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Cross-Validation Of A Recently Published Equation Predicting Energy Expenditure To Run Or Walk A Mile In Normal Weight And Overweight Adults

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CROSS-VALIDATION OF A RECENTLY PUBLISHED EQUATION PREDICTING ENERGY EXPENDITURE TO RUN OR WALK A MILE IN NORMAL WEIGHT AND OVERWEIGHT ADULTS

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ABSTRACT

An equation recently published by Loftin, et al. (2010) was cross-validated using 30 subjects consisting of 10 normal weight walkers, 10 overweight walkers, and 10 distance runners. Gender was balanced across sub-groups. Participants walked or ran for 5 minutes at their preferred pace. Preferred walking pace was determined by six timed 50-ft trials and preferred running pace by the runner's typical training pace. Energy expenditure (EE) was determined via indirect calorimetry and reported in absolute units (kcal), and corrected to a mile distance. Body composition was assessed via DXA. EE per mile was predicted using the Loftin, et al. (2010) equation. The equation [Kcal = mass (kg) x 0.789 – gender (men=1, women=2) x 7.634 + 51.109; R^2 = 0.632, SEE = 10.9 kcal/mile] yielded a mean of 99.7 $\pm$ 10.9 kcal/mile which was significantly different ($p < 0.05$) than the measured mean of the cross-validation group (107.8 $\pm$ 15.5 kcal/mile). However, the mean was within the standard error of the estimate of the original equation. Further analysis included a Chow test which yielded no significant differences between regression coefficients of the original equation and the cross-validation (CV) group [Kcal = mass (kg) x 0.825 – gender (men=1, women=2) x 1.687 + 47.6; R^2 = 0.625, SEE = 9.82 kcal/mile] equation. Also, absolute EE per mile for the CV group was similar across sub-groups. It appears the Loftin, et al. regression equation is useful for exercise prescription in that it allows for the prediction of EE for either walking or running a mile in normal weight and overweight adults.

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CHAPTER I

INTRODUCTION

The ability to accurately predict energy requirements for individuals is important for weight management (Mifflin, St. Jeor, Hill, Scott, Daugherty, & Koh, 1990). Even a modest weight loss of 10% can generate many positive effects not only in physical health, but also for an individual's self-esteem (Larsson & Mattsson, 2003). In order to simply maintain current weight, energy expenditure (EE) must equal intake (Welle, Forbes, Statt, Barnard, & Amatruda, 1992). To reduce mass there must be a greater amount of energy expended than consumed, or a decrease in energy intake (Welle et al., 1992). An accurate method for determining overall energy requirements and expenditure is important for normal weight and overweight populations (Mifflin et al., 1990). Limited research has examined overweight men and women when assessing EE to walk or run a mile (Loftin, Waddell, Robinson, & Owens, 2010).

Total energy expenditure (TEE) is composed of resting energy expenditure (REE), which makes up 50-80% of energy use, thermic effect of food digestion (about 10%), and non-resting energy expenditure (10-40%) (Heilbronn et al., 2006). TEE can be increased by prolonging exercise activity or raising the intensity of exercise (Ekkekakis & Lind, 2006). However overweight individuals tend to experience a greater amount of muscular and skeletal pain or intolerance to increases in exercise intensity thus leading to a less pleasant experience and greater likelihood of cessation of regular exercise (Ekkekakis & Lind, 2006).

An effective weight loss program should include an aspect of regular physical activity as well as encouragement for it to continue for six continuous months to decrease the likelihood of weight regain after initial improvement (Ekkekakis & Lind, 2006). The American College of Sports Medicine recommends daily activity should include at least 30 minutes of moderate-intensity activity at least 5 days each week (ACSM, 2006). However, in the United States only about 22% of men and 19% of women report that they meet the minimum requirements of daily activity (Ekkekakis & Lind, 2006). The problem is even greater in the obese adult population (Body mass index > 30 kg/m^2) as only 19% of men and 16% of women report that they meet the minimum requirements (Ekkekakis & Lind, 2006). Determining types of exercise programs which are beneficial to overweight subjects is an important topic of research.

The effects of a simple walk can be more than just simply expending calories. Walking together with friends or family can generate many positive effects, both physical and psychological (Larsson & Mattsson, 2003). Currently, Mississippi has the largest percentage of adults in the United States who are considered obese at 34.4% (Sherry, Blanck, Galuska, Pan, Dietz, & Balluz, 2010). Both overweight and normal weight adults who are able to walk continually for one hour at their preferred pace can expect to complete about three miles; this amount meets the daily physical activity guidelines of the American College of Sports Medicine of daily walking at 3.0 mph for one hour (Loftin et al., 2010). While there are sufficient studies of self-reported energy intake, there remains a lack of research comparing EE for normal weight and overweight subjects conducted under free-living conditions (Welle et al., 1992). To date, limited study has been conducted on caloric cost over a defined distance (Loftin et al., 2010).

Establishing a caloric prediction equation to more accurately estimate EE is an important goal. The primary purpose of this study was to cross-validate a recently published equation by Loftin, et al. (2010). The secondary purposes were to compare EE for normal weight vs.

overweight adults when walking or running a mile as well as evaluate submaximal VO_2 response to exercise for normal weight vs. overweight adults.

The formal null hypotheses to be tested are as follows.

Hypotheses

H_{01}: The Loftin et al., (2010) equation will accurately ($p > 0.05$) predict energy expenditure (kilocalories) to walk or run a mile in overweight walkers, normal weight walkers, and distance runners.

H_{02}: There will be no significant difference in absolute kilocalories expended per mile walked or run between overweight walkers, normal weight walkers, and distance runners.

H_{03}: There will be no significant difference in kilocalories expended per mile walked or run between overweight walkers, normal weight walkers, and distance runners when expressed relative to absolute mass.

H_{04}: There will be no significant difference in kilocalories expended per mile walked or run between overweight walkers, normal weight walkers, and distance runners when expressed relative to fat-free mass.

H_{05}: There will be no significant difference in percentage of VO_2 max between overweight walkers, normal weight walkers, and distance runners when walking or running on a treadmill.

Operational Definitions

The following definitions are set to adequately assess variables relevant to the study.

Metabolism: sum of physical and chemical processes within a cell which yield energy necessary for life

Kilocalorie: unit of measure of energy where 1.0 cal is equal to amount of heat energy needed to raise the temperature of 1.0g of H_2O 1°C. 1 kilocalorie = 1000 calories.

Indirect calorimetry: method of determining energy expenditure by measuring oxygen uptake (VO_2), carbon dioxide production (VCO_2), and pulmonary ventilation (VE).

Fat-free mass: mass of the body that is not fat; includes muscle, bone, skin, and organs.

VO_2: volume of oxygen consumed per minute.

Net Energy Expenditure (NEE): calculated as the resting energy expenditure subtracted from the total gross energy expenditure to approximate the energy expended due to activity.

Excess Post-exercise Oxygen Consumption (EPOC): elevated oxygen consumption during recovery from exercise that is in excess to the amount that would be consumed at rest during equivalent time period.

Normal Weight: Body fat percentage less than 30%.

Overweight: Body fat percentage greater than or equal to 30%.

Distance Runner: Will be defined as a recreational runner who has completed either a 10K, half-marathon, or marathon race in the past six months and accumulates an average of at least 20 miles per week.

Delimitations

This study focuses on adults 18 years of age or older from the University of Mississippi campus or residing in Oxford, Mississippi. In order to participate, subjects must be able to answer "NO" to each question on the Physical Activity Readiness Questionnaire (PAR-Q) (Thomas, Reading, & Shepherd, 1992). Subjects will be considered for the Overweight Walkers group as long as subjects are considered overweight but otherwise healthy. Subjects must weigh less than 300 lbs and be able to walk on a treadmill. Each subject must also be able to give written consent.

Limitations

There are a few limitations in the design of the study that should be considered. Participants will be recruited on a voluntary basis, and it's possible that the subjects may already be interested in exercise and physical activity.

CHAPTER II

REVIEW OF LITERATURE

Preferred walking speed and its effect on metabolic cost of locomotion has become a particular topic of interest (Bogdanis, Vangelakoudi, & Maridaki, 2008; Browning, Baker, Herron, & Kram, 2006; Browning & Kram, 2005; Loftin et al., 2010). It has been suggested that the body is able to sense metabolic cost to perform work at a certain walking pace and controls movement pace of the legs in order to minimize energy cost (Browning & Kram, 2005). Research has found that when allowed to walk at their own desired pace, each individual works to maintain a pace that is neither too fast or too slow as to cause them to feel overstrained or uncomfortably slow (Larsson & Mattsson, 2003). Physiologically, it is much more economically sound for an individual to walk at this desired pace rather than any other (Larsson & Mattsson, 2003). Due to factors beyond their control, elderly NW individuals prefer a significantly slower pace compared to their younger counterparts while still operating at a minimum cost per distance (Browning & Kram, 2005). One particular study found that for adults classified as NW, their preferred pace of 1.4 meters/second or 3 mph produced the least amount of energy cost per distance and required only 36% of their aerobic capacity (Browning & Kram, 2005). Currently there exists a lack of knowledge on what pace overweight and obese individuals best operate in regard to EE and fat oxidation (Bogdanis et al., 2008; Browning & Kram, 2005). It is clear however that each individual operates best at a pace which their own body recognizes.

In order to properly prescribe an exercise routine, it is important to have accuracy in caloric expenditure estimations. To be able to correctly evaluate how much metabolic energy is spent during exercise is an essential component of any weight management program (Browning et al., 2006). A person who is classified as obese has been shown to expend many more total calories while walking than a NW person (Browning et al., 2006). Loftin, Waddell, Robinson, and Owens (2010) noted that when overweight walkers, normal weight walkers, and marathon runner's energy expenditure per mile were compared relative to their own body mass, all groups were significantly different from each other. Normal weight walkers expended 10% more kilocalories/mile per kg of mass than overweight walkers while marathon runners were found to expend 14% more kilocalories (kcal) than the overweight group (Loftin et al., 2010). In the regression equation devised for predicting EE to walk or run a mile, it was noted that 59.1% of the variance was due to body mass with another 4.1% accounted for by gender, showing the trend that the higher the body mass the more kcal/mile expended (Loftin et al., 2010). Browning et al. (2006) also showed that part of the difference in EE can be justified by the differences in amount of body fat a person has. However, despite the logical expectation that location of adipose tissue would affect the difference in caloric expenditure, it was not found to be affected by how body mass was distributed (Browning et al., 2006). Pertaining to gender differences in metabolic expenditures, it has been shown that NW men and women have comparable gross energy expenditures during walking (Browning et al., 2006). However, when these same two groups are compared by evaluating standing metabolic rates, NW women have significantly smaller rates than males due to their lower amount of lean body mass (Browning et al., 2006). This same study also found that the net metabolic cost of walking for the obese walkers was about 10% greater per kg of body weight than the NW group (Browning et al., 2006). It was noted that body fat percentage accounted for about 45% of the difference in the net metabolic cost of walking (Browning et al., 2006). Increasing the amount of body fat reduces the standing metabolic rate due to the added weight in the ratio of body weight to energy expenditure, but does not change the gross metabolic cost of walking (Browning et al., 2006). Additionally, when evaluating VO_2 max for obese compared to NW individuals, obese women had 33% lower and obese men had 28% lower values (Browning et al., 2006).

In research examining the contribution of body composition factors contributing to the EE to complete a marathon, Loftin, Sothern, Koss, et al. (2007) observed that larger men and women runners had slower times and overall expended more calories than the runners who were considered smaller. In this same study, while running at marathon pace for one hour, men expended significantly more energy (2,792 kcal) compared to women (2,436 kcal) when values were corrected to marathon time (Loftin et al., 2007). The researchers noted that the gender differences were probably due to variance in body size and composition (Loftin et al., 2007). Also, mass accounted for about 63% of the EE variance with FFM accounting for 42% and FM 20% of this variance (Loftin et al., 2007). It has been found that while standing and comparing EE to body mass only, obese subjects had a 20% lower VO_2 than NW subjects (Browning et al., 2006). However, when this datum is evaluated to amount of lean body mass, no differences can be distinguished between obese and NW subjects (Browning et al., 2006). Loftin, et al. (2010) found that evaluating EE per mile relative to amount of FFM showed similar results between overweight walkers, normal weight walkers, and marathon runners. Evidence for baseline EE being no different when comparing FFM for obese and NW individuals is gaining support.

In order to perform the same relative amount of work as a NW person, overweight individuals must put forth an increased amount of effort to overcome their greater body mass due to excess adipose tissue. So far, limited study has been conducted to determine the exact metabolic difference between exercise for overweight individuals compared to NW (Loftin et al., 2010). Browning and Kram (2005) found that for overweight women, walking was more expensive metabolically compared to their normal weight subjects across a variance of speeds; the total number of calories they expended was 11% higher when performing the same amount of work. When walking at their preferred speed, the obese women used 51% of their VO_2 max while the normal weight women only operated at 36% of their VO_2 max (Browning & Kram, 2005). Treuth, Figueroa-Colon, Hunter, Weinsler, Butte, and Goran (1998) studied exercise ability of overweight children and found that the additional energy required to perform work was due to an increased body mass. Bogdanis et al. (2008) evaluated peak fat oxidation rate and found that in both males and females, leaner or physically active people were able to perform fat oxidation rates double those of the sedentary, overweight individuals, suggesting a decreased ability to utilize fat (Bogdanis et al., 2008). Browning and Kram (2005) suggested that simply adding 1 kg of weight to the legs of a normal weight person can cause oxygen consumption to be increased by about 3.5% when walking. The researchers also found that in addition to an increase of leg weight, obese individuals tend to have a wider leg-swing and step width when walking to support their body weight. When NW subjects perform a step width double what they normally do, it can increase their EE by as much as 25%. Limited research has determined how much the metabolic rate cost per distance varies for overweight adults at varying speeds (Browning & Kram, 2005).

Exercise for overweight individuals is typically characterized as more difficult and less enjoyable than what their NW counterparts feel about the same workload. Larsson and Mattsson (2003) have speculated that reasons for exercise being expressed as less enjoyable for obese people may be due to the possibility of increased friction experienced between thighs and with arms against their torso. Ekkekakis & Lind (2006) reported that overweight and obese individuals have expressed higher perceived exertion ratings with increased exercise intensity compared to NW subjects as well as an inability to tolerate an increase in intensity. Studies have found that when overweight subjects are exposed to the same speed of treadmill exercise, they must operate at a higher percentage of their previously determined aerobic capacity, which is significantly affected by the fact that their peak aerobic capacity is much lower than that of NW subjects (Browning & Kram, 2005; Ekkekakis & Lind, 2006). Larsson and Mattsson (2003) found that when performing the same level of aerobic work, overweight subjects worked at an average of 56% of their VO_2 max while the NW subjects operated at 36%.

While most studies have pointed to the differences in overall EE between overweight and NW people, the reasons for this difference is still being evaluated. The lack of a reliable, unobtrusive method for measuring daily physical activity has caused the ability to discern the relationship of overweight individual’s added weight and EE difficult (Rutter, 1994). Despite most studies finding marked differences in EE for NW and overweight individuals, studies which take into account the amount of FFM a person has have been finding little to no difference in EE (Bogdanis et al., 2008; Ekkekakis & Lind, 2006; Loftin et al., 2010; Welle et al., 1992). Absolute EE for walking or running a mile at preferred pace has been shown to be essentially the same in NW and overweight adults (Loftin et al., 2010). It has been shown that males tend to expend more kcal/mile than females, but when expressing the data relative to amount of FFM no gender differences were noted (Loftin et al., 2010). An additional study noted that when taking FFM mass into account, baseline BMI was also not a functional predictor (Larsson & Mattsson, 2003). A study evaluating 24-hour EE of overweight individuals who went through a weight loss program found that FFM accounted for 86% of the variance in EE (Heilbronn et al., 2006). An interesting finding by Welle et al. (1992) was that when Basal Metabolic Rate (BMR) was adjusted for lean body tissue, the difference between NW and overweight subjects was eliminated. An additional study of BMR in children by Treuth et al. (1998) also found that when adjusting BMR for body composition and applying it to FFM, all previously observed differences (overweight children averaged 222 Kj/day higher than NW children) were no longer present, suggesting no difference in carbohydrate or fat oxidation. This same study also pointed out that when adjusting the children's submaximal VO_2 scores for FFM from treadmill walking, there were no observed differences (Treuth et al., 1998).

As noted from the literature, establishing a caloric prediction equation to more accurately estimate EE is an important goal. The focus of this study was to cross-validate the regression equation devised by Loftin, et al. (2010). Determining accurate EE is important to be able to properly assess exercise prescription (Mifflin et al., 1990).

CHAPTER III

METHODOLOGY

Subjects

A total of 30 participants were recruited from the University of Mississippi and Oxford, MS community. The participants consisted of 10 normal weight walkers (NWW), 10 overweight walkers (OW), and 10 distance runners (DR). In order to neutralize the gender factor on EE, an even number of males and females for each category were recruited and tested (5 males and 5 females per group).

Procedures

Pre-screening was conducted to determine contraindications to exercise. The PAR-Q was used in order to screen for any contra-indications to exercise. Participants completed a 7-day physical activity questionnaire to determine physical activity status (Sallis, Haskell, Wood, et al., 1985). Participants were considered for the overweight walkers group as long as they were considered overweight but otherwise healthy to be determined by answers to the PAR-Q. Self-reported height and weight were obtained for calculating BMI for group placement of potential walker participants. Walker participants with BMI greater than 25.0 kg/m^2 were initially assumed to be in the OW group and those below 25.0 kg/m^2 in the NWW group. However, body fat percentage was the final group determinant and would override BMI if necessary (Adams et al., 2007).

Each participant's body composition was evaluated using dual energy x-ray absorptiometry (DXA) and was measured on a Hologic Delphi, QDR series (Bedford, MA) apparatus. Indirect calorimetry was used to measure EE during treadmill walking or running. All metabolic data (oxygen uptake, carbon dioxide production, pulmonary ventilation) was measured using a ParvoMedics TrueOne 2400 (Sandy, Utah) measurement system. Before any metabolic testing was commenced, the system was calibrated against standard gases (O_2=16.0%, CO_2=4.0%). EE was measured in absolute units (kcal) as well as relative to mass or fat-free mass; all caloric data were corrected to a 1-mile distance. Each participant had their caloric expenditure predicted for a 1-mile walk or run using the EE prediction equation developed by Loftin, et al. (2010).

The NWW and OW were evaluated by walking on a treadmill at their preferred pace. This speed was determined by evaluating their pace from 6 timed 50 feet trials on an indoor track. After a brief warm-up, the NWW and OW walked for 5 minutes on the treadmill at their preferred pace. Immediately following the 5-minute walk, NWW and OW participants stood on the treadmill for an additional 5 minutes to assess excess post-exercise oxygen consumption (EPOC). After the 5-minute standing period ended, NWW and OW participants were provided a brief rest period long enough for their HR to be within 10 beats of $HR_{resting}$. Once the rest period ended, participants performed a submaximal treadmill test using a modified Balke protocol (Froelicher, Brammell, Davis, Noguera, Stewart, & Lancaster, 1974) until their heart rate (HR) reached the target HR of 60% of predicted heart rate reserve (HRR) by adding the percentage of HRR [60% HRR = (HR_{max} – HR_{rest}) x 0.60] to the $HR_{resting}$. The protocol involved stages which increased by 1 mph and 1% grade every minute. The first stage began with the treadmill at 2 mph and 2% grade. The protocol was ended when the participant reached 60% of HRR.

Independent regression equations were used to examine the VO_2 – HR association and VO_2 max was estimated at the extrapolated HR max.

After a brief warm-up, the DR were asked to run at their distance training pace for 5 minutes to project the pace of running a mile. Their training pace was determined from their self-reported race times (10K, half marathon, or full marathon) from the previous 6 months. Immediately following the 5-minute run, DR participants stood on the treadmill for an additional 5 minutes to assess EPOC. After the 5-minute standing period ended, DR participants were provided a brief rest period long enough for their HR to be within 10 beats of $HR_{resting}$. Once rest period ended, participants performed a submaximal treadmill test using a modified Balke protocol until their HR reached the target HR of 60% of HRR. The protocol involved stages which increased by 1 mph and 1% grade every minute. The first stage began with the treadmill at 4 mph and 4% grade. The protocol was ended when the subject reached 60% of HRR.

Statistical Analysis

The primary statistical analysis included a cross validation of the Loftin et al. published equation (2010) [Kcal = mass(kg) x 0.789 – gender (men=1, women=2) x 7.634 + 51.109]. A dependent t-test was employed to compare the measured EE of the cross-validation group to predicted EE from the equation noted above. Regression coefficients generated from the cross-validation group were compared to the original equation's coefficients using a Chow test (1960). Statistical shrinkage was also evaluated between r^2 values of the original equation and cross-validation regression analysis. Finally, a one-way ANOVA was used to compare EE among the normal weight walkers, overweight walkers, and distance runners in the cross-validation group. Statistical significance was set at the 0.05 level.

CHAPTER IV

RESULTS

Subject Characteristics

Physical characteristics of each group are presented in Table 1 (page 19). The OW group was found to have a significantly ($p > 0.05$) higher mass than both the NWW and DR, as well as having a higher body fat percentage. Fat weight was found to be significantly greater in the OW as compared to the NWW and DR while fat-free weight showed no significant difference between groups. Height was similar across the three groups as no significant difference in height was evident. The DR group was also found to be older than both the NWW and OW.

Caloric Expenditure per Mile Measurements

The results presented in Table 2 (page 20) refer to the kilocalories (both measured and predicted) expended per mile for each group as well as standing ambulatory rest (SAR) and net energy expenditure (NEE). Predicted kcal/mile was determined using the Loftin et al. equation (2010). The predicted kcal to walk or run a mile was 99.7 $\pm$ 10.9 kcal/mile. The overall mean for the measured kcal expended when corrected to one-mile distance was 107.8 $\pm$ 15.5 kcal/mile. A dependent t-test revealed the Loftin, et al. (2010) equation significantly underestimated the kcal to walk or run a mile in the cross-validation group, however the measured kcal was within the standard error of estimate (10.9 kcal) of the predicted values using the original equation.

Table 1 – *Physical Characteristics*

Variable	Group	Mean	SD	Min.	Max.	Gender	Mean	SD	Min.	Max.
Age (years)	NWW	22.6 [a]	2.5	18.0	25.0	M	21.6	3.0	18.0	25.0
						F	23.6	1.5	21.0	25.0
	OW	23.0 [a]	2.7	20.0	29.0	M	23.6	3.8	20.0	29.0
						F	22.4	1.1	21.0	24.0
	DR	28.7 [b]	7.3	21.0	42.0	M	30.8	5.8	21.0	36.0
						F	26.6	8.6	22.0	42.0
Mass (kg)	NWW	71.9 [a]	17.5	50.5	104.0	M	85.4	14.0	66.8	104.0
						F	58.4	6.1	50.5	64.6
	OW	86.8 [b]	8.1	76.4	101.0	M	91.2	8.1	78.6	101.0
						F	82.3	5.8	76.4	91.1
	DR	69.7 [a]	14.2	55.5	84.6	M	75.3	7.6	64.3	84.6
						F	64.1	7.9	55.5	73.9
Height (m)	NWW	1.75 [a]	0.10	1.63	1.87	M	1.83	0.03	1.80	1.87
						F	1.66	0.05	1.63	1.75
	OW	1.72 [a]	0.11	1.56	1.91	M	1.79	0.09	1.68	1.91
						F	1.64	0.05	1.56	1.69
	DR	1.73 [a]	0.10	1.56	1.92	M	1.80	0.09	1.68	1.92
						F	1.66	0.06	1.56	1.72
Body fat %	NWW	19.5 [a]	6.1	9.7	29.1	M	14.5	3.2	9.7	18.7
						F	24.5	3.1	20.4	29.1
	OW	30.7 [b]	6.8	21.4	40.5	M	25.0	3.7	21.4	29.8
						F	36.4	3.0	33.3	40.5
	DR	19.0 [a]	5.3	12.1	26.9	M	14.5	1.9	12.1	17.2
						F	23.5	3.1	19.0	26.9
Fat weight (kg)	NWW	13.4 [a]	3.4	7.5	19.4	M	12.6	4.6	7.5	19.4
						F	14.3	1.9	11.9	15.9
	OW	26.5 [b]	5.6	16.8	36.9	M	22.9	4.8	16.8	28.2
						F	30.0	4.0	27.0	36.9
	DR	13.1 [a]	3.6	7.8	19.9	M	11.0	2.3	7.8	13.7
						F	15.2	3.6	10.5	19.9
Fat-free weight (kg)	NWW	58.4 [a]	16.8	38.1	84.3	M	72.7	9.9	57.7	84.3
						F	44.1	5.4	38.1	49.1
	OW	60.3 [a]	9.3	47.0	72.8	M	68.3	4.8	61.8	72.8
						F	52.3	3.3	47.0	55.2
	DR	56.6 [a]	9.5	42.7	71.7	M	64.3	5.4	56.5	71.7
						F	48.9	4.8	42.7	54.0

* different letters indicate $p < 0.05$.

Table 2 – *Energy Expenditure to walk or run a mile*

Variable	Overall Mean	SD	Group	Mean	SD
Measured Kcal/mile	107.8	15.5	NWW	100.2 [a]	15.3
			OW	115.6 [a]	12.4
			DR	107.8 [a]	15.8
Predicted Kcal/mile	99.7	13.8	NWW	96.4 [a]	17.2
			OW	108.1 [b]	9.3
			DR	94.7 [a]	10.4
SAR (kcal/min)	1.83	0.52	NWW	1.67 [a]	0.52
			OW	1.83 [a]	0.34
			DR	1.94 [a]	0.38
Net EE (kcal/mile)	78.3	17.1	NWW	65.04 [a]	14.1
			OW	76.87 [a]	10.2
			DR	92.94 [b]	14.3
Kcal/mile/kgBW	1.44	0.16	NWW	1.43 [a]	0.18
			OW	1.33 [b]	0.10
			DR	1.55 [c]	0.14
kcal/mile/kgFFW	1.88	0.26	NWW	1.79 [a]	0.32
			OW	1.94 [a]	0.22
			DR	1.92 [a]	0.23

* different letters indicate $p < 0.05$.

Regression Analysis

The predicted kcal value and measured value were found to have a strong, positive correlation, with $r = 0.778$ ($r^2 = 0.605$). A scatter plot indicating the relationship of mass and kcal to walk or run a mile can be found in Figure 1 (page 22). Using the cross-validation data, a regression equation was formed in order to compare coefficients with the original Loftin, et al. (2010) equation. The coefficient for weight was 0.825 for the cross-validation data compared to 0.789 for Loftin, et al. (2010). The coefficient for gender was 1.687 for the cross-validation data compared to 7.634 for Loftin, et al. (2010). The constant was 47.579 for the cross-validation data compared to 51.1 for Loftin, et al. (2010). A Chow test (1960) was performed to evaluate any differences between the regression coefficients of the Loftin, et al. (2010) equation and regression coefficients of the cross-validation group. The test found that there was no significant difference between groups ($p > 0.05$).

R-values were also highly correlated as cross-validation data $r = 0.790$ ($r^2 = 0.625$) and $r = 0.795$ ($r^2 = 0.632$) for Loftin, et al. (2010). Calculating cross-validated r^2 found that values were strongly correlated and estimated shrinkage was 0.027; which is minimal and suggestive of no significant difference in r^2 values. Regression scatter plot is presented in Figure 1 (page 22). Comparison of predictive ability of Loftin, et al. (2010) equation and cross-validation equation is presented in Figure 2 (page 23).

Figure 1 – Scatterplot of the cross-validation group (kcal/mile vs. mass)

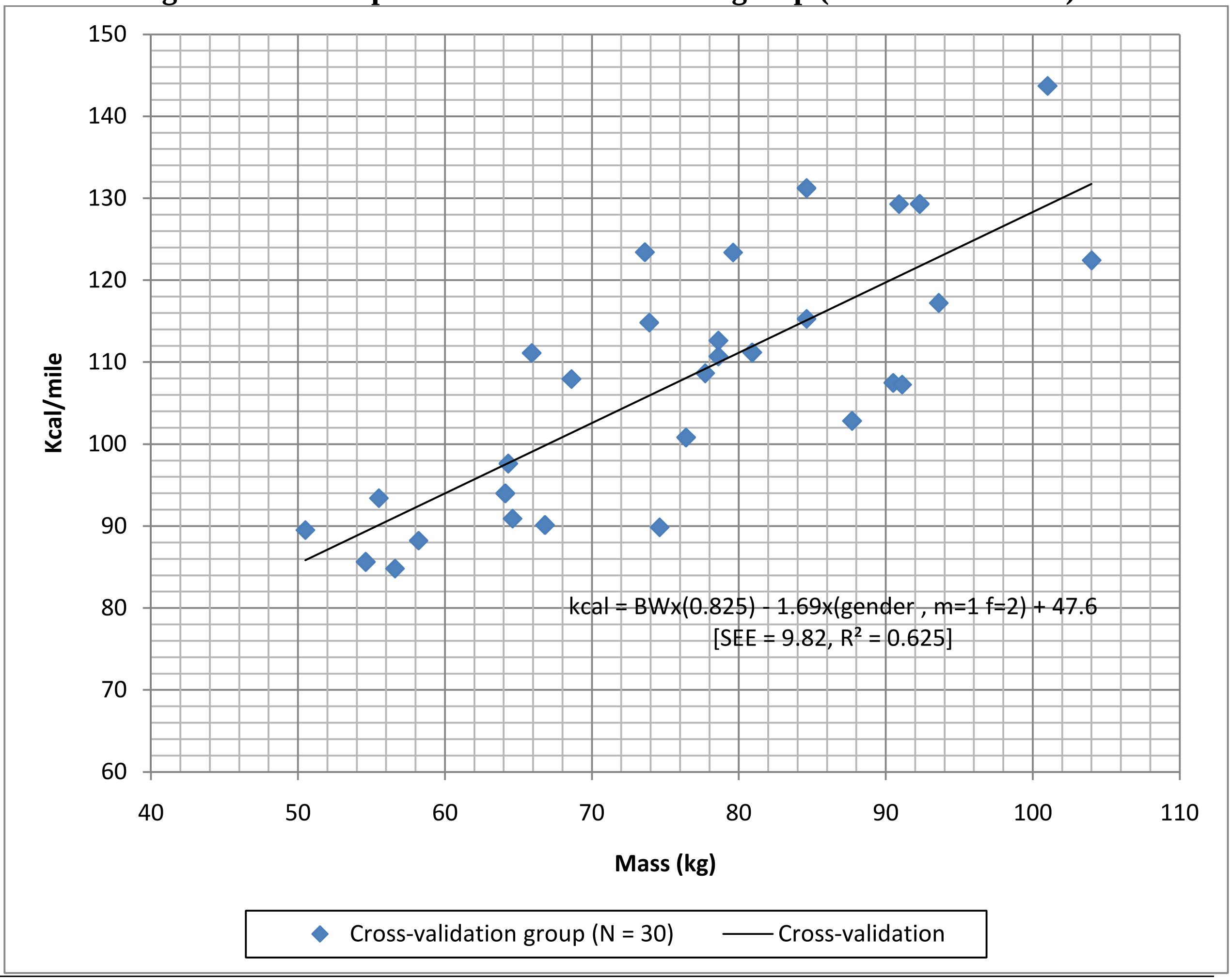
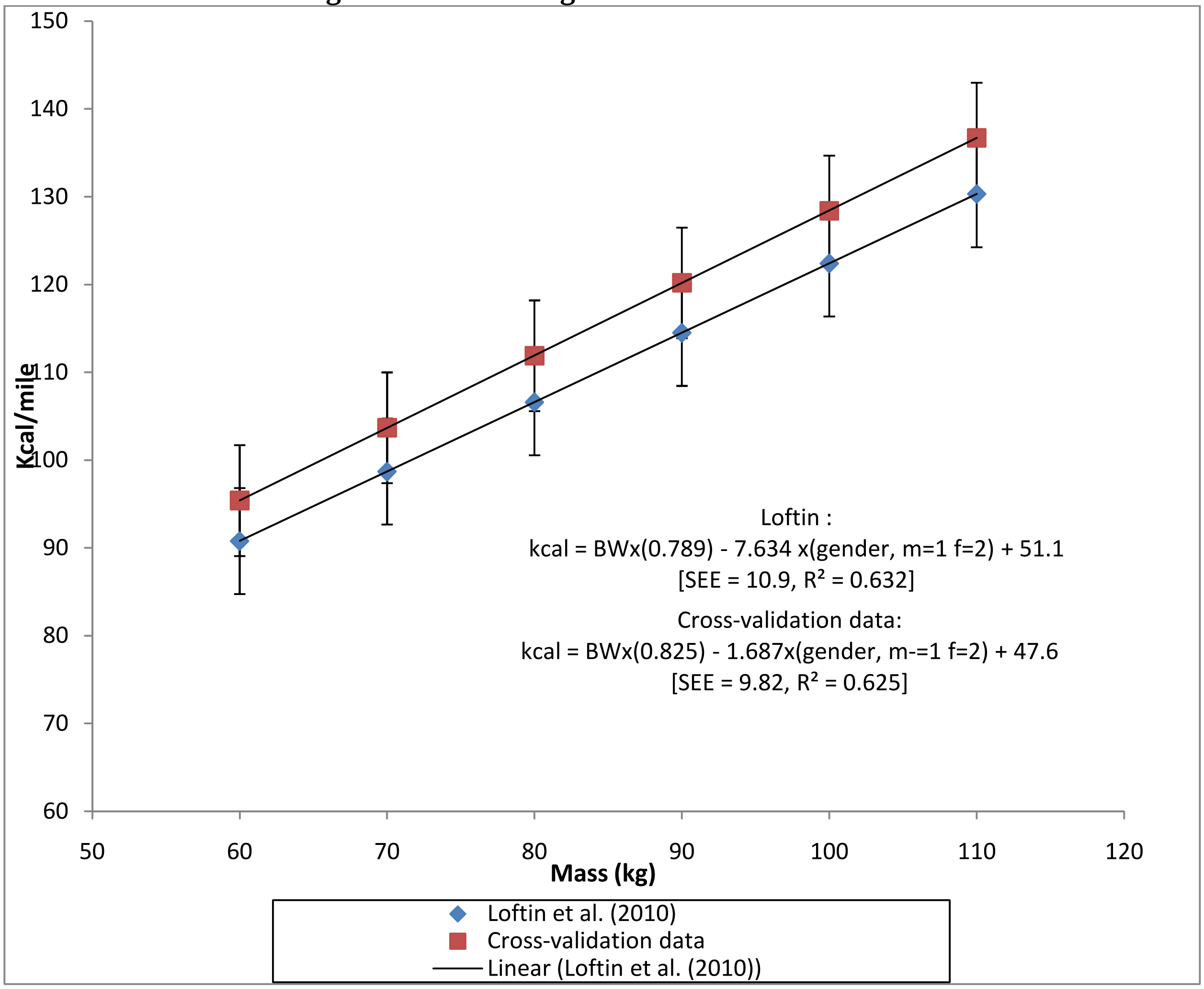


Figure 2 – Predicting kcal/mile based on mass



In addition to data collected during exercise, data were collected at rest as well as relative to mass and FFM. There was no significant difference in kcal expended per minute of rest (SAR) between groups. NEE was found to be significantly greater for the DR group than both walker groups. When gross caloric expenditure was expressed relative to mass, DR were found to expend more kcal/mile than both other groups. However, when EE per mile were compared relative to FFM, results were found to be similar across groups.

Table 3 (page 25) presents data relating the time to complete one mile by group as well as an assessment of percentage of VO_2 max performed during the 5-minute run or walk. When VO_2 max was predicted from performing a VO_2 sub-max test, predicted VO_2 max was found to be significantly higher for the DR group compared to both walker groups. The DR group performed their 5-minute run at a significantly higher percentage of their VO_2 max as determined from the VO_2 submax test than both the NWW and OW groups. As would be expected, the DR group's treadmill speed was significantly greater than the pace for both the NWW and OW. Because the DR group was running and traveling at a much faster pace than both walker groups, the DR would take a significantly shorter amount of time to complete one mile.

Table 3 – *Oxygen consumption for submax test and at preferred pace and time to complete one mile.*

Variable	Group	Mean	SD
VO2 max (Ml/kg/min)	NWW	46.28 [a]	10.4
	OW	39.06 [a]	6.9
	DR	63.45 [b]	12.8
Percent of VO2 max worked during 5-min walk/run	NWW	35.1 [a]	9.2
	OW	37.0 [a]	6.8
	DR	59.8 [b]	10.2
Preferred Pace (mph)	NWW	3.14 [a]	0.31
	OW	3.05 [a]	0.41
	DR	6.82 [b]	0.72
Time to complete one mile at preferred pace (min)	NWW	19.3 [a]	0.60
	OW	20.0 [a]	0.87
	DR	8.9 [b]	0.28

* different letters indicate $p < 0.05$.

Summary of results and formal hypotheses

The formal null hypotheses and the statistical statements as determined by the data analysis are as follows.

Hypotheses:

Ho_1: The Loftin et al., 2010 equation will accurately ($p > 0.05$) predict energy expenditure (kilocalories) to walk or run a mile in overweight walkers, normal weight walkers, and distance runners. Fail to reject.

H_{02}: There will be no significant difference in absolute kilocalories expended per mile walked or run between overweight walkers, normal weight walkers, and distance runners. Fail to reject.

H_{03}: There will be no significant difference in kilocalories expended per mile walked or run between overweight walkers, normal weight walkers, and distance runners when expressed relative to absolute mass. Reject.

H_{04}: There will be no significant difference in kilocalories expended per mile walked or run between overweight walkers, normal weight walkers, and distance runners when expressed relative to fat-free mass. Fail to reject.

H_{05}: There will be no significant difference in percentage of VO_2 max between overweight walkers, normal weight walkers, and distance runners when walking or running on a treadmill. Reject.

CHAPTER V

DISCUSSION

Cross-validation

The main focus of this study was to cross-validate the recently published Loftin, et al. (2010) prediction equation using normal weight walkers (NWW), overweight walkers (OW), and distance runners (DR). The findings of this study suggest there is sufficient evidence to indicate that the original equation is valid in predicting the number of kilocalories it takes to walk or run one mile at an individual's preferred pace taking into account mass and gender. It appears the equation is useful for exercise prescription in that it allows for the prediction of EE for either walking or running a mile in normal weight and overweight adults.

Measured and predicted kcal/mile were assessed per walk or run group as well as a cross-validation group mean and predicted mean using the Loftin, et al. (2010) equation. The difference in mean (8.1 kcal/mile) was within the published standard error (SEE = 10.9) stated by Loftin, et al. (2010). A regression scatter plot is presented in Figure 1 (page 23) and using the coefficients determined from the line of best fit, it would appear that these coefficients are highly correlated ($r = 0.778$) to those of the original equation published by Loftin, et al. (2010). However, the dependent t-test expressed significant differences in mean kcal/mile which necessitated further analysis. In order to assess the regression coefficients of the Loftin, et al. (2010) equation and those of the cross-validation group, a Chow test (1960) was performed. This test showed that there was no significant difference ($p > 0.05$) between the regression coefficients of the two groups. The dependent t-test result initially suggested a significant difference between the means of the measured kcal/mile and the predicted kcal/mile, despite the difference in mean being within the published standard error. The Chow test result furthers the case of what was previously stated about the SEE, showing no significant difference between the two regression analyses to warrant rejecting the original equation for a new one. This is suggestive of the Loftin, et al. (2010) equation having the ability to accurately predict EE per mile based on mass and gender.

The r^2 value of the cross-validation regression equation (r^2= 0.625) was found to be similar to the published r^2 = 0.632 for Loftin, et al. (2010). The predicted kcal value and measured value were found to have a strong, positive correlation, with r = 0.778 (r^2 = 0.605). Calculating cross-validated r^2 found that values were strongly correlated and estimated shrinkage was 0.027. This statistic was estimated by subtracting the r^2 value of the cross-validation data from the r^2 value of the Loftin, et al. (2010) equation. The degree of shrinkage can be used as a guide to represent consistency and uniformity across samples (Guan, Xiang, & Keating, 2004). The closer this value is to zero, the greater the reliability that the data are stable and reproducible between groups (Guan et al., 2004). This difference of 0.027 therefore is minimal and suggestive of no significant difference in r^2 values.

Additionally, using measured kcal, weight, and gender as the factors, a regression equation was derived from the cross-validation subjects. Figure 2 (page 24) shows the comparison of the Loftin, et al. (2010) equation and this cross-validation regression equation. Regression slopes showed similar trends and inspection of the graphs of the lines with the SEE of both lines included shows that their standard error bars overlap each other, echoing the statement that the equations do not produce significantly different results. This data suggests that the difference between the cross-validation data and original data published by Loftin et al. is not significant enough to warrant rejecting the Loftin, et al. (2010) equation in favor of a new one.

Energy Expenditure Across Sub-groups

When measured kcal/mile was compared between groups, there were no significant differences. These results are similar to findings in other related studies assessing gross EE between normal weight and overweight individuals over a defined distance or time (Browning et al., 2006; Loftin et al., 2010; Welle et al., 1992). These data suggest that when considering the gross caloric expenditure to walk or run one mile, caloric expenditure will be similar whether walking or running. This consideration could prove to be very important to a member of the general public who may be contemplating beginning an exercise regimen but may not have the capability to perform any intensive exercise greater than walking. Data suggest that if a person can begin his or her exercise with a light to moderate intensity walk, they could perform the necessary amount of exercise at their own pace while decreasing the risk for injury or over-exertion. This could be highly important to an overweight population as they often tend to express a greater amount of muscular or skeletal pain with increases in intensity (Ekkekakis & Lind, 2006). That added pain or discomfort could potentially lead to greater likelihood of failing to complete their prescribed exercise (Ekkekakis & Lind, 2006).

Estimated VO_2 max was determined from a submaximal treadmill test performed after the 5-minute walk or run. The DR group was found to have a significantly higher VO_2 max than both walker groups, with no significant difference between NWW and OW. These results are not unexpected due to the process involved in recruiting the DR subjects, race times for 10K, half-marathon, or marathon from the past six months were asked of them to determine preferred pace.

Due to the fact that most, if not all, of the DR have regular training regimens it would be expected that they were in fact trained distance runners. Therefore, it was expected that the DR would have a significantly higher VO_2 max than the walker groups due to the considerable training that they have previously performed for these races.

While the separate walker groups were different in their physical makeup, caloric expenditure per mile was similar. It was found that both NWW and OW groups performed at a similar percentage of their VO_2 max during the 5-minute walk, 35.1% for NWW and 37.0% for OW. As would be expected due to the higher aerobic capacity demands of running, the DR group performed their 5-minute run at a significantly higher percentage of their VO_2 max than both walker groups (59.8%). The finding that NWW and OW were walking at similar percentages of their VO_2 max differs from previous studies related to preferred pace of overweight and normal weight individuals. Browning & Kram (2005) reported that the overweight women in their study operated at 51% of their VO_2 max at their preferred speed while normal weight women walked at their preferred speed at 36% of their VO_2 max. Ekkekakis & Lind (2006) also noted that their overweight women performed the walk at the preferred pace at a significantly higher percentage of their VO_2 max than the normal weight women throughout the 20 minutes. Loftin et al. (2010) reported that a gender difference in kcal/mile was initially noticed between NWW and marathon runners but that it was not found to be significant.

In this study, no significant differences were found in kcal/min between groups during standing ambulatory rest (SAR). As previously stated, the gross EE (GEE), which is referred to as measured kcal/mile in this study, was found to have similar values across groups but when net EE (NEE) was assessed, the DR group was found to expend a significantly greater number of kcal/mile than both walker groups. No significant difference was found between the NWW and

OW groups for NEE. However, caution must be taken with the assessment of these values. The walker groups were found to average 19.3 min/mile and 20.0 min/mile for NWW and OW respectively, while DR were found to average 8.9 min/mile. This is to be expected that running one mile would be completed much faster than walking one mile. These NEE values are based on the time taken to travel one mile, so the resting EE (REE) values in the NEE calculations were much lower for the DR due to them completing the mile in less than half the time it took both walker groups. Since the GEE values show no significant difference per mile and the SAR values are found to be similar, caution must be taken when taking into account the NEE values due to the factor that difference in time to complete one mile plays into these calculations.

Energy Expenditure Relative to Mass

When measured kcal/mile for each subject was assessed relative to kg of body weight (BW), the DR were found to expend the most kcal/mile/kgBW, significantly above NWW and OW who were not significantly different from one another. Similar findings comparing kcal per kg of BW have been reported in other recent studies (Browning et al., 2006; Loftin et al., 2010; Treuth et al., 1998). However, when this same kcal/mile data were assessed relative to FFW, no significant differences across groups was found. Loftin, et al. (2010) found similar data in their study when kcal/mile was compared related to FFW. Browning et al. (2006) assessed preferred speed of walking for both normal weight and overweight men and women. They reported differences with kcal/kgBW as previously mentioned, but also found no significant differences between groups when kilocalories was assessed relative to the subject’s FFW. Welle et al. (1992) studied normal weight and overweight women in free-living conditions and measured their EE using the doubly-labeled water method and also found that total EE (TEE) was greater in the overweight subjects than the normal weight but that differences disappeared when TEE was made relative to FFW. In a study of female children between the ages of 7-10 years old, basal metabolic rate (BMR), sleeping metabolic rate (SMR), 24 hour sedentary EE, and TEE were assessed between separate groups of girls considered overweight and non overweight, or normal weight (Treuth et al., 1998). Similar to findings with this study, data were found to be significantly different between groups but when data were assessed per kg of FFW, no significant differences between groups were observed (Treuth et al., 1998). Several studies back up the data presented in this study showing no significant differences in kcal/mile when taking into account each individual subject’s FFW.

Time to Complete One-mile at Preferred Pace

As referenced earlier, the DR group time to complete one-mile at preferred pace was significantly lower than both walker groups. This is due to the fact that they were running on the treadmill and therefore moving at a significantly higher speed (6.82 mph) compared to both walker groups, 3.14 mph for NWW and 3.05 mph for OW. These results for preferred pace are comparable to what was reported by Loftin, et al. (2010) for their NWW, OW, and marathon runner groups. Ekkekakis & Lind (2006) had overweight and normal weight subjects walk for two 20-minute sessions on a treadmill, one at preferred pace and the other at 10% higher than their preferred. This particular study also found that their overweight and normal weight subjects preferred to walk at a similar speed (Ekkekakis & Lind, 2006). Browning and Kram (2005) also reported similar results of normal weight women and overweight women preferring to walk at comparable speeds on the treadmill.

Conclusion

The primary purpose of this study was to cross-validate the equation published by Loftin, et al. (2010). The findings of this study suggest there is sufficient evidence to indicate that the original equation is valid in predicting the number of kilocalories it takes to walk or run one mile at an individual's preferred pace taking into account mass and gender. The secondary purpose of this study was to assess differences in gross caloric expenditure to walk or run one mile between normal weight walkers, overweight walkers, and distance runners. Results showed that there was no significant difference in absolute kilocalories per mile across groups, suggesting that absolute caloric expenditure is similar whether a mile is walked or ran. Another purpose of this study was to assess any differences in the percentage of VO_2 max required by NWW, OW, and DR to walk or run one mile. Results found that DR worked at a significantly higher percentage of their VO_2 max during their 5-minute run than both walkers groups, while no differences were seen between walker groups.

Recommendations for Future Research

This study focused on the cross-validation of the Loftin, et al. (2010) equation and measured caloric expenditure between normal weight walkers, overweight walkers, and distance runners to walk or run one mile. Results showed no significant differences in measured kcal/mile when made relative to fat-free mass between groups, suggesting that subjects were similar metabolically if the excess mass due to extra adipose tissue was eliminated. Other studies have found similar results across groups when relating data to FFM with walking or in free-living conditions (Browning et al., 2006; Loftin et al., 2010; Treuth et al., 1998; Welle et al., 1992). Future research could be dedicated to assessing the effect that added adipose tissue has on gross caloric expenditure to complete different daily tasks, such as walking up flights of stairs or raising and lowering oneself from a chair. This knowledge would be beneficial to daily exercise prescription for obese individuals who are looking to begin a weight-loss program.

LIST OF REFERENCES

Adams, T.D., Heath, E.M., LaMonte, M.J., Gress, R.E., Pendleton, R., Strong, M., Smith, S.C., & Hunt, S.C. (2007). The relationship between body mass index and per cent body fat in the severely obese. *Diabetes, Obesity, and Metabolism, 9*, 498-505.

American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription, 5th Edition*. Philadelphia, PA: Wolters Kluwer/Lippincott Williams &Wilkins, 2006. Pp. 341-342.

Bogdanis, G.C., Vangelakoudi, A., & Maridaki, M. (2008). Peak fat oxidation rate during walking in sedentary overweight men and women. *Journal of Sports Science and Medicine, 7*, 525-531.

Browning, R.C., Baker, E.A., Herron, J.A., & Kram, R. (2006). Effects of obesity and sex on the energetic cost and preferred speed of walking. *Journal of Applied Physiology, 100,* 390- 398.

Browning, R.C., & Kram, R. (2005). Energetic cost and preferred speed of walking in obese vs. normal weight women. *Obesity Research, 13(5)*, 891-899.

Chow, G.C. (1960). Tests of equality between sets of coefficients in two linear regressions. *Econometrica, 28*, 591-605.

Clark, R.R., Sullivan, J.C., Bartok, C., & Schoeller, D.A. (2003). Multicomponent cross-validation of minimum weight predictions for college wrestlers. *Medicine & Science in Sports & Exercise, 342-347.*

Ekkekakis, P., & Lind, E. (2006). Exercise does not feel the same when you are overweight: the impact of self-selected and imposed intensity on affect and exertion. *International Journal of Obesity*, *30,* 652-660.

Froelicher, V.F., Brammell, H., Davis, G., Noguera, I., Stewart, A., & Lancaster, M.C. (1974). A comparison of the reproducibility and physiologic response to three maximal treadmill exercise protocols. *Chest, 65,* 512-517.

Guan, J., Xiang, P., and Keating, X.D. (2004). Evaluating the replicability of sample results: A tutorial of double cross-validation methods. *Measurement in Physical Education and Exercise Science, 8(4),* 227-241.

Heilbronn, L.K., de Jonge, L., Frisard, M.I., DeLany, J.P., Larson-Meyer, D.E., Rood, J., … Ravussin, E. (2006). Effect of 6-month calorie restriction on biomarkers of longevity, metabolic adaptation, and oxidative stress in overweight individuals: a randomized controlled trial. *Journal of the American Medical Association, 295(13),* 1539-1548.

Hicks, V.L., Stolarczyk, L.M., Heyward, V.H., & Baumgartner, R.N. (2000). Validation of near-infrared interactance and skinfold methods for estimating body composition of American Indian women. *Medicine & Science in Sports & Exercise,* 531-539.

Holiday, D.B., Ballard, J.E., & McKeown, B.C. (1995). PRESS-related statistics: regression tools for cross-validation and case diagnostics. *Medicine & Science in Sports & Exercise,* 612-620.

Larsson, U.E., & Mattsson, E. (2003). Influence of weight loss programmes on walking speed and relative oxygen cost (%vo2max) in obese women during walking. *Journal of Rehabilitative Medicine*, *35*, 91-97.

Loftin, M., Nichols, J., Going, S., Sothern, M., Schmitz, K.H., Ring, K., Tuuri, G., & Stevens, J. (2007). Comparison of the validity of anthropometric and bioelectric impedance equations to assess body composition in adolescent girls. *International Journal of Body Composition Research, 5(1),* 1-8.

Loftin, M., Sothern, M. Koss, C. Tuuri, G., VanVrancken, C., Kontos, A., & Bonis, M. (2007). Energy expenditure and influence of physiologic factors during marathon running. *Journal of Strength and Conditioning Research*, *21(4),* 1188-1191.

Loftin, M., Waddell, D., Robinson, J., & Owens, S. (2010). Comparison of energy expenditure to walk or run a mile in adult normal weight and overweight men and women. *Journal of Strength and Conditioning Research*, *24(10),* 2794-2798.

Mifflin, M.D., St. Jeor, S.T., Hill, L.A., Scott, B.J., Daugherty, S.A. , & Koh, Y.O. (1990). A new predictive equation for resting energy expenditure in healthy individuals. *American Journal of Clinical Nutrition*, *51*, 241-247.

Rutter, S. (1994). Comparison of energy expenditure in normal-weight and overweight women using the caltrac personal activity computer. *International Journal of Eating Disorders*, *15(1),* 37-42.

Sallis, J.F., Haskell, W., Wood, P., et al. (1985). Physical activity assessment methodology in the five-city project. *American Journal of Epidemiology, 121,* 91-106.

Segal, K.R., Van Loan, M., Fitzgerald, P.I., Hodgdon, J.A., & Van Itallie, T.B. (1988). Lean body mass estimation by bioelectrical impedance analysis: a four-site cross-validation study. *American Journal of Clinical Nutrition, 47,* 7-14.

Sherry, B., Blanck, H.M., Galuska, D.A., Pan, L., Dietz, W.H., & Balluz, L. (2010). Vital signs: state-specific obesity prevalence among adults – united states 2009. *Centers for Disease Control and Prevention Morbidity and Mortality Weekly Report*, *59,* 1-5.

Treuth, M.S., Figueroa-Colon, R., Hunter, G.R., Weinsier, R.L., Butte, N.F., & Goran, M.I. (1998). Energy expenditure and physical fitness in overweight vs. non-overweight prepubertal girls. *International Journal of Obesity*, *22*, 440-447.

Thomas, S., Reading, J., & Shephard, R.J. (1992). Revision of the physical activity readiness questionnaire (par-q). *Canadian Journal of Sport Sciences, 17:4,* 338-345.

Welle, S., Forbes, G.B., Statt, M., Barnard, R.R., & Amatruda, J.M. (1992). Energy expenditure under free-living conditions in normal-weight and overweight women. *American Journal of Clinical Nutrition*, *55*, 14-21.

LIST OF TABLES

Table 4 – Results of Dependent T-test between Measured Kcal/mile & Predicted Kcal/mile.

	Measured Kcal/mile (n=30)	**Predicted Kcal/mile** (n=30)
Mean	107.8	99.7
Standard Deviation	15.5	13.8
Standard Error Estimate	9.8	10.9
Correlation	0.78	
Upper Limit of CI	-4.44	
Lower Limit of CI	-11.8	
T	-4.509	
Sig.	0.000 *	

* Significant at $p < 0.05$

Table 5 – Results of Regression Analysis for Cross-validation sample (n=30)

Dependent Variable	R^2	Adj. R^2	Sig.	Std. Error of Estimate
Measured kcal/mile	0.625	0.597	.000 *	9.82

Independent Variable	Beta	t	Sig.
Mass	0.825	5.32	0.000 *
Gender	-1.69	-0.389	0.700

* Significant at $p < 0.05$

Table 6 – *Results of ANOVA based on participant age (years).*

	NWW (n=10)	OW (n=10)	DR (n=10)
Mean	22.6	23.0	28.7
Standard Deviation	2.50	2.71	7.27
Standard Error of Mean	0.792	0.856	2.300
F	5.253		
Sig.	.012 *		

Post-hoc: Tukey HSD

		Mean Diff.	Std. Error	Sig.
NWW	OW	-0.400	2.106	0.980
	DR	-6.100	2.106	.020 *
OW	NWW	0.400	2.106	0.980
	DR	-5.700	2.106	.030 *
DR	NWW	6.100	2.106	.020 *
	OW	5.7	2.106	.030 *

* Significant at $p < 0.05$

Table 7 – *Results of ANOVA based on participant mass (kg).*

	NWW (n=10)	OW (n=10)	DR (n=10)
Mean	71.91	86.76	69.72
Standard Deviation	17.51	8.11	9.40
Standard Error of Mean	5.54	2.57	2.97
F	5.595		
Sig.	.009 *		

Post-hoc: Tukey HSD

		Mean Diff.	Std. Error	Sig.
NWW	OW	-14.850	5.543	.032 *
	DR	2.190	5.543	0.918
OW	NWW	14.850	5.543	.032 *
	DR	17.040	5.543	.013 *
DR	NWW	-2.190	5.543	0.918
	OW	-17.040	5.543	.013 *

* Significant at $p < 0.05$

Table 8 – *Results of ANOVA based on participant height (m).*

	NWW (n=10)	OW (n=10)	DR (n=10)
Mean	1.75	1.72	1.73
Standard Deviation	0.097	0.106	0.103
Standard Error of Mean	0.031	0.034	0.033
F	0.277		
Sig.	0.760		

Table 9 – *Results of ANOVA based on body fat percentage.*

	NWW (n=10)	OW (n=10)	DR (n=10)
Mean	19.50	30.66	18.98
Standard Deviation	6.08	6.79	5.32
Standard Error of Mean	1.92	2.15	1.68
F	11.732		
Sig.	.000 *		

Post-hoc: Tukey HSD

		Mean Diff.	Std. Error	Sig.
NWW	OW	-11.160	2.724	.001 *
	DR	0.520	2.724	0.980
OW	NWW	11.160	2.724	.001 *
	DR	11.680	2.724	.001 *
DR	NWW	-0.520	2.724	0.980
	OW	-11.680	2.724	.001 *

* Significant at $p < 0.05$

Table 10 – *Results of ANOVA based on fat weight (kg).*

	NWW (n=10)	**OW** (n=10)	**DR** (n=10)
Mean	13.44	26.46	13.09
Standard Deviation	3.44	5.62	3.59
Standard Error of Mean	1.09	1.78	1.14
F	30.942		
Sig.	.000 *		

Post-hoc: Tukey HSD

		Mean Diff.	Std. Error	Sig.
NWW	OW	-13.013	1.936	.000 *
	DR	0.350	1.936	0.982
OW	NWW	13.013	1.936	.000 *
	DR	13.363	1.936	.000 *
DR	NWW	-0.350	1.936	0.982
	OW	-13.363	1.936	.000 *

* Significant at $p < 0.05$

Table 11 – *Results of ANOVA based on fat-free weight (kg).*

	NWW (n=10)	OW (n=10)	DR (n=10)
Mean	58.44	60.31	56.61
Standard Deviation	16.824	9.254	9.452
Standard Error of Mean	5.320	2.926	2.989
F	0.224		
Sig.	0.801		

Table 12 – *Results of ANOVA based on measured kcal/mile.*

	NWW (n=10)	**OW** (n=10)	**DR** (n=10)
Mean	100.2	115.6	107.8
Standard Deviation	15.33	12.41	15.84
Standard Error of Mean	4.847	3.925	5.009
F	2.780		
Sig.	0.080		

Table 13 – *Results of ANOVA based on predicted kcal/mile.*

	NWW (n=10)	**OW** (n=10)	**DR** (n=10)
Mean	96.4	108.1	94.7
Standard Deviation	17.21	9.30	10.42
Standard Error of Mean	5.443	2.942	3.296
F	3.275		
Sig.	0.053		

Table 14 – *Results of ANOVA based on standing ambulatory rest (kcal/min).*

	NWW (n=10)	**OW** (n=10)	**DR** (n=10)
Mean	1.67	1.83	1.94
Standard Deviation	0.521	0.335	0.384
Standard Error of Mean	0.165	0.106	0.121
F	1.033		
Sig.	0.370		

Table 15 – *Results of ANOVA based on net energy expenditure (kcal/mile).*

	NWW (n=10)	OW (n=10)	DR (n=10)
Mean	65.04	76.87	92.94
Standard Deviation	14.12	10.16	14.31
Standard Error of Mean	4.466	3.212	4.526
F	11.601		
Sig.	.000 *		

Post-hoc: Tukey HSD

		Mean Diff.	Std. Error	Sig.
NWW	OW	-11.833	5.816	0.123
	DR	-27.908	5.816	.000 *
OW	NWW	11.833	5.816	0.123
	DR	-16.075	5.816	.027 *
DR	NWW	27.908	5.816	0.146
	OW	16.075	5.816	.027 *

* Significant at $p < 0.05$

Table 16 – *Results of ANOVA based on kcal/mile per kg of body mass.*

	NWW (n=10)	OW (n=10)	DR (n=10)
Mean	1.43	1.33	1.55
Standard Deviation	0.178	0.096	0.139
Standard Error of Mean	0.056	0.030	0.044
F	5.970		
Sig.	.007 *		

Post-hoc: Tukey HSD

		Mean Diff.	Std. Error	Sig.
NWW	OW	0.099	0.063	0.282
	DR	-0.120	0.063	0.160
OW	NWW	-0.099	0.063	0.282
	DR	-0.219	0.063	.005 *
DR	NWW	0.120	0.063	0.160
	OW	0.219	0.063	.005 *

* Significant at $p < 0.05$

Table 17 – *Results of ANOVA based on kcal/mile per kg of fat-free mass.*

	NWW (n=10)	OW (n=10)	DR (n=10)
Mean	1.79	1.94	1.93
Standard Deviation	0.322	0.220	0.228
Standard Error of Mean	0.102	0.069	0.072
F	1.043		
Sig.	0.366		

Table 18 – *Results of ANOVA based on VO2 max (Ml/kg/min) from submax test.*

	NWW (n=10)	**OW** (n=10)	**DR** (n=10)
Mean	46.28	39.06	63.45
Standard Deviation	10.390	6.916	12.793
Standard Error of Mean	3.286	2.187	4.046
F	14.739		
Sig.	.000 *		

Post-hoc: Tukey HSD

		Mean Diff.	Std. Error	Sig.
NWW	OW	7.215	4.615	0.278
	DR	-17.173	4.615	.003 *
OW	NWW	-7.215	4.615	0.278
	DR	-24.388	4.615	.000 *
DR	NWW	17.173	4.615	.003 *
	OW	24.388	4.615	.000 *

* Significant at $p < 0.05$

Table 19 – *Results of ANOVA based on percentage of VO2 max (Ml/kg/min) worked during 5-min walk or run.*

	NWW (n=10)	**OW** (n=10)	**DR** (n=10)
Mean	35.1	37.0	59.8
Standard Deviation	9.209	6.826	10.152
Standard Error of Mean	2.900	2.200	3.200
F	24.067		
Sig.	.000 *		

Post-hoc: Tukey HSD

		Mean Diff.	Std. Error	Sig.
NWW	OW	-1.860	3.9536	0.886
	DR	-24.630	3.9536	.000 *
OW	NWW	-1.860	3.9536	0.886
	DR	-22.770	3.9536	.000 *
DR	NWW	24.630	3.9536	.000 *
	OW	22.770	3.9536	.000 *

* Significant at $p < 0.05$

Table 20 – *Results of ANOVA based on preferred treadmill speed (mph) for 5-min walk or run.*

	NWW (n=10)	OW (n=10)	DR (n=10)
Mean	3.14	3.05	6.82
Standard Deviation	0.310	0.414	0.724
Standard Error of Mean	0.098	0.131	0.229
F	175.348		
Sig.	.000 *		

Post-hoc: Tukey HSD

		Mean Diff.	Std. Error	Sig.
NWW	OW	0.090	0.2297	0.919
	DR	-3.680	0.2297	.000 *
OW	NWW	-0.090	0.2297	0.919
	DR	-3.770	0.2297	.000 *
DR	NWW	3.680	0.2297	.000 *
	OW	3.770	0.2297	.000 *

* Significant at $p < 0.05$

Table 21 – *Results of ANOVA based on time (min) to complete one mile at preferred pace.*

	NWW (n=10)	**OW** (n=10)	**DR** (n=10)
Mean	19.3	20.0	8.9
Standard Deviation	1.909	2.750	0.883
Standard Error of Mean	0.604	0.870	0.279
F	96.943		
Sig.	.000 *		

Post-hoc: Tukey HSD

		Mean Diff.	Std. Error	Sig.
NWW	OW	-0.728	0.894	0.697
	DR	10.396	0.894	.000 *
OW	NWW	0.728	0.894	0.697
	DR	11.124	0.894	.000 *
DR	NWW	10.396	0.894	.000 *
	OW	-11.124	0.894	.000 *

* Significant at $p < 0.05$

Table 22 – *Results of ANOVA based on excess post-oxygen consumption (L) following 5-min walk or run at preferred pace.*

	NWW (n=10)	**OW** (n=10)	**DR** (n=10)
Mean	0.593	0.654	1.979
Standard Deviation	0.409	0.279	0.376
Standard Error of Mean	0.129	0.088	0.119
F	47.643		
Sig.	.000 *		

Post-hoc: Tukey HSD

		Mean Diff.	Std. Error	Sig.
NWW	OW	-0.061	0.160	0.924
	DR	-1.386	0.160	.000 *
OW	NWW	0.061	0.160	0.924
	DR	-1.325	0.160	.000 *
DR	NWW	1.386	0.160	.000 *
	OW	1.325	0.160	.000 *

* Significant at $p < 0.05$

Table 23 – Results of Chow test of significance between regression coefficients of cross-validation sample (n=30) and original Loftin et al. sample (n=50).

Data set	R^2	Adj. R^2	Std. Error of Estimate
Loftin, et al. (2010)	0.657	0.643	10.562
Cross-validation group	0.662	0.640	10.615

Change Statistics	R^2 change	F change	Sig. of F Change
Loftin, et al. (2010) vs. Cross-validation group	0.006	0.624	0.539

LIST OF APPENDICES

APPENDIX: A

RECRUITMENT FLYER

The University of Mississippi

is recruiting adult overweight walkers, adult normal weight walkers, and adult distance runners aged 18-44 years

Cross-Validation of a Recently Published Equation Predicting Energy Expenditure to Run or Walk a Mile in Normal Weight and Overweight Adults

Start Date January 2011

HESRM is conducting a research study looking at the energy expenditure differences between normal weight and overweight individuals with exercise. We would like to determine if there are differences between a normal weight and overweight adult population when comparing the way they walk or run to how much oxygen they use.

We will be providing you a FREE DXA scan that measures your body composition.

Please note: This research will not pay for participation. All participants must NOT be pregnant or have any form of diagnosed heart disease. The study will consist of one session which could last about 3 hours. Participants will be subject to a DXA scan which will expose them to a small dosage of radiation.

If you are interested, please call (770-842-0218) or email (cemorri1@olemiss.edu) Cody Morris. Mr. Morris is a Masters candidate in the Department of HESRM.

The University of Mississippi

Department of Exercise Science
University, MS
234 Turner Center
662.915.5570

APPENDIX: B

RECRUITMENT PHONE SCRIPT

Phone script no subjects scheduled

Thank you (______________) for inquiring about our study. HESRM is recruiting 15 normal weight adults, 15 overweight adults, and 15 distance runners aged 18-44 for a study looking at the differences between normal weight and overweight individuals. We would like to determine if there are differences between a normal weight and overweight adult population when comparing the way they walk to how much oxygen they use.

As a subject, you will be required to come to the physiology lab at the Turner Center on the University of Mississippi campus for one three hour session. We will require you to fill out 2 forms (PAR-Q and 7-day PAQ) in order to determine whether you are healthy enough to participate and to record your recent physical activity. We will then ask to measure your height and weight. You will be required to complete a pregnancy test before a DXA scan. We do this because the DXA scan gives off a minimal amount of radiation that may harm your fetus. We will give you written and oral instructions on how to complete the pregnancy test. The DXA scan will require you to lie flat on the scanner while the wand travels back and forth over your body. The DXA scan measures your body fat percentage.

Once completed, we will measure your resting blood pressure and heart rate. After this, you will be asked to walk 50 feet at your normal walking pace and do this 6 times. Then you will be asked to complete a moderate intensity exercise on a treadmill. A laboratory technician will fit you with a mouthpiece with a tube attached to a machine that measures how much oxygen you use. You will insert the mouthpiece into your mouth and breathe normally. You will either walk or run at your preferred speed for 5 minutes. A laboratory technician will set the speed on the treadmill for you and inform you about the protocol.

If you are in the treadmill walking group, after completing your 5-minute walk you will perform a moderate-intensity treadmill exercise to predict the maximum amount of oxygen your body can consume during exercise. This additional test will be ended when you reach 60% of your predicted Heart Rate Reserve, which is the difference between your age-predicted heart rate max and resting heart rate. The protocol involves stages which increase by 1 mph and 1% grade every minute. The first stage begins with the treadmill at 2 mph and 2% grade.

If you are in the treadmill running group, after completing your 5-minute run you will perform a moderate-intensity treadmill exercise to predict the maximum amount of oxygen your body can consume during exercise. This additional test will be ended when you reach 60% of your predicted Heart Rate Reserve, which is the difference between your age-predicted heart rate max and resting heart rate. The protocol involves stages which increase by 1 mph and 1% grade every minute. The first stage begins with the treadmill at 4 mph and 4% grade.

Then you are finished with the study. We will provide you with water at the end of the day.

Would you like to participate in our study? ____yes ____no

(no). Thank you very much for calling.

(yes). I need to ask you some questions to see if you qualify for the study. Answering them is, of course, voluntary. You can tell me you don't want to do this or you can stop at any time, and there will be no penalty of any kind – these are your rights. All of your answers will be kept confidential. These questions have to do with your health and some are very personal. Are you willing to hear them?

Great.
Are you between the ages of 18-44?
Are you a man or a woman?
Do you feel any pain in your chest when you perform exercise?
Are you taking any prescription medications?
Do you have a medical condition that would prevent you from walking on the treadmill?
Do you have any joint conditions would prevent you from walking on the treadmill?
Are you pregnant?
From the last time you weighted yourself, how much did you weigh? _______(wt)
________(date)
How tall are you? _________(ht)

(Don't ask, just do the math) Based on the last two questions, what is their BMI?
__________(BMI)

Ask questions from the PAR-Q here!

Based on the questions above and the questions from the PAR-Q, could the person participate in the study? ____yes ____no

If yes, assign day for the subject to come to the lab.

Date____________________ Email ___________________________

If no, thank them for their call.

APPENDIX: C

RECRUITMENT EMAIL SCRIPT

Students, faculty, and staff,

Ready to get the new year started off right?

The University of Mississippi Department of Health, Exercise Science, and Recreation Management is recruiting subjects for a study entitled, "Cross-Validation of a Recently Published Equation Predicting Energy Expenditure to Run or Walk a Mile in Normal Weight and Overweight Adults". We will be looking at the energy expenditure differences between normal weight and overweight individuals with exercise. We would like to determine if there are differences between a normal weight and overweight adult population when comparing the way they walk or run to how much oxygen they use.

We will be providing you a FREE DXA scan that measures your body composition.

Please note: This research will not pay for participation. All participants must NOT be pregnant or have any form of diagnosed heart disease. The study will consist of one session which could last about 3 hours. Participants will be subject to a DXA scan which will expose them to a small dosage of radiation.

If you are interested, or need further information, please reply to Cody Morris by email: cemorri1@olemiss.edu

Mr. Morris is a Masters candidate in HESRM.

APPENDIX: D

RESPONSE TO RECRUITMENT INTEREST EMAIL

Part 1 - Gauging Interest

Thank you (______________) for inquiring about our study. HESRM is recruiting 15 normal weight adults, 15 overweight adults, and 15 distance runners aged 18-44 for a study looking at the differences between normal weight and overweight individuals. We would like to determine if there are differences between a normal weight and overweight adult population when comparing the way they walk to how much oxygen they use.

As a subject, you will be required to come to the physiology lab at the Turner Center on the University of Mississippi campus for one three hour session. We will require you to fill out 2 forms (PAR-Q and 7-day PAQ) in order to determine whether you are healthy enough to participate and to record your recent physical activity. We will then ask to measure your height and weight. You will be required to complete a pregnancy test before a DXA scan. We do this because the DXA scan gives off a minimal amount of radiation that may harm your fetus. We will give you written and oral instructions on how to complete the pregnancy test. The DXA scan will require you to lie flat on the scanner while the wand travels back and forth over your body. The DXA scan measures your body fat percentage.

Once completed, we will measure your resting blood pressure and heart rate. After this, you will be asked to walk 50 feet at your normal walking pace and do this 6 times. Then you will be asked to complete a moderate intensity exercise on a treadmill. A laboratory technician will fit you with a mouthpiece with a tube attached to a machine that measures how much oxygen you use. You will insert the mouthpiece into your mouth and breathe normally. You will either walk or run at your preferred speed for 5 minutes. A laboratory technician will set the speed on the treadmill for you and inform you about the protocol.

If you are in the treadmill walking group, after completing your 5-minute walk you will perform a moderate-intensity treadmill exercise to predict the maximum amount of oxygen your body can consume during exercise. This additional test will be ended when you reach 60% of your predicted Heart Rate Reserve, which is the difference between your age-predicted heart rate max and resting heart rate. The protocol involves stages which increase by 1 mph and 1% grade every minute. The first stage begins with the treadmill at 2 mph and 2% grade.

If you are in the treadmill running group, after completing your 5-minute run you will perform a moderate-intensity treadmill exercise to predict the maximum amount of oxygen your body can consume during exercise. This additional test will be ended when you reach 60% of your predicted Heart Rate Reserve, which is the difference between your age-predicted heart rate max and resting heart rate. The protocol involves stages which increase by 1 mph and 1% grade every minute. The first stage begins with the treadmill at 4 mph and 4% grade.

Once this final stage is completed, then you are finished with the study. We will provide you with water at the end of the day.

Would you like to participate in our study? ____yes ____no

Part 2 – Eligibility criteria

Dear (   ),
Thank you for your interest in our study! I need to ask you some questions to see if you qualify for the study. Answering them is, of course, voluntary. You can tell me if you don't want to do this by responding back to my email saying so, and there will be no penalty of any kind – these are your rights. All of your answers will be kept confidential. These questions have to do with your health and some are very personal. If you are willing, please reply back to this email with the answers to these questions. If you are not, simply reply back that you are not interested in participating.

1. Are you between the ages of 18-44?
2. Are you a man or a woman?
3. Do you feel any pain in your chest when you perform exercise?
4. Are you taking any prescription medications?
5. Do you have a medical condition that would prevent you from walking on the treadmill?
6. Do you have any joint conditions would prevent you from walking on the treadmill?
7. Are you pregnant?
8. From the last time you weighed yourself, how much did you weigh? _______(weight) ________(date)
9. How tall are you? _________(height)

YES or NO

1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
2. Do you feel pain in your chest when you do physical activity?
3. In the past month, have you had chest pain when you were not doing physical activity?
4. Do you lose your balance because of dizziness or do you ever lose consciousness?
5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?
6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
7. Do you know of any other reason why you should not do physical activity?

PAR-Q

YES NO

☐ ☐ 1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?

☐ ☐ 2. Do you feel pain in your chest when you do physical activity?

☐ ☐ 3. In the past month, have you had chest pain when you were not doing physical activity?

☐ ☐ 4. Do you lose your balance because of dizziness or do you ever lose consciousness?

☐ ☐ 5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?

☐ ☐ 6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?

☐ ☐ 7. Do you know of any other reason why you should not do physical activity?

(Not included with email)

ASSESSMENT

Based on the questions above and the questions from the PAR-Q, could the person participate in the study? ____yes ____no

If yes, assign day for the subject to come to the lab.

Date____________________ Email __________________________

APPENDIX: E

INFORMED CONSENT

INFORMED CONSENT

Consent to Participate in an Experimental Study

Title: Cross-Validation of a Recently Published Equation Predicting Energy Expenditure to Run or Walk a Mile in Normal Weight and Overweight Adults

Investigator
Cody E. Morris, B.S.
Department of Health, Exercise Science, and Recreation Management
215 Turner Center
The University of Mississippi
(662) 915-5570

Sponsor
Mark Loftin, Ph.D.
Department of Health, Exercise Science, and Recreation Management
215 Turner Center
The University of Mississippi
(662) 915-5526

Description

You are being asked to participate in a research study looking at the differences between normal weight and overweight individuals. We would like to determine if there are differences between a normal weight and overweight adult population when comparing the way they walk to how much oxygen they use.

Your participation is voluntary. If you decide to participate in this study, the test will require about three hours to finish. During the tests, we will be asking you to perform several different walking tests while we measure the amount of oxygen you use. We will also be measuring the exact dimensions of your body and determining your body fat percentage. We will explain the tests to you and you can ask any questions you have about the study.

Inclusion Criteria

- You must be between the ages of 18 and 44 and be in good health.
- You must be capable of understanding and providing written informed consent after a full explanation of the study.
- You must be able to walk on a treadmill for 5 minutes.

Exclusion Criteria

- You weigh more than 300 pounds.
- Blood pressure will be measured twice at rest and if two systolic blood pressure values are found to be above 140 or two diastolic blood pressures are found to be above 90, you will not be permitted to participate in the study.
- You are pregnant.

DXA

- You will complete a DXA evaluation. This test will determine your percentage of body fat.
- If you are female, you will be required to complete a urine pregnancy test, unless you have had a hysterectomy. A trained laboratory technician will escort the female subjects to the restroom and offer instructions in order to complete the test. If the pregnancy test is positive, a DXA scan will not be completed and you will be ineligible to participate in the study.
- You will remove any metal objects from anywhere on your body and lie back on the DXA table.
- Your body fat percentage will be explained to you. We will answer any questions you may have.
- The DXA should take about 30 minutes to complete.

Evaluation of Readiness for Exercise

- You will complete a physical activity readiness questionnaire (PAR-Q) and body measures.
- The PAR-Q consists of seven questions that determine if you have any heart disease, chest pain, dizziness, bone or joint problems, or are taking any prescription drugs that may limit your physical activity.
- If you answer yes to any of the questions on the PAR-Q, you will be ineligible to participate in the study.
- We will be measuring your height and weight, both without shoes.
- Your blood pressure will be analyzed twice using a sphygmomanometer by a trained lab technician. If your blood pressure is 140/90 or greater, you will be excluded from the study.
- You will be asked to complete a physical activity questionnaire that determines how much exercised you have performed over the last 7 days.

Preferred Walking Speed

- You will walk 50 feet at your normal walking pace and do this 6 times.

Oxygen Use While on a Treadmill

- You will stand quietly on the treadmill.
- A laboratory technician will fit you with a mouthpiece with a tube attached to a machine that measures how much oxygen you use.
- You will insert the mouthpiece into your mouth and breathe normally.
- You will either walk or run at your preferred speed for 5 minutes. A laboratory technician will set the speed on the treadmill for you and inform you about the protocol.
- If you are in the treadmill walking group, after completing your 5-minute walk you will perform a moderate-intensity treadmill exercise to predict the maximum amount of

oxygen your body can consume during exercise. This additional test will be ended when you reach 60% of your predicted Heart Rate Reserve, which is the difference between your age-predicted heart rate max and resting heart rate. The protocol involves stages which increase by 1 mph and 1% grade every minute. The first stage begins with the treadmill at 2 mph and 2% grade.

- If you are in the treadmill running group, after completing your 5-minute run you will perform a moderate-intensity treadmill exercise to predict the maximum amount of oxygen your body can consume during exercise. This additional test will be ended when you reach 60% of your predicted Heart Rate Reserve, which is the difference between your age-predicted heart rate max and resting heart rate. The protocol involves stages which increase by 1 mph and 1% grade every minute. The first stage begins with the treadmill at 4 mph and 4% grade.

Risks and Benefits

A very low but possible risk for you (and for an unborn fetus) is from radiation exposure from the DXA scan. The effective dose of radiation for the whole body scan is similar to the daily background radiation experienced in most parts of the world and only about 1/30th of the maximal permissible X-ray dose per year.

Feedback from the DXA scan may provide a greater understanding of your body composition including percent of body fat. If you wish, we will fax the DXA results to your physician.

Cost and Payments

There is no cost or payment for participation in this study.

Confidentiality

The study procedures will be monitored continuously so as to ensure your privacy and the confidentiality of your information. The principal investigator (Cody Morris) will be responsible for the data and safety monitoring. Confidentiality will be maintained by password protection and encoding all computer data file names, by not including participant names in the data files, and by using encoded identifiers for all computer data subdirectories. Furthermore, all other research records will be kept separate, stored in secure, locked cabinets with access restricted to the investigators. The data CDs and hard copy information linking case numbers to participant names will be kept for an indefinite period of time. Only the principal investigator (Cody Morris) of the research team will have access to the confidential data records. The stored CDs will only be available to the investigators documented on the research protocol.

Right to Withdraw

You do not have to take part in this study. If you start the study and decide that you do not want to finish, all you have to do is to tell Cody Morris or Dr. Mark Loftin in person, by letter, or by telephone at the Department of Health, Exercise Science, and Recreation Management, 215 Turner Center, The University of Mississippi, University MS 38677, or 915-5570. Whether or not you choose to participate or to withdraw will not affect your standing with the Department of Health, Exercise Science, and Recreation Management, or with the University.

The researchers may terminate your participation in the study without regard to your consent and for any reason, such as protecting your safety and protecting the integrity of the research data.

Compensation for Illness or Injury
"I understand that I am not waiving any legal rights or releasing the institution or their agents from liability from negligence. I understand that in the event of physical injury resulting from the research procedures, The University of Mississippi does not have funds budgeted for compensation for 1) lost wages, 2) medical treatment, or 3) reimbursement for such injuries. The University will help, however, obtain medical attention which I may require while involved in the study by securing transportation to the nearest medical facility."

IRB Approval
This study has been reviewed by The University of Mississippi's Institutional Review Board (IRB). The IRB has determined that this study fulfills the human research subject protections obligations required by state and federal law and University policies. If you have any questions, concerns, or reports regarding your rights as a participant of research, please contact the IRB at (662) 915-7482.

Statement of Consent
I have read the above information. I have been given a copy of this form. I have had an opportunity to ask questions, and I have received answers. I consent to participate in the study.

Signature of Participant Date

Signature of Investigator Date

NOTE TO PARTICIPANTS: DO <u>NOT</u> SIGN THIS FORM
IF THE IRB APPROVAL STAMP ON THE FIRST PAGE HAS EXPIRED.

APPENDIX: F

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE (PAR-Q)

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

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

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

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

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

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

If you answered

YES to one or more questions

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

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

NO to all questions

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

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

DELAY BECOMING MUCH MORE ACTIVE:

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

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

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

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

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

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

NAME ____________________

SIGNATURE ____________________ DATE ____________________

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

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

continued on other side...

APPENDIX: G

7-DAY PHYSICAL ACTIVITY RECALL

7-Day Physical Activity Recall SSN

PAR#: 1 2 3 4 5 6 7 Participant________________

Interviewer____________ Today is________ Today's Date_ ______

1. Were you employed in the last seven days? 0. **No** (Skip to **Q#4**) 1. **Yes**
2. How many days of the last seven did you work? ____ days
3. How many total hours did you work in the last seven days? ____ hours last week
4. What two days do you consider your weekend days? ____________ ____________ (mark days below with a squiggle)

WORKSHEET **DAYS**

	SLEEP	1 __	2 __	3 __	4 __	5 __	6 __	7 __
MORNING	**Moderate**							
	Hard							
	Very Hard							
AFTERNOON	**Moderate**							
	Hard							
	Very Hard							
EVENING	**Moderate**							
	Hard							
	Very Hard							
Total Min Per Day	Strength: Flexibility:	_____	_____	_____	_____	_____	_____	_____

4a. Compared to your physical activity over the past 3 months, was last week's physical activity more, less, or about the same? 1. More 2. Less 3. About the same	6. Do you think this was a valid PAR Interview? 1. Yes 0. No If NO, go to the back and explain.
5. Were there any problems with the PAR interview? 0. No 1. Yes If **YES**, go to the back and explain.	7. Were there any special circumstances concerning this PAR ? 0. No 1. Yes, If YES, what were they?(circle) 1. Injury all week 2. Illness all week 3. Illness part week 4. Injury part week 5. Pregnancy 6. Other:

Worksheet Key:
An asterisk (*) denotes a work-related activity.
A squiggly line through a column (day) denotes a weekend day.

Rounding: 10-22 min.=.25; 23-37 min.=.50; 38-52 min.=.75; 53-1:07 hr/min. =1.0; 1:08-1:22 hr/min.=1.25

5. Explain why there were problems with this PAR interview:

____
____
____
____

6. If PAR interview was not valid, why was it not valid?

____
____
____
____

7. Please list below any activities reported by the subject which you do not know how to classify.

____
____
____
____

8. Please provide any other comments you may have.

____
____
____
____

APPENDIX: H

PREGNANCY TESTING PROCEDURES

Pregnancy Testing Procedures

Subjects will come to Turner 248A, the DXA lab. The researcher will give a urine pregnancy testing kit to the subject and give oral directions, as well as written directions. The researcher will escort the subject to the restroom and obtain urine sample from subject once completed. The researcher will then take the sample to turner 248A to analyze the sample.

FOR POSTIVE TEST ONLY!
Script for Positive Pregnancy Test

The pregnancy test appears to be positive. We cannot complete a body composition scan on you because of the positive reading. We recommend that you see your physician.

APPENDIX: I

STEPS FOR PROTOCOL

Steps for Protocol

Subject: ______
Group: ☐ NWW ☐ OW ☐ DR

Phone Call/Email (DATE): ____________________
☐ Phone Script
☐ PAR-Q
BMI calculation (wt kg/H m^2): _________________________

Lab arrival (DATE): ____________________

☐ Informed Consent
☐ PAR-Q
☐ 7-day PAQ
☐ 3-day food recall

-Age: ____________

-Height: ____________

-Weight: ___________
☐ More than 300 lbs? Rule out.
☐ Less than 300 lbs? Proceed.

-Gender: _______
☐ If female,
- ☐ Pregnant? Rule out.
- ☐ Hysterectomy? Proceed.
- ☐ Perform pregnancy test. Provide directions.
  - ☐ Positive? Rule out.
  - ☐ Negative? Proceed.

Enter Body Composition Lab for DXA.

☐ Subject removes all metal objects from body.
☐ Perform DXA.

-DXA Scan Body Fat %: _______________

-Group determination: NWW - OW - DR

Re-enter Ex. Phys. Lab

-Resting BP (1)__________ (2)__________

☐ Over 140/90 twice? Rule out.

☐ Within normal limits? Proceed.

-Resting HR: ____________

☐ Over 100 bpm? Rule out.

☐ Less than 100 bpm? Proceed.

-Heart Rate Max calculation (220-age): ___________________________

-60% HRR: ________________________

60% HRR = $[(HR_{max} - HR_{rest}) \times 0.60] + HR_{resting}$

-Walk speed evaluation (50 ft trials):

- Times: 1. _______ 2. _______ 3. _______
  4. _______ 5. _______ 6. _______
- Preferred Walking Speed: __________
- DR Preferred Running Speed: ___________
  - Times: 10K - _____________
    ½ Marathon: ____________________
    Marathon: _______________________

☐ Put together breathing mask.

☐ Place mask on subject.

☐ Stand subject on treadmill.

☐ Subject stands for Standing Ambulatory Rest data (5 min)

☐ Brief warm-up (1 min at ½ preferred pace): _______

☐ Subject walk/run at preferred pace (5 min)

☐ Subject stands for EPOC data (5 min)

☐ Brief rest period for HR to return to w/in 10 bpm of $HR_{resting}$

☐ Submax. VO_2 test:

-NWW/OW: 2 mph/2%, increase 1 mph/1% each min.
-DR: 4 mph/4%, increase 1 mph/1% each min.
-Time exercised: __________
-VO_2 achieved: ____________

☐ End of test.
☐ Provide subject w/ water and thank them for their time.

DATA

-Standing Ambulatory rest: _______________________

-Predicted EE using Loftin, et al. (2010) equation: _______________

Kcal = [mass(kg) x 0.789] – [gender (men=1, women=2) x 7.634] + 51.109

-Actual EE from preferred walk/run: ______________________________

-EPOC evaluation: _____________________________

% of HRR worked: _______________

Extrapolated VO_{2max}: _______________________________________

% of estimated VO_2 max worked: ______________________

TOTAL TIME FOR TESTING________________________

NOTES

VITA

Previous Degrees Attained:

- LIPSCOMB UNIVERSITY, Nashville, TN

  Bachelor of Science – Exercise Science (Minor: Biology)

  December 2008

Relevant Academic and Professional Employment:

- UNIVERSITY OF MISSISSIPPI, University, MS

  Graduate Instructor

  August 2009 – Present

- BAPTIST MEMORIAL HOSPITAL – NORTH MISSISSIPPI, Oxford, MS

  Cardiac Rehabilitation Graduate Assistant

  June 2010 – July 2011

- LIFESIGNS MD, INC., Nashville, TN

  Onsite Screening Specialist

  May 2008 – July 2009