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IDENTIFICATION OF THE PRACTICES, PREFERENCES, KNOWLEDGE,
ATTITUDES AND BARRIERS TO STRENGTH TRAINING
PARTICIPATION OF YOUNG COLLEGE
AGED WOMEN

Brianna Ackerman

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INTRODUCTION: The American College of Sports Medicine (ACSM) and United States Department of Health and Human Services classify muscular fitness as a key component of health (13,20). While important for both men and women, women can benefit from resistance training, specifically strength training, in many ways. Muscular strength gains, increases and maintenance of lean body mass such as muscle and bone and possible fat loss are some benefits that women who regularly participate in resistance training can achieve (4,5,6,9,18).

PURPOSE: The purpose of this study was to identify the practices, preferences, knowledge, attitudes and barriers to strength training participation in young, college aged female students.

METHODS: All students received a University wide survey constructed using online survey software, SelectSurvey. Two hundred and three women responded to the survey.

RESULTS: Sixty-one percent (n=150) of females reported that they met the American College of Sports Medicine's guidelines for physical activity (exercising 3-5 days per

week for 20-60minutes per session) and 51.1% (n=58) reported participating in some form of resistance training 2-3 days per week. Women chose to use specialized equipment such as medicine balls, kettlebells, body bars and resistance bands over any other mode of resistance training. Over half the women, 55.1% (n=86) reported that using lighter weights and high repetitions elicited the best body toning results. Respondents reported a strong knowledge base of resistance training and its physiological benefits and 65.1% (n=94) reported that they enjoy resistance training. Forty-one percent of women reported feelings of discomfort when in the weight room primarily due to the presence of men training at the same time. Despite the strong knowledge base and the general positive feelings about resistance training women are still participating at rates far less than men. Sixty-seven percent (n=97) of females reported that they would be more likely to participate in resistance training if the Student Fitness Center had a women's only weight room and 60.6% (n=86) said they would be more inclined to participate if the Student Fitness Center offered more instructional resistance training classes. Sixty-five percent (n=91) of women felt that they would benefit from an introductory resistance training course hosted by the fitness center and would be more likely to continue with resistance training after finishing the course.

CONCLUSIONS: Women possess knowledge about resistance training yet their knowledge tends to be misguided. Despite having knowledge in regards to resistance training women are failing to translate that knowledge into behavior. Thirdly, women find the predominantly male weight room an inhospitable environment to venture in to. Efforts must be made to find plausible female accommodations within facilities to

promote female strength training. Efforts should be made to encourage women to strength train to set them up for a lifetime of health and independence.

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ATTITUDES AND BARRIERS TO STRENGTH TRAINING
PARTICIPATION OF YOUNG COLLEGE
AGED WOMEN

BRIANNA ACKERMAN

A Thesis Submitted in Partial
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for the Degree of

MASTER OF SCIENCE

School of Kinesiology and Recreation

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2015

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CHAPTER I

INTRODUCTION

Muscular strength along with muscular endurance, cardiorespiratory conditioning, flexibility and body composition make up the five facets of health related physical fitness (13). Muscular strength is the ability of a muscle to exert maximal force. Muscle strength training usually requires loads of $\geq 85\%$ of 1RM and less than 6 repetitions per set. According the National Strength and Conditioning Association (NSCA) resistance training is a specialized method of conditioning that involves the progressive use of resistance to increase one's ability to exert or resist force (3). It is recommended that adults train each major muscle group 2-3 days/week for 2-4 sets of complex resistance exercise such as bench press or squats and allow at least 48 hours between sessions for each muscle group (13). Recommendations lack gender specificity, indicating the importance for both men and women to participate in resistance training.

The health benefits associated with improving muscular fitness are abundant for both men and women. Women can benefit from resistance training, specifically strength training, in many ways. Women who strength train regularly will elicit muscular strength gains, increase and maintain lean body mass such as muscle and bone and may demonstrate fat loss (4,5,6,9,18). Throughout a lifetime regular strength training can help combat the effects of sarcopenia, age related muscle loss, which starts around age 30 and

continues to steadily decline as one ages with rapid acceleration around age 75 (13,18). Possibly the most important physiologic benefit that women can gain from regular strength training throughout their lifetime is increased bone mineral density (BMD) (9,10). Young women who strength train regularly can increase their BMD by applying stress to their muscles. Additionally stress is applied to the bone(s) that the muscle is attached to causing breakdown and rebuilding of the bony matrix, the continual breakdown and rebuilding of the bony matrix results in denser bones. Having denser bones throughout the lifespan helps reduce a woman's risk of fracture as well developing osteoporosis or age related bone loss (9). Accompanying the many physiological benefits of strength training are a number of psychological benefits women can capitalize on. Women can benefit from increased self-esteem, personal well-being, improved body image and overall better self concept and mental health (1,6,7,16,17).

Despite its benefits, women are participating in strength training at rates much less than men. In 2011 the Centers for Disease control reported that only 20.2% of adult women in the U.S were meeting muscle strengthening guidelines (10). Data for the college demographic similarly reports that only 22.2% of college-aged women participate in resistance training. Women ages 18-22, typically college age, demonstrate the largest decline in physical activity among all populations (10). In a recent study utilization rates at a university fitness center were monitored over the course of 21 months. All five areas of the fitness center dedicated to resistance training were monitored over five distinct hours of the day, a morning hour, noon hour, peak facility utilization hour, peak women's utilization hour and an evening hour. In the weight room where strength training equipment is available, women's utilization rates never reached over 5.5% of total

participants. Even at peak women's hours, the total percent of women in the weight room peaked at 4.4%. Women showed the strongest participation over all hours of the day in the section of the gym dedicated to core work where women were relegated to use equipment such as medicine balls, body bars, kettlebells and resistance bands to perform their resistance training. The amount of weight, even at maximum values, of the equipment in the core area does not provide training intensities appropriate for strength training.

Based on the literature, there are numerous physiological and psychological benefits that accompany strength training. Despite the known benefits, trends show that women are consistently participating in strength training at rates far less than men. Recent data show that the youngest demographic of adult women demonstrates the largest rate in decline in physical activity (10) The purpose of this study is to identify the variables that keep women from participating in regular strength training. It is expected that numerous factors will play a role in preventing women from strength training, such as; women lacking the knowledge of the benefits of strength training both physiologically and psychologically, the stigma that strength training should primarily be reserved as a male activity, intimidation of the maleness of the strength training environment and the failure to make strength training a priority.

CHAPTER II

REVIEW OF RELATED LITERATURE

Muscular strength along with muscular endurance, cardiorespiratory conditioning, flexibility and body composition make up the five facets of health related physical fitness. The health benefits associated with improving muscular fitness are abundant for both men and women. Women can benefit from resistance training, specifically strength training, in many ways. Despite the known benefits, trends show that women are consistently participating in strength training at rates far less than men.

Strength Gains

Muscular strength is the ability of a muscle to exert maximal force. Muscle strength training usually requires loads of $\geq 85\%$ of 1RM and less than 6 repetitions per set. According to the National Strength and Conditioning Association (NSCA) resistance training is a specialized method of conditioning that involves the progressive use of resistance to increase one's ability to exert or resist force (3). It is recommended that adults train each major muscle group 2-3 days/week for 2-4 sets of complex resistance exercise such as bench press or squats and allow at least 48 hours between sessions for each muscle group (14). Recommendations are not gender specific indicating the importance of all adults to participate in regular resistance training.

In a study by Jack Wilmore (19) efforts were made to compare strength gains in both men and women simultaneously while following a 10-week strength training program. A total of 47 women and 26 men were enrolled in a 10-week strength training class at the University of California Davis. Classes met twice a week for 40 minutes per session. Both men and women followed the same progressive training protocol, training at intensities that allowed for weights to be lifted 7-9 repetitions. Initial strength values were collected after 4 sessions were completed and final measurements were taken upon completion of the 10-week program. Leg strength was assessed using a leg dynamometer and arm and shoulder strength assessed using the bench press.

Wilmore found significant strength gains in both men and women. Women demonstrated increases in the bench press and leg press by 28.6% and 29.5% relative to lean body mass. When compared to the progress of the men in the study leg strength values were actually higher for women than they were for men relative to their lean body mass. When strength was reported relative to body size and lean mass, gender strength differences are nearly eradicated and women elicit strength values nearly identical to men, which indicates that muscle quality is not gender specific.

A second study by Brown and Wilmore (4) followed the effects of maximal resistance training on the strength and body composition of women athletes over a 6-month period. Seven nationally ranked female track and field throwing athletes took part in the study, 2 athletes withdrew from the strength training aspect of the program. Strength training took place three days per week for 1-1 ½ hours per session allowing for one day of rest in between. Initial strength measurements were taken after the first week of training and were tested on half squat strength and bench press. For the first two

months of the strength training program athletes were asked to train at 6 sets of half squats, leg press and supine bench at loads of 50-80% of their 1-RM. After two months the athletes were asked to perform 5 sets of each exercise at loads of near maximal effort. In addition to strength training, the athletes were also required to participate in a general conditioning program 3-4 days per week for 1 ½ hours per session. The conditioning program lasted for the first 3 months of the program and transitioned into more sport specific drills in the latter 3 months of the program.

Brown and Wilmore's subjects demonstrated substantial gains in strength following the 6-month near maximal training program. The athletes exhibited strength gains in the bench press of 15-44% and improvements of 16-53% in the half squat. The two athletes who did not strength trained showed one no increases in strength while the other showed a 12.5% increase in the half squat possibly high volume of conditioning and drills being done. The strength gains were substantial yet not accompanied by significant muscle hypertrophy. This points to the evidence that muscle quality is similar amongst the sexes but women lack the amount of free testosterone that men naturally produce which allows for greater hypertrophy in men.

Chilibeck et al (5) conducted a study to compare strength and lean muscle mass increases during resistance training in young women. A total of 29 women participated in the study, 19 women followed a strength training program for 20-weeks, training 2 days per week, performing complex exercises at intensities of 70-90% 1-RM, the remaining 10 women served as the control group and did not take part in any strength training. Strength and body compositional measurements were taken at week 0, 10 and 20 by means of 1-RM testing and DEXA screening.

Chilibeck et al.'s strength training group elicited significant strength gains across the entire 20-week training program. The most substantial strength changes were achieved in the first 10 weeks of the training program, which may be attributed to neural adaptations early on in the program, however strength continued to improve from mid program measurements to the final program measurements pointing towards actual gains in strength (5).

Females in all three studies showed substantial increases in strength, even following programs as short as 10 weeks. All protocols in the three studies called for intensities that would elicit gains in power and strength, lower repetitions and higher volume of weight lifted. Brown and Wilmore's study suggest that when expressed in relative terms women possess strength almost identical to that of men, emphasizing muscle quality across the genders. Wilmore demonstrates that large increases in strength can be achieved with very little change in body size, which could be a barrier keeping many women from participating in strength training. Chilibeck et al demonstrates the dose response of strength training that gains can continue to be achieved if progressively overloaded and gains can happen within a relatively short amount of time.

Increases and Maintenance of Lean Body Mass

Strength training is an essential component to improving body composition mainly by maintaining and/or increasing lean muscle mass. It is imperative to include strength training when trying to achieve fat loss through aerobic exercise and dietary restriction. Studies by both Chilibeck (5) and Brown and Wilmore (4) not only demonstrate strength gains while following a strength training program but also elicit positive changes in lean body mass.

Chilibeck et al. (5) tracked strength and muscle mass increases over a 20-week strength training program. Strength, measured by 1-RM testing and body compositional changes, measured by DEXA, were measured at week(s) 0, 10 and 20. The lean tissue mass of the arm, trunk, and leg of the dominant side of the body were measured via whole body DEXA scans. Lean mass increased from pre-training to post-training by 9.8% in the arms, 3.2% in the trunk and 3.4% in the legs over the course of 20 weeks. No changes in lean mass occurred in the control group.

Brown and Wilmore (4) gathered similar findings. In his 6-month study following seven nationally ranked female track and field throwers the athletes exhibited significant gains over the course of the strength training program. The athletes strength trained at values 50-80% of 1-RM for the first 3 months of the study and trained at near maximal values for the second 3 months of the study. Wilmore's athletes were simultaneously participating in a general conditioning program 3-4 days per week for 1 ½ hours per session for the first 3 months of the study and transitioned into more sport specific drill work for the second half of the study. Body composition was assessed using hydrostatic weighing at the beginning and end of the 6-month study. Results from the study showed the three subjects that had the highest body weight lost weight almost entirely due to adipose tissue while simultaneously increasing in lean mass of 1.25kg. One strength training subject elicited weight loss but showed no gains in lean body mass due to large caloric restrictions in her diet.

Chilibeck et al.'s (5) Brown and Wilmore's (4) studies show the benefits of regular strength training on increases in lean body mass in two different situations. Brown and Wilmore's subjects were simultaneously participating in a general conditioning program

while participating in the strength training program. Three of the subjects demonstrated fat loss and increased lean body mass. One subject did not elicit any gains in lean mass due to the large caloric restriction in her diet but was able to maintain the lean body mass she already had by strength training. Chilibeck's subjects strictly participated in resistance training for 20 weeks. All subjects showed increases in lean body mass in all three examined areas of the body; arms, trunk and legs. Adding lean body mass to the bodies frame helps one maintain a healthy body compositional profile which reduces the risk of over-fatness and obesity and the risk factors that accompany those ailments.

Negating the Effects of Sarcopenia

Throughout a lifetime regular strength training can help combat the effects of sarcopenia, age related muscle loss, which starts around age 30 and continues to steadily decline as one ages with rapid acceleration around age 75. A study by Tracy et al. (18) compared the effects of strength training in 65-75 year old men and women on muscle quality and volume. Twelve men and eleven women who had been previously sedentary volunteered for the 9-week strength training program. Strength was evaluated by means of a 1-RM knee extension test. Three days per week the subjects took part in 4 sets of heavy unilateral knee extension, weight was set at the individual's 5-RM load. Body composition was measured prior to the start of the program via a Lunar DPXL DEXA. Tracy et al. found that strength training program not only elicited substantial strength gains in both the men and the women but additionally showed significant increases in muscle quality in both the men and women. Total muscle volume was examined after the training program to assess muscle quality. Ideally strength training should be performed throughout the lifetime however, Tracy et al.'s survey demonstrates the effectiveness of

strength training even in sedentary individuals when related to slowing, reversing and even preventing the effects of sarcopenia.

Influence on Bone Mineral Density

Possibly the most important physiologic benefit that women can gain from regular strength training throughout their lifetime is increased bone mineral density (BMD) (9,11). Young women who strength train regularly can increase their BMD by applying stress to their muscles which in turn applies stress to the bone(s) that the muscle is attached to causing breakdown and rebuilding of the bony matrix. The continual breakdown and rebuilding of the bony matrix results in denser bones. Having denser bones throughout the lifespan helps reduce a woman's risk of fracture as well developing osteoporosis or age related bone loss (9). Nindl et al. (11) sought to find regional body compositional changes following a 24-week total body periodized strength training program. Subjects in his study were measured by a DEXA prior to beginning the program. The training program lasted for 24 weeks and muscle strength and endurance training focused on military specific tasks. Training sessions took place 5 days per week for 1 ½ hours per session. Strength training exercises were executed in a circuit like fashion, performing the exercise for 30 seconds followed by 1 ½ minutes of rest before moving on to the next exercise.

Following the 24-week program Nindl et al. was unable to find any change in regional bone mineral content. A similar study conducted by Lohman et al. (9) followed the effects of resistance training on both total body and regional bone mineral density in premenopausal women. Lohman et al.'s study lasted 3 times longer than Nindl et al.'s

study, 18 months, and did find significant increases in regional bone mineral density but not total body bone mineral density.

One hundred and six women took part in Lohman et al.'s study and followed a training regimen that called for 3 strength sessions a week lasting for 1 hour. The women performed 3 sets of 8-12 repetitions of 12 free weight exercises, training intensity was determined around 70% of the subjects 1-RM and increased by 5% every 6 months. Bone mineral density was determined via DEXA, and re-measured at 5 months, 12 months and 18 months. Significant bone mineral density changes in the lumbar spine were apparent at the 5, 12 and 18-month mark. And significant changes were also found in the femur trochanter at the 12 and 18-month mark. Strength training has been shown to have a positive impact on bone mineral density, however consistency is a major factor in eliciting these changes.

CHAPTER III
METHODOLOGY

Participants

Two hundred and three females from a large university participated in the study. The minimum age requirement was 18, the onset of adulthood, maximum age requirement was cut off at 32 due to the possibility that any student above age 32 could potentially differ physiologically, socially and motivationally than the younger students within this age range.

Survey

The participants were recruited for this study via email sent by way of the university's listserv with a link to the survey. Two weeks following the initial survey a reminder email was sent out asking students to fill out the survey if they had not done so already. The survey was closed one week after the reminder email was distributed. Approved by the University Institutional Review Board, the multi-section survey was constructed using online survey software, Select Survey. All participation was voluntary, students were asked to answer each question honestly and to the best of their ability. Questions were arranged in Likert scale {(Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree) or (Never, Some of the Time, Most of the Time, Every Time, Do Not

Know)), True/False or Yes/No fashion with one opened ended question at the conclusion of the survey.

Demographics

The first section of the survey included demographic information about the respondents such as age, race/ethnicity, year in school, major, and whether or not the participant was currently or had previously played on either a collegiate or high school sports team (which could affect the respondent's exposure to resistance training presently or in past years). Demographic information can be found in Table 1.

Physical Activity Practices

Questions in this section were geared towards identifying general activity levels of the respondents and which activities they typically engaged in. Activity levels were based on recommendations set forth by the U.S Department of Health and Human Services 2008 Guidelines for moderate to vigorous activity for at least 10 minutes per bout and current ACSM guidelines of activity 2-3 times per week. Cardio/aerobic exercise, resistance training and group class participation were the examined activities.

Strength Training Practices

All respondents who indicated participation in resistance training in the Physical Activity Practices section were prompted to answer questions relating to their strength training practices within a typical week. Questions were aimed at identifying the types of equipment used, muscle groups trained and respondents' resistance training preferences. Respondents that indicated regular participation in resistance training were required to answer additional questions in a subset category labeled Strength Training Preferences.

Strength Training Knowledge

In an effort to better assess the general student bodies' knowledge about strength training all respondents were asked to answer general questions about strength training and the effect it has on the human body. Answers were arranged in True, False or I Don't Know fashion.

Attitudes To Strength Training

All respondents to the survey were asked to complete this section regarding their personal attitudes to strength training.

Barriers to Strength Training

All respondents were asked to complete the section regarding barriers to strength training and whether or not the question was a barrier for them.

Factors That Would Help Increase Strength Training at the Student Fitness Center

Respondents were asked to identify what factors would help increase their participation in strength training at the Student Fitness Center.

CHAPTER IV
RESULTS AND DISCUSSION

Results

Two hundred and three participants took part in the study. Twenty-four percent (n=48) of participants identified themselves as Seniors followed by Freshmen at 23.6% (n=47). This sample strongly represented women who are both at the end of their undergraduate college years and those who are just beginning. Fifty-four (n=109) percent of the women had or are currently participating in some sort of athletic sport.

Demographic information is represented in Table 1.

Prochaska's Transtheoretical Model of Change (14) was used to help identify participants' motivation in regards to regular physical activity (regular physical activity is as outlined by the CDC-ACSM physical activity recommendations and U.S Department of Health and Human Services 2008) (10,13,20) results can be found in Table 2. Fifty-four percent (N=114, n=61) of the women reported participating in cardio/aerobic exercise 3-5 days per week as recommended by ACSM and 10.5% (n=12) reported participating every day of the week. Fifty-one percent (n=58) of women reported participating in resistance training exercise and 18.3% (n=27) reported participating in group classes 3-5 days per week as outlined by CDC-ACSM recommendations.

Fifty-one percent (N=113, n=58) of women identified themselves as regularly participating in resistance training (16,23). The type of equipment the women used in a typical session was identified by a Likert scale rating how often women trained with five different modalities, results found in Table 3. Women reported focusing primarily on training the calves and gluteals every time they trained at 13.3% and 18.8% respectively, and 56.3% and 43.7% admitted to training their arms (biceps, triceps) and core most of the time when they resistance trained. Fifty-six percent of women indicated that they only train areas of the body they perceive as problem areas instead of training all areas of the body regularly.

Of the 161 women that responded to the Strength Training Preferences portion of the survey only 39.8% (n=64) of women resistance train with muscular strength in mind and only 47.2% prefer to train adopting a high weight-low repetition training plan. Sixty-four percent (n=104) of women did not prefer to incorporate Olympic lifts like Power Cleans or Snatches into their training plan.

In efforts to have a “toned” body, 55.1% (n=86) of the 156 women who responded to the Strength Training knowledge portion of the survey agreed that using lighter weights and high repetitions was the best training plan to achieve toned results. Yet, 70.5% (n=110) of women disagreed that lifting heavy weights would cause a woman to bulk up much like a man. Forty-eight percent (n=75) of women believed in spot reduction, that exercising a certain muscle would decrease the amount of fat surrounding that muscle and provided relatively similar responses in regards to if strength training is the best way to lose fat with 37.2% (n=58) answering true. However 91.7% (n=144)

agreed that regular strength training helps individuals to maintain a healthy body composition profile and 71% (n=111) agreed regular participation improves bone health.

Only 24.4% (n=36) of the 149 women who answered the Attitudes to Strength Training portion of the survey found strength training itself to be intimidating. Sixty-five percent (n=94) of women in this study reported they enjoyed strength training and feel a sense of accomplishment (78.2% (n=115)) when they participate in strength training. Seventy-nine percent (n=117) agreed that strength training is an important component of weight loss and management. However, only 22.4% (n=33) of women indicated they choose to strength train over any other mode of exercise.

Of the 141 women who answered the Barriers to Strength Training portion of the survey 41.2% (n=58) of women reported feeling uncomfortable in the weight room environment due to the behavior of their male peers. Thirty-one percent (n=44) of women felt they did not know what exercises to perform when strength training and time constraint was a barrier for 38.1% (n=54) of women.

Sixty-seven percent (N=143, n=97) of women indicated they would be more likely to participate in strength training if the student fitness center had a women's-only weight room and 65% (n=91) would like to see an introductory strength training basics course for beginners. Sixty percent of women (n=86) would like to see more strength training group classes offered when asked what factors would help increase female strength training on campus.

Discussion

The results from this study demonstrate that the lack of women's participation in strength training is driven by many variables. Overall the participants in this study

possessed a basic general knowledge base about the numerous health benefits of regular resistance training, but lacked specific knowledge of the benefits of regular strength training.

Over 90% of women in this study agreed that regular strength training makes an individual stronger, helps that individual maintain a healthy body composition profile and is a key component contributing to overall health. Confusion starts to arise when comparing fat loss and caloric expenditure with that of aerobic exercise. Thirty-seven percent of women in this study believe that strength training is the best way to lose fat and 31.2% of women believe that strength training burns more calories than aerobic exercise. This demonstrates that 1/3 of women in this study choose to perform strength training exercise over any other mode of exercise in efforts to lose fat. While strength training is an important factor for improving body composition it is actually the combination of dietary restriction and aerobic exercise that results in fat loss. Strength training is an essential component to improving body composition mainly by maintaining and/or increasing lean muscle mass and by improving bone density.

In a study by Brown and Wilmore (4), body compositional changes of female throwing athletes were monitored over 6 months. The athletes participated in not only a maximal strength training program but also in a general aerobic conditioning program 3 to 4 days per week for the first 3 months of the study. The study included both strength trainers and non-strength trainers and all subjects participated in the general conditioning program. After the first 3 months of training the subjects that had the highest body weight elicited weight loss entirely due to loss of adipose tissue and simultaneous gains in lean tissue. The strength training subjects all demonstrated increases in lean body mass over

the first 3 months and the non-strength trainers demonstrated losses in lean body mass. One subject elicited weight loss but showed no gains in lean body mass due to large caloric restrictions in her diet. Brown and Wilmore's study shows that fat loss can be achieved through aerobic exercise and diet restriction however this combination alone can lead to decreases in lean body mass. Strength training is necessary to maintain lean body mass that the female already has and ultimately increase lean body mass when combined with aerobic training and dietary restriction. It is important for women to realize that while strength training is an important contributor to attaining ideal body composition it is only with aerobic exercise and caloric restriction that the greatest changes can be attained.

In addition to improving lean body mass by gaining muscle, strength training is also the best way to build stronger, denser bones. Women are at much greater risk of Osteoporosis, age related bone loss, due to the cessation of estrogen production upon the onset of menopause. Strength training serves as the vehicle by which increased bone mineral density and bone content occur (13). Muscles targeted by strength training provide specific stress to the bones in which the muscles are attached, promoting more rapid breakdown and rebuilding of the bony matrix, resulting in stronger, denser bones. Strength training has been shown to prevent, slow down and even reverse the effects of age related bone loss (13). The positive effects that strength training has on bone density require a significant amount of time to take effect. In studies by Nindl et al (11) and Lohman et al (9), even after 18 months of regular strength training total body increases in bone mineral density were yet to be seen. However, small, but significant regional changes were seen by Lohman et al (9). in the lumbar spine after 5 months of regular

strength training and in the femur trochanter after 12 months of regular strength training. Efforts should be made by females early on in the lifespan to participate regularly in strength training to maximize their bone building benefits which can carry over to later in life.

Women should be participating in heavy strength training activities regularly if they wish to see significant changes in their body composition, particularly in regards to bone and muscle mass. Of the 113 women that identified themselves as participating in resistance training regularly, 80% (n=90) strength trained with the goal of reaching a desired body composition. However, 55% of the 156 women who answered the strength training knowledge section of the survey agreed that lifting lighter weights for a higher amount of repetitions was the best way to achieve a “toned” body, or in other words a desired body composition. This demonstrates confusion about exactly what type of resistance training is best for enhancing body composition. Additionally, only 39.8% (n=64) of the same women preferred to train for muscular strength and 64.6% of these women preferred not to use complex, multi-joint movements such as those included in Olympic lifts like the power clean and snatch as recommended by ACSM. The anabolic hormones secreted by strength training not only effects lipolysis and glucose utilization but also effects hormone receptor sensitivity to the anabolic hormones making the receptors more sensitive and ready to accept those hormones specified for muscle growth. Muscular hypertrophy, or muscular growth, is a result from strength training pointing directly to increases in muscle cross sectional area. Strength and muscle cross-sectional area are positively related.

In a study by Jack Wilmore (19) strength gains in both men and women were examined following a 10-week strength training program. Wilmore found that strength gains in women in the bench press and leg press increased by 28.6% and 29.5% relative to lean body mass. When compared to the progress of the men in the study leg strength values were actually higher for women than they were for men relative to their lean body mass and many studies have reported that strength values between men and women are nearly identical when expressed in relation to cross sectional area. This study is interesting due to the fact that when strength is reported relative to body size and lean mass, gender strength differences are nearly eradicated, which indicates that muscle quality is not gender specific. When strength between men and women is reported in absolute terms, women tend to possess strength values that are about 2/3 that of men's strength. It is important for women to understand the difference between strength in relative and absolute terms, for when strength is reported in relative terms women elicit strength values nearly identical to men demonstrating that women can reap all of the same physiological benefits of strength training that men can.

Men typically strength train following programs that allow for gains in hypertrophy, power and strength, at minimum, lifting loads $\geq 67\%$ of max at 8 repetitions or less, and at some recommendations $> 85\%$ of max (3). Men generally have a larger body size than women, and large natural hypertrophic gains can be seen when following programs that allow for hypertrophy due to the large amount of free testosterone that men produce. One of the anticipated barriers to strength training for women was that women would abstain from strength training in fear of losing their femininity, or bulking up when following a regular strength training program. While some muscular hypertrophy is

attainable for female strength trainers, gains near values of that of men are impossible for most women to achieve naturally. Women lack the amount of free testosterone in their bodies that men naturally produce in larger quantities. Therefore women can see substantial gains in strength, and increases in lean mass without acquiring large amounts of bulk, maintaining their natural feminine physique.

When asked if lifting heavy weights would cause women to bulk up, 70.1% of women reported that they did not believe they would become bulky like a male when strength training. This response was somewhat surprising. The high response could have been due to one of the restrictions of this study, selection bias. Women who identify themselves as regular strength trainers or take an interest in strength training would be more likely to respond to the survey than women who do not participate in strength training. Women who participate in strength training already have positive feelings about the activity and are more likely to be better informed than their non-strength training counterparts. Participants in this study apparently feel more positive towards strength training than the overall female population. According to the CDC (10), only 20.2% of all women in the United States were meeting muscle strengthening guidelines in 2011. Only 22.2% of college aged women were meeting the guidelines, compared to the 51% of women in the current study that reported regularly meeting the muscle strengthening guidelines. The women in the current study are a select group of women who consider strength training of greater importance compared to the national average. Due to the variation between the current study's participants and average women, results may not be representative of all women's values towards strength training.

Findings in an observational study by Shari Dworkin (7) support this notion. Dworkin observed what type of exercises women typically chose to participate in, aerobic or strength training at two gyms, one elite gym and one moderately priced gym in Los Angeles for two years. Upon observing their behavior she interviewed the women and asked why they chose a particular mode of exercise over the other. Around 75% of the women that Dworkin interviewed expressed shying away from weight training due to the fear of social repulsion of becoming too bulky, and fear becoming bulky in general, these fears were expressed by both non-lifters and moderate lifters. Dworkin went on to explain the social stigma of how women “should” look and that the women felt aerobic exercise contributed greatly to attaining the ideal feminine physique, much more so than strength training would. Dworkin also pointed out the women’s confusion between what the women *thought* their bodies would do (bulk up) in response to resistance training and what their bodies *biologically* would do (increase in lean mass, but not elicit gains similar to males).

A common barrier to exercise in general is the fact that people do not make physical activity a priority and strength training is no exception to this. Thirty-eight percent of women in this study reported they find it hard to make time to strength train meaning over 1/3 of women choose to participate in muscular endurance or aerobic type activities if they choose to be physically active at all, which is not surprising. It is important for women to realize that due to the amount of physiological stress that heavy strength training applies to the body a large amount of repetitions are not needed to elicit results. A lower volume of repetitions and higher volume of weight lifted could mean less time spent doing the activity depending on rest periods between each set. More work can

be done performing heavy strength exercises than can be accomplished by participating in muscular endurance and aerobic exercise done for the same amount of time.

In addition to the many physiological benefits of strength training, psychological benefits were also noted as a result of strength training. Sixty-five percent of respondents reported they enjoyed strength training and 78.2% reported feeling a sense of accomplishment after strength training. Sixty-four percent of women reported feeling more confident when they follow a strength training program. While this may be an effect of the selection bias of this study, in a study by Ahmed et al. (1), similar attitudes were expressed by females after strength training. Ahmed et al. issued a questionnaire to 49 women after they completed 12-weeks of strength training classes. The questionnaire focused on the effects of strength training on the women's overall health and fitness, body image and attitude towards physical change. Responses to Ahmed et al.'s findings were very positive, 97.5% of women reported feeling more fit and healthier than before they started the classes. Fifty-one percent of women reported improvement in their perception of their body image and 85.3% reported an improved attitude towards their physical self after the classes and reported increased feelings of happiness and confidence. These findings are especially important when dealing with a society that is so quick to turn to medicine to alleviate psychological distress. Relief for rampant disorders such as anxiety, depression and low self-image/worth could be possible through other natural ways such as strength training.

The largest barrier to strength training for women in this study was feelings of discomfort while in the weight room. This supports the hypothesis that women shy away from resistance training because they are intimidated, not by the activity itself, but by the

environment that is available. The open-ended question at the end of the survey further validated this hypothesis with many women voicing that they felt sexualized and viewed and/or treated condescendingly by their male peers when trying to navigate through the weight room. The uncomfortable environment generated by their male peers keeps them from trying to exercise in the weight room where primarily all of the larger sized weights and lifting platforms suitable for heavy strength training are located.

Similar findings were uncovered by Salvatore and Marecek (16) when evaluating barriers for women's weight lifting. Forty-four percent Salvatore and Marecek's subjects voiced concerns of feeling watched, scrutinized, judged and evaluated by their male peers on their bodily appearance and competence while in the weight room. Many of the women in the current study echo the feelings of the women in Salvatore and Marecek's study and feel the weight room is an uninviting environment for a female. To quote one subject, "It is very difficult for a woman to feel comfortable in a weight room with all men. It would be nice not to feel like I am being undressed with someone's eyes while I am trying to lift". Another subject reported receiving negative feedback in other ways, reporting, "As a female, I feel uncomfortable strength training around men and have received condescending comments while strength training at the gym".

These feelings of being unwelcome in the weight room and feeling sexualized while trying to strength train could have an effect on the type of resistance training that women decide to do. As previously mentioned, 55.1% of the women in this study choose to employ lighter weights and higher repetitions when they resistance train, this could be because the heaviest weights and lifting platforms are all located within the male dominated weight room. Women feel so uncomfortable going into the weight room they

avoid the area altogether leaving them with sections of the gym that have lighter weights and more specialized equipment such as medicine balls, body bars and resistance bands which cannot provide intensities appropriate for strength training.

The feedback women provided on several possible interventions that would make them more likely to participate in strength training clearly outlined the desire for a more welcoming environment. Sixty-seven percent of women said they would be more likely to participate in strength training if there were a women's only weight room available for them away from the male dominated weight room. Such an area would provide a safe environment in which women could be among other women and not feel ostracized by their male counterparts. Women also voiced the desire for the addition of several strength training classes to the student fitness center's group class line up. Many of the group fitness classes offered by campus recreation tend to have a higher female population, which could provide a more female friendly environment. Females also responded that having more resources available to them for assistance in the weight room would be a motivating factor. Resources such as a comprehensive introductory class to show women different exercises, how to perform them safely and modify them in different areas of the gym if the weight room is excessively crowded, and provide information on why resistance training is important and how it benefits their body and lifestyle.

CHAPTER V

CONCLUSION

Conclusions from this study are threefold. First, women possess knowledge about resistance training yet their knowledge tends to be misguided. Although benefitting more than an individual who does not resistance train, the 51.1% of women from this study that meet ACSM guidelines for resistance training are still not practicing the most beneficial form of resistance training; lifting heavy weights. Further effort must be made to inform women of the numerous physiological and psychological benefits that can be attained from strength training such as firmer muscles, better muscular definition and improved self-image. Secondly, despite having knowledge in regards to resistance training women are failing to translate that knowledge into behavior. Women are failing to make strength training a priority within their physical activity routine, a crucial element for the maintenance of lean body mass, especially if the women primarily train aerobically. Thirdly, women find the predominantly male weight room an inhospitable environment to venture in to. Efforts must be made to find plausible female accommodations within facilities to promote female strength training. The benefits that women are missing out on from not strength training not only hurt the individual but can have societal effects as well. Interventions made within the university setting would be a great place to start. College age women show the greatest decline in physical activity practices and are at a

crucial age to start establishing life-long habits. Efforts should be made to encourage women to strength train to set them up for a lifetime of health and independence.

Table 1. Subject Demographics

Demographics	Frequency (n)	Percentage
Age		
18-22	160	78.8%
23-27	35	17.3%
28-32	8	3.9%
Year in School		
Freshman	47	23.6%
Sophomore	25	12.6%
Junior	39	19.6%
Senior	48	24.1%
Masters	31	15.6%
Doctoral	9	4.5%

Table 2. Prochaska's Transtheoretical Model of Change

Stage of Change	Frequency (n)	Percentage
Yes, > 6 months	85	42.3%
Yes, < 6 months	37	18.4%
No, intend to start in next 30 days	41	20.2%
No, intend to start in next 6 months	28	13.9%
No, do not intend to start	10	5%

Table 3. Subject Equipment Preferences

Equipment Used	Never	Some of the Time	Most of the Time	Every Time
Free Weights	53.3%	40%	6.7%	0%
Weight Machines	31.3%	31.3%	25%	12.4%
Specialized Equipment (resistance bands, body bars, medicine balls, kettle bells)	37.4%	31.3%	31.3%	0%
Body Weight Exercises	43.8%	18.7%	25%	12.5%
Group Resistance Training Classes	31.3%	37.4%	31.3%	0%

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APPENDIX
SURVEY QUESTIONNAIRE

Supplemental Document