Salisbury
UNIVERSITY

Honors College

Honors Thesis

An Honors Thesis Titled

Comparison of Energy Expenditure between Footbag and Elliptical Cross Trainer

Submitted in partial fulfillment of the requirements for the Honors Designation to the

Honors College

of

Salisbury University

in the Major Department of

Health and Sports Sciences

by

Colleen E. Lynch

Date and Place of Oral Presentation: November 2017, MARC-ACSM

Signatures of Honors Thesis Committee

Mentor:		Dr. Scott Mazzetti
Reader 1:	Stephen Gehnrich	Dr. Stephen Gehnrich
Reader 2:	Leanne Wood	Dr. Leanne Wood
Director:		
	Signature	Print

This thesis is a compilation of the work done by the students within the Laboratory for Human Performance (LHP) in the Department for Health and Sports Sciences. The LHP is a student run lab under the supervision of Dr. Scott Mazzetti. This study has been started and stopped several times over the last decade, with only the last two attempts of the study being used in this analysis. This is due to the previous attempts being done with different equipment and in a different location. When I took over this study there were already 7 previous subjects who had completed data collection, but no analysis of the data had been started. During my time in the LHP running this study we completed data collection of 6 subjects. As well, I completed data analysis of all 13 subjects.

Before beginning the most recent round of data collection, we had to meet as a lab group to determine the protocol to follow and make sure the data we were collecting was the same as the previous attempt. The other students in the LHP aided in the data collection process. They all had various roles during the trials, from collecting different data points, running the stopwatch, to playing hacky sack with the subject. During each trial, I was scribing and making sure that all aspects of the study went smoothly. Since the LHP is an environment for everyone to learn, it was very important to ensure that each individual in the laboratory had an opportunity to aid and experience the research process. Some of this involved double checking the data analysis I completed and providing feedback on the different sections of my writing. During the data collection and data analysis processes I was writing the final thesis.

Comparison of Energy Expenditure between Footbag and Elliptical Cross Trainer

Colleen E. Lynch, Ryan M. Sapp, Benjamin M. Meister, Alison C. Schwartz, Cody B. Revel, Kerry E. Lynch, Nicholas A. Carlini, Zackary J. Valenti, William A. Fountain, Michael E. Quarantillo, and Scott A. Mazzetti. Salisbury University, Salisbury, MD.

ABSTRACT

More than 60% of adult Americans do not engage in the recommended minimum amount of exercise, with ~40% of young adults (18-24 yr) also not achieving recommendations. Previous research has shown that adults can achieve recommended activity levels by playing children's games, and soccer activities have recently been shown to elicit similar energy costs compared to running. Including recreational game activities in conjunction with a traditional aerobic exercise regimen may help individuals accumulate exercise above the minimum recommended amounts to help achieve weight-management goals. However, more research is needed to help us better understand if energy expenditure from other game activities is similar to traditional aerobic exercise. Therefore, we compared energy expenditure during and after 'footbag freestyle' game-play (FOOTBAG) versus aerobic exercise on an elliptical cross trainer (AEROBIC). Twelve men (21.1 ± 1.2 yr) performed a maximal graded exercise test on an elliptical cross-trainer to determine VO_{2max}. After baseline and familiarization sessions, subjects performed three experimental protocols, once per week, randomly assigned in a counterbalanced order including 30 min of FOOTBAG, AEROBIC, and a no-exercise control trial (CTRL). Expired air was collected continuously before (15 min), during (30 min), and for 30min after each protocol using a metabolic cart. Data were analyzed using a two-way repeated measures ANOVA with Fisher's Least Significant Difference (LSD) post hoc analyses. Significant differences ($p<0.05$) among the average rates of energy expenditure ($kcal \cdot min^{-1}$) included FOOTBAG and AEROBIC > CTRL from 0-10, 11-20, and 21-30min of activity, as

well as +5min after exercise. No significant differences in the rates of energy expenditure among groups were observed at rest, nor after +10, +15 and +30min of recovery. Total energy expenditure (kcal) was significantly greater ($p<0.05$) during AEROBIC (199.5±33.2) and HACKY (196.3±40.8) compared to CTRL (40.4±3.8). Total energy expenditure was not significantly different between FOOTBAG and AEROBIC. In summary, energy expenditure was similar between FOOTBAG and AEROBIC, suggesting that game activities can elicit similar moderate-intensity metabolic responses (almost 5 METS) compared to popular aerobic exercise modes in young adults. Therefore, game activities like 'footbag freestyle' can be included in addition to regularly planned aerobic exercise to help meet, or even exceed minimum activity recommendations.

Keywords: hacky sack, metabolic rate, metabolic equivalents, calorie expenditure, moderate-intensity exercise

INTRODUCTION

According to the Centers for Disease Control, more than 60% of adult Americans do not engage in the minimum recommended amount of daily exercise. The American College of Sports Medicine suggests 150 minutes of moderate intensity physical activity per week; which averages out to ~20 minutes per day. The inadequate amount of physical activity is evident even among young adults, where 43% of 18-24 year olds do not engage in the minimum amount of exercise (McCracken et al., 2007). While the Surgeon General recommends including 30 minutes of moderate physical activity on most days of the week, the American College of Sports Medicine, the Institute of Medicine, and the International Association for

the Study of Obesity have emphasized that the volume of exercise must be longer than 30 minutes for weight management. As the prevalence of obesity continues to rise in the US, there is a need to identify strategies that promote increased participation in physical activities for Americans. Fischer et al. (2004) showed that adults can successfully achieve the recommended physical activity levels and substantial energy expenditure by playing children's games with their kids. However, it remains unclear how energy expenditure responses from game activities compare with more traditional aerobic exercises, such as running, cycling, and other machine-based exercise such as on the elliptical cross-trainer.

Energy expenditure through various modes of exercise has been widely studied, but most of these studies focus on a "traditional" form of exercise, such as treadmill running or cycling. Brown et al. (2010) have shown that there was not a significant difference in energy expenditure between elliptical trainer and treadmill. However, Porcari et al. (1998) found that these two forms of exercise (elliptical and treadmill running) resulted in a significantly higher energy expenditure than treadmill walking, cycling and stepping. Geus et al. (2006) examined energy expenditure from commuter cycling at a self-selected speed, and determined that it met physical activity recommendations set by ACSM for cardiorespiratory fitness, which is 30 minutes a day, three to five times a week (American College of Sports Medicine, 2017). Thus it seems that individuals desiring to exceed the 30 minutes per day, or 5 days per week for the purpose of weight management, could consider using a combination of various traditional exercise modes to avoid boredom.

More recently there have been several studies focusing on other forms of activity, such as skiing or tennis, in an effort to determine if they elicit similar energy expenditure costs compared to traditional forms of exercise. Stoggl et al. (2016) compared the energy expenditure between alpine skiing, cross country skiing, and indoor cycling, and determined that cross country skiing and indoor cycling had higher energy expenditure than alpine skiing. In another study, Fernandez-Fernandez and colleagues (2009) compared energy expenditure between advanced and recreational tennis players, determining that there was no significant difference in the total energy expenditure based upon skill level.

The game of footbag, more popularly known by the brand name Hacky Sack, was started in 1972 when Mike Marshall and John Stalberger began kicking a bean bag repeatedly. The goal was to keep the bean bag off the ground for as long as possible using all parts of the body except for the hands and arms. The new game grew in popularity, especially with high school and college students. These players would stand in circles and take turns keeping the footbag off the ground. Overtime, there have been several different games of footbag created each with a different objective. 'Footbag net' utilizes a net placed on a court divided into four quadrants, it can be played in singles or doubles and is played like a cross between volleyball and tennis. 'Footbag consecutive' has the goal of keeping the footbag in the air using only the feet. 'Footbag freestyle' is when a group of players stand in a circle and attempt to keep the footbag in the air (World Footbag, 2017). Any number of players can participate, and each player can employ their own style. The popularity of footbag peaked in the 1980's, when the rights were sold to Whamo, Inc., but it has maintained its popularity over the years, especially among young adults. There is even the International Footbag Players Association (IFPA) World

Footbag Championship still being held annually since 1980 (IFPA World Footbag Championships, 2017). Despite its sustained popularity over the past 4 decades, it remains unclear whether footbag game-play is sufficiently intense to contribute meaningful energy expenditure responses similar to that of other traditional aerobic activities. Therefore, the purpose of this investigation was to compare energy expenditure during and after 'footbag freestyle' to moderate-intensity elliptical exercise at 35% of VO_{2max}. If such alternative physical activities can elicit similar energy expenditure responses, then they could help individuals by allowing them to incorporate more recreational, game-play activities into their weekly physical activity programs in conjunction with planned, traditional aerobic exercise sessions. Doing so would enable individuals to increase exercise frequency or total duration beyond the minimum required exercise standards set forth by ACSM for the purpose of enhanced weight-management.

METHODS

Participants

Twelve males (21.1 ± 1.2) volunteered for this investigation (Table 1). Participants were physically active and experienced with recreational 'footbag freestyle' (greater than 2 years), but were not highly trained footbag competitors. All participants were non-smoking, free of chronic diseases, and free of medications, ergogenic supplements, glandular disorders, and any conditions that could affect metabolism.

Table 1. Subject Characteristics.

N=12	MEAN ± SD
Age (yr)	21.1 ± 1.2
Height (cm)	175.3 ± 7.5
Weight (kg)	76.4 ± 10.3
Body Fat %	10.2 ± 3.6
BMI ($kg \cdot m^{-2}$)	24.8 ± 2.2

Values are means ± SD.

Protocol

Study Design

We tested the hypothesis that energy expenditure during and after "footbag freestyle" would be similar to moderate-intensity aerobic exercise performed on an elliptical cross trainer exercise machine. After two baseline testing trials, participants performed three experimental testing sessions, once each week, including no-exercise control resting (CTRL), 'footbag freestyle' (FOOTBAG), and aerobic exercise on an elliptical cross trainer at 35% of VO_{2max} (AEROBIC) (Figure 1). The first baseline testing visit consisted of body composition and VO_{2max} testing, and the second visit consisted of a familiarization trial and was completed within 2-3 days of the maximal exercise test. The next three visits were performed once-weekly, on the same day of the week, at the same time in the morning following an overnight fast (10-12 hours) with CTRL being performed first, and then FOOTBAG and AEROBIC being performed in a randomized, counterbalanced order.

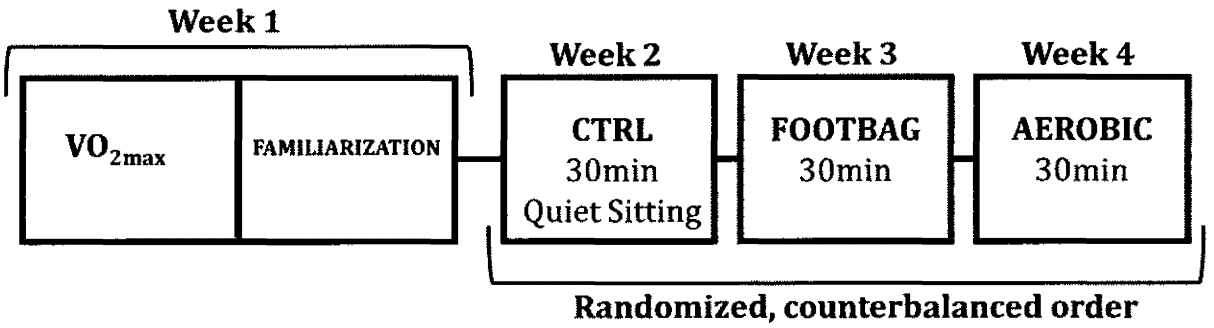

Figure 1. Study timeline used to compare energy expenditure among no-exercise (CTRL), 'freestyle footbag' game play (FOOTBAG), and aerobic exercise on an elliptical exercise machine (AEROBIC).

Baseline Testing and Familiarization

During the first visit (Week 1), body mass and height were measured to the nearest 0.10 kg and 0.10 cm, respectively, using a Cardinal Detecto 750 scale (Detecto Scale Company, Webb City, MO) and a Seca Model 213 Stadiometer (Seca, Chino, CA). Skinfold measurements were obtained from seven sites (triceps, sub-scapular, mid-axillary, pectoral, supra-iliac, abdominal, and thigh), and the equation described by Jackson and Pollock (1978) was used to estimate body density. Skinfolds were taken on the right side of the body in duplicate, with a third measurement being taken if the first two were not within 2 mm. Duplicate skinfold measurements were then averaged and used for calculation of percent body fat. Percent body fat was estimated using the value obtained for body density and the Siri equation (Siri WE, 1961).

Table 2. VO_{2max} protocol.

Stage (2 min each)	Resistance (units)	Cadence (rpm)	Metronome (bmp)
1 (warm-up)	1	60	120
2	3	70	140
3	6	70	140
4	9	80	160
5	12	80	160
6	15	90	180
7	18	90	180
8	21	100	200
9	24	100	200

Participants then performed a maximal graded exercise test (VO_{2max}) at ambient temperature on a Keiser-m5 Strider Elliptical Exercise Machine (Keiser Corporation, Fresno, CA). Testing was performed using a two-way non-rebreathing mouth piece and nose clip supported by head gear (Hans Rudolph, Inc., Kansas City, MO), and expired air was sampled continuously using a metabolic cart (ParvoMedics, Sandy, UT). Oxygen and CO_2 gas analyzers were calibrated before each test with standard gases of known concentrations. Briefly, after a two-minute warm-up stage, participants exercised on the elliptical exercise machine to volitional exhaustion with the resistance and speed being incrementally increased (see Table 2). VO2max was confirmed if subjects accomplished three of the four following criteria: an increase in workload and no change in VO2 > 200 ml O_2, a rating of perceived exertion (RPE) $\geq$ 17, RER > 1.1 and a heart rate maximum within +/- 10 beats per minute of age predicted heart rate max (ref 3 from rock paper). VO_{2max} for each participant was determined as the highest rate of O_2 consumption measured over a 30 second average.

Two to three days later, participants performed a 20-min submaximal exercise session on the elliptical exercise machine at ambient temperature to become familiarized with the exercise intensity used during the subsequent AEROBIC testing session (35% of VO_{2max}), and to become familiar with exercising while wearing a two-way non-rebreathing nose and mouth face mask. Expired air was continuously sampled using the metabolic cart. During this familiarization trial, elliptical resistance was adjusted if necessary until the desired exercise intensity was established and recorded for use during the subsequent AEROBIC experimental testing session. Immediately after the 20min elliptical exercise, participants played 'footbag freestyle' with two additional players to become familiarized with footbag play while wearing the nose and mouth breathing facemask, and to establish a game-playing rapport with the two footbag players, who would also be playing during the subsequent FOOTBAG experimental testing session.

Experimental Protocols

This study had three different experimental protocols: a control, hacky sack play, and elliptical cross training. These protocols were presented in a randomized, counter-balanced approach between each participant. Before the participant started any experimental protocols, they sat in a recliner for a 30-minute period (15 minutes to stabilize a resting state /15 minutes to collect resting values via the metabolic cart), making sure that we had appropriate and accurate resting data and a consistent baseline before each trial. Once this 30-minute period was completed the participant moved onto one of the experimental protocols (Figure 2).

CTRL Protocol: Exactly one week later (Week 2), participants performed a no-exercise resting CTRL energy expenditure trial that required the participant to lay in a reclined position for 90 total minutes. The first 15 minutes, participants stayed in the reclined position quietly without the face mask, and then for 75 minutes while wearing the two-way non-rebreathing nose and mouth face mask, with expired air being continuously sampled by the metabolic cart to mimic the 15-min resting, 30 min protocol, and 30 min recovery phase also used in the other two experimental protocols.

Experimental Protocols: Exactly one week later, participants performed either the FOOTBAG or the AEROBIC protocol using a randomized, counterbalanced design. Both FOOTBAG and AEROBIC protocols consisted of laying in a reclined position for 15 min (without the mask), followed by continuous expired air collection for a 15 min pre-exercise resting period (laying in a reclined position), during (30 min), and for 30 min after each protocol using the face mask and metabolic cart described above. Participants were instructed to remain still, silent and awake during the pre- and post-activity periods.

FOOTBAG Protocol: During the 30-min FOOTBAG protocol, participants played 'freestyle footbag' with the same two experienced footbag players from the familiarization session. The FOOTBAG play was intended to be as "authentic" as possible, meaning the participant was not fed the footbag every time it was dropped and play resumed. Instead, the participant and two other experienced players naturally restarted the game by taking turns serving it to each of the three players. To minimize down time when the footbag was inadvertently kicked out of play, our research team dispersed three additional lab members around the footbag circle and

tossed the footbag to a 'feeder' who always had an additional footbag to serve back into the game to one of the three players. Participants and additional footbag players were regularly reminded that the goal of the footbag play was to have fun, and try to keep the footbag from hitting the floor using only the feet and legs, chest, head, shoulders and arms.

AEROBIC Protocol: During the 30-min AEROBIC protocol, participants exercised at 35% of VO_{2max} on the elliptical exercise machine while wearing the nose and mouth breathing facemask.

Indirect Calorimetry: Oxygen consumption ($L \cdot min^{-1}$) data (30 sec averages) were used to calculate average rates of energy expenditure ($kcal \cdot min^{-1}$) at baseline (REST); during activity (averaged across each of the three ten-minute periods; 0-10, 11-20, and 21-30), and for +5, +10, +15, and +30 min post-activity. All data were corrected for dead-space associated with the time necessary for expired air to travel from the mouth to the analyzers. Energy expenditure ($kcal \cdot min^{-1}$) was calculated using O_2 consumption data and the equation $L \cdot min^{-1}$ multiplied by 4.9 (Weir, 1949). Because there were no differences in energy expenditure rates before each trial, and differences after each trial were minimal, total energy expenditure values (kcals) were calculated for the 30-min duration of each protocol using the trapezoidal area under the curve method (AUC) for each participant and for each trial separately.

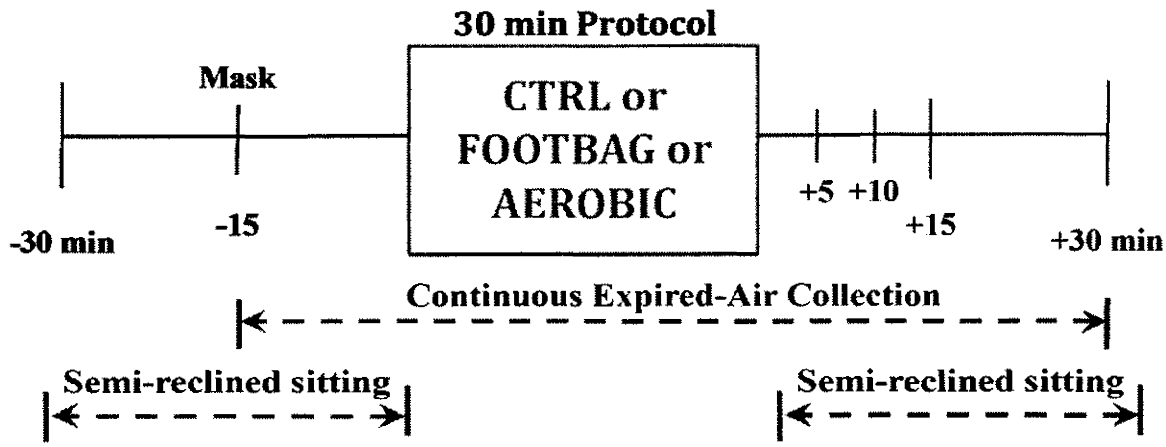

Figure 2. Experimental protocol used to compare energy expenditure among no-exercise (CTRL), 'freestyle footbag' game play (FOOTBAG), and aerobic exercise on an elliptical exercise machine (AEROBIC).

Statistical Analysis

Results were considered significant at $p < 0.05$. Data are presented as means ± standard deviations (MEANS ± SD). A three-factors repeated measures analysis of variance (ANOVA) was used to test for significant group x time interactions, and Fisher's Least Significant Difference (LSD) post hoc analyses were used when appropriate to determine specific pair-wise differences (Statistica V4.1, StatSoft, Inc.). Separate one-way ANOVA's were used to test for group differences at REST for each variable, and for group differences in total energy expenditure.

RESULTS

Rate of Energy Expenditure

Rates of energy expenditure ($kcal \cdot min^{-1}$) increased significantly ($p < 0.05$) with FOOTBAG and AEROBIC during activity and after +5 min of recovery compared to the Rest time point (Figure 3). There was a significant group x time interaction (p=0.00) for the rates of energy

expenditure, with FOOTBAG () and AEROBIC () > CTRL (), from 0-10, 11-20, and 21-30 min of activity, respectively. Rates of energy expenditure were not significantly different between FOOTBAG and AEROBIC. There were also no differences in rates of energy expenditure at Rest, but the rates of energy expenditure for FOOTBAG and AEROBIC were significantly greater after +5min of recovery. Total energy expenditure (kcal) during 30 min of FOOTBAG (196.3±40.8 kcal) and AEROBIC (199.5±33.2 kcal) activity were significantly greater than CTRL (40.4±3.8 kcal) (Figure 4). Total energy expenditure was not significantly different between FOOTBAG and AEROBIC.

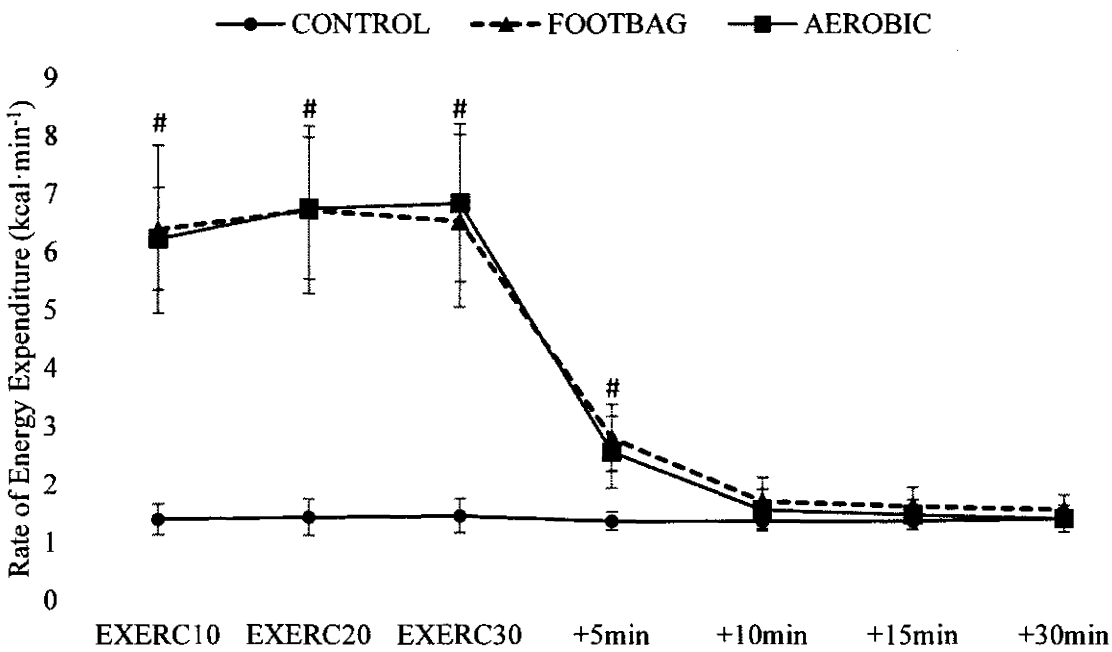

Figure 3. Rates of energy expenditure (kcal·min^{-1}) during EXERC10 (0-10 min), EXERC20 (11-20 min), EXERC30 (21-30 min), and for 30 minutes after a no-exercise control trial (CTRL), 'freestyle footbag' game play (FOOTBAG), and aerobic exercise on an elliptical exercise machine (AEROBIC). Data are MEANS ± SD. # denotes $P < 0.05$ vs. corresponding CTRL value.

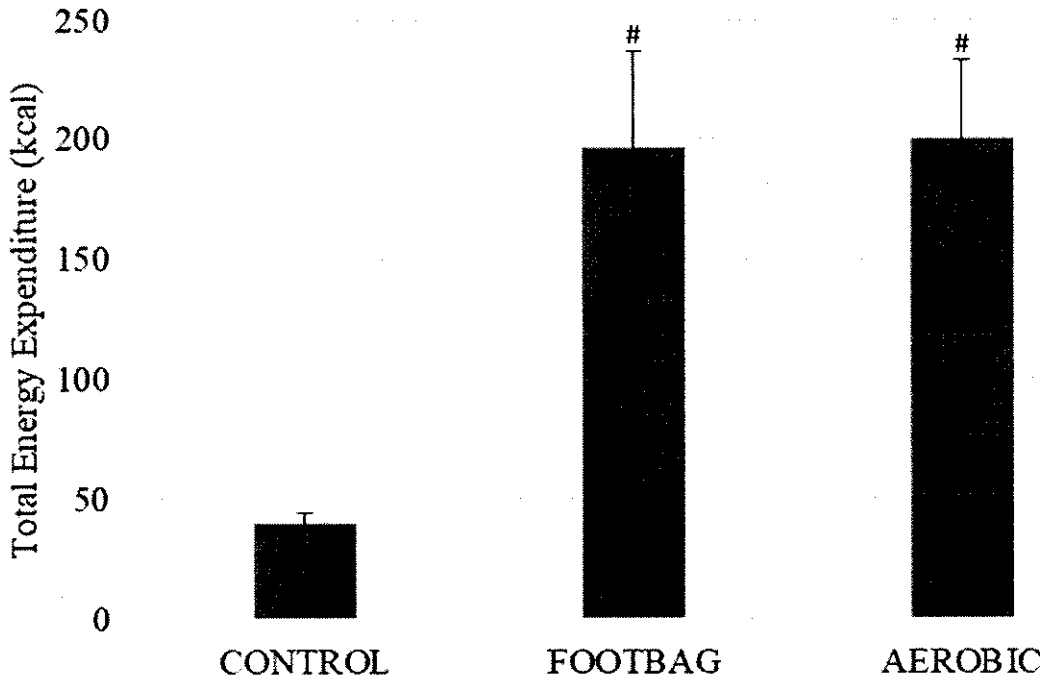

Figure 4. Total energy expenditure (kcal) from 30 minutes of a no-exercise control trial (CTRL), 'freestyle footbag' game play (FOOTBAG), and aerobic exercise on an elliptical exercise machine (AEROBIC). Data are MEANS ± SD. # denotes $P < 0.05$ vs. corresponding CTRL value.

DISCUSSION

To our knowledge, this was the first study to compare energy costs of 'freestyle footbag' with moderate-intensity aerobic exercise. In support of our hypothesis, we found energy expenditure to be similar during and after FOOTBAG compared to AEROBIC in college-aged men. The recommended minimum amount of weekly exercise for maintaining or improving health-related physical fitness by ACSM is 150 minutes per week of moderate-intensity exercise, where moderate-intensity is defined as 3.0-5.9 METs (reference). The average METs (mean ± SD) for FOOTBAG and AEROBIC were 4.8 ± 0.7 and 4.9 ± 0.5 METs, respectively, thus supporting the potential use of 'freestyle footbag' as a component of weekly exercise regimens. Thus 'freestyle footbag' could be incorporated into moderate-intensity weekly exercise routines to aid in achieving or exceeding weekly recommendations.

Our findings are in support of previous research examining energy costs of similar game activities with college-aged participants. In a study presented at an ACSM research conference, Soelberg et al. (2015) reported that experienced footbag players expended about 32% more energy (~382 kcals·hr-1) than non-experienced players (~290 kcals·hr-1). Our subjects were also experienced, and the 30 min FOOTBAG trial resulted in energy expenditure rates estimated at approximately 393 kcals·hr-1, which is very similar to the experienced group from Soelberg et al. (2015). In comparing METs from each study, experienced footbag players from Soelberg et al. (2015) averaged 4.5 METs, compared to 4.8 METs with our FOOTBAG trial. The energy expenditure rate for racquetball in college-aged participants was ~783 kcals·hr-1 (Berg et al., 2007), however such racquet sports require players to move consistently across larger distances, and these authors used a portable metabolic system allowing free movement and requiring more activation of the larger leg and trunk muscles. In our study, participant's movement was limited due to the 2.74 m air collection hose attached to the metabolic cart.

In adults aged 20 to 55 years, energy expenditure from other similar game activities have ranged from ~480 kcals·hr-1 for soccer and dodgeball (Fischer et al., 2004) to ~660 kcals·hr-1 for badminton (Deka et al., 2017). Interestingly, Fischer and colleagues (2004) had adults play games such as soccer and nerfball with their children and quantified energy expenditure for 10-minute periods of play. Again, the fact that energy expenditure was higher with soccer, dodgeball and badminton compared to footbag (393 kcals·hr-1) can likely be explained by more larger, lower body muscle recruitment, since these studies also used portable metabolic systems allowing participants to move about more freely. Clearly more research is needed to

help us fully understand whether games like footbag are feasible and effective for various adult groups, such as ages 20 to 55.

The current study compared energy expenditure during and after 'freestyle footbag' versus moderate-intensity aerobic exercise on an elliptical cross trainer to help us consider the proposed value of game play as a supplemental physical activity to help recreational exercisers meet or even exceed weekly physical activity requirements. Energy expenditure during and after footbag was similar to aerobic exercise performed at 35% of VO2max in college-aged men. From these findings, one can draw the connection between a traditional form of aerobic exercise (i.e. elliptical cross trainer) and a game activity that involves more intermittent, sporadic movements (i.e. footbag) to elicit similar energy costs at moderate-intensities within the young adult population. Future research is evidently needed to further develop our understanding of the effectiveness of physically active games as a component of weekly exercise regimens, especially with different age groups and with various games. Nonetheless, the value of our findings point to the incorporation of fun, game play activities as additional components of a weekly exercise routine in college-aged recreational exercisers.

ACKNOWLEDGEMENTS

The authors would like to thank the study participants for their time and effort. This project was supported in part by Salisbury University Department of Health and Sport Sciences, University Student Academic Research Award (USARA), and the Salisbury University Honors College.

REFERENCES

American College of Sports Medicine (2017). *ACSM's Guidelines for Exercise Testing and Prescription, 10th Edition.* Lippincott Williams & Wilkins.

Beltz NM, Gibson AL, Janot JM, Kravitz L, Mermier CM, Dalleck C. Graded exercise testing protocols for the determination of VO2max: historical perspectives, progress, and future considerations. J Sports Med. 2016;12:2016.

Brown, G. A., Cook, C. M., Krueger, R. D., & Heelan, K. A. (2010). Comparison of Energy Expenditure on a Treadmill vs. an Elliptical Device at a Self-Selected Exercise Intensity. *Journal of Strength and Conditioning Research, 24*(6), 1643-1649. doi:10.1519/jsc.0b013e3181cb2854

Clarke TC, Norris T, Schiller JS. Early release of selected estimates based on data from 2016 National Health Interview Survey. National Center for Health Statistics. May 2017. Available from: http://www.cdc.gov/nchs/nhis.htm.

Fernandez-Fernandez, J., Sanz-Rivas, D., Sanchez-MuÃ±oz, C., Pluim, B. M., Tiemessen, I., & Mendez-Villanueva, A. (2009). A Comparison of the Activity Profile and Physiological Demands Between Advanced and Recreational Veteran Tennis Players. *Journal of Strength and Conditioning Research,23*(2), 604-610. doi:10.1519/jsc.0b013e318194208a

Fischer, S., Watts, P., Jensen, R., & Nelson, J. (2004). Energy expenditure, heart rate response, and metabolic equivalents (METs) of adults taking part in children's games. *Energy Expenditure, Heart Rate Response, and Metabolic Equivalents (METs) of Adults Taking Part in Children's Games., 44*(4), 398-403.

Geus, B. D., Smet, S. D., Nijs, J., & Meeusen, R. (2006). Determining the intensity and energy expenditure during commuter cycling. *British Journal of Sports Medicine, 41*(1), 8-12. doi:10.1136/bjsm.2006.027615

IFPA world footbag championships. (2017).

Jackson AS, Pollock ML. Generalized equations for predicting body density of men. Br J Nutr. 1978;40:497–504.

McCracken, M., Jiles, R., & Michels Blanck, H. (2007). Health Behaviors of the Young Adult U.S. Population: Behavioral Risk Factor Surveillance System, 2003. *Preventing Chronic Disease,* 4(2), A25.

Porcari, J. P., Zedaker, J. M., Naser, L., & Miller, M. (1998). Evaluation Of An Elliptical Exerciser In Comparison To Treadmill Walking And Running, Stationary Cycling, And Stepping. *Medicine & Science in Sports & Exercise, 30*(Supplement), 168. doi:10.1097/00005768-199805001-00958

Siri WE. Body composition from fluid spaces and density: analysis of methods. In: Brozek J, Henschel A, editors. Techniques for Measuring Body Composition. Washington: National Academy of Sciences; 1961. pp. 223–244.

Soelberg, K., Jay, T. M., Thornton, M. A., Bohne, M. J., Namanny, S. F., & Jensen, E. B. (2015). Energy expenditure among experienced and non-experienced hacky sack players. *Medicine & Science in Sports & Exercise, 47*, 399. doi:10.1249/01.mss.0000477520.06135.ae

Thornton, M., Soelberg, K., Eccles, B., Jensen, E. B., & Namanny, S. F. (2015). The effect of experience on exercise intensity during hacky sack play. *Medicine & Science in Sports & Exercise, 47*, 399. doi:10.1249/01.mss.0000477523.50778.a7

Weir, J. B. de V. (1949). New methods for calculating metabolic rate with special reference to protein metabolism. *The Journal of Physiology*, *109*(1-2), 1–9.

World footbag - footbag sports. Retrieved from http://worldfootbag.com/about-footbag/footbag-sports/