METABOLIC COST OF HATHA YOGA

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CHAPTER 1

INTRODUCTION

With levels of obesity and physical inactivity approaching epidemic proportions (23), some leading organizations have developed recommended guidelines for promotion of physical activity and enhancement of physical fitness (6, 20, 24). Also, the U.S. Surgeon General (6) suggests that people of all ages, both males and females, can substantially improve their health and quality of life by including a moderate amount of physical activity (e.g., a 30-min brisk walk or 15-min run), on most, if not all, days of the week (6). Moreover, additional health and fitness benefits might be gained through more frequent or longer duration of physical activity (6, 24). The American College of Sports Medicine (ACSM) recommends that in order to maintain optimal levels of cardiorespiratory fitness and body composition, an individual should perform 20 to 60 minutes of continuous or intermittent aerobic exercise at 50 to 85% of maximum oxygen uptake reserve (VO_2R), or 65 to 90% maximum heart rate 3 to 5 days per week (24). Also, a bout of aerobic exercise conducted at recommended intensity and duration is expected to expend at least 250 calories (24). When combined with appropriate dietary intake, sufficient aerobic training performed a minimum of 3 days per week will increase an individual's likelihood of successful weight-loss and long-term weight control (15, 24). Typically, these guidelines are met through conventional forms of physical activity, such as walking-hiking, running-jogging, cycling-bicycling, and group exercise (formerly known as aerobic dance) (24, 29). Surprisingly, less than 40% of adults meet the U.S. Surgeon General guidelines (6), and no more than 15% of adults participate in physical activities with sufficient intensity and regularity to meet minimum ACSM recommendations (6, 24).

In an effort to increase the percent of those who meet recommended physical activity guidelines and, to promote physical fitness, curb obesity, and enhance health, some people participate in unconventional forms of physical activity, such as hatha yoga into their routine, specifically hatha yoga (12). The tradition of Yoga originated at least 5,000 years ago in India (9), where it was employed to help one redirect one's search for happiness and perfection from external sources (e.g. power and wealth) to internal, innate attributes (11, 28). Hatha yoga, i.e., the yoga of physical discipline, is one path (i.e., technique) of yoga that can be practiced to achieve a state of perfection and happiness (11, 28). Traditional hatha yoga integrates the practice of asanas (supine, seated, and standing postures), pranayamas (breathing techniques), yamas (the practice of nonviolence, truthfulness, nonstealing, and continence), and niyamas (observances of cleanliness, contentment, and practices which bring about perfection of body and sense, etc). Due to the focus of hatha yoga on physical preparation and enhancement, hatha yoga has become the most commonly practiced path of yoga in the United States (9, 11).

Since the late 1960's (2, 9), all paths of yoga, including hatha yoga, have undergone various adaptations in the United States (9). Specifically, hatha yoga has become a method intended for physical fitness and health maintenance (9) rather than a method intended for perfection and happiness (8, 11). Consequently, the format of hatha yoga classes in the United States are typically 60 to 90 minutes in duration and are primarily limited to asanas and pranayamas (8).

Although hatha yoga has become a popular form of physical activity, there is no evidence whether it is an adequate mode of physical activity for providing the proper training stimulus required to improve cardiovascular fitness and weight control as described by ACSM (24). Most research on the cardiovascular and metabolic responses to hatha yoga is limited to static asanas (26, 27), pranayamas (22), and hatha yoga routines consisting of only standing asana (7). Specifically, Prasad et al (22) compared a certain yogic breathing technique to traditional modes of exercise, and in two similar studies standing (26) and seated (27) asanas where compared to resting in a chair and to lying in a supine horizontal position (26, 27). In all three studies, the specific hatha yoga techniques employed were not intense enough to be considered an adequate mode of physical activity for increasing aerobic capacity. The only study to examine the cardiovascular and metabolic responses to an entire hatha yoga routine of standing asanas confirmed the results of previous studies. DiCarlo et al. (7) demonstrated that 32-minutes of Iyengar-style hatha yoga standing asanas required a value of approximately 4 METs or 34% VO_2max, much lower than recommended physical activity guidelines (24). Previous research has not investigated the cardiovascular and metabolic responses to a typical hatha yoga routine consisting of supine, seated, and standing asanas. Due to the limitations of previous research on this topic, it is still unknown as to whether hatha yoga is an adequate mode of physical activity for providing the proper training stimulus required to improve cardiovascular fitness and promote weight control as described by the ACSM (24).

Purpose of the Study

The purpose of this investigation was: 1) to determine the acute metabolic and cardiovascular responses of a typical hatha yoga routine; 2) to compare these responses to the acute metabolic and cardiovascular responses to resting in a chair and walking on the treadmill at 93.86 $m \cdot min^{-1}$ (3.5 mph); and 3) to identify whether a typical hatha yoga routine is an adequate mode of exercise for providing the proper training stimulus to enhance cardiovascular fitness and weight control as described by the American College of Sports Medicine (a minimum of 50% VO_2R or 65% HRmax) (24) .

CHAPTER 2

METHODS

Subjects

Subjects included male and female volunteers recruited from a lifetime fitness and wellness yoga class at a University. To ensure subjects ability to follow a videotaped routine as well as reduce the risk of injury, subject participation criteria included a minimum of 1 month of formal yoga classes (at least 2 days per week). Written consent was obtained from all subjects after a detailed description of all testing procedures was provided. This investigation was submitted to and approved by the Protection of Human Subjects Committee, Texas State University at San Marcos.

Instrumentation

A calibrated physician's scale (Detecto Scale Co., Jericho, New York) was used to obtain height and weight, and Lange calipers (Cambridge, MD) were used to measure skinfold thickness. Maximal and submaximal exercise tests were preformed on a Trackmaster treadmill (FullVision, Newton, KS). During each exercise test, subject's heart rate (HR) was measured by a Polar Vantage

XL telemetric heart rate monitor (Stanford, CT). Measures of expired air was analyzed throughout all tests with a PARVO Medics metabolic analyzer (Salt Lake City, UT). Ventilation (V_E), oxygen consumption (VO_2), carbon dioxide production (VCO_2), and respiratory exchange ratio (RER) were determined from 60-second averages. Calibration was preformed before each test using a certified gas mixture (O_2 = 16% and CO_2 = 4%, Scott Medical Products, Plumsteadville, PA).

Test Procedure

Subjects visited the laboratory on two separate occasions, 2 to 14 days apart. Subjects were instructed to: (a) drink plenty of fluids over the 24-hr period preceding the test; (b) avoid food, tobacco, nicotine, alcohol, and caffeine for at least 4 hours before testing; (c) avoid strenuous physical activity the day of the test; and (d) get 6 to 8 hours of sleep the night before the test (1).

The first laboratory visit included completion of an informed consent and a comprehensive health appraisal questionnaire as well as measurement of (a) height and weight (in exercise clothes, without shoes), (b) skinfold thickness, (c) resting oxygen consumption (VO_2), (d) exercise VO_2, and (e) maximal oxygen consumption (VO_2max). Body composition was assessed using a 3-site skinfold procedure (13). All body size and composition measures were taken by an experienced test administrator, previously trained according to ACSM standards for body composition assessment (1).

Prior to maximal exercise testing, VO_2 measurements were taken while resting in a chair and walking at 93.86 m min^{-1} (3.5 mph). Resting and submaximal VO_2 were recorded for at least 5 minutes, or until a steady-state condition was achieved. Stable VO_2 and VCO_2 values ($\pm$10%) and steady HR ($\pm$ 5 beats·min^{-1}) during the last 3 minutes of each stage was the criteria for determining steady-state intensity (31).

After a brief rest period, subject's VO_2max was measured using the Bruce treadmill protocol (1). Peak VO_2 was considered VO_2max if three of the following criteria were not met: (a) leveling off of VO_2 despite an increase in workload; (b) achieving age-predicted maximal HR (220-age); (c) an RER greater than 1.15; and (d) failure to maintain pace despite strong verbal encouragement. Measurements of VO_2, VCO_2, VE, and RER were determined from 60-second averages. HR was recorded at the end of each minute.

To determine cardiovascular and metabolic responses to a typical hatha yoga session and to compare those results to that of a more traditional low impact exercise, such as walking 93.86 m·min^{-1} (3.5 mph), subjects returned to the laboratory on a second occasion. Each subject was individually tested while performing a 30-minute hatha yoga routine. The hatha yoga routine was developed and videotaped by the primary investigator. The American Aerobic Association International Sports Medicine Association (AAAI-SMA) certified yoga instructor, with two years of yoga instructing experience, developed a choreographed hatha yoga routine consisting of 5 minutes of preparation/warm-up asanas, 20 minutes of conditioning asanas, and 5 minutes of cool-down/resting asanas.

Table 1: The 30-Minute Hatha Yoga Routine

Hatha Yoga Routine	
Warm-up	
Seated crossed leg: deep breathing	Should stretch overhead
Neck turns	Right knee to chest, hip opener
Chin to chest, chin to sky	Left knee to check, hip opener
Shoulder rolls backward	Cat/cow
Should rolls forward	Mountain
Conditioning Asanas	
Sun Salutation (lasted 5 minutes)	Mountain
Mountain	Should stretch overhead
Right Triangle	Swan Dive: Forward Bend
Right Lunge	Plank
Right Warrior I	Knees, Chest, & Chin
Right Warrior II	Cobra
5 Pointed Star	Downward Facing Dog
Forward Bend	Table Top
Backward Bend	Downward Facing Dog: Right Leg Up
5 Pointed Star	Table Top
Left Triangle	Downward Facing Dog: Left Leg Up
Left Lunge	Downward Facing Dog
Left Warrior I	Table Top
Left Warrior II	Cat/Cow
5 Pointed Star	Fetus
Forward Bend	Seated Forward Bend
Backward Bend	Spinal Twist Left
Mountain	Spinal Twist Right
Right Leg Up Tree	Fish
Left Leg Up Tree	Butterfly
Mountain (held for 40 seconds)	Body Circles: Right
Right Leg Up Tree	Body Circles: Left
Left Leg Up Tree	
Cool-Down	
Corpus	Right Arm Lift: 3 Inches Off floor
Knee to Chest: Right Leg	Left Arm Lift: 3 Inches Off floor
Spinal Twist: Right Leg to Left Side	Right Leg Lift: 3 Inches Off floor
Knee to Chest: Left Leg	Left Leg Lift: 3 Inches Off floor
Spinal Twist: Left Leg to Right Side	Corpus

The routine comprised of movements that are implemented in typical hatha yoga classes found in health clubs, fitness centers, private studios, etc. (Birkel). Subjects were asked to follow exact movements of the instructor on the videotape. During the conditioning phase, all asanas were held for 20 seconds except for the asanas during the Sun Salutation. The Sun Salutation involves 12 poses that are performed in coordination with each breath (2). The series of poses were repeated for 5 minutes. In addition, to closely resemble a typical hatha yoga session, the lights in the laboratory were dimmed and soft music played in the background.

Statistical Analysis

A repeated measures analysis of variance (ANOVA) was conducted to determine if there were overall differences in absolute VO_2 ($L \cdot min^{-1}$), relative VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$), METs, EE ($kcals \cdot min^{-1}$), or HR among the independent variables: 1) sitting in a chair, 2) walking at 93.86 $m \cdot min^{-1}$ (3.5 mph), and 3) performing a hatha yoga routine. Paired t-tests compared the physiological differences between: 1) hatha yoga and resting in a chair; and 2) hatha yoga and walking at 93.86 $m \cdot min^{-1}$ (3.5 mph). Single-sample t-tests compared the %VO_2R and %MHR of the 30-minute yoga routine to the ACSM guidelines of 50% VO_2R and 65% MHR.

In addition, a repeated measures analysis of variance (ANOVA) was conducted to determine if there were overall differences in absolute VO_2 ($L \cdot min^{-1}$), relative VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$), METs, EE ($kcals \cdot min^{-1}$), or HR among the independent variables: 1) Sun Salutation, and 2) other conditioning asanas (Non-Sun Salutation asanas). Paired t-tests compared the physiological differences between Sun Salutations and other conditioning asanas (Non-Sun Salutation asanas). Single-sample t-tests compared the %VO_2R and %MHR of the Sun Salutation to the ACSM guidelines of 50% VO_2R and 65% MHR.

CHAPTER 3

RESULTS

Of the 30 subjects who volunteered for the study, 29 completed all three of the exercise tests. A female participant withdrew from the study due to pregnancy. In addition, since only 2 male participants completed all of the exercise tests, and their metabolic values were not comparable to the data collected from the sample of female participants (n=27), the male subjects were excluded from this analysis. Lastly, the metabolic responses of one female participant were unduly influenced by prescription medication and excluded from this analysis. After data screening, the final sample size included 26 subjects. Table 2 includes the subjects' descriptive characteristics. This sample appears to be representative of female college students that are of fair to good aerobic fitness (17).

Table 2: Physical Characteristics of All Subjects (n = 26)

Variable	Mean $\pm$ SD	Range
Age (years)	23.39 $\pm$ 4.30	19.00 – 40.00
Height (m)	1.62 $\pm$ .07	1.48 – 1.71
Weight (kg)	59.63 $\pm$ 11.84	41.36 – 93.18
% Body fat	22.79 $\pm$ 7.67	6.40 – 37.28
VO_2max ($ml \cdot kg^{-1} \cdot min^{-1}$)	32.70 $\pm$ 5.04	25.50 – 44.00

Table 3 reports the physiological responses (mean $\pm$ SD) for each dependent variable measured during each test. Repeated Measures ANOVA comparing the physiological responses of resting in a chair, walking at 93.86 $m \cdot min^{-1}$ (3.5 mph), and performing the hatha yoga routine revealed significant differences in: 1) absolute VO_2 ($L \cdot min^{-1}$, $F = 281.74$, $p < .05$) 2) relative VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$, $F = 577.8$, $p < .05$), 3) %VO_2R ($F = 1070.6$, $p < .05$) 4) METs ($F = 557.8$, $p < .05$), 5) EE ($kcal \cdot min^{-1}$, $F = 275.2$, $p < .05$), 6) HR ($F = 217.05$, $p < .05$), and 7) %MHR. When compared to chair rest, hatha yoga elicited higher: 1) absolute VO_2 ($L \cdot min^{-1}$, $t = -11.9$, $p < .05$), 2) relative VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$, $t = -12.7$, $p < .05$), 3) %VO_2R ($t = -11.45$, $p < .05$), 4) METs ($t = -12.7$, $p < .05$), 5) EE ($kcal \cdot min^{-1}$, $t = -12.0$, $p < .05$), 6) HR ($t = -10.5$, $p < .05$), and 7) %MHR ($t = -11.16$, $p < .05$). Moreover, when compared to chair rest, hatha yoga required a 111% greater absolute VO_2 ($L \cdot min^{-1}$), 111% greater relative VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$), 4330% greater %$VO_2R$, 111% greater METs, 109% greater EE ($kcal \cdot min^{-1}$), 24% greater HR, and a 111% greater %MHR. When compared to walking at 93.86 $m \cdot min^{-1}$ (3.5 mph), hatha yoga elicited lower: 1) absolute VO_2 ($L \cdot min^{-1}$, $t = -14.4$, p

< .05), 2) relative VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$, $t = -18.3$, $p < .05$), 3) $\%VO_2R$ ($t = -15.9$, $p < .05$), 4) METs ($t = -18.3$, $p < .05$), 5) EE ($kcal \cdot min^{-1}$) ($t = -14.1$, $p < .05$), 6) HR ($t = -10.7$, $p < .05$), and 7) %MHR ($t = -11.49$, $p < .05$). Moreover, when compared to walking at 93.86 $m \cdot min^{-1}$ (3.5 mph), hatha yoga required a 53% lower absolute VO_2 ($L \cdot min^{-1}$), 53% lower relative VO_2 $ml \cdot kg^{-1} \cdot min^{-1}$, 68% lower $\%VO_2R$, 53% lower METs, 53% lower EE $kcal \cdot min^{-1}$, 19% lower HR, and 21% lower %MHR.

Table 3: Cardiovascular and Metabolic Responses (mean $\pm$ SD) to Chair Rest, Treadmill Walk, and Yoga Routine.

Variable	Chair Rest*	Yoga Routine	Treadmill Walk**
VO_2 ($L \cdot min^{-1}$)	.21 $\pm$ .06	.45 $\pm$ .12	.97 $\pm$ .23
VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$)	3.59 $\pm$ .71	7.59 $\pm$ 1.35	16.17 $\pm$ 1.88
$\%VO_2R$	0.33 $\pm$ 2.55	14.62 $\pm$ 5.51	44.80 $\pm$ 10.04
METs	1.03 $\pm$ .20	2.17 $\pm$ .39	4.62 $\pm$ .54
EE ($kcal \cdot min^{-1}$)	1.07 $\pm$ .27	2.23 $\pm$ .57	4.76 $\pm$ 1.15
HR ($beats \cdot min^{-1}$)	84.87 $\pm$ 11.79	105.28 $\pm$ 14.92	133.41 $\pm$ 17.13
%MHR	45.73 $\pm$ 5.67	56.89 $\pm$ 8.36	67.77 $\pm$ 8.75

Note: EE = energy expenditure, HR = heart rate, %MHR = percent maximal heart rate.

* Significantly lower than the 30-minute hatha yoga routine, $p < .05$.

** Significantly higher than the 30-minutes hatha yoga routine, $p < .05$.

For improvements in cardiovascular fitness and promotion of weight control, the ACSM recommends that apparently healthy, fit adults exercise at 65%-90% of predicted MHR or 50%-85% VO_2R (24). During the hatha yoga routine, the participants exercised at 56.89% of MHR and 14.62% VO_2R. When compared to the minimum recommended exercise guidelines, %MHR during hatha yoga was significantly lower than 65%MHR ($t = -4.9$, $p < .05$) and $\%VO_2R$ was significantly lower than $50\%VO_2R$ ($t = -32.7$, $p < .05$).

Table 4 reports the physiological responses (mean ± SD) measured during Sun Salutation (i.e., during minutes 8 through 10) and during Non-Sun Salutation conditioning asanas (i.e., during minutes 11 through 25). Repeated Measures ANOVA comparing the physiological responses to Sun Salutation and Non-Sun Salutation revealed significant differences in: 1) absolute VO_2 ($L\,min^{-1}$, $t = 14.12$, $P < .05$), 2) relative VO_2 ($ml\,kg^{-1} \cdot min^{-1}$, $t = 17.55$, $P < .05$), 3) $\%VO_2R$ ($t = 14.46$, $P < .05$), 4) METs ($t = 17.55$, $P < .05$), 5) EE ($t = 13.29$, $P < .05$), 6) HR (12.06, $P < .05$), and %MHR ($t = 11.68$, $P < .05$). When comparing Sun Salutations to Non-Sun Salutations, Sun Salutations required an 82% greater absolute VO_2 ($L \cdot min^{-1}$), 81% greater relative VO_2 ($ml\,kg^{-1}\,min^{-1}$), 154% greater $\%VO_2R$, 81% greater METs, 65% greater EE ($kcal\,min^{-1}$), 20% greater HR, and 20% greater %MHR.

Table 4: Cardiovascular and Metabolic Responses (mean ± SD) to Sun Salutation and Non-Sun Salutation.

Variable	Non-Sun Salutation	Sun Salutation*
VO_2 (L min^{-1})	.43 ± .11	.78 ± .21
VO_2 (ml·kg min^{-1})	7.23 ± 1.36	13.08 ± 2.46
%VO_2R	13.20 ± 5.46	33.54 ± 10.65
METs	2.10 ± .41	3.70 ± .70
EE (kcal min^{-1})	2.28 ± .59	3.76 ± 1.03
HR (beats min^{-1})	103.61 ± 16.64	123.85 ± 16.67
%MHR	55.98 ± 9.19	66.99 ± 9.99

Note: EE = energy expenditure, HR = heart rate, %MHR = percent maximal heart rate.

* Significantly higher than Non-Sun Salutations, $p < .05$.

Moreover during the Sun Salutations, the participants exercised at 66.99% of MHR and 33.54% VO_2R, when comparing the metabolic and cardiovascular responses of Sun Salutation to the minimum recommended physical activity guidelines as described by the ACSM (24). The %MHR of Sun Salutation was not significantly different ($t = 1.0$, $p > .05$) than the recommended minimum of 65%MHR, however the %VO_2R of the Sun Salutation was significantly lower ($t = -7.88$, $p < .05$) than the recommended minimum of 50%VO_2R.

CHAPTER 4

DISCUSSION, CONCLUSIONS, AND PRACTICAL APPLICATION

Hatha yoga, is comprised of asanas (static poses), and pranayamas (breathing techniques) (9). It has become a popular form of physical activity in the United States (11). However, research has not yet determined whether it is an adequate mode of physical activity for providing the proper training stimulus required to improve cardiovascular fitness and weight control as described by the ACSM (24). This study examined the oxygen requirement and heart rate responses to a 30-minute hatha yoga routine comprised of a variety of asanas that are commonly performed during hatha yoga classes at a health club, private studio, fitness facility, etc. In addition, those responses were compared to the oxygen requirement and heart rate responses to walking at 93.86 m min^{-1} (3.5 mph), which is a well-established, adequate mode of moderate exercise for promoting cardiorespiratory fitness and weight control (1). According to the ACSM, an acceptable mode of moderate exercise for most healthy adults includes walking 3 to 4 mph (1). In particular, this study showed that the cardiovascular and metabolic responses during a 30-minute hatha yoga routine, although higher than at rest, were lower than the responses seen during moderate exercise, i.e., walking at 93.86 $m \cdot min^{-1}$ (3.5 mph).

Previous research has been limited in scope to the metabolic and cardiovascular responses to a particular static asanas and suggests that performing a static asana places minimal stress on the cardiovascular system (26, 27). For example, Rai et al (27) found that the average VO_2, METs, EE, and HR during Siddhasana (i.e., a static seated asana) were 0.28 $LO_2 \cdot min^{-1}$, 1.20 METs, 1.35 $kcal \cdot min^{-1}$, and 73.8 $beats \cdot min^{-1}$, respectively, in 6 men with a high breathing frequency (i.e., >10 breaths per minute during supine lying). In 4 men with a low breathing frequency (i.e., <5 breaths per minute during supine lying), average VO_2, METs, EE, and HR during Siddhasana were 0.23 $LO_2 \cdot min^{-1}$, 1.00 METs, 1.12 $kcal \cdot min^{-1}$, and 82.10 $beats \cdot min^{-1}$, respectively. The true relative exercise intensity ($\%VO_2R$) of Siddhasana was not determined in this study; however, since Siddhasana required approximately 1 MET, it appears this asana fails to require an intensity beyond a state of rest. When compared to the 30-minute hatha yoga routine in the present study, Siddhasana required a 62% lower absolute VO_2, 81% lower METs, 65% lower $kcal \cdot min^{-1}$, and 43% lower $beats \cdot min^{-1}$, respectively, in 6 men with a high breathing frequency, and a 97% lower absolute VO_2, 117% lower METs, 99% lower $kcal \cdot min^{-1}$, and 28% lower $beats \cdot min^{-1}$, respectively, in 4 men with a low breathing frequency.

In a similar study (26), for the high breathing frequency group, the mean VO_2, METs, EE, and HR during Virasana (i.e., a standing yogic asana) were 0.57 $LO_2 \cdot min^{-1}$, 2.53 METs, 2.76 $kcal \cdot min^{-1}$, and 104.35 $beats \cdot min^{-1}$, respectively, and for the low breathing frequency group (n=4), were 0.50 $LO_2 \cdot min^{-1}$, 2.10 METs, 2.12 $kcal \cdot min^{-1}$, and 101.40 $beats \cdot min^{-1}$, respectively. Because VO_2max was not measured in either study, percentage of oxygen uptake reserve (%VO_2R) could not be derived, and thus, true relative intensity of exercise could not be determined. However, based on the reported MET values, Virasana requires a light to very light exercise intensity (i.e., < 4.8 METs for young adults 20 to 39 years of age) and does not meet the minimal exercise intensity recommendations (i.e., 4.8 METs) for promoting cardiovascular fitness and weight control in young adults (24). In present study the 30-minute hatha yoga routine required a MET value of 2.17, approximately 14% lower than the MET value of Virasana, in addition, VO_2max was measured, thus, VO_2R was derived and true relative intensity of exercise was determined to be 14.62% VO_2R When compared to the average METs for walking at 93.86 $m \cdot min^{-1}$ (3.5 mph) as determined in this study, Virasana has at least a 45% lower metabolic cost, 2.17 METs during Virasana vs. 4.62 METs during walking at 93.86 $m\ min^{-1}$ (3.5 mph). In comparison, the hatha yoga routine (which was comprised of many different static postures) performed in this study had a 53% lower metabolic cost than treadmill walking at 93.86 $m \cdot min^{-1}$ (3.5 mph).

Research on the cardiovascular and metabolic responses during an entire hatha yoga routine, consisting of many different asanas, is limited (7). DiCarlo et al. (7) documented the cardiovascular and metabolic responses to a 32-minute yoga routine consisting of two sets of 12 standing asansa performed on each side of the body. Mean HR and VO_2 for the hatha yoga routine were 135 beats min^{-1} and 14.43 $ml\ kg^{-1}\ min^{-1}$, respectively. In the present investigation, mean HR and VO_2 during the hatha yoga routine was lower: 105 beats min^{-1} and

7.59 $ml \cdot kg^{-1} min^{-1}$. Such differences are expected since the routine in DiCarlo et al. (7) consisted of only standing asanas, whereas the routine in the present study included supine lying, sitting, and standing asanas. A variety of asanas were employed in this present study in an attempt to characterize the physiological responses to a typical hatha yoga routine that may be seen in a health club.

DiCarlo et al. (7) also compared the cardiovascular and metabolic responses of the 32-minute yoga routine to 32 minutes of walking on a treadmill at 107.27 $m \cdot min^{-1}$ (4 mph). On average, HR recorded during minutes 16, 24, and 32 was higher during the yoga routine than during treadmill walking (138, 139, 144 $beats \cdot min^{-1}$ vs 117, 118, 120 $beats \cdot min^{-1}$). HR recorded during minute 8 was the same during the yoga routine as during treadmill walking (119 $beats \cdot min^{-1}$ vs 114 $beats \cdot min^{-1}$). Conversely, the VO_2 recorded during minutes 8, 16, 24, and 32 was significantly lower during the yoga routine than during treadmill walking (13.7, 15.6, 14.0 and 14.4 $ml \cdot kg^{-1} min^{-1}$ vs 18.6, 19.0, 19.0, and 19.2 $ml \cdot kg^{-1} min^{-1}$). The metabolic cost of the yoga routine was 4.1 METS or 34% of VO_2max while the metabolic cost of treadmill walking at 107.27 $m \cdot min^{-1}$ (4 mph) was 5.4 METs or 46% of VO_2max.

In comparison to the present study, the 32-minute hatha yoga routine also required less oxygen than walking at a moderate intensity. In contrast to the findings in the present study, DiCarlo et al. (7) reported a higher heart rate response to the yoga routine than to treadmill walking. However, in both studies, hatha yoga was shown to elicit a disproportionately high heart rate response relative to the oxygen consumption. For instance, in the present study, participants exercised at 14.6% VO_2R and 67% MHR. During steady-state exercise, 20% of VO_2R is expected to correspond to 35% of MHR (24). Similar results have been seen in another study that integrate arm movements while exercising (21) and may be due to the perception of an increase in strain relative to the size of musculature used when arm movements are integrated with lower body exercise (21). In other words, an increase in strain without a proportionate increase in muscle tissue augments peripheral feedback to the medulla, thereby resulting in an increase in heart rate without a concomitant increase in oxygen consumption (18). Additionally, disproportionate elevations in heart rate may be a response to the increase in venous pooling that may occur while holding static standing postures for extended periods of time (19). Because of the excessive elevation in HR during hatha yoga, determining the intensity of hatha yoga using the %MHR method may not be as appropriate as %VO_2R. In the present study RPE was not measured. Future studies should investigate whether RPE is a more appropriate indication of intensity during hatha yoga.

The present study also determined whether hatha yoga is an acceptable form of physical activity for promoting good cardiovascular health and optimal body composition. As identified by the ACSM, weight control and cardiovascular benefits result from regular aerobic performed for 20 to 60 minutes in duration at 50 to 85% of VO_2R or 65 to 90% of MHR (24). Results of this study revealed that the 30-minute hatha yoga routine did not require a high enough intensity to produce an adequate training stimulus. For instance, participants exercised, on average, at 14.6% VO_2R and 56.89% MHR, significantly below the ACSM minimum recommendations for optimal intensity. However, further analysis revealed that the Sun Salutation, a specific series of more challenging asanas, increased exercise intensity well-above average values. Compared to the other conditioning asanas, the Sun Salutation increased VO_2, METs, EE, and HR by 76, 76, 72, and 20%, respectively. Percent VO_2R during Sun Salutation was 33.5% VO_2R, which was significantly lower ($t = -7.88$, $p < .05$) than the 50% minimum recommended by the ACSM. However, %MHR during Sun Salutation was 67% MHR, greater and not significantly different than the minimum of 65% MHR recommended by the ACSM. Therefore, in order to increase intensity, the Sun Salutation or similar series of asanas should comprise the greatest portion of a hatha yoga session.

Furthermore, according to the ACSM, when exercising within the recommended range of intensity and duration, a person is expected to expend at least 250 kcal (24). In the present study, subjects expended 2.23 $kcal \cdot min^{-1}$. In order to expend at least 250 kcal during a similar hatha yoga session, a person would have to exercise approximately 112 minutes. Such a long duration may seem unreasonable; however, a typical hatha yoga class is 90 minutes in duration. Therefore, a participant in a 90-minute hatha yoga class can expect to expend approximately 200 kcal, which meets the current U.S. Surgeon General's recommendations of performing physical activity that uses approximately 150 kcal per day (6). Furthermore, a hatha yoga session comprised mainly of Sun Salutation and series of asanas similar to the Sun Salutation will greatly increase energy expenditure. Mean energy expenditure for Sun Salutation was 3.76 $\pm$ 1.03 kcal min^{-1} compared to Non-Sun Salutation 2.28 $\pm$ 0.59 kcal min^{-1} ($t = 13.3$. $p < .05$).

In conclusion, based on $\%VO_2R$, the hatha yoga routine in this study was performed at a very light intensity, much lighter than walking at 93.86 m min^{-1} (3.5 mph). Such an intensity is too low to produce a training stimulus and result in large cardiovascular fitness improvements. However, with the integration of more challenging asanas, such as the Sun Salutation, a hatha yoga routine performed for 90 minutes may expend in excess of 250 kcal, adequate for the promotion of weight control. Although there may be little cardiovascular benefit to performing hatha yoga, it might still be considered an acceptable form of physical activity for enhancing muscular fitness (5, 16, 25), flexibility (10), and psychological well-being (11).

Practical Application

Information derived from this study can be used to characterize intensity of hatha yoga as well as to modify hatha yoga in order to increase intensity. A typical 90-minute hatha yoga session employs a variety of supine lying, sitting, and standing asanas. Based on the results of this study, such a variety of asanas does not achieve adequate intensity for promoting cardiovascular fitness. However, this study did determine that the implementation of more challenging asanas, such as the Sun Salutation, will raise intensity and caloric expenditure, and possibly help with the promotion of weight control. For example, the average energy requirement for the Sun Salutation is 3.77 $kcal \cdot min^{-1}$, 1.54 $kcal \cdot min^{-1}$, higher than the average energy requirement for the hatha yoga routine in this study. Furthermore, due to the disproportionately high heart rate relative to oxygen consumption, the %MHR method should not be employed to determine intensity during hatha yoga.

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APPENDIX A

HYPOTHESIS, DELIMITATIONS, SIGNIFICANCE OF THE STUDY

Hypothesis

On the basis of the available research, it is hypothesized that a typical HY routine will not produce a large enough training stimulus for optimal cardiovascular fitness and weight control as describe by ACSM (24), but will result in a high enough exercise intensity to meet the Surgeon General's recommendations for improving health and quality of life (6).

Delimitation

This study is delimited to female college students, ranging in age from 19 to 40 years, with a minimum of 4 weeks of hatha yoga experience. Metabolic measurements will be limited to oxygen consumption (VO_2), METs, kilocalories (kcal), and heart rate (HR).

Significance of the Study

In recent years, exercise participants have taken up hatha yoga as a form of physical exercise. The question at hand, which has not yet been determined by research, is whether hatha yoga offers an adequate training stimulus to provide cardiovascular fitness and weight control benefits.

A major concern that society is facing today is the obesity epidemic, as well as all of the many health risks involved with being obese. A fairly recent trend in the fitness field is a rise in the popularity of hatha yoga. Hatha yoga seems to attract participants with its low impact nature. Results from such a study may prove valuable to exercise participants as to whether or not their hatha yoga session is within recommended intensity (50 to 85% of maximum oxygen uptake reserve) for improving cardiovascular fitness and weight control.

APPENDIX B

REVIEW OF LITERATURE

Review of Literature

The U.S. Surgeon General suggests that people of all ages, both males and females, can substantially improve their health and quality of life by including a moderate amount of physical activity (e.g., a 30-minute brisk walk or 15-minute run), on most, if not all, days of the week (6). Moreover, additional health and fitness benefits can be gained through greater amounts of physical activity (6, 24). Specifically, in order to maintain optimal levels of cardiorespiratory fitness and body composition, the American College of Sports Medicine (ASCM) recommends that an individual perform 20 to 60 minutes of continuous or intermittent aerobic exercise at 50 to 85% of maximum oxygen uptake (VO_2) 3 to 5 days per week (24). A bout of aerobic exercise conducted at recommended intensity and duration will expend at least 250 to 300 calories. When combined with appropriate dietary intake, sufficient aerobic training performed a minimum of 3 days per week will increase an individual's likelihood of successful weight-loss and long-term weight control (15, 24). Typically, these guidelines are met through conventional forms of physical activity, such as walking-hiking, running-jogging, cycling-bicycling, and group exercise (formerly known as aerobic dance) (24, 29). Surprisingly, less than 40% of adults meet the U.S. Surgeon General guidelines (6), and no more than 15% of adults participate in physical activities with sufficient intensity and regularity to meet minimum ACSM recommendations (6, 24).

In particular, to help individuals of varying age, fitness, motivation levels, and exercise goals meet recommended exercise guidelines, a variety of both conventional and unconventional exercise options is warranted. For instance, alternative forms of low impact physical activity, such as hatha yoga, may appeal to individuals who are often deterred by more conventional forms of exercise (4, 14).

Hatha yoga, i.e., the yoga of physical discipline, is one of the eight principle branches of yoga (9). Hatha yoga is a combination of four practices, two being more associated with a mental state of thought and belief, and two being physical, the practice of asanas (poses) and pranayamas (breathing techniques) (9). Hatha yoga has become increasing popular in recent years in the U.S. (11), and is the most widely practiced form of yoga in the United States (9). Since 1994, there has been a three-fold increase in yoga participants, with the current number of participants approaching 20 million (4, 14). However, research on the acute and chronic cardiovascular and metabolic responses to hatha yoga is limited. Because many individuals have incorporated hatha yoga into their physical activity programs, there is a need for research to determine whether hatha yoga is an adequate mode of exercise for providing the proper training stimulus to enhance cardiovascular fitness and weight control as described by ACSM (24).

History of Yoga

Yoga can be dated as far back as 5,000 years ago in India (9). Although difficult to define, the traditional practice of yoga is employed for one to reach the ultimate goal of potential perfection and internal happiness (9). Hatha yoga, i.e.

the physical discipline uses asanas, pranayama, and mental exercises (meditation) (12) to achieve the state of mental equanimity (30) and self-awareness (8). In other words, through the practice of eastern-style yoga, a yogi can free his or her mind and allow the focus to be exclusively on a particular object of thought (3, 8).

The traditional goal of regular hatha yoga practice is to achieve enlightenment through proper purification and preparation of the body (9). Since the late 1960's (2, 9), all styles of yoga, including hatha yoga, have undergone various adaptations in the U.S. (9). Specifically, hatha yoga has been use as a method for achieving physical fitness and maintaining health (9) rather than a method for reaching potential perfection and internal happiness for spiritual growth and self-realization (9, 11). Subsequently, the practice of hatha yoga in the U.S. incorporated only the physical aspects, asanas and pranayamas (9).

Although hatha yoga has become a popular form of physical activity, research has not determined whether it is an adequate mode of exercise for providing the proper training stimulus required to promote cardiovascular fitness and weight control as described by the ACSM (24). Most research on the cardiovascular and metabolic responses to yoga has concerned eastern yoga and been performed in India (22, 26, 27). However, due to the differences in focus, format, and purpose among eastern yoga and western hatha yoga, results of these eastern studies should not be used to describe the physiological responses to western-style hatha yoga.

Physiological Responses to an Acute Bout of Hatha Yoga

In determining whether regular hatha yoga practice positively impacts cardiorespiratory fitness and weight control, there is a need to first review the results of previous investigations on the physiological responses to asanas and pranayamas. From that, it may be determined whether a typical hatha yoga routine consisting of asanas and pranaymas provides an adequate training stimulus, i.e., whether it is performed at 50-85% of VO_2max, 50-85% of HRR, and 50-85% of MHR, (24), for promoting cardiorespiratory fitness and weight control. Current research is limited and includes the following physiological responses to one or more asanas and a single pranayama technique: energy expenditure (EE) in $kcal \cdot min^{-1}$ (22, 26, 27), HR in $beats \cdot min^{-1}$ (7, 22, 26, 27), VO_2 in either $LO_2 \cdot min^{-1}$ or $mlO_2 \, kg^{-1} \cdot min^{-1}$ (7, 22, 26, 27), and Metabolic Equivalents (METs) (7, 22, 26, 27).

Previous research is limited to mainly to the metabolic and cardiovascular responses to a particular static asana and suggests that performing a static asana places minimal stress on the cardiovascular system (26, 27). For example, in a study by Rai and Ram (26), reported in male yoga instructors, ages 25 to 37 years, mean VO_2, METS, EE, and HR were 0.57 $LO_2 \, min^{-1}$, 2.53 METs, 2.76 $kcal \cdot min^{-1}$, and 104.35 $beats \cdot min^{-1}$, respectively, during Virasana (i.e., a standing yogic asana) in 6 man with a high breathing frequency group (i.e., greater than 10 breaths per min), and 0.57 $LO_2 \cdot min^{-1}$, 2.53 METs, 2.76 $kcal \cdot min^{-1}$, and 104.35 $beats \, min^{-1}$, respectively, during Virasana in 4 men with a low breathing frequency (i.e., less than 5 breaths per min). According to their breathing frequency recorded during Shavasana, subjects were assigned to a breathing frequency group. Because VO_2max was not measured, percentage of oxygen uptake reserve (%VO_2R) could not be derived, and thus, true relative intensity of exercise could not be determined. However, based on the reported MET values, it appears that Virasana requires at a light to very light exercise intensity (i.e., <4.8 METs for young adults 20 to 39 years of age) and does not meet the recommendations (i.e., 4.8 METs) for improving cardiovascular fitness and weight control in young adults (24). When compared to conventional forms of moderate intensity aerobic exercise, such as walking at 93.86 m min^{-1} (3.5 mph), i.e., 5.5 METs (32), Virasana has at least a 45% lower metabolic cost.

Rai *et al* (27) also studied the cardiovascular and metabolic responses to Siddhasana (i.e., a seated yogic posture), resting in a chair, and Shavasana (i.e., resting in a supine position) in 10 male yoga instructors, ages 25 to 37 years old. Again, according to their breathing frequency recorded during Shavasana, subjects were assigned to either a high breathing frequency (i.e., greater than 10 breaths per min) or a low breathing frequency (i.e., less than 5 breaths per min) group. Mean VO_2, METs, EE, and HR during Siddhasana (i.e., a static seated asana) were 0.28 $LO_2 \cdot min^{-1}$, 1.20 METs, 1.35 $kcal \cdot min^{-1}$, and 73.8 $beats \cdot min^{-1}$, respectively, in 6 men with a high breathing frequency (i.e., greater than 10 breaths per min). For the low breathing frequency group (n=4), mean VO_2, EE, METS, and HR were 0.23 $LO_2 \cdot min^{-1}$, 1.00 METs, 1.12 $kcal \cdot min^{-1}$, and 82.10 $beats \cdot min^{-1}$, respectively. True exercise intensity of Siddhasana was also not determined in this study. However, since Siddhasana was performed at approximately 1 MET, it appears that this asana fails to require oxygen beyond a state of rest. Based on METs, the results of these two studies suggest that the metabolic requirement of the static seated asana, Siddhasana is not any higher than that of rest, while the standing yogic asana, Virasana, is almost 2.5 times that of rest. Therefore, in order to approach the recommended exercise intensity for promoting cardiovascular fitness and weight control, a typical hatha yoga routine should primarily consist of standing asanas.

The first study conducted in the United States on hatha yoga investigated the physiological responses to a continuous routine of various standing asanas (7). This study documented the effects of a 32-minute hatha yoga routine consisting of 12 standing asanas in 10 subjects (6 male and 4 female, aged 38-47 years) with at least 1 year of hatha yoga practice, and compared those responses to 32 minutes of walking on a treadmill at 107.27 $m \cdot min^{-1}$ (4 mph). Subjects held each asana for forty seconds and were allotted ten seconds for transitions between all asanas. On average, HR recorded during minutes 16, 24, and 32 was significantly higher (21 – 24 bpm) during yoga routine than treadmill. HR recorded during minute 8 was the same during the yoga routine as during treadmill walking (119 $beats \cdot min^{-1}$ vs 114 $beats \cdot min^{-1}$). Conversely, VO_2 during treadmill in min 8, 16, 24, and 32 were significantly higher (14.4 - 18.95 $LO_2 \cdot min^{-1}$) than VO_2 values during yoga routine metabolic cost of the yoga routine was reported to be 4.1 METS or 34% of VO_2max. The higher HR and RPE reported during yoga routine could possibly be attributed to the dynamic exercise involving large muscle groups, hip and torso flexion, and/or the arm level during isometric contractions. Participants experiencing these responses could possibly misperceive the intensity of such a workload, when in fact the cardiovascular responses to the exercise are not enough to produce a training stimulus.

An integral part of hatha yoga is incorporating certain breathing techniques (pranayama), with asanas. A study conducted by Prasad et al (22) investigated the energy cost of nadisodhana (alternate nostril breathing) during vajrasans (a sitting asana). Results were then compared to more traditional forms of physical activity: 1) treadmill walking and 2) field-walking. Twelve healthy males with three years of hatha yoga experience, including pranayama training volunteered for the study. Each subject performed 4 tests: 1) a graded maximal exercise test (Bruce protocol), 2) nadisodhana 3) treadmill walking, and 4) field-walking each for a duration of 30 minutes. Test 2 involved nadisodhana breathing consisting of nasal inhalation and exhalation at a 1:2 ratio. Subjects were instructed to cycle their breaths according to an 8 second inhalation followed with a 16 second exhalation. After 5 cycles subjects were instructed to breathe normally for 1 minute and to repeat this routine for 30 minutes. In test 3, subjects walked at a pace of 49.88 m min^{-1} (1.86 mph) for 30 minutes on a treadmill. Test 4 required the subjects to walk a distance of 24.94 $m \cdot min^{-1}$ (.93 mph) in 30 minutes on a 400 m track. All 4 tests were performed one hour after bed rest between the hours of 7am and 8am on consecutive days with graded maximal testing conducted on the 4th day. The energy expenditure of nadisodhana and field-walking were derived from individual regression equations using the O_2 consumption and HR recorded during maximal exercise testing. Mean VO_2, EE, and HR were 0.72 $LO_2 \cdot min^{-1}$, 3.59 $kcal \cdot min^{-1}$, and 80.2 $beats \cdot min^{-1}$, respectively, during treadmill walking, 0.56 $LO_2 \cdot min^{-1}$, 2.80 $kcal \cdot min^{-1}$, and 74.8 $beats \cdot min^{-1}$, respectively, during field-walking, and 0.45 $LO_2 \cdot min^{-1}$, 2.23 $kcal \cdot min^{-1}$, and 66.9 $beats \cdot min^{-1}$, respectively, during nadisodhana. Although speculative, incorporating such breathing techniques while performing lying and/or sitting asanas may increase the intensity of hatha yoga.

It appears that the practice of hatha yoga has become a popular form of physical activity and a method employed by many as a means for achieving physical fitness and health maintenance (9). Due to the limitations of research o this topic it is still unknown as to whether hatha yoga is an adequate mode of physical activity for providing the proper training stimulus required to improve cardiovascular fitness and weight control as described by ACSM (24). More research is needed to investigate the acute cardiovascular and metabolic responses to western-style hatha yoga and whether a typical western-style hatha yoga session meets minimum recommendations prescribed by ACSM for improvement in cardiovascular fitness and weight control.

Since each of the studies, except one, looked at either a single pranayama technique or a single asana, are only a few of the many asanas and pranayamas that are performed during a typical hatha yoga routine, caution should be used when using these results to determine whether a typical hatha yoga routine will provide an adequate training stimulus for promoting cardiovascular fitness and weight control.

However, even though hatha yoga has become a popular form of physical activity and a method employed by many as a means for achieving physical fitness and health maintenance (9), research has not yet determined whether it is an adequate mode of exercise for providing the proper training stimulus required to promote cardiovascular fitness and weight control as described by ACSM (24). More research is needed to investigate the acute cardiovascular and metabolic responses to western-style hatha yoga and whether a typical western-style hatha yoga session meets minimum recommendations prescribed by ACSM for improvement in cardiovascular fitness and weight control.

APPENDIX C

INFORMED CONSENT

Statement of Informed Consent

You are invited to participate in a study investigating the metabolic effects of hatha yoga. The purpose of this investigation is to determine whether a typical hatha yoga routine is an adequate mode of exercise for providing the proper training stimulus to enhance cardiovascular fitness and weight control as described by the American College of Sports Medicine. I am a graduate student and a graduate teaching assistant at Texas State University-San Marcos, in the Health, Physical Education, and Recreation Department. I am performing this study to fulfill my master's thesis requirement. I hope to learn that hatha yoga is an acceptable form of exercise for improving health-related physical fitness. You were selected as a possible participant in this study because your class was chosen to be the <u>experimental</u> class. You will be one of 30 students chosen to participate in this study.

1. Purpose and Explanation of the Test

If you decide to participate, you will complete the following on the first day of testing: a) a health history questionnaire; b) height, weight, 3-site sum of skinfold, waist to hip ratio; c) 5-minute chair rest; d) a 5-minute treadmill walk at 3.5mph; e) a graded maximal exercise test. You will then be asked to return to the lab within 7 days for performance of a 30-minute typical hatha yoga routine.

2. Attendant Risks and Discomforts

There exists the possibility of certain changes occurring during walking, yoga, and graded maximal exercise test. These include abnormal blood pressure, fainting, irregular, fast, or closing heart rhythm, and in rare instances, heart attack, stroke, or death. Although there has been no research identifying a college-age student's risk of death during graded maximal exercise, the studies on the risk of death during graded maximal exercise for middle-aged men is 1 death per 10,000 tests. Every effort will be made to minimize these risks by evaluation and preliminary information relating to your health and fitness and by careful observations during testing. In addition, emergency equipment is located nearby in the athletic training offices and is available at all times.

3. Responsibilities of the Participant

Information you possess about your health status or previous experiences of heart-related symptoms (such as shortness of breath with low-level activity, pain, pressure, tightness, heaviness in the chest, neck, jaw, back and/or arms) with physical effort may affect the safety of your exercise test. Your prompt reporting of these and any other unusual feelings with effort during the exercise test itself is of great importance. **You are responsible for fully disclosing your medical history**, as well as symptoms that may occur during the test. You are also expected to report all medications (including non-prescription) taken recently and, in particular, those taken today, to the testing staff.

4. Benefits to be Expected

The results obtained from the exercise test may be used to classify your level of progress in an already established training program. Results can also be used to determine whether you are at risk for a chronic disease, such as cardiovascular disease, diabetes type II, and/or osteoporosis.

5. Inquiries

Any questions about the procedures used in the exercise test or the results of your test are encouraged. If you have any concerns or questions, please ask us for further explanations.

6. Use of Medical Records

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. The data collected for this research will be kept for approximately one year in a file cabinet located in a locked closet in the Human Performance Lab.

7. Freedom of Consent

I hereby consent to voluntarily engage in an exercise test to determine my exercise capacity and state of cardiovascular health. My permission to perform this exercise test is given voluntarily. **<u>I understand that I am free to stop the test at any point, if I so desire.</u>**

If you have any questions, please feel free to ask me now. If you any additional questions later feel free to contact me, (512) 245-1972, or the chair of my thesis, Dr. Lisa Lloyd, (512) 245-8358 and we will be happy to answer them. Your decision whether or not to participate in this study or to discontinue will not prejudice your future relations with Texas State University or with me (i.e., your grade will not be affected if you decide to withdraw from this study).

You will be offered a copy of this form to keep.

Your signature indicates that you have read the information provided above and have decided to participate.

I have read this form, and I understand the test procedures, risks, discomforts, and benefits of the study that I am about to participate in. Knowing these risks and discomforts, and having had an opportunity to ask questions that have been answered to my satisfaction, I consent to participate in this study.

____________________________________ __________________

Signature of Participant Date

____________________________________ __________________

Signature of Witness Date

____________________________________ __________________

Signature of Investigator Date

APPENDIX D

RAW DATA

Subjects	Gender (F=0)	Age	Weight (lbs)	Weight (kg)	Height (in)	Height (m)	BMI (kg/m2)	Female Tricep 1	Female Tricep 2	Female Tricep 3	Tricep Avg	Female SI 1
1	0	40	114.5	52.04545	61.5	1.5621	21.32874	22	22		22	18
2	0	23	127	57.72727	65.25	1.65735	21.01612	14	12	13	13	11
3	0	23	104	47.27273	65.25	1.65735	17.21005	14	14		14	3
4	0	26	147	66.81818	67.5	1.7145	22.73106	9	9		9	6
5	0	23	145	65.90909	66	1.6764	23.45255	11	16	16	14.33333	26
6	0	25	121	55	65.5	1.6637	19.87068	12	13		12.5	12
7	0	22	134.5	61.13636	67.5	1.7145	20.79815	10	10		10	8
8	0	19	107.5	48.86364	63.75	1.61925	18.63623	14	12	12	12.66667	11
9	0	22	145	65.90909	63	1.6002	25.7393	12	11		11.5	18
10	0	22	121	55	64	1.6256	20.81303	26	26		26	14
11	0	27	141	64.09091	64.5	1.6383	23.87864	20	19		19.5	16
12	0	20	91	41.36364	64.5	1.6383	15.41104	4	4		4	2
13	0	22	169	76.81818	65.5	1.6637	27.75326	26	25		25.5	26
14	0	23	153	69.54545	64.25	1.63195	26.1129	27	26		26.5	16
15	0	25	139	63.18182	62.25	1.58115	25.27237	20	19		19.5	13
16	0	23	142	64.54545	63.5	1.6129	24.81137	25	25		25	11
17	0	20	126	57.27273	58.5	1.4859	25.93992	27	25	23	25	20
18	0	21	155.25	70.56818	64.75	1.64465	26.08927	37	35		36	15
19	0	22	100	45.45455	58.5	1.4859	20.58724	17	16		16.5	16
20	0	21	103	46.81818	58.25	1.47955	21.38727	14	13		13.5	7
21	0	22	100	45.45455	59.25	1.50495	20.06934	11	10		10.5	8
22	0	32	124	56.36364	65	1.651	20.67783	25	24		24.5	14
23	0	22	166	75.45455	61.75	1.56845	30.67214	25	23	24	24	22
24	0	22	107	48.63636	63.5	1.6129	18.69589	12	11		11.5	6
25	0	20	205	93.18182	65.5	1.6637	33.6652	31	34	30	31.66667	26
26	0	21	123	55.90909	65.5	1.6637	20.19912	21	25	21	22.33333	10

Female SI 2	Female SI 3	Avg SI	Female Thigh 1	Female Thigh 2	Female Thigh 3	Ave Thigh	SSF	FEMALE Body Density	FEMALE % Bodyfat	Waist (cm)	Hip (cm)
19		18.5	31	30		30.5	71	1.034951	28.28333	67	90
11		11	26	23	22	23.66667	47.66667	1.054117	19.58733	51	89
4		3.5	28	27		27.5	45	1.056196	18.66284	56.5	87
7		6.5	8	8		8	23.5	1.073739	11.00596	70	92
21	21	22.66667	24	25		24.5	61.5	1.043855	24.20369	73	96
13		12.5	20	20		20	45	1.055918	18.7864	64.5	89
8		8	21	21		21	39	1.061134	16.48217	62	87.5
12		11.5	17	16		16.5	40.66667	1.060202	16.89218	64	83
18		18	20	21		20.5	50	1.052464	20.32505	76	103
12	13	13	39	33	32	34.66667	73.66667	1.035697	27.93922	62.5	88.5
18	18	17.33333	41	35	38	38	74.83333	1.034241	28.61201	64	96.5
3		2.5	6	6		6	12.5	1.084585	6.395712	54.5	74
27		37	39	37	37	37.66667	100.1667	1.01998	35.30371	78.5	105
15		15.5	41	34	38	37.66667	79.66667	1.031716	29.78322	78	109
17	20	27	23	20		21.5	68	1.039059	26.39258	66.5	94.5
14	15	13.33333	30	31		30.5	68.83333	1.038772	26.52409	67	96
14	15	16.33333	29	27	29	28.33333	69.66667	1.038628	26.59032	81	94.5
16		15.5	58	56		57	108.5	1.015844	37.27939	73	107
15		15.5	23	23		23	55	1.048707	22.01	56.5	82
7		7	20	20		20	40.5	1.060058	16.95561	59	86
8		8	13	12		12.5	31	1.067789	13.57473	56	81
12	12	12.66667	24	24		24	61.16667	1.042839	24.66563	62	89
20	22	21.33333	25	29	26	26.66667	72	1.036793	27.43378	84	107
5		5.5	15	16		15.5	32.5	1.066519	14.12687	51	81
25		25.5	42	46	44	44	101.1667	1.019728	35.42337	84.5	122.5
9		9.5	15	16		15.5	47.33333	1.054654	19.34844	59	85.5

Ratio	Chair-Rest Min 3 (ml/kg/min)	Chair-Rest Min 4 (ml/kg/min)	Chair-Rest Min 5 (ml/kg/min)	Chair-Rest Min 3 (L/min)	Chair-Rest Min 4 (L/min)	Chair-Rest Min 5 (L/min)	Chair-Rest Min 3 (HR)	Chair-Rest Min 4 (HR)	Chair-Rest Min 5 (HR)	Average (ml/kg/min)	
0.744444	4.1	4.4	4	0.21	0.23	0.21	91	91	87	4.1666667	0.029762
0.573034	4.5	5.1	4.2	0.26	0.29	0.24	87	84	86	4.6	0.038194
0.649425	3.7	3.7	3.9	0.18	0.18	0.19	97	96	109	3.7666667	0.010217
0.76087	4.1	4.3	4.1	0.28	0.29	0.27	68	67	67	4.1666667	0.02008
0.760417	3.7	3.7	2.8	0.24	0.24	0.18	82	86	80	3.4	-0.00431
0.724719	2.8	2.2	1.8	0.15	0.12	0.1	92	96	90	2.2666667	-0.04602
0.708571	3.6	3.4	3.4	0.22	0.21	0.2	81	84	83	3.4666667	-0.00085
0.771084	2.8	2.9	3.9	0.14	0.14	0.19	91	98	103	3.2	-0.00917
0.737864	3.8	3	3.4	0.25	0.2	0.22	75	74	74	3.4	-0.00389
0.706215	3.7	3.7	3.7	0.2	0.2	0.2	110	113	112	3.7	0.007813
0.663212	3.9	3.8	3	0.25	0.24	0.19	72	80	70	3.5666667	0.002315
0.736486	3.3	4	4	0.14	0.16	0.16	65	64	63	3.7666667	0.008715
0.747619	3.8	3.5	3.7	0.29	0.27	0.28	91	89	90	3.6666667	0.006061
0.715596	3.9	3.4	4.3	0.27	0.23	0.3	73	77	75	3.8666667	0.014493
0.703704	3.1	3.8	3.1	0.19	0.24	0.2	64	68	69	3.3333333	-0.00758
0.697917	4	3.6	3.4	0.26	0.23	0.22	73	66	74	3.6666667	0.004115
0.857143	3.7	2.2	2.2	0.21	0.13	0.12	90	92	98	2.7	-0.02857
0.682243	5.9	4.8	4.9	0.42	0.34	0.34	106	101	107	5.2	0.069388
0.689024	4.3	4.1	4.2	0.19	0.18	0.19	78	75	81	4.2	0.024823
0.686047	4.6	4.5	4.8	0.22	0.21	0.23	88	87	88	4.6333333	0.028333
0.691358	3.5	3	3	0.16	0.14	0.14	83	83	83	3.1666667	-0.01134
0.696629	4.4	4.3	3.5	0.25	0.24	0.2	91	93	93	4.0666667	0.017436
0.785047	3	2.7	2.6	0.23	0.21	0.2	80	78	78	2.7666667	-0.02537
0.62963	2.6	2	2	0.12	0.1	0.1	91	84	89	2.2	-0.03951
0.689796	2.9	3	2.8	0.27	0.28	0.26	90	88	90	2.9	-0.02381
0.690058	0.8	1	0.8	0.04	0.06	0.04	86	86	86	0.8666667	0.046667

Average (L/min)	Average (HR)	3.5mph Min 3 (ml/kg/min)	3.5mph Min 4 (ml/kg/min)	3.5mph Min 5 (ml/kg/min)	3.5mph Min 3 (L/min)	3.5mph Min 4 (L/min)	3.5mph Min 5 (L/min)	3.5mph Min 3 (HR)	3.5mph Min 4 (HR)	3.5mph Min 5 (HR)	Average (ml/kg/min)
0.216667	89.66667	12.9	12.4	14.4	0.67	0.65	0.75	133	133	135	13.23333333
0.263333	85.66667	19.5	19.2	18.8	1.13	1.11	1.08	139	139	141	19.16666667
0.183333	100.6667	15	14.5	14.1	0.71	0.68	0.67	124	122	122	14.53333333
0.28	67.33333	14.6	14.9	14.4	0.97	1	0.96	105	103	102	14.63333333
0.22	82.66667	14	14.7	13.3	0.92	0.97	0.88	145	146	148	14
0.123333	92.66667	19.2	19.2	18.9	1.05	1.05	1.04	156	155	157	19.1
0.21	82.66667	14.6	14.4	15	0.89	0.88	0.92	121	117	116	14.66666667
0.156667	97.33333	18.4	17	17.5	0.9	0.83	0.86	146	147	140	17.63333333
0.223333	74.33333	15.6	14.7	18.9	1.03	0.97	1.25	103	129	134	16.4
0.2	111.6667	16.8	15.5	15.2	0.92	0.86	0.83	171	173	173	15.83333333
0.226667	74	12.7	14.2	14.7	0.81	0.91	0.94	118	116	121	13.86666667
0.153333	64	12.5	14	14	0.52	0.58	0.58	109	105	108	13.5
0.28	90	16	16.5	15.8	1.23	1.27	1.21	121	121	122	16.1
0.266667	75	19.1	19.3	18.2	1.33	1.34	1.27	138	138	141	18.86666667
0.21	67	16.8	16.4	16.6	1.06	1.04	1.05	122	124	122	16.6
0.236667	71	15.2	15.4	14.7	0.98	0.99	0.95	109	107	108	15.1
0.153333	93.33333	17	17.7	15.5	0.98	1.01	0.89	155	160	161	16.73333333
0.366667	104.6667	17.9	16.2	17.9	1.27	1.14	1.26	153	155	158	17.33333333
0.186667	78	21.4	19.6	19.3	0.97	0.89	0.88	149	143	139	20.1
0.22	87.66667	16.3	17.1	15.8	0.76	0.8	0.74	121	125	127	16.4
0.146667	83	15.7	15.1	16.3	0.71	0.69	0.74	120	121	122	15.7
0.23	92.33333	16.9	17.4	17.4	0.95	0.98	0.98	128	129	130	17.23333333
0.213333	78.66667	15.8	16.8	16.2	1.2	1.27	1.22	139	142	143	16.26666667
0.106667	88	16	13.5	13.2	0.78	0.66	0.64	135	136	132	14.23333333
0.27	89.33333	17	17.2	17	1.58	1.6	1.58	143	149	148	17.06666667
86	86	12.5	12.3	11.4	0.7	0.69	0.64	140	141	137	50.69222222

	METs	Average (L/min)	Average (HR)	VO2 max (ml/kg/min)	VO2 max (L/min)	VO2 Max (HR)	Yoga min 1 (ml/kg/min)	Yoga min 2 (ml/kg/min)	Yoga min 3 (ml/kg/min)	Yoga min 4 (ml/kg/min)	Yoga min 5 (ml/kg/min)
0.434524	3.780952	0.69	133.6667	25.9	1.35	172	4.8	5.7	5.4	2.9	5
0.543981	5.47619	1.106667	139.6667	32.3	1.87	195	4.1	4.2	7.2	3.9	7.8
0.422733	4.152381	0.686667	122.6667	29.6	1.4	178	4.3	4.5	4.9	4	5.5
0.335341	4.180952	0.976667	103.3333	36.7	2.45	163	5.5	4.7	5.1	3.9	7.3
0.452586	4	0.923333	146.3333	26.7	1.76	184	4.7	4.8	5.2	3.9	7.3
0.58209	5.457143	1.046667	156	30.3	1.67	199	7	6	6.3	4.6	9
0.285592	4.190476	0.896667	118	42.6	2.6	189	3.4	4.1	4.4	4	7
0.432212	5.038095	0.863333	144.3333	36.2	1.77	197	4.5	3.6	5.1	2.7	7.9
0.501946	4.685714	1.083333	122	29.2	1.93	193	2.3	2.4	3.8	3.6	5.4
0.481771	4.52381	0.87	172.3333	29.1	1.6	191	3.4	3.4	4	3.4	5.1
0.359954	3.961905	0.886667	118.3333	32.3	2.07	175	1.6	1.4	4	2.5	3.2
0.326797	3.857143	0.56	107.3333	34.1	1.41	175	4.7	3.6	6.5	4.1	7
0.458182	4.6	1.236667	121.3333	31	2.38	168	4.9	4.2	5	3.6	6.1
0.607378	5.390476	1.313333	139	28.8	2	172	4.5	3.9	5.7	4.4	8.6
0.595455	4.742857	1.05	122.6667	25.5	1.61	155	4.5	3.2	7.3	4.1	6.8
0.28642	4.314286	0.973333	108	44	2.84	197	5.4	3.7	3.5	3.3	6.4
0.472619	4.780952	0.96	158.6667	31.5	1.8	203	2.6	3.5	4.3	3.6	4.3
0.564626	4.952381	1.223333	155.3333	28	1.93	197	4.6	4.6	6.6	6.8	6.3
0.588652	5.742857	0.913333	143.6667	31.7	1.44	187	5.6	4.2	5.5	4.2	6.7
0.3225	4.685714	0.766667	124.3333	43.5	2.04	195	3.3	4	6.2	5.2	9
0.414966	4.485714	0.713333	121	32.9	1.49	176	4.8	3.2	7.1	3.3	5.7
0.422564	4.92381	0.97	129	36	2.03	190	5.5	4.6	5.7	3.3	5.4
0.441753	4.647619	1.23	141.3333	32.4	2.44	195	3.4	2.8	5.7	3.2	7
0.326241	4.066667	0.693333	134.3333	36.4	1.77	181	7.2	6.4	5.6	4	9.7
0.53836	4.87619	1.586667	146.6667	28.7	2.67	203	4.1	3.1	3.2	3.3	6
0.676667	139.3333	0.676667	139.3333	34.8	1.94	197	3.9	4.1	5.9	4.8	8.2

Yoga min 6 (ml/kg/min)	Yoga min 7 (ml/kg/min)	Yoga min 8 (ml/kg/min)	Yoga min 9 (ml/kg/min)	Yoga min 10 (ml/kg/min)	Yoga min 11 (ml/kg/min)	Yoga min 12 (ml/kg/min)	Yoga min 13 (ml/kg/min)	Yoga min 14 (ml/kg/min)	Yoga min 15 (ml/kg/min)	Yoga min 16 (ml/kg/min)
4.7	5.8	7.6	5.8	6.6	4.2	4.9	9.2	4.8	6.4	8
8.8	13.7	14.2	14.2	15.6	11	10.8	10.7	11	9.6	9.8
5.1	11.7	12.2	13.6	11.2	9.3	9.1	8.3	7.9	8.2	8.7
10.5	13.7	16.4	15	13.3	9.8	9.6	8	8.3	9.4	7.8
11.6	16.1	16.2	15.8	14.6	11.3	11.3	10	8.8	9.8	8.7
11.6	16	15.8	15.5	15.9	11.5	11.3	10.7	7.6	10.7	9
10.6	16.5	14.5	16.1	12.9	10.5	9.9	7.8	10.8	10	8.4
8.1	13	14.3	14	14.4	9.3	10.4	9	8.3	8.1	8.6
8.8	12.4	14	13.3	12.1	8.4	6.5	7.4	6.5	5.1	6.9
5.8	11	11.6	11.1	11.5	6.3	7.9	6.6	4.5	7	7
5.6	10	12	10.1	11.1	7.7	7.5	6.3	6.5	5.7	6.3
8.3	11.9	13.9	13.5	12.5	10.9	8.9	7.9	8.8	8.7	8.1
7	9.5	11	9.3	10.2	8	7.4	7.8	6.6	7.5	7.3
11.3	15.7	16.1	16.3	14.4	11.5	8.5	9.1	9.3	8.6	7.8
11.6	16.6	18.5	15.3	16.1	10.4	10.7	9.4	7.7	9.4	9.5
8.5	10.6	12.9	11.4	11.7	8.2	7.6	8.5	7.2	7.6	7.1
5.1	8.7	7.5	6.3	9.4	5.9	5.4	4.9	3.2	3.8	5.6
10.5	14.3	14.1	16	12.2	12.9	9	9.5	8.9	9.2	8.3
8.2	10.2	13.7	12	11.9	6.6	11.1	6	8.1	6.6	4.5
6.2	13.8	14	12.5	13.6	10.1	8.6	6.7	7.9	7.8	7.1
7.7	11.6	12.6	10.4	11.9	6.7	8.6	7.1	6.9	7.9	7.5
7.1	10.4	11.7	11.2	10.5	8.8	3.7	8.4	6.5	7.8	6.6
9.5	15.4	13.9	13.6	13.8	7.3	7.7	6.7	6.8	6.3	7.4
11.5	16.4	17.5	16.3	13.2	13.5	11.5	11	10.7	9.3	10.1
9	11.5	13	11.1	12.5	9.4	9.4	6.8	6.3	8.8	8.1
9	15.5	16.2	16.2	15.5	11.8	10.2	9.7	9.2	10.6	9.9

Yoga min 17 (ml/kg/min)	Yoga min 18 (ml/kg/min)	Yoga min 19 (ml/kg/min)	Yoga min 20 (ml/kg/min)	Yoga min 21 (ml/kg/min)	Yoga min 22 (ml/kg/min)	Yoga min 23 (ml/kg/min)	Yoga min 24 (ml/kg/min)	Yoga min 25 (ml/kg/min)	Yoga min 26 (ml/kg/min)	Yoga min 27 (ml/kg/min)
6.3	8.9	5.9	7.1	10.2	9.5	8.2	4.6	7.6	6.9	6.8
9.7	8.6	7.6	11	7.8	9.5	8.8	8.2	6.3	8.5	7
7.3	7.1	5.2	9.1	7.9	9.6	8.8	7.4	7.8	8.2	7.1
7.8	8.4	6.8	9	6.9	8.8	7.1	6.9	7.6	6.4	7.8
7.9	8	8.2	11.1	12	12.3	11	8.9	7.6	7.2	7.4
9.3	8.5	8.7	9.6	11.5	11.8	12	11.2	9.8	11.1	8.6
6.9	6.2	8.2	6.5	5.3	4.3	4.8	9.6	7.6	8.8	8.1
7.9	6.6	7.3	8.5	6.7	8.2	7.8	5.1	6.4	5.8	6.6
5.8	6.3	6	7.5	6.5	7.8	7.6	6.3	5.2	6.1	5.3
6.4	7.7	4.4	7.2	4.4	5.7	3.9	5.4	4.8	6.1	4.2
5.8	5.6	5.9	7.2	7.3	7.3	6.1	6.3	4.7	4.9	5.5
7.4	6.6	5.5	8.2	7.5	8.1	6.5	7.4	8	6.7	7.8
7.1	7	4.6	6.9	7.6	6.6	7	5.4	5.8	6.4	5.3
9.3	9	8.7	9.8	9	11	8.8	7.7	7.1	6.8	6.6
9.5	9.6	7.2	8.6	8.3	7.5	6.7	6.7	8.2	7.7	7.2
6.1	5.6	4.4	7.8	4.7	6.2	4.4	4.8	4.9	5.2	6
5.9	5.9	2.4	2.7	2	1.2	1.5	4.8	4.7	4.7	4
7.5	9	8.9	8.4	9	7.3	7.6	7.1	6.5	7.3	7
11.6	5.8	7.9	6.8	8.8	5.5	9.9	6.7	3.5	7.9	7.1
7.4	7.2	5.3	9	7.1	6.2	4.4	6.2	7.7	7.1	6.8
6	6.8	5.2	6.1	5.8	5.1	4.6	6.3	6.1	4.9	3.5
6.4	7.9	7.1	7.6	7.1	5.9	5.3	4.4	6.1	5	5
6.6	6.5	4.7	6.9	5.3	5.7	5.2	5.7	6.5	7.4	6.6
8.9	9.5	9.6	10.4	9.5	13.5	9.8	8.2	9.7	9.7	10.1
8.8	8.2	3.1	8.1	5.2	5.9	6	7.1	8	7.2	7.6
8.3	7.4	7	9.3	8	9.4	9.8	8.2	8	8.1	7.4

Yoga min 28 (ml/kg/min)	Yoga min 29 (ml/kg/min)	Yoga min 30 (ml/kg/min)	Yoga (ml/kg/min) average	METs	%VO2R	Yoga min 1 (L/min)	Yoga min 2 (L/min)	Yoga min 3 (L/min)	Yoga min 4 (L/min)	Yoga min 5 (L/min)	Yoga min 6 (L/min)
7.1	6.6	4.2	6.39	1.825714	0.13	0.25	0.3	0.28	0.15	0.26	0.24
5.3	7.1	5.5	8.9166667	2.547619	0.19	0.24	0.24	0.41	0.23	0.45	0.51
6.8	5.5	5.5	7.7266667	2.207619	0.16	0.2	0.21	0.23	0.19	0.26	0.24
6.7	8.8	3.7	8.3666667	2.390476	0.15	0.37	0.31	0.34	0.26	0.49	0.7
6.3	4.9	4.4	9.2433333	2.640952	0.25	0.31	0.31	0.34	0.25	0.48	0.76
9.1	7.7	6.7	10.136667	2.89619	0.25	0.39	0.33	0.34	0.25	0.5	0.64
6.8	6.1	2.4	8.0833333	2.309524	0.12	0.21	0.25	0.27	0.24	0.43	0.65
5.4	6.4	4.7	7.8233333	2.235238	0.13	0.22	0.17	0.25	0.13	0.39	0.4
5.1	3.9	3.2	6.7166667	1.919048	0.13	0.15	0.16	0.25	0.24	0.35	0.58
4.4	5.8	4.6	6.1533333	1.758095	0.10	0.19	0.19	0.22	0.19	0.28	0.32
3.5	3.5	3.3	5.9466667	1.699048	0.08	0.1	0.09	0.26	0.16	0.21	0.36
9.4	7	5.2	8.02	2.291429	0.15	0.19	0.15	0.27	0.17	0.29	0.34
5.5	4.7	3.5	6.6266667	1.893333	0.11	0.37	0.33	0.38	0.28	0.47	0.54
5.6	5.3	4.5	8.83	2.522857	0.21	0.31	0.27	0.4	0.3	0.6	0.78
6.2	5.8	3.6	8.7966667	2.513333	0.24	0.28	0.2	0.46	0.26	0.43	0.73
4.5	4.4	3.2	6.5266667	1.864762	0.07	0.35	0.24	0.22	0.22	0.41	0.55
4.9	3.9	3.8	4.55	1.3	0.04	0.15	0.2	0.25	0.2	0.25	0.29
6.8	4	4.3	8.4833333	2.42381	0.20	0.33	0.33	0.47	0.48	0.44	0.74
5	8.2	5.1	7.4966667	2.141905	0.14	0.25	0.19	0.25	0.19	0.3	0.37
5.7	4.1	3.7	7.4633333	2.132381	0.10	0.15	0.19	0.29	0.24	0.42	0.29
4.2	3.3	1.7	6.42	1.834286	0.10	0.22	0.15	0.32	0.15	0.26	0.35
5.4	5.1	4	6.65	1.9	0.10	0.31	0.26	0.32	0.18	0.31	0.4
3.7	5	3.9	7.0066667	2.001905	0.12	0.25	0.21	0.43	0.24	0.52	0.71
8.9	8	6.9	10.22	2.92	0.20	0.53	0.31	0.27	0.2	0.47	0.56
6	6.7	4.4	7.2633333	2.075238	0.15	0.39	0.29	0.3	0.31	0.56	0.84
7.7	6.1	4.9	9.01	2.574286	0.22	0.23	0.33	0.27	0.46	0.5	0.87

Yoga min 7 (L/min)	Yoga min 8 (L/min)	Yoga min 9 (L/min)	Yoga min 10 (L/min)	Yoga min 11 (L/min)	Yoga min 12 (L/min)	Yoga min 13 (L/min)	Yoga min 14 (L/min)	Yoga min 15 (L/min)	Yoga min 16 (L/min)	Yoga min 17 (L/min)	Yoga min 18 (L/min)
0.3	0.39	0.3	0.34	0.22	0.26	0.48	0.25	0.33	0.41	0.33	0.46
0.79	0.82	0.82	0.9	0.63	0.62	0.62	0.64	0.56	0.56	0.56	0.49
0.55	0.58	0.64	0.53	0.44	0.43	0.39	0.37	0.39	0.41	0.34	0.33
0.92	1.1	1	0.89	0.65	0.64	0.53	0.55	0.63	0.52	0.52	0.56
1.06	1.07	1.04	0.96	0.75	0.75	0.66	0.58	0.64	0.57	0.52	0.53
0.88	0.87	0.85	0.87	0.64	0.62	0.59	0.42	0.59	0.5	0.51	0.47
1.01	0.89	0.99	0.79	0.64	0.61	0.48	0.66	0.61	0.51	0.42	0.38
0.63	0.7	0.68	0.7	0.45	0.51	0.44	0.41	0.4	0.42	0.38	0.32
0.82	0.92	0.87	0.8	0.56	0.43	0.49	0.43	0.34	0.46	0.38	0.41
0.61	0.64	0.61	0.63	0.35	0.44	0.36	0.25	0.39	0.39	0.35	0.42
0.64	0.77	0.65	0.71	0.5	0.48	0.4	0.42	0.37	0.4	0.37	0.36
0.49	0.58	0.56	0.52	0.45	0.37	0.33	0.37	0.36	0.34	0.31	0.27
0.73	0.85	0.72	0.79	0.61	0.57	0.6	0.51	0.58	0.56	0.54	0.54
1.09	1.12	1.13	1	0.8	0.59	0.63	0.65	0.6	0.55	0.65	0.63
1.05	1.17	0.97	1.02	0.66	0.68	0.59	0.49	0.6	0.6	0.6	0.6
0.68	0.84	0.74	0.76	0.53	0.49	0.55	0.46	0.49	0.46	0.4	0.36
0.5	0.43	0.36	0.54	0.34	0.31	0.28	0.18	0.22	0.32	0.34	0.34
1.01	0.99	1.13	0.86	0.91	0.63	0.67	0.63	0.65	0.58	0.53	0.64
0.46	0.62	0.55	0.54	0.3	0.51	0.27	0.37	0.3	0.2	0.53	0.26
0.65	0.66	0.59	0.63	0.47	0.4	0.31	0.37	0.37	0.33	0.35	0.34
0.53	0.57	0.47	0.54	0.3	0.39	0.32	0.31	0.36	0.34	0.27	0.31
0.58	0.66	0.63	0.59	0.49	0.21	0.47	0.37	0.44	0.37	0.36	0.45
1.15	1.04	1.01	1.03	0.84	0.57	0.5	0.51	0.47	0.55	0.49	0.48
0.8	0.85	0.79	0.64	0.65	0.56	0.52	0.45	0.49	0.43	0.46	0.47
1.07	1.21	1.04	1.17	0.87	0.88	0.64	0.58	0.82	0.75	0.82	0.77
0.91	0.91	0.86	0.66	0.57	0.54	0.51	0.59	0.55	0.46	0.41	0.39

Yoga min 19 (L/min)	Yoga min 20 (L/min)	Yoga min 21 (L/min)	Yoga min 22 (L/min)	Yoga min 23 (L/min)	Yoga min 24 (L/min)	Yoga min 25 (L/min)	Yoga min 26 (L/min)	Yoga min 27 (L/min)	Yoga min 28 (L/min)	Yoga min 29 (L/min)	Yoga min 30 (L/min)
0.3	0.37	0.53	0.5	0.43	0.24	0.4	0.36	0.35	0.37	0.35	0.22
0.44	0.64	0.45	0.55	0.51	0.48	0.37	0.49	0.4	0.31	0.41	0.32
0.25	0.43	0.38	0.45	0.42	0.35	0.37	0.39	0.34	0.32	0.26	0.26
0.45	0.6	0.46	0.59	0.47	0.46	0.51	0.43	0.52	0.44	0.59	0.25
0.54	0.73	0.79	0.81	0.73	0.59	0.5	0.48	0.49	0.41	0.33	0.29
0.48	0.53	0.63	0.65	0.66	0.62	0.54	0.61	0.47	0.5	0.42	0.37
0.5	0.4	0.32	0.26	0.29	0.59	0.46	0.54	0.49	0.42	0.37	0.14
0.36	0.42	0.33	0.4	0.38	0.25	0.31	0.28	0.32	0.27	0.31	0.23
0.4	0.49	0.43	0.51	0.5	0.42	0.34	0.4	0.35	0.34	0.26	0.21
0.24	0.39	0.24	0.31	0.21	0.3	0.26	0.34	0.23	0.24	0.32	0.25
0.38	0.46	0.47	0.47	0.39	0.4	0.3	0.31	0.35	0.22	0.22	0.21
0.23	0.34	0.31	0.33	0.27	0.3	0.33	0.28	0.32	0.39	0.29	0.22
0.35	0.53	0.59	0.51	0.54	0.41	0.44	0.49	0.4	0.41	0.36	0.27
0.61	0.68	0.64	0.77	0.61	0.53	0.49	0.47	0.46	0.39	0.37	0.31
0.46	0.54	0.53	0.48	0.42	0.42	0.52	0.49	0.46	0.39	0.37	0.22
0.28	0.5	0.3	0.4	0.28	0.31	0.31	0.33	0.39	0.29	0.28	0.2
0.13	0.15	0.12	0.07	0.09	0.27	0.27	0.27	0.23	0.28	0.22	0.22
0.62	0.6	0.63	0.52	0.54	0.5	0.46	0.52	0.49	0.48	0.28	0.3
0.36	0.31	0.4	0.25	0.45	0.31	0.16	0.36	0.32	0.23	0.37	0.23
0.25	0.42	0.33	0.29	0.21	0.29	0.36	0.33	0.32	0.27	0.19	0.17
0.24	0.28	0.26	0.23	0.21	0.29	0.28	0.22	0.16	0.19	0.15	0.08
0.4	0.43	0.4	0.33	0.3	0.25	0.34	0.28	0.28	0.3	0.29	0.22
0.35	0.51	0.39	0.43	0.38	0.42	0.48	0.55	0.5	0.28	0.37	0.29
0.5	0.5	0.46	0.66	0.48	0.4	0.47	0.47	0.49	0.43	0.39	0.34
0.29	0.76	0.48	0.55	0.56	0.66	0.75	0.67	0.71	0.56	0.63	0.41
0.52	0.45	0.53	0.55	0.46	0.45	0.45	0.42	0.43	0.34	0.27	0.24

Yoga (L/min) average	Yoga min 1 (HR)	Yoga min 2 (HR)	Yoga min 3 (HR)	Yoga min 4 (HR)	Yoga min 5 (HR)	Yoga min 6 (HR)	Yoga min 7 (HR)	Yoga min 8 (HR)	Yoga min 9 (HR)	Yoga min 10 (HR)	Yoga min 11 (HR)
0.332333	102	92	94	102	106	108	129	138	140	145	145
0.515333	88	82	95	101	110	121	134	128	135	117	121
0.365	97	100	104	108	132	126	131	120	120	123	105
0.558333	70	72	72	83	92	92	97	99	98	101	66
0.609	73	70	81	102	114	120	134	129	135	151	120
0.558	102	103	109	130	128	143	156	148	139	151	131
0.494	78	75	87	106	118	130	127	129	141	140	129
0.382	80	85	99	105	145	115	121	125	127	144	97
0.443	61	70	76	98	100	145	127	116	119	122	88
0.338667	103	104	109	111	135	150	152	154	157	169	152
0.381	69	74	84	96	141	132	15	127	122	109	168
0.332333	57	68	75	85	113	94	96	100	82	98	93
0.509	97	90	102	107	115	114	127	120	125	132	108
0.614333	80	79	92	102	112	125	134	131	132	137	112
0.556333	78	73	85	103	107	131	137	142	142	126	116
0.420667	65	65	63	82	92	99	102	96	99	96	80
0.260667	73	71	84	96	101	114	119	115	122	115	94
0.598667	72	110	111	120	113	131	139	145	144	142	139
0.340333	94	78	84	83	103	94	101	90	93	101	98
0.349333	89	91	88	103	104	111	112	117	112	90	115
0.291667	86	86	95	92	103	113	111	109	107	113	86
0.374	91	100	114	114	119	129	131	127	131	125	114
0.531667	75	76	87	93	115	116	121	115	115	130	119
0.501333	74	90	104	111	136	135	138	126	131	124	124
0.678	100	89	103	108	120	113	135	92	137	137	129
0.495161	78	81	93	104	114	111	111	129	128	122	111

Yoga min 12 (HR)	Yoga min 13 (HR)	Yoga min 14 (HR)	Yoga min 15 (HR)	Yoga min 16 (HR)	Yoga min 17 (HR)	Yoga min 18 (HR)	Yoga min 19 (HR)	Yoga min 20 (HR)	Yoga min 21 (HR)	Yoga min 22 (HR)	Yoga min 23 (HR)
145	135	132	143	143	143	143	139	134	122	133	126
124	100	130	121	109	112	109	103	113	94	100	97
138	129	112	95	107	114	128	131	107	99	108	100
66	66	66	71	71	71	71	97	71	81	80	77
155	134	133	102	109	117	125	132	140	133	132	99
142	128	147	122	125	132	130	144	132	150	129	122
120	116	135	133	117	126	103	112	107	110	113	117
148	129	119	124	118	112	132	108	111	120	118	125
116	81	111	83	109	97	102	94	91	86	106	74
154	158	163	153	156	151	162	141	131	147	127	126
92	137	113	112	107	100	92	104	99	104	99	115
71	63	97	80	98	78	88	85	75	77	72	75
142	128	127	122	113	106	103	109	112	104	116	105
112	112	104	104	104	104	104	135	114	119	117	112
111	107	122	124	109	99	97	124	104	93	103	114
110	79	92	61	80	72	91	80	68	70	69	63
94	94	94	94	94	115	106	102	99	94	94	101
131	141	140	140	140	140	113	139	118	126	129	132
89	78	76	76	107	96	82	85	88	82	83	81
109	97	99	110	105	104	95	100	101	93	84	94
118	99	111	87	95	97	93	97	89	88	82	75
134	116	128	111	122	113	132	127	111	118	108	108
96	104	105	101	101	101	101	111	86	92	94	109
102	102	102	110	110	120	115	111	106	112	103	121
145	131	137	116	136	134	128	153	124	118	160	100
91	92	98	79	79	79	79	90	87	78	88	113

Yoga min 24 (HR)	Yoga min 25 (HR)	Yoga min 26 (HR)	Yoga min 27 (HR)	Yoga min 28 (HR)	Yoga min 29 (HR)	Yoga min 30 (HR)	Yoga (HR) average	3.5mph Min 3 (REE)	3.5mph Min 4 (REE)	3.5mph Min 5 (REE)	3.5mph Average (REE)
127	123	113	102	104	103	108	123.9667	3.3	3.2	3.7	3.4
104	92	97	91	91	88	83	106.3333	5.6	5.6	5.4	5.533333
113	101	97	91	98	87	92	110.4333	3.4	3.3	3.3	3.333333
84	80	75	86	84	73	68	79.33333	4.8	4.9	4.7	4.8
104	97	97	101	98	84	85	113.5333	4.5	4.8	4.3	4.533333
145	130	124	119	124	102	111	129.9333	5.2	5.2	5.1	5.166667
107	86	98	92	89	73	84	109.9333	4.4	4.3	4.5	4.4
116	93	92	109	111	94	85	113.5667	4.5	4.2	4.3	4.333333
96	82	83	87	86	69	69	94.8	5	4.8	6.1	5.3
106	106	109	111	115	95	92	133.3	4.6	4.3	4.1	4.333333
90	95	95	90	108	79	85	101.7667	4	4.5	4.6	4.366667
91	67	83	88	90	62	61	82.06667	2.5	2.8	2.8	2.7
120	97	101	86	100	95	92	110.5	6	6.2	5.9	6.033333
121	79	82	95	102	74	82	107.0667	6.5	6.6	6.3	6.466667
107	95	87	95	92	71	72	105.5333	5.2	5.2	5.2	5.2
71	59	70	68	67	58	53	77.33333	4.6	4.7	4.5	4.6
99	90	92	93	82	71	74	96.2	4.7	5	4.4	4.7
120	115	115	114	123	102	105	124.9667	6.2	5.6	6.3	6.033333
87	84	83	80	78	78	77	86.96667	4.8	4.4	4.3	4.5
97	94	92	84	86	106	78	98.66667	3.7	4	3.7	3.8
88	87	84	87	80	73	71	93.4	3.5	3.4	3.7	3.533333
110	104	104	95	100	92	99	114.2333	4.6	4.8	4.8	4.733333
82	91	94	89	104	78	77	99.26667	5.8	6.2	6	6
114	113	98	108	115	77	77	110.3	3.7	3.2	3.1	3.333333
116	110	117	115	115	95	93	120.2	7.8	7.9	7.8	7.833333
80	81	77	85	91	79	81	93.63333	3.4	3.4	3.1	3.3

3.5mph TOTAL (REE)	VO2 max 1 (REE)	VO2 max 2 (REE)	VO2 max 3 (REE)	VO2 max 4 (REE)	VO2 max 5 (REE)	VO2 max 6 (REE)	VO2 max 7 (REE)	VO2 max 8 (REE)	VO2 max 9 (REE)	VO2 max 10 (REE)	VO2 max 11 (REE)
10.2	1.4	3	3.8	4.3	5.2	6.5	6.9				
16.6	2.2	4	4.5	5.9	7	7.2	9.4				
10	2.7	3.3	3.7	4.3	5.2	5.4	6.4				
14.4	2.1	4.8	4.9	6.1	7.5	8	9.1	11.4	12.4		
13.6	2.4	4.1	5.1	6.1	7.8	8.2					
15.5	2.3	4.1	4.1	5.2	6.3	6.9	8.4				
13.2	2.1	4.4	5	5.7	6.9	7.1	8.8	10.5	10.3	12.2	13.2
13	2.8	3.4	4.4	5	6.1	6.4	7.7	9.3	8.9		
15.9	2.1	4.1	4.6	5.9	6.9	7.7	9.3	10.3			
13	2.6	4.8	4.9	5.6	6.9	7.2	8.4				
13.1	1.9	3.3	3.8	4.8	6.4	6.9	8.9				
8.1	1.3	2.1	3.1	3.5	4.7	5	5.2	6.3	6.9		
18.1	2.4	3.4	3.8	4.6	8.1	8.8	10.7				
19.4	3.4	5.9	6.9	8	10						
15.6	2.3	4.5	4.9	5.9	7.4	7.7					
13.8	2.4	4.8	5	6.3	7.1	7.6	9.3	11.3	12.4	14	
14.1	2.1	3.3	4.4	5.1	6.6	6.9	8.4				
18.1	2.8	4.8	5.8	6.7	7.9	8.6					
13.5	1.6	3.5	4	4.6	5.8	6.2	6.9				
11.4	1.7	3.7	3.8	4.5	5.8	5.9	7.4	9.4	9.8	11	
10.6	2	2.7	4.1	4.5	5.3	5.7	7.2				
14.2	2.1	2.8	2.9	3.9	6.1	6.6	7.6	9.8	10.7		
18	2.1	4.9	5.4	6.6	7.1	8.2	10.6	12.9			
10	1.3	2.4	3.5	4.3	5.6	5.8	6.6	8.7	8.3		
23.5	3.7	6.4	7.3	9.6	10.8	11.8	13.5				
9.9	1	1.9	2.9	3.4	5.4	5.6	6.6	8	8.9		

VO2 max 12 (REE)	VO2 max AVERAGE (REE)	VO2 max TOTAL KCALS(REE)	Yoga min 1 (REE)	Yoga min 2 (REE)	Yoga min 3 (REE)	Yoga min 4 (REE)	Yoga min 5 (REE)	Yoga min 6 (REE)	Yoga min 7(REE)	Yoga min 8 (REE)	Yoga min 9 (REE)
	4.442857	31.1	1.3	1.6	1.6	0.8	1.3	1.2	1.5	1.9	1.5
	5.742857	40.2	1.2	1.2	2	1.1	2.2	2.4	3.7	3.9	3.9
	4.428571	31	1	1.1	1.2	1	1.3	1.2	2	2.8	3.1
	7.366667	66.3	1.9	1.6	1.8	1.4	2.4	3.5	4.5	5.3	4.9
	5.616667	33.7	1.5	1.6	1.7	1.3	2.3	3.6	5	5.2	5.1
	5.328571	37.3	1.9	1.7	1.8	1.3	2.4	3	4.1	4.1	4.1
13.7	8.325	99.9	1	1.2	1.3	1.2	2.1	3.1	4.8	4.2	4.8
	6	54	1.1	1	1.3	0.7	1.9	2	3.1	3.3	3.3
	6.3625	50.9	0.8	0.8	1.2	1.2	1.7	2.8	3.8	4.4	4.2
	5.771429	40.4	1	1	1.1	0.9	1.4	1.6	2.9	3.1	3
	5.142857	36	0.5	0.5	1.2	0.8	1	1.7	2.9	3.6	3.1
	4.233333	38.1	1	0.8	1.3	0.9	1.4	1.7	2.4	2.8	2.7
	5.971429	41.8	1.8	1.7	2	1.5	2.2	2.6	3.5	4	3.5
	6.84	34.2	1.5	1.3	1.9	1.5	2.9	3.8	5.2	5.3	5.5
	5.45	32.7	1.4	1	2.3	1.4	2.1	3.5	5	5.6	4.7
	8.02	80.2	1.8	1.3	1.2	1.1	2	2.7	3.2	3.9	3.5
	5.257143	36.8	0.7	1	1.2	1	1.2	1.4	2.3	2	1.7
	6.1	36.6	1.5	1.5	2.2	2.3	2.1	3.5	4.7	4.7	5.5
	4.657143	32.6	1.3	1	1.3	1	1.5	1.9	2.3	3	2.7
	6.3	63	0.8	0.9	1.4	1.2	2.1	1.4	3.1	3.1	2.8
	4.5	31.5	1.1	0.8	1.7	0.8	1.3	1.7	2.5	2.8	2.3
	5.833333	52.5	1.5	1.3	1.7	1	1.5	2	2.8	3.1	3
	7.225	57.8	1.2	1	2	1.2	2.5	3.3	5.4	4.9	4.8
	5.166667	46.5	1.7	1.6	1.5	1	2.3	2.7	3.7	4	3.8
	9.014286	63.1	2.1	1.6	1.6	1.5	2.6	3.9	5	5.8	5
	4.855556	43.7	1.1	1.1	1.7	1.4	2.3	2.5	4.1	4.3	4.4

Yoga min 10(REE)	Yoga min 11(REE)	Yoga min 12(REE)	Yoga min 13(REE)	Yoga min 14 (REE)	Yoga min 15 (REE)	Yoga min 16 (REE)	Yoga min 17 (REE)	Yoga min 18 (REE)	Yoga min 19 (REE)	Yoga min 20 (REE)	Yoga min 21 (REE)
1.7	1.1	1.3	2.5	1.3	1.8	2.2	1.7	2.3	1.6	1.9	2.7
4.4	3.2	3.1	3.1	3.2	2.8	2.9	2.8	2.5	2.2	3.2	2.3
2.6	2.2	2.2	2	1.9	1.9	2.7	1.7	1.7	1.2	2.1	1.8
4.4	3.3	3.2	2.7	2.7	3.1	2.6	2.6	2.8	2.3	3	2.3
4.7	3.7	3.7	3.3	2.9	3.2	2.9	2.6	2.6	2.7	3.6	3.9
4.2	3.1	3.1	2.9	2.1	2.9	2.5	2.5	2.3	2.3	2.6	3
3.8	3.1	3	2.4	3.2	3	2.6	2.1	1.9	2.5	2	1.6
3.4	2.3	2.6	2.2	2.1	2	2.1	1.9	1.6	1.8	2.1	1
3.8	2.7	2.1	2.4	2.1	1.7	2.3	1.9	2	2	2.4	2.1
3.1	1.7	2.2	1.8	1.3	2	2	1.8	2.1	1.2	1.9	1.2
3.5	2.4	2.4	2	2.1	1.8	2	1.8	1.8	1.9	2.3	2.3
2.5	2.2	1.8	1.6	1.8	1.8	1.7	1.5	1.4	1.1	1.7	1.5
3.8	3	2.9	3.1	2.6	3.1	2.9	2.7	2.7	1.8	2.6	2.9
4.9	3.9	3	3.1	3.2	3	2.7	3.2	3.1	3	3.4	3.2
5	3.2	3.4	2.9	2.4	2.9	3	3	3	2.3	2.7	2.7
3.6	2.6	2.4	2.7	2.4	2.5	2.3	2	1.8	1.4	2.5	1.5
2.5	1.6	1.5	1.4	0.9	1.1	1.6	1.7	1.7	0.7	0.8	0.6
4.2	4.4	3.2	3.3	3.1	3.2	2.9	2.6	3.1	3	2.9	3.1
2.6	1.5	2.5	1.4	1.8	1.5	1	2.5	1.3	1.8	1.5	1.9
3	2.3	2	1.6	1.8	1.8	1.7	1.7	1.7	1.2	2	1.6
2.6	1.5	1.9	1.6	1.6	1.8	1.7	1.4	1.5	1.2	1.4	1.3
2.8	2.4	1	2.3	1.8	2.2	1.8	1.8	2.2	2	2.1	2
4.9	4.1	2.9	2.5	2.5	2.3	2.7	2.4	2.4	1.8	2.5	1.9
3.1	3.2	2.8	2.7	2.6	2.3	2.5	2.1	2.3	2.3	2.5	2.3
5.7	4.4	4.5	3.3	2.9	4	3.8	4.1	3.8	1.5	3.7	2.3
4.2	3.3	2.9	2.8	2.6	3	2.8	2.4	2.1	2	2.6	2.3

Yoga min 22(REE)	Yoga min 23 (REE)	Yoga min 24 (REE)	Yoga min 25 (REE)	Yoga min 26 (REE)	Yoga min 27 (REE)	Yoga min 28 (REE)	Yoga min 29 (REE)	Yoga min 30 (REE)	Yoga (REE) average	Yoga Total KcALS
2.5	2.2	1.2	2	1.8	1.8	1.8	1.8	1.2	1.703333	51.1
2.7	2.5	2.4	1.9	2.5	2.1	1.6	2.1	1.6	2.556667	76.7
2.2	2.1	1.8	1.8	1.9	1.7	1.6	1.3	1.3	1.813333	54.4
2.9	2.4	2.3	2.5	2.1	2.6	2.2	3	1.3	2.786667	83.6
4	3.6	3	2.5	2.4	2.4	2.1	1.6	1.4	3.003333	90.1
3.2	3.2	3.1	2.7	3	2.3	2.5	2.1	1.9	2.73	81.9
1.3	1.4	3	2.3	0.7	2.5	2.1	1.9	0.8	2.363333	70.9
2	1.9	1.3	1.5	1.4	1.6	1.3	1.5	1.2	1.883333	56.5
2.5	2.5	2.1	1.7	2	1.7	1.7	1.3	1	2.163333	64.9
1.6	1.1	1.5	1.3	1.7	1.1	1.2	1.6	1.2	1.686667	50.6
2.4	1.9	2	1.5	1.5	1.7	1.1	1.1	1	1.86	55.8
1.7	1.3	1.5	1.7	1.4	1.6	1.9	1.5	1.1	1.643333	49.3
2.5	2.7	2.1	2.2	2.5	2	2	1.8	1.4	2.536667	76.1
3.8	3	2.7	2.4	2.4	2.2	1.9	1.8	1.5	3.01	90.3
2.4	2.1	2.1	2.6	2.4	2.3	2	1.8	1.1	2.743333	82.3
2	1.4	1.5	1.6	1.7	1.9	1.4	1.4	1	2.076667	62.3
0.3	0.4	1.4	1.4	1.4	1.2	1.4	1.1	1.1	1.276667	38.3
2.6	2.6	2.5	2.2	2.5	2.4	2.3	1.4	1.5	2.9	87
1.3	2.3	1.6	0.8	1.7	1.5	1.1	1.8	1.2	1.686667	50.6
1.4	1	1.4	1.7	1.6	1.5	1.3	0.9	0.8	1.693333	50.8
1.2	1.1	1.4	1.4	1.1	0.8	0.9	0.7	0.4	1.45	43.5
1.7	1.5	1.2	1.7	1.4	1.4	1.5	1.4	1.1	1.84	55.2
2.1	1.9	2.1	2.3	2.7	2.4	1.3	1.8	1.4	2.573333	77.2
3.2	2.4	2	2.3	2.3	2.4	2.1	1.9	1.7	2.443333	73.3
2.7	2.8	3.3	3.7	3.3	3.4	2.8	3.1	2.1	3.343333	100.3
2.6	2.8	2.3	2.3	2.3	2.1	2.1	1.7	1.4	2.516667	75.5

VITA

I, Carolyn Cook Clay, was born in Austin, Texas, March 8, 1980, to Van and Piper Cook. After graduating from Bastrop High in 1998 I began my college career at Texas Lutheran University. Within two semesters I transferred to Southwest Texas State University (now Texas State University-San Marcos). During my undergraduate studies I became extremely involved in the field of Exercise Physiology by: 1) becoming a certified American College of Sports Medicine Health/Fitness Instructor $_{SM}$, 2) working as a research assistant, and intern, 3) joining professional organizations and attending professional conferences, 4) presenting a poster presentation at state level, and 5) serving as a student officer at both the university and state level.

After receiving my bachelor's in Exercise and Sports Science I immediately continued into my graduate work. I became a graduate teaching assistant for the Health, Physical Education, and Recreation Department, and co-developed Total Fitness, a wellness program for the faculty and staff of Texas State University-San Marcos. I will continue working at Texas State University-San Marcos as wellness coordinator for the university and surrounding area.

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This thesis was typed by Carolyn Cook Clay.