable, throughout the six weeks, was shown to be insignificant (p= .213). There was no significant effect within the four different groups (p= .059) or between the four different groups (p= .154).

**Moderate activity:** The variable is defined in the IPAQ as doubles tennis, carrying light loads, and bicycling at a regular pace for greater than ten minutes. The test for sphericity showed that the assumption was violated (p=.029). Therefore, the Greenhouse Geisser adjustment was used. Throughout the six week study, the moderate activity variable was not significant, (p= .839) nor was a significant interaction within the groups found (p=.279). There was no significant group effect (p= .156).

**Walking:** The test for sphericity showed that the assumption was violated (p<.01). Therefore, the Greenhouse Geisser adjustment was used. There was not a significant effect for total walking minutes (p= .456) or within the four different groups over time (p=.721). In addition, no significant effect was seen between the four groups (p= .172).
Sitting: The test for sphericity showed that the assumption was violated (p=.016). Therefore, the Greenhouse Geisser adjustment was used. Throughout the study, there was not a significant effect for total sitting minutes (p=.425) or within the four different groups (p=.579). No significant difference was seen between the groups (p=.573).

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Two Weeks</th>
<th>Four Weeks</th>
<th>Six Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vigorous activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Minutes/week)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>170.00 +/- 176.21</td>
<td>120.00 +/-120.00</td>
<td>193.33 +/-181.93</td>
<td>170.00 +/-181.24</td>
</tr>
<tr>
<td>RMR</td>
<td>92.00 +/-125.10</td>
<td>415.00 +/-578.03</td>
<td>182.50 +/-302.23</td>
<td>195.83 +/-236.46</td>
</tr>
<tr>
<td>Education</td>
<td>135.00 +/-149.16</td>
<td>75.00 +/-99.24</td>
<td>84.00 +/-123.93</td>
<td>81.00 +/-123.32</td>
</tr>
<tr>
<td>Combination</td>
<td>408.33 +/-497.48</td>
<td>420.00 +/-493.58</td>
<td>248.33 +/-180.17</td>
<td>218.33 +/-193.42</td>
</tr>
<tr>
<td>Moderate Activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Minutes/week)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>133.33 +/-157.57</td>
<td>172.22 +/-170.49</td>
<td>213.33 +/-399.53</td>
<td>152.77 +/-162.57</td>
</tr>
<tr>
<td>RMR</td>
<td>104.17 +/-116.96</td>
<td>140.00 +/-123.93</td>
<td>176.25 +/-154.55</td>
<td>232.91 +/-341.82</td>
</tr>
<tr>
<td>Education</td>
<td>150.00 +/-255.34</td>
<td>199.00 +/-317.82</td>
<td>91.50 +/-93.86</td>
<td>151.50 +/-254.71</td>
</tr>
<tr>
<td>Combination</td>
<td>517.78 +/-733.83</td>
<td>255.56 +/-146.97</td>
<td>267.22 +/-185.92</td>
<td>265.00 +/-171.02</td>
</tr>
<tr>
<td>Walking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Minutes/week)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>698.33 +/-661.40</td>
<td>519.44 +/-682.86</td>
<td>614.44 +/-722.04</td>
<td>528.33 +/-613.60</td>
</tr>
<tr>
<td>RMR</td>
<td>719.17 +/-980.33</td>
<td>1011.25 +/-1305.44</td>
<td>1245.00 +/-1516.12</td>
<td>1004.16 +/-1522.96</td>
</tr>
<tr>
<td>Education</td>
<td>304.50 +/-308.06</td>
<td>333.00 +/-277.00</td>
<td>214.00 +/-144.83</td>
<td>303.00 +/-316.76</td>
</tr>
<tr>
<td>Combination</td>
<td>998.33 +/-1285.26</td>
<td>1078.89 +/-1102.07</td>
<td>1642.78 +/-2851.48</td>
<td>1670.00 +/-2840.33</td>
</tr>
<tr>
<td>Sitting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Minutes/weekday)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1371.43 +/-741.06</td>
<td>1800.00 +/-783.53</td>
<td>1533.33 +/-732.58</td>
<td>1623.80 +/-580.72</td>
</tr>
<tr>
<td>RMR</td>
<td>1547.32 +/-781.26</td>
<td>1892.85 +/-730.70</td>
<td>1400.00 +/-906.62</td>
<td>1450.00 +/-709.13</td>
</tr>
<tr>
<td>Education</td>
<td>1804.29 +/-918.17</td>
<td>1710.00 +/-843.32</td>
<td>1590.00 +/-649.16</td>
<td>1871.42 +/-697.32</td>
</tr>
<tr>
<td>Combination</td>
<td>1157.14 +/-812.02</td>
<td>1319.04 +/-654.45</td>
<td>1547.62 +/-1024.42</td>
<td>1447.61 +/-842.49</td>
</tr>
</tbody>
</table>

40
Barriers to Exercise Questionnaire

Table 5 represents the mean (+/-SD) barriers score for each group during the six week study. The subject’s answers to the barriers to exercise survey were added and calculated to give a score. The higher the score, the higher the barriers towards exercise. The test for sphericity showed that the assumption was violated (p<.01). Therefore, the Greenhouse Geisser adjustment was used. There was a significant effect for barriers towards exercising throughout the six weeks (p=.027). The contrast showed a significant difference between the second week and the fourth week (p=.024). There was not a significant interaction within the groups for the barrier surveys given overtime (p=.638). Also, there was not a significant difference when comparing the four different groups to each other (p=.982).

<table>
<thead>
<tr>
<th>Barriers to Exercise</th>
<th>Baseline</th>
<th>Two Weeks</th>
<th>Four Weeks</th>
<th>Six Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>29 +/-5</td>
<td>28 +/-5*</td>
<td>31 +/-6*</td>
<td>31 +/-6</td>
</tr>
<tr>
<td>RMR</td>
<td>29 +/-4</td>
<td>29 +/-3*</td>
<td>31 +/-5*</td>
<td>31 +/-5</td>
</tr>
<tr>
<td>Education</td>
<td>28 +/-5</td>
<td>30 +/-4*</td>
<td>31 +/-5*</td>
<td>31 +/-5</td>
</tr>
<tr>
<td>Combination</td>
<td>30 +/-5</td>
<td>31 +/-5*</td>
<td>31 +/-5*</td>
<td>31 +/-6</td>
</tr>
</tbody>
</table>

*Significance = P<.05
Chapter 5

Discussion

In the United States, the rate of overweight and obesity continues to rise. This increase can be evidently seen on the average college campus. Physical inactivity and poor food choices are the main culprits for this continuous rise in obesity. Past research has had mixed results when evaluating proper interventions that may decrease obesity, because no current studies have incorporated knowledge of resting metabolic rate (RMR) as an intervention tactic, this study set out to determine whether RMR knowledge and/or nutrition education would have a positive impact on healthy lifestyle choices among college-aged students.

Body Weight and Resting Metabolic Rate

According to data from the National College Health Risk Behavior Survey (NCHRBS), approximately 35% of college students are categorized as overweight or obese (Lowry, et al 2000). Overweight is defined as having a body mass index (BMI) of 25-29.9 kg/m², and obese being a BMI of 30 kg/m² or greater. The current study, however, was almost divided in half between normal weight (55%) and overweight or obese (45%) individuals, based on BMI. In contrast, Huang., et al (2003) had 26.5% of participants as overweight or obese according to BMI. Hajhosseini., et al (2006) and Hoffman, Policastro, Quick and Lee (2006) examined body weight and body composition in regards to the “Freshman 15”. In contrast to the current study, both had levels of overweight or obese participants in ranges lower than the NCHRBS (25.9%; 22% respectively). The difference in levels of overweight and obese participants may be due to the region the data was collected. The data for the current study was collected in Georgia that has
an obesity rate of 29.6% ("U.S. obesity trends," 2011). The other studies were conducted in New Jersey (23.8%), Kansas (29.4%), and California (24%) ("U.S. obesity trends," 2011).

The current study also examined participants resting metabolic rate (RMR) at baseline and at the end of the six weeks. Similar to Hajhosseini., et al (2006), there were no significant changes in the subject’s RMR. In contrast to Hajhosseini, et al (2006), the present study informed subjects on their RMR, and some subjects were educated on what that number represents, benefits of increasing it, and ways to increase it, in hopes of sparking a desire to be more physically active and make healthier food choices. Stieglar and Cunliffe (2006) and Schwartz and Doucet (2009) reviewed a vast number of interventions that used diet, exercise, or a combination for weight loss. Changes in RMR were measured in each study reviewed. Any changes found were mainly due to the increase or decrease in fat free mass (FFM) or highly metabolically active muscle. In contrast, there were no significant changes in the subject’s RMR over the six weeks; indicating that a significant change in body composition was unlikely. Significant decreases in RMR can be seen in weight loss interventions due to a decrease in FFM. Hunter, et al (2008) noted a significant decrease in RMR in the participants not participating in resistance training during a weight loss intervention. In contrast to the current study, no changes in RMR were observed. This may be due to the absence of a planned exercise regimen for the subject’s.

**Nutrition and Prevention on Weight Gain**

Previous studies have evaluated ways to motivate college aged students into healthier eating habits via increasing their fruit and vegetable intake or providing them general nutrition knowledge.
In this particular study, there was a significant difference in fruit and vegetable consumption between the groups. The RMR Group and the Combination Group consumed significantly more fruits and vegetables than the control group. In addition, the RMR Group ate significantly more fruits and vegetables than the Education Groups. No significant difference between groups was found for mean fiber intake or fat intake. There was also no significant difference in any of the three variables over time. In contrast to these results, Richards, Kattelmannm and Ren (2006), found a significant increase in fruit and vegetable consumption after using newsletters and motivational interviews. However, subjects were stratified by stage of change for fruit and vegetable consumption which may be the reason for the significant results. Also, the intervention was tailored in promoting fruits and vegetables, whereas the current study only had a one-time nutrition seminar that focused on general nutrition tips. Similar to the present study, Franko., et al (2008) had no significant change in percent of energy from fat after an internet-based education program. However, they did find a significant increase in fruit and vegetable consumption. This could be due to the fact that they had two 45 minute internet web sessions, while the present study only had one in person educational session. Surprisingly, similar findings were seen in Gow, Trace and Mazzeo (2010) that examined a six week intervention to combat the “Freshman 15”. No significant difference was seen for fruit, vegetable, fat, and fiber intake at the end of the study. The weekly, 45 minute web session that encompassed all aspects of health during the college years did not increase healthy food choices; therefore it can be concluded that more measures need to be taken to encourage healthy food choices.
Physical Activity

Lowry., et al (2000) used data from the National College Youth Risk Behavior Survey that analyzed 4609 undergraduate college students. Only 19.5% of students reported participating in moderate activity for five or more days per week. The current study used the International Physical Activity Questionnaire to assess vigorous and moderate activity, walking and total sitting minutes per week. When initial recruitment began, sedentary individuals were a part of the selection criteria; however, it was dropped due to the lack of response from that particular group of people. There was not a significant difference between any of the groups for any of the activity measures. Similarly, Franko., et al (2008) and Gow., et al (2010) had no significant difference in the participant’s physical activity measures. This may be due to the fact that they are self-reported values. The subjects had the potential to over and under estimate on any parameter. In contrast with the current study, Ford and Torok (2008) and Jackson and Howton (2008) had significant increases in physical activity. Ford and Torok (2008) used motivational signage to increase stair usage, and Jackson and Howton (2008) used pedometers to increase number of steps taken per day.

There was a significant increase in barriers towards exercise between the second and fourth week of the intervention. Research has shown mixed results. In contrast to the current study, Franko., et al (2008) found that intervention groups had significantly lower barriers towards exercise score than the control group at the six month assessment. They did include physical activity into their web session and the present study did not include a physical activity presentation. The increase in barriers towards the end of the current study may be because the end of the semester was approaching and school work was becoming a priority.
A limitation of this study is the accuracy of the participant’s answers for both the food frequency questionnaire and the activity questionnaire. Subjects may have over or underestimated their food consumption or activity levels, which may have affected the results. There were also only three different ethnicities, which may not make the results generalizable. Also, since there was a prize at the end of the study, motivation could have been strictly for the chance to win. Another limitation of this study was the subject’s heart rate, which was not taken into account prior to the RMR measurements. It was up to the subjects to be in a fasted state, and refrain from exercise, caffeine, and nicotine at least 12 hours prior to measurement. If the participants had an elevated heart rate prior to testing, it could have affected the results. Another limitation of the study was that body composition was not considered. Body Mass Index (BMI) was the only item used to put them in the normal, overweight/obese categories; this was based on self-reported height and weight, so these numbers could have been inaccurate. Lastly, the study had a small sample size, which may have affected the overall results.

In the future, studies could use a 3-day dietary recall instead of a food frequency questionnaire. Normand and Osborne (2010) demonstrated that informing college students of their caloric and fat content promoted a decrease in both. Therefore, letting the subjects relate their RMR with their caloric consumption may be beneficial in not only promoting healthier food choices, but also increasing physical activity. A good addition to the study would have been heart rate monitors and an exercise session to show students just how many calories exercise can burn. Past research has supported that increased knowledge appears to be related to an increase in healthy behavioral patterns (Kolodinsky et al., 2007). Taking their anthropometrics, instead of having them be self-reported, in addition should be included. Also, it may be beneficial to have more time spent with the researcher. A longer intervention may also be more beneficial in
facilitating a change. Finally, although it was attempted, sedentary individuals would be an ideal candidate for a study of this kind instead of people who already participate in regular physical activity.

Informing an individual on their Resting Metabolic Rate (RMR) did not appear to increase an individual’s physical activity or decrease barriers towards exercise. Also, a one-time nutritional seminar did not decrease fat, or increase fiber and fruit and vegetable consumption. College-aged individuals can be difficult to motivate in changing current dietary and physical activity behaviors. In order to encourage them to adopt healthier food choices, more needs to be provided. In addition, to increase physical activity more information needs to be given so they can actually compare their RMR to other factors, such as their daily caloric intake and energy expenditure via exercise. More appropriate interventions need to be developed to help lower the incidence of overweight and obesity in college-aged individuals.
References


*Save time and money at the grocery store.* (n.d.). Retrieved from http://www.eatright.org/Public/content.aspx?id=11628


PART 1. Please think about what you usually ate or drank during the past month, that is, the past 30 days. Please read each question carefully and:

- Report how many times per day, week, or month you ate each food.
- Choose the best answer for each question.
- Mark only one response for each question.

1. How many times per day, week, or month did you usually eat cold cereals?

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2. How many times per day, week, or month did you use milk, either to drink or on cereal?

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2a. What kind of milk did you usually use? (Pick the one you used most often).

1. Whole milk
2. 2% fat
3. 1% fat
4. 1/2% fat
5. Non-fat or skim
6. DID NOT DRINK MILK IN PAST MONTH.

3. How many times per day, week, or month did you usually eat bacon or sausage, not including low fat, light, or turkey varieties?

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4. How often did you eat hot dogs made of beef or pork?

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5. How often did you eat whole grain bread including toast, rolls, and in sandwiches? Whole grain breads include whole wheat, rye, oatmeal, and pumpernickel.

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11. How often did you eat other white potatoes? Count baked potatoes, boiled potatoes, mashed potatoes, and potato salad. Do not include yams or sweet potatoes.

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12. How often did you eat cooked dried beans, such as refried beans, baked beans, bean soup, and pork and beans?

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13. How often did you usually eat other vegetables?

**COUNT:**
- Any form of vegetable—raw, cooked, canned, or frozen.

**DO NOT COUNT:**
- Lettuce salads
- White potatoes
- Cooked dried beans
- Rice

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14. How many times per day, week, or month did you usually eat any kind of pasta? Count spaghetti, noodles, macaroni and cheese, pasta salad, rice noodles, soba, and any other kind of pasta.

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15. How often did you eat peanuts, walnuts, seeds, or other nuts? Do not include peanut butter.

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16. How often did you eat regular fat potato chips, tortilla chips, or corn chips? Do not include low-fat chips.

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1a. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling? 
Think about only those physical activities that you did for at least 10 minutes at a time.

_______ days per week

1b. How much time in total did you usually spend on one of those days doing vigorous physical activities?

_______ hours _______ minutes

☐ none

2a. Again, think only about those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_______ days per week

2b. How much time in total did you usually spend on one of those days doing moderate physical activities?

_______ hours _______ minutes

☐ none

3a. During the last 7 days, on how many days did you walk for at least 10 minutes at a time? This includes walking at work and at home, walking to travel from place to place, and any other walking that you did solely for recreation, sport, exercise or leisure.

_______ days per week

3b. How much time in total did you usually spend walking on one of those days?

_______ hours _______ minutes

☐ none

The last question is about the time you spent sitting on weekdays while at work, at home, while doing course work and during leisure time. This includes time spent sitting at a desk, visiting friends, reading traveling on a bus or sitting or lying down to watch television.

4. During the last 7 days, how much time in total did you usually spend sitting on a week day?

_______ hours _______ minutes

This is the end of questionnaire, thank you for participating.
APPENDIX C

EXERCISE BENEFITS/BARRIERS SCALE

DIRECTIONS: Below are statements that relate to ideas about exercise. Please indicate the degree to which you agree or disagree with the statements by circling SA for strongly agree, A for agree, D for disagree, or SD for strongly disagree.

1. I enjoy exercise.
2. Exercise decreases feelings of stress and tension for me.
3. Exercise improves my mental health.
4. Exercising takes too much of my time.
5. I will prevent heart attacks by exercising.
6. Exercise tires me.
7. Exercise increases my muscle strength.
8. Exercise gives me a sense of personal accomplishment.
9. Places for me to exercise are too far away.
10. Exercising makes me feel relaxed.
11. Exercising lets me have contact with friends and persons I enjoy.
12. I am too embarrassed to exercise.
13. Exercising will keep me from having high blood pressure.
14. It costs too much to exercise.
15. Exercising increases my level of physical fitness.
16. Exercise facilities do not have convenient schedules for me.
17. My muscle tone is improved with exercise.
18. Exercising improves functioning of my cardiovascular system.
19. I am fatigued by exercise.
20. I have improved feelings of well being from exercise.
21. My spouse (or significant other) does not encourage exercising.
22. Exercise increases my stamina.  
23. Exercise improves my flexibility.  
24. Exercise takes too much time from family relationships.  
25. My disposition is improved with exercise.  
26. Exercising helps me sleep better at night.  
27. I will live longer if I exercise.  
28. I think people in exercise clothes look funny.  
29. Exercise helps me decrease fatigue.  
30. Exercising is a good way for me to meet new people.  
31. My physical endurance is improved by exercising.  
32. Exercising improves my self-concept.  
33. My family members do not encourage me to exercise.  
34. Exercising increases my mental alertness.  
35. Exercise allows me to carry out normal activities without becoming tired.  
36. Exercise improves the quality of my work.  
37. Exercise takes too much time from my family responsibilities.  
38. Exercise is good entertainment for me.  
39. Exercising increases my acceptance by others.  
40. Exercise is hard work for me.  
41. Exercise improves overall body functioning for me.  
42. There are too few places for me to exercise.  
43. Exercise improves the way my body looks.
INFORMED CONSENT
Individual Resting Metabolic Rate and Nutrition Education: Does this knowledge lead individuals into making healthier lifestyle choices?

1. Principal Investigators: Melissa Updyke, Masters Student, Sports Nutrition, 678-633-4922

2. Purpose of the Study: The purpose of this study is to examine whether college students make healthier lifestyle choices after receiving information on individual resting metabolic rate and/or nutrition education.

3. Procedures to be followed: You will randomly be placed into one of four groups. Following an overnight fast, you will report to Hollis 2118 A pre- and post the six-week study to have your height, weight, and resting metabolic rate measured. Once you arrive, you will first sit still for five to ten minutes to get in a relaxed state. Once relaxed, you will place your nose clip on and breathe nasally to ensure no air is leaking out. You should then breathe normally into your mouth piece that will be hooked onto the MedGem. The test will take approximately five to ten minutes to measure and you will be asked to sit as still as possible for that time period to allow for an accurate measurement. When the MedGem beeps, your measurement is complete and you may remove the mouth piece and nose clip. In addition, you will also be asked to complete online surveys at baseline and during weeks two, four, and six. You also may be asked to attend a onetime nutrition seminar.

4. Discomforts and Risks: Some individuals may find the nose clips uncomfortable while measuring their resting metabolic rate due to them having to breathe solely through their mouth. If the individual does find it uncomfortable, a soft tissue will be placed between the nose and clip. This will minimize discomfort. Also, some individuals might experience some unpleasant psychological effects after learning their BMI classification.

5. Benefits: The present study hopes to further the literature on ways to encourage individuals into making healthier lifestyle choices.

6. Duration/Time: Resting metabolic rate and weight will be measured at baseline and at the completion of the study. A onetime nutrition education seminar may be required at the beginning of the study. Online surveys will be completed on four separate occasions (baseline and weeks two, four, and six).

7. Statement of Confidentiality: All scientific and personal data collected on subjects for presentation purposes will be kept confidential and stored in a locked file drawer in Hollis 2118A. This information will be available only to the principal investigators. Your identity will not be
revealed in publications or presentations that result from this study so as to protect your privacy and confidentiality. All data will be reported as means and standard errors.

8. **Right to Ask Questions:** You have the right to ask questions and have those questions answered. If you have questions about this study, please contact Melissa Updyke, Masters Student, Sports Nutrition, 678-633-4922, mupdyke1@georgiasouthern.edu or Dr. Amy Jo Riggs, RD, Ph.D., Assistant Professor, Department of Health and Kinesiology, 478-7753, ajriggs@georgiasouthern.edu. For questions concerning your rights as a research participant, contact Georgia Southern University Office of Research Services and Sponsored Programs at IRB@georgiasouthern.edu or 912-486-0843.

9. **Compensation:** There will be a drawing at the end of the study for three people to receive Wal-Mart gift cards.

10. **Voluntary Participation:** Your participation in this study is entirely voluntary. If you decide to participate, you are free to withdraw your consent and to stop participating at any time without penalty or loss of benefits to which you are otherwise entitled.

11. **Penalty:** If you decide not to participate, you will not be penalized, and you will not lose any benefits or services to which you are otherwise entitled.

12. You must be 18 years of age or older to consent to participate in this research study. If you consent to participate in this research study and to the terms above, please sign your name and indicate the date below.

You will be given a copy of this consent form to keep for your records.

**Title of Project:** Individual Resting Metabolic Rate and Nutrition Education: Does this knowledge lead individuals into making healthier lifestyle choices?

**Principal Investigators:**
Melissa Updyke, Masters Student, Sports Nutrition, 678-633-4922
Amy Jo Riggs, RD, Ph.D., Assistant Professor, Department of Health and Kinesiology, 478-7753

________________________  __________________________
Participant Signature     Date

I, the undersigned, verify that the above informed consent procedure has been followed.

________________________  __________________________
Investigator Signature     Date