



Western Washington University
Western CEDAR

WWU Graduate School Collection

WWU Graduate and Undergraduate Scholarship

Spring 2015

Hardiness: An examination of psychological characteristics of participating in high intensity interval training

Matthew Vezzani

Western Washington University, vezzanm@students.wvu.edu

Follow this and additional works at: <https://cedar.wvu.edu/wwuet>



Part of the [Kinesiology Commons](#)

Recommended Citation

Vezzani, Matthew, "Hardiness: An examination of psychological characteristics of participating in high intensity interval training" (2015). *WWU Graduate School Collection*. 403.

<https://cedar.wvu.edu/wwuet/403>

This Masters Thesis is brought to you for free and open access by the WWU Graduate and Undergraduate Scholarship at Western CEDAR. It has been accepted for inclusion in WWU Graduate School Collection by an authorized administrator of Western CEDAR. For more information, please contact westerncedar@wvu.edu.

Hardiness: An examination of psychological characteristics of participating in high intensity interval training

By
Matthew Vezzani

Accepted in Partial Completion
of the Requirements for the Degree
Master of Science

Kathleen L. Kitto, Dean of Graduate School

Advisor Committee

Chair, Dr. Linda Keeler

Dr. Dave Suprak

Lori deKubber

Master's Thesis

In presenting this thesis in partial fulfillment of the requirements for a master's degree at Western Washington University, I grant to Western Washington University the non-exclusive royalty-free right to archive, reproduce, distribute, and display the thesis in any and all forms, including electronic format, via any digital library mechanisms maintained by WWU.

I represent and warrant this is my original work, and does not infringe or violate any rights of others. I warrant that I have obtained written permission from the owner of any third party copyrighted materials included in these files.

I acknowledge that I retain ownership rights to the copyright of this work, including but not limited to the right to use all or part of this work in future works, such as articles or books. Library users are granted for individual, research and non-commercial reproduction of this work for educational purposes only. Any further digital posting of this document requires specific permission from the author.

Any copying or publication of this thesis for commercial purposes, or for financial gain, is not allowed without my written permission.

Signature: Matthew Vezzani

Date: 04/05/2015

Hardiness: An examination of psychological characteristics of participating in high intensity interval training

A Thesis
Presented to
The Faculty of
Western Washington University

In Partial Fulfillment
Of the Requirement for the Degree
Master of Science

By
Matthew Vezzani
April, 2015

Abstract

CrossFit, a form of high intensity interval training (HIIT), has grown in popularity (Thompson, 2013). Some physiological benefits of CrossFit have been documented (O'Hara et al., 2013), yet psychological effects have not been investigated. Hardiness has been linked to the performance of elite athletes (Sheard, 2009). Hardy individuals tend to have a strong sense of commitment, control and challenge (Kobasa, 1979) that enables athletes to create opportunities from stressful situations (Maddi, 2006). The CrossFit training style ("What is Fitness?", 2002) may promote the development of commitment, control and challenge. The purpose of the study was to see if CrossFit training affected individual scores of hardiness, and if the scores differed from a second type of HIIT program. The study included novice CrossFit and boot camp participants. Thirty participants completed both the pre and post-assessments. The Personal Views Survey III-R (Maddi et al., 2006) was used to produce hardiness levels before and two months after their initial training session. A mixed between-within subjects ANOVA revealed no statistically significant interaction effect between group and time, Wilks' Lambda = .96, $F(1, 28) = 1.04$, $p = .05$, $\eta_p^2 = .04$. Further, there was no statistically significant main effect for time, $F(1, 28) = .507$, $p = .05$, with a small effect size ($\eta_p^2 = .02$) nor group, $F(1, 28) = 1.042$, $p = .05$, with a small effect size ($\eta_p^2 = .04$). Qualitative results indicated that some participants noticed various mental changes over the course of the study suggesting that for some, cognitions were affected by HIIT. While hardiness may have not been affected by HIIT, other psychological constructs may have. Further research examining the effects of HIIT training should look at other psychological constructs such as coping styles.

Acknowledgements

I would like to express my deepest appreciation to all of my professors at Western Washington University, and specifically to my thesis committee for their time, advice and patience throughout the duration of this project. Thank you Dr. Keeler for guiding me through the past two years of my life and sharing your wisdom, time and devotion. Without your guidance I would not be the person I am today. Thanks to Dr. Dave Suprak and Lori deKubber for dedicating their time and expertise to my research and helping me throughout the writing and research process. I would like to acknowledge Alex, Brook and Piper, who were the best group of friends to have on this journey we call graduate school. My time with you three will forever be remembered as I reflect back on these two years. I would also like to acknowledge my family, friends and my girlfriend Nora, who provided constant support and understanding over the past two years. It has been a fulfilling and deeply profound period in my life that will provide a sturdy foundation for my future endeavors. Thank you to all who played a part in this incredible journey.

TABLE OF CONTENTS

Abstract.....	iv
Acknowledgements.....	v
List of Tables.....	viii
List of Appendices.....	ix
CHAPTER I	THE PROBLEM AND ITS SCOPE
Introduction.....	1
Purpose of the Study.....	2
Hypothesis.....	3
Significance of the Study.....	3
Limitations of the Study.....	4
Definition of Terms.....	4
CHAPTER II	REVIEW OF LITERATURE
Introduction.....	6
High Intensity Interval Training.....	6
CrossFit Training.....	8
Boot camp exercise classes.....	16
High intensity interval training (HIIT) and psychological measures.....	17
Hardiness.....	20
Hardiness in Sport.....	31
Hardiness and HIIT.....	35
CrossFit and hardiness.....	36

CHAPTER III	METHODS AND PROCEDURES	
	Introduction.....	40
	Description of Study Population.....	40
	Design of the Study.....	41
	Data Collection Procedures.....	41
	Data Analysis.....	44
CHAPTER IV	RESULTS AND DISCUSSION	
	Results.....	45
	Discussion.....	47
CHAPTER V	Summary, Conclusion, and Recommendations	
	Summary.....	57
	Conclusion.....	57
	Recommendations.....	58
	Bibliography.....	62
	Appendices.....	73

LIST OF TABLES

Table 1. Means and Standard Deviations for Total Hardiness Scores in Pre and Post Assessments for CrossFit and Boot Camp Groups.....	46
Table 2. Means and Standard Deviations for Hardiness Subscale Scores in Pre and Post Assessments for Both CrossFit and Boot Camp Groups.....	47

LIST OF APPENDICES

Appendix A. Personal Views Survey III-R.....	73
Appendix B. Qualitative Questions.....	75
Appendix C. Demographics Questions.....	76
Appendix D. Boot camp survey qualifying questions.....	77

Chapter I

The Problem and Its Scope

Introduction

Hardy individuals are believed to have a strong sense of commitment, control and challenge (Kobasa, 1979) that results in an existential courage that motivates individuals to create opportunities from stressful situations (Maddi, 2006). Commitment is defined as the ability to be seriously involved in a situation and the tendency to refuse to give up easily (Maddi, 2002). Control is the belief that one can be influential over events experienced in life. Challenge is the belief that life changes and it should be perceived as an opportunity for personal growth rather than a threat (Thomas, Reeves & Agombar, 2013). The construct of psychological hardiness has been linked to health preserving effects in the face of stressful events (Kobasa, Maddi & Kahn, 1982), problem solving coping (Maddi, 1999), socially supportive interactions with others (Maddi et al., 2006) and the performance of elite athletes (Sheard, 2009). In performance settings such as a sport, or possibly a high intensity interval training program like CrossFit, competition presents many factors that can be perceived as stressors. Having adaptive responses (i.e., viewing stress as facilitative) to stressors allows hardy individuals to cope better with future stressful situations (Hanton, Neil & Evans, 2011). Elite-level sports can have a stressful nature from the competitive environment they are built upon (Jones, 1995). Having a higher level of hardiness could allow individual athletes to perform better than those with lower levels who may have difficulty overcoming stressful situations.

Engaging in sports may be stressful for participants, as well as exercise. High intensity interval training (HIIT) is a form of exercise characterized by repeated bouts of intense exercise separated by short intervals of rest or low intensity exercise (Gillen, 2012). High intensity

interval training (HIIT) has become popular (Thompson, 2013), and one type in particular, CrossFit, continues to grow in number of gyms (“What is CrossFit?”, n.d.). CrossFit training seemingly involves conditioning, weightlifting and gymnastics; aspects of several different sports (“What is Fitness?”, 2002). In addition to CrossFit training, boot camp fitness classes are another form of HIIT. A typical boot camp class involves a variety of conditioning, body weight movements and resistance training loosely based on variety and intensity that may be prevalent in military training (Rao et al., 2012). Both forms of HIIT are becoming popular, but with the increasing number of participants trying CrossFit training (Thompson, 2013), and the unique combination of skills and structure of the training, it seems logical to examine what types of personality characteristics are involved during CrossFit training. There is limited research on psychological outcomes of HIIT. Some researchers posit the theory that the intense nature of HIIT may make it more stressful for the participant, and in turn, less pleasurable (Oliveira, Slama, Deslandes, Furtado & Santos, 2013). CrossFit training, in particular, could be interpreted as more stressful than other exercise due to the strenuous Olympic weightlifting component. On the other hand, the perceived higher demand of CrossFit training could result in more stressful situations than typical physical activity, potentially cultivating the development of hardiness. To date, there has been limited research on the interaction between hardiness and any form of exercise, much less HIIT.

Purpose of the Study

The purpose of this study is twofold. The main purpose is to examine if CrossFit training affects individual levels of hardiness of novice participants. The second purpose of the study is to examine if there are individual differences in hardiness levels among CrossFit participants compared to other HIIT program participants, specifically, boot camps. In this study, the

following research questions will be investigated: Do novices participating in CrossFit training demonstrate differences in levels of hardiness from pre to post the first eight weeks of training? Do changes in hardiness levels in individuals in CrossFit training differ from those in other HIIT training (i.e., boot camp type exercise class) over the same time period?

Hypotheses

It is hypothesized that 1) individuals in CrossFit will show increased levels of hardiness from the beginning of training to the end of an eight week period and, 2) individuals in CrossFit will have higher levels of hardiness than participants in a boot camp exercise class after eight weeks of training.

Significance of the Study

Research into hardiness and sport suggests that hardiness affects performance in one way or another, including prediction of male basketball player success (Maddi & Hess, 1992), differentiating levels of competitive motocross (Thomas et al., 2013) and swimming (Goss, 1994). Hardiness has also been linked to differentiating skill levels in a variety of sports (Sheard & Golby, 2010; Golby & Sheard, 2004; Thomas et al., 2013; Goss, 1994), but no known studies involving the interaction of hardiness and HIIT training have been undertaken, nor has a study been done on CrossFit training and the influence on hardiness. The significance of this study lies in the fact that it is one of the first to include an examination of the psychological aspects of individuals participating in CrossFit training. The physiological benefits of CrossFit training have been examined (Smith, Sommer, Starkoff & Devor, 2013), but the psychological effects have not been researched.

Limitations of the Study

1. The population of CrossFit training participants were limited to the affiliate gyms in Whatcom and Skagit counties.
2. The population of boot camp participants was limited to the participants in the few classes offered in the Whatcom County area.
3. Participants who adhered through the initial training requirement for CrossFit, who subsequently became the participants for the study, may have already had high levels of hardiness, thus explaining why they did not stop coming to class.
4. A qualifying question to make sure that participants had attended at least one boot camp class per week was included in the post assessment for boot camp participants, but was not included in the post assessment for the CrossFit group.

Definition of Terms

Boot Camp: A form of high intensity interval training group exercise, named after the military basic training version that are held at gyms, outside or in private facilities (Fitness Bootcamp Power, 2011). Boot camp classes include both resistance training and aerobic activities repeated in succession with short breaks in between activities for a period of 45-60 minutes (Rao et al., 2012).

CrossFit Affiliate: A CrossFit location that contains a Level 1 certified CrossFit trainer and pays annual dues to CrossFit to be called an affiliate.

CrossFit Training: A form of HIIT training that aims to use varied functional movements performed at relatively high intensity attempting to optimize fitness (“What is CrossFit?”, n.d.) .

CrossFit Organization: The corporation founded by Greg Glassman that publishes CrossFit.com and the CrossFit Journal, organizes the CrossFit Games and the training and education seminars for prospective trainers and affiliate owners (“What is CrossFit?”, n.d.) .

Hardiness: A combination of commitment, control and challenge (Kobasa, 1979) that results in an existential courage that motivates individuals to create opportunities from stressful situations (Maddi, 2006).

High Intensity Interval training (HIIT): Exercise that includes repeated bouts of intense exercise separated by short intervals of rest or low intensity exercise (Gillen, 2012)

WOD: “Workout of the day”, a term for an event at a CrossFit competition or a daily workout done at a CrossFit affiliate. An example of a WOD is the workout known as “Fran,” that includes 21 repetitions of squat thrusters and 21 repetitions of pull-ups followed by 15 reps of both, and then 9 repetitions of both, completed for time.

Chapter II

Review of Literature

Much of the information about high intensity interval training (HIIT), specifically CrossFit training, is written in a non-empirical form, as little research has been done on the subject yet. The following literature summary aims to provide information about HIIT as a whole, and provide information about CrossFit training and boot camp as individual forms of HIIT. In addition, a comprehensive review of the psychological construct of hardiness is included. The section on hardiness covers the theoretical history, training programs, the relationship with performance and the possible relationship with HIIT participants.

High Intensity Interval Training

HIIT can be described as exercise that includes repeated bouts of intense exercise separated by short intervals of rest or low intensity exercise (Gillen, 2012). The goal in HIIT is to complete each interval at an intensity that is greater than the anaerobic threshold (Laursen & Jenkins, 2002). The anaerobic threshold is reached when an activity requires energy faster than is aerobically produced, so the body uses a quicker anaerobic process for energy (Tortora & Nielsen, 2012).

Within exercise training, HIIT has been used as an alternative to traditional training to improve aerobic fitness (Smith et al., 2013). Additionally, HIIT has been used in the training of elite endurance athletes because it effectively stresses the physiological systems that will be used during a specific endurance-type exercise (Laursen & Jenkins, 2002). As a form of training, HIIT has been shown to increase maximal oxygen uptake (Hatle et al., 2014) and an increase in respiratory muscle strength due to the amount of strain HIIT type exercises put on the respiratory muscles (Dunham & Harms, 2012).

In terms of performance, HIIT training has been linked to increased muscular and cardiovascular strength in both untrained persons (Gibala, Little, MacDonald & Hawley, 2012) and athletes (Iaia & Bangsbo, 2010). HIIT can enhance endurance and maximal oxygen uptake in cross-country skiers (Sandbakk, Sandbakk, Ettema & Welde, 2013), increased sprint performance in junior soccer players (Sperlich et al., 2011) and increased 2000 meter row performance (Driller, Fell, Gregory, Shing & Williams, 2009). In sedentary and recreationally active individuals, HIIT has shown to improve endurance performance better than continuous (no intervals) or submaximal (less than maximum output) training (Laursen & Jenkins, 2002).

Along with performance, HIIT has also been linked to several health benefits including the reduction of subcutaneous fat, reduction in total body mass, the burning of more calories, an increase in post exercise fat oxidation and energy expenditure than steady-state exercise (Shirayev & Barclay, 2012). In patients with cardiovascular diseases, HIIT has been shown to reduce blood pressure and increase myocardial function (Molmen-Hansen et al., 2012). On top of the benefits, HIIT programs are considered safe (Shirayev & Barclay, 2012), and have been used effectively with patients who have diabetes (Little et al., 2011), stable angina (Meyer et al., 2010), heart failure (Wisløff et al., 2007) and coronary artery grafting (Moholt et al., 2009).

In addition to its safety and health benefits, King, Haskell, Young, Oka and Stefanick (1995) propose a theory that HIIT shows potential for increased exercise adherence rates due to the potential for equal or improved outcomes for less time compared to continuous moderate exercise. A proposed factor leading to increased exercise adherence could prove to be very important in the field of exercise as long term exercise adherence is less than 50% after 6 months (Thurston & Green, 2004).

CrossFit training. In the past decade a new form of HIIT, CrossFit training, has slowly gained popularity (Thompson, 2013) to the point that the CrossFit Games were even televised recently on ESPN (Cooperman, 2013). According to their website, CrossFit gyms, called affiliates, have increased in number to more than 5,500 locations with more than 35,000 accredited CrossFit Level 1 trainers (“What is CrossFit?”, n.d.). Level 1 trainers are the individuals who are responsible for relaying the various methodology, teachings and functional movements that CrossFit training focuses on. However, Level 1 certification only requires a two-day training program, which could lead to large amounts of variability in terms of trainer quality and knowledge. CrossFit training can be done in a variety of environments, and can utilize existing terrain and readily available resources (O’Hara et al., 2012). According to the CrossFit journal, CrossFit promotes a type of exercise, movement, nutrition and community; however, there is a lack of empirical evidence on CrossFit training effects (“What is Fitness?”, 2002),

CrossFit training is defined as exercise that optimizes fitness through the use of constantly varied functional movements performed at relatively high intensity (“What is CrossFit?”, n.d.). The definition, created by the founder of CrossFit Incorporated, Greg Glassman, is based off his idea of fitness being defined as increased work capacity across broad time and modal domains. This definition is different from the one found in traditional exercise and biology research that defines fitness as a state or condition, which permits the individual to carry out his/her daily activities without undue fatigue and with sufficient reserve to enjoy leisure pursuits (Malina & Little, 2008). The traditional definition of exercise and the definition of CrossFit training use different words but include similar elements in work capacity, and daily activities or functional movements. The difference in the definitions appears to be the inclusion of the concept of time in the CrossFit version. According to an article with no author published

in the CrossFit journal (“What is Fitness?”, 2002), the CrossFit organization makes use of three different standards for guiding and evaluating fitness (“What is Fitness?”, 2002). The first is based on ten general skills, the second based on performance of athletic skills, the third is based on energy systems that drive all human action.

The first standard for guiding and evaluating fitness outlines what the creators of CrossFit training consider 10 general physical skills: cardiovascular/respiratory endurance, stamina, strength, flexibility, power, coordination, agility, balance and accuracy (“What is Fitness?”, 2002). These 10 areas include and expand on the areas emphasized by traditional fitness definitions that include cardiorespiratory endurance, muscular strength and endurance, musculoskeletal function of the lower trunk and upper thighs, flexibility and body composition (Malina & Little, 2008). The sports medicine and exercise science organization known as the American College of Sports Medicine (ACSM), suggests that a fitness assessment involves five components of health outlined as body composition, cardiorespiratory fitness, flexibility, muscular strength and muscular endurance (Percia, Davis, Dwyer, 2012). In comparison, CrossFit uses several more parameters or skills to evaluate fitness than traditional definitions of fitness and the ACSM.

In theory, the founders of CrossFit training believe that improvements in endurance, stamina, strength and flexibility are measured by a change in the body composition and are achieved through the training. Although the CrossFit Journal (“What is Fitness?”, 2002) was not specific in what types of body composition measurements signified improvements, several measurements of body composition and physiological characteristics have shown an interaction with physical outcomes and forms of exercise in the literature. In terms of endurance, HIIT has been shown to increase maximal oxygen uptake, a characteristic of strong aerobic capacity

(Hatle et al., 2014). In considering strength, resistance training has been linked to an increase in lean body mass in aging adults (Peterson, Sen & Gordon, 2011), increased bone mass in untrained men (Nybo et al., 2010) and a decrease in percentage of body fat in older men (Sillanpaa et al., 2008). HIIT, as well as CrossFit training, have also been shown to improve body composition in terms of reduction in body fat percentage (Smith et al., 2013; Tremblay, Simoneau & Bouchard, 1994). Additionally, researchers found that participating in HIIT increased exercise induced fat oxidation in overweight/obese men (Alkahtani, King, Hills & Byrne, 2013), and moderately active women (Talanian, Galloway, Heigenhauser, Bonen, & Spriet, 2006).

In addition to using body composition measurements to indicate certain physical improvements, the CrossFit organization believes that improvements in coordination, agility, accuracy and balance are achieved through changes in the nervous system as the result of practice. The nervous system consists of the brain, spinal cord, nerves and special sense organs (Tortora & Nielsen, 2012). Motor control in the human body is regulated by a hierarchical system in the brain made up of the neocortex, the brainstem, and the spinal cord (Kolb & Whishaw, 2011). While the neocortex plans movements, organizes movement sequences and produces precise movements, the brainstem is also important for maintaining posture, for standing upright and making coordinated movements with the limbs. While these areas of the brain play a role in motor movement, the concept of neuroplasticity could be the underlying mechanism for the improvements in coordination. The concept of neuroplasticity describes how the brain adapts to the world through the constant changing of neural connections in response to experience (Kolb & Whishaw, 2011). Additionally, it explains how the motor cortex has the ability to acquire new motor skills. In terms of accuracy, it is suggested that the cerebellum plays

a major role in the maintaining movement accuracy (Kolb & Whishaw, 2011). Additionally, researchers have suggested that the cerebellum may act as a clock to make sure that movements and perceptions are properly timed. While experiments show a correlation between the cerebellum and accuracy correction (Kolb & Whishaw, 2011), it is unclear as to how improvements in accuracy would be measured in the cerebellum. In addition to accuracy, the cerebellum is also thought to help maintain balance along with the vestibular system, which consists of two organs located in the inner ear (Kolb & Whishaw, 2011). All of the areas in the brain listed above play a role in coordination, balance and accuracy.

While it is somewhat clear as to what areas of the brain are involved in coordination, balance and accuracy, research on functional changes in these areas indicating improvement appear sparse. Some methods for improving these areas have been tested. In a study done by Jay et al. (2013), they found that kettlebell training (a common method used in CrossFit training workouts), increased postural coordination through improvements in postural reactions after deviation from a normal state. In the balance realm, McLeod, Armstrong, Miller and Sauers (2009) examined the effects of a neuromuscular-training program on balance in high school athletes. Results suggested that neuromuscular training did improve dynamic balance measured through a reduction in errors in the Balance Error Scoring System and the Star Excursion Balance Test. DiBrezza, Shadden, Raybon and Powers (2005) used an exercise intervention, and found that it increased dynamic balance in elderly adults. While the interventions used in the two previously mentioned studies appear to show that neuromuscular and exercise improve some aspects of coordination and balance, it also appears that there are multiple ways to measure changes in coordination and balance.

The second standard outlined by the CrossFit organization focuses on what training should allow an individual exerciser to do (“What is Fitness?”, 2002). The CrossFit organization proposes that fitness is about performing well at any physical task that an individual is presented with (“What is CrossFit?”, n.d.). This proposal is similar to the idea perpetuated in the fitness field that an individual becomes more physically fit when their ability to function within their own circumstances improves (Kilgore & Rippetoe, 2007). The founders of the CrossFit organization believe that the demands of life create an infinite combination of movements and training should prepare individual’s to perform each task well (“What is Fitness?”, 2002). This is reportedly why CrossFit training involves an array of sets, rest periods, reps and exercises, order of exercises, routines, and periodization; however, there has been no known empirical evidence to support that their training method accomplishes the goal of improving an individual’s ability to perform random tasks well.

According to the creators of the CrossFit organization, and their definition of fitness, the third standard focuses on the idea of three proposed metabolic pathways that provide energy for human action (“What is Fitness?”, 2002). The three pathways according to CrossFit training methodology, known as metabolic engines, are the phosphagen, glycolytic and the oxidative pathways (“What is Fitness?”, 2002). The phosphagen pathway dominates the high powered activities, the glycolytic pathway dominates the moderate powered and the oxidative pathway dominates low-powered activities (“What is Fitness?”, 2002). The CrossFit organization’s definition of fitness requires that workouts hit all three of these areas; however, there has been no known empirical evidence to support this. These metabolic engines referenced appears similar to the phosphagen, glycolysis and aerobic energy systems described in traditional physiology literature. The phosphagen system, the quickest way to synthesize adenosine triphosphate (ATP)

for energy, is an anaerobic (without oxygen) system that delivers energy for short-term, intense activities that require a large amount of power from the muscles (Karp, 2009). Glycolysis, an anaerobic system, is used for what is commonly referred to as maximum effort exercise lasting from 30 seconds to about 2 minutes. Glycolysis is the second fastest way to synthesize ATP. Glycolysis produces a small amount of energy, but it does so quickly. Finally, the aerobic system, supplies energy for low-powered activities. The aerobic system produces the most ATP, but also takes the longest (Karp, 2009). In theory, CrossFit training promotes competency in all three of these areas; however, there is no empirical research to support this.

In addition to promoting competency in all three metabolic pathways, the CrossFit organization has suggested that CrossFit training elicits a strong neuroendocrine response that can result in the release of human-like growth hormones and insulin, which contribute to an increase in muscular tissue growth and increased muscular strength (O'Hara et al., 2012). The stated objective of CrossFit training is to construct workouts that create a broad and inclusive fitness. All the workouts remain the same but are designed to be scaled up or down in weight or intensity, allowing people of all fitness levels an opportunity to participate. For example, in workouts involving pull-ups, bands can be used by individuals who cannot do a pull-up yet to make pull-ups doable. In workouts involving prescribed weight, the weight can be decreased for individuals not yet strong enough to do the recommended weight. CrossFit training also apparently encourages keeping track of personal bests through recording times, one rep maximum lifts and setting goals ("What is CrossFit?", n.d.). Research does support the positive effects of goal setting on both group (Burke, Shapcott, Carron, Bradshaw & Estabrooks, 2010) and individual exercise performance (Smith, Hauenstein & Buchanan, 1996). Keeping score of the workouts, keeping time and recording personal records could act as a form of goal setting

that helps the individual CrossFit participant improve performance. By knowing their previous scores or time, an individual could plan and set goals to increase their score the next time.

As per the CrossFit organization's functional movement portion of the definition of fitness, CrossFit training includes various movements and lifts ("What is Fitness?", 2002). Many of these lifts can be very challenging and difficult to perform well, possibly requiring additional commitment to mastering the technique. To increase scores and times in CrossFit training, participants have to improve in the various lifts and skills CrossFit training includes. In CrossFit training, exercises are identified as "workouts of the day" (WOD). WOD's are completed for time, or as many rounds as possible or every minute on the minute. CrossFit training categorizes the deadlift, power clean, snatch front and back squat as functional lifts. Research in the strength and conditioning field supports this claim, as it has found that Olympic weightlifting can significantly improve sprint speed, squat jump, countermovement jumps, agility tests and half-squat one rep maximum lifts (Tricoli, Lama, Carnevale & Ugrinowitsch, 2005). With the increased challenge provided by the difficult Olympic lifts, a stronger sense of personal commitment may be needed by a participant to improve their performance.

In addition to improving performance in skills such as speed, jumping and agility, the CrossFit organization believes the deadlift, clean, squat and jerk produce a strong neuroendocrine response, resulting in changes hormonally and physically ("What is Fitness?", 2002). According to Fragala et al. (2011), the neuroendocrine system is a critically important system for maintain the body's homeostasis. All the systems of the body collaborate to maintain homeostasis at any given point in time. Disruptions to the overall homeostasis triggers physiological feedback mechanisms to re-establish homogeneity (Fragala et al., 2011). The neuroendocrine system is a specialized communication system in the body that utilizes chemical

messages in the forms of hormones to target specific organs. Fragala et al. (2011) claim that the response of the neuroendocrine system to exercise is dependent upon the intensity and volume of the exercise performed, with resistance protocols of moderate to high intensity and high in volume stressing large muscle mass groups with short rest period produce the greatest hormonal response. These optimal conditions for the neuroendocrine response appear to describe the CrossFit style of training involving lots of reps with very little rest. While Fragala et al. (2011) does not claim that the amount of weight is a major factor in stress response, the intensity factor and large muscle group activation could explain why the CrossFit organization emphasizes the deadlift, squat and clean and jerk. This increase in intensity and workload from the CrossFit style of training could also be perceived as very challenging. With an increased level of challenge, the more CrossFit training could contribute to the development of a hardy attitude, especially with the commitment it takes to get better at high intensity lifts and workouts. Those individuals high in hardiness tend to refuse to give up easily and actively try to influence events in their life (Maddi, 2002), characteristics that could prove to be both very beneficial and improved by the high intensity workouts and complex lifts in CrossFit training.

Training methodologies and physiological implications aside, part of the popularity of CrossFit training may be due to its availability. The CrossFit organization provides training seminars throughout the world and has several websites that provide content such as free workouts, training, support and a journal of additional instruction so that information is available to anyone who seeks it (“What is CrossFit?”, n.d.). Through the various marketing the CrossFit organization uses, it appears to be accessible to anyone who has internet access and is interested in attempting it. The problem with the information on CrossFit training is the lack of empirical research on it outside of the articles published in the CrossFit organization’s own CrossFit

journal. In a search of the literature, only a few studies were found on the physiological effects of Crossfit training (e.g., O'Hara et al., 2012), and none relating to psychological characteristics were found.

Boot camp exercise classes. Another popular form of HIIT exercise are boot camp classes or organizations (Porcari, Hendrickson & Foster, 2008). Boot camp is a form of group exercise, named after the military basic training version that are held at gyms, outside or private facilities (Fitness Bootcamp Power, 2011). Boot camp classes include both resistance training and aerobic activities (Rao et al., 2012). These exercises are done in intervals, and can include weightlifting, pushups/sit-ups, exercise balls and leg work (Rao et al., 2012). Boot camp classes are led by group fitness instructors (“Boot camp Workout”, 2013). A quick search on the internet reveals multiple boot camp certification or group fitness instructor certification options offered by a variety of companies including the American Council on Exercise and the American College of Sports Medicine (Tomich, 2010). The idea of the classes is to use the group setting to create camaraderie that fosters supportive motivation from each participant to push themselves further than they would on their own (“Boot camp Workout”, 2013). The classes provide social support aimed at increasing motivation and accountability to create consistent exercise patterns.

From examining descriptions of classes available from different organization's websites online, it appears that many of the boot camp exercises are similar to CrossFit training in that they use similar movements and body weight (e.g., pushups, pull-ups) for resistance (“Boot camp Workout”, 2013). Boot camp classes are also similar in that they are reportedly designed to lose body fat, increase strength and cardiovascular performance (“Boot camp Workout”, 2013). Porcari et al. (2008) found that participants in fitness boot camp type workouts were exercising at the recommended levels of intensity to increase cardiorespiratory endurance, according to the

recommendations set by the American College of Sports Medicine. Porcari et al. (2008) attempted to analyze the health and fitness benefits of boot camp style workouts by examining the results of oxygen consumption and caloric burn tests during participation a boot camp workout. The researchers found that the average boot camp exerciser burned approximately 9.8 calories per minute, and working at a range of 77 to 91 percent of heart rate max, well within the recommended levels mentioned before. However, the small population of the study (12 participants) limits the significance of the results. The study also did not include any psychological assessments.

Both boot camp and CrossFit training are forms of HIIT that offer an alternative to traditional training methods. While boot camp consists of both resistance and aerobic exercises, CrossFit training is a combination of gymnastics, Olympic weightlifting and aerobic exercises. Both are structured differently and last varying amounts of times. It appears that a big difference between boot camp type classes and CrossFit training is the sense of community and relatedness that is a targeted objective of the CrossFit organization. Where it appears boot camp classes are primarily fitness classes that offer social support in a group setting with a large social aspect, the CrossFit style training seems to emphasize a sort of lifestyle of training through its outreach and purposed sense of community. While boot camp is limited to group exercise classes, CrossFit training has expanded into a competitive setting. It could be argued that this expansion allows CrossFit training to be considered both a form of training and a sport.

High intensity interval training (HIIT) and psychological measures. HIIT influences a smattering of physiological adaptations (Gibala et al., 2012), but limited research has been done on the psychological outcomes of HIIT. Oliveira et al. (2013) examined the psychological responses to both continuous training and to HIIT in a group of 15 men from a university

community in Rio de Janeiro. The psychological responses measured included perceived exertion, affective valence (pleasure and displeasure) and perceived activation (arousal). To quantify total mood disturbance, Oliveira et al. (2013) used the profile of moods states (POMS). The POMS is a self-report assessment that asks participants to respond to all the scales according to their feelings at the current moment. Questionnaires were given to the participants ten minutes prior to each session and five minutes after. Both the continuous training and HIIT sessions involved participants using the treadmill. During the HIIT, participants were required to reach 100% of maximal oxygen uptake levels two minutes followed by variable rest periods. The number of HIIT intervals was adjusted to maintain the same average time that was applied in the continuous training session. The average duration of the continuous training sessions was 23.9 minutes, and the HIIT session average dropped to 19.2 minutes after eight participants dropped out due to fatigue. Significant main effects were observed for rate of perceived exertion, with higher scores occurring during the HIIT session. A main effect for perceived activation was also found with higher scores found after the HIIT session, meaning that participants felt a higher level of arousal in the HIIT condition compared to the continuous training condition. Scores from the feeling scale were lower during the HIIT in comparison to continuous training, meaning that participants in the HIIT condition felt more displeasure than pleasure. During HIIT it appears that the rating of perceived exertion and perceived activation increased over time, while reports of pleasure decreased, suggesting that participants felt less enjoyment after a HIIT session.

Given the intense nature of HIIT style training, it is reasonable to assume that participants may not find it as enjoyable as other forms of exercise. The negative enjoyment felt by the participants following HIIT in the Oliveira et al. (2013) study contrast the results found in a

study done by Bartlett et al. (2011). The purpose of the Bartlett et al. (2011) study was to measure perceived enjoyment using the Physical Activity Enjoyment Scale following high intensity interval training (HIIT) continuous running versus moderate intensity continuous running. The study consisted of eight healthy active men, 20-30 years of age. All participants exercised between two and three times a week. The participants were initially tested for maximal oxygen uptake ($VO_2\text{max}$). Participants then participated in both the HIIT running session and moderate intensity session seven days apart. The HIIT session consisted of six intervals of three minutes running at 90% $VO_2\text{max}$ separated by three minute active recovery periods at a running velocity of 50% $VO_2\text{max}$. Each session had a seven minute warm up and seven minute cool down for a total time period of 50 minutes. The moderate intensity continuous running protocol used for the control group consisted of 50 minute continuous running at velocity corresponding to 70% $VO_2\text{max}$. The Physical Activity Enjoyment Scale was administered at the end of each session. Pearson correlations revealed a stronger positive relationship between ratings of perceived enjoyment and the HIIT running condition compared to the relationship between perceived enjoyment and the moderate intensity running condition. Ratings of perceived exertion were also highest during the HIIT protocol compares to the moderate intensity protocol. The results of the Bartlett et al. (2011) study suggested that recreationally active males perceived HIIT running as more enjoyable than continuous running, despite higher ratings of perceived exertion (Bartlett et al., 2011). A limitation of this study was the physical activity history of the participants. The participants were active recreational activity participants, which could explain the higher ratings of perceived enjoyment compared to participants who may not exercise regularly. Based on the conflicting results between the Oliveira et al. (2013) and the Bartlett et al. (2011) studies, it seems inconclusive as to how HIIT influences individual affect.

Hardiness

Hardiness has been considered a personality characteristic (Thomas et al., 2013) that can be a pathway to resilience under stress (Maddi, 2006). Hardiness has been a commonly researched topic in life (Kobasa et al., 1982; Maddi, 2006; Sandvik et al., 2013) and sport (Maddi & Hess, 1992; Sheard, 2009; Sheard & Golby, 2010). Hardiness is believed to affect stress in two ways (Thomas et al., 2013). First, hardy individuals can change their perception of the stressor. Second, it is believed that hardy individuals can use coping mechanisms that alleviate the stressfulness of a situation (Thomas et al., 2013). Hardiness may contribute to facilitating turning stressors into advantageous situations, enhancing performance characteristics such as creativity, wisdom, and fulfillment, and also maintaining or enhancing physical and mental health in the process (Maddi, 2006). To understand the interaction between hardiness and stress, it is important to know the three characteristics of hardiness.

Kobasa (1979) defined people with hardiness as those who exhibit three characteristics: commitment, control and challenge. *Commitment*, defined as the ability to be seriously involved in a situation and the tendency to refuse to give up easily, even when stress levels rise which allows an individual to be actively involved in their environment. Maddi (2002) considered commitment a predisposition to be involved in elements of life rather than be detached and isolated. Someone who is strong in commitment knows that no matter how hard life gets, the best course of action is to stay involved in the events and people in one's life versus retreating into isolation (Maddi, Harvey, Khoshaba, Fazel & Resurreccion, 2009). *Control* is the belief that one can be influential over events experienced in life (Maddi, 2002). A person fights to gain a sense of influence over events in their life rather than be passive or powerless (Maddi, 2002). In the

face of the more difficult times in life, there is value in continuing to try and affect outcomes versus giving into passivity and powerlessness (Maddi et al., 2009). A hardy person has great decisional control, allowing them to choose among a variety of courses to deal with stress (Kobasa, 1979). *Challenge* is the belief that life changes and it should be perceived as an opportunity for personal growth rather than a threat (Thomas et al., 2013). This mindset for approaching the change that accompanies life suggests that a hardy individual wants to learn from both positive and negative experiences rather than avoiding potential threats and playing it safe (Maddi, 2002). The characteristics of commitment, control and challenge can act as stress buffers (Maddi, 2002). Hardy persons have the belief that they can control or influence the events of their experience, feel deeply involved in or committed to the activities of their lives, and view the anticipation of change as an exciting challenge to further development (Kobasa, 1979).

Where Kobasa (1979) first defined hardiness, Maddi has expanded upon the hardiness research for several decades. Maddi first investigated hardiness along with his students in a study of the employees at the Illinois Bell Telephone (IBT) company in Chicago, Illinois (1975). The study involved examining the managers through the administration of psychological and medical methods over a period of 12 years. During the beginning of the study, IBT was a subsidiary of AT&T which was operating as a federally regulated monopoly. Soon after the study began the telephone industry became deregulated forcing AT&T and its subsidiaries to break up, causing major upheaval at IBT resulting in the loss of half the employees. Maddi (2004) and his colleagues began to notice that most of the employees showed major signs of succumbing to stress including suicide, violence in the workplace, divorces, depression and anxiety. Some of the employees, however, were actually thriving in the face of the upheaval, feeling enlivened and

rising up in the company. The research into what differed between the thriving and depressed managers led Maddi to the exploration of hardiness.

According to Maddi (2004), the result of hardiness is existential courage. Existential courage comes from the field of existential psychology, which emphasizes the ongoing search for meaning in life that requires individuals to continually be involved in a decision making process (Maddi, 2004). According to Maddi (2004), everything a person does in life involves making a decision, whether the individual is aware of it or not. This un-avoidable decision making process is what existential psychologists believe characterizes human life. In order to turn the constant novel stressors into opportunities, an individual must choose to pursue the implications of a stressor rather than hiding from them and falling into the past to the already known (Maddi et al., 2009). Furthermore, Maddi et al. (2009) postulated that all decisions are either representative of the past or the future. A future oriented decision involves treading uncharted territory that is new and unfamiliar (Maddi, 2004). According to existential theory, choosing the future maximizes information (Maddi, 2004). By choosing the future as frequently as possible, individuals can satisfy organismic needs, personal learning and development (Maddi, 2004).

If existential courage is the product of hardiness, then increasing existential courage could increase hardiness. Through the research done with IBT, Maddi (2004) was able to develop a prototype training program. The program was developed through the research at IBT along with the work of Khoshaba and Maddi (1999). Khoshaba and Maddi (1999) decided to investigate the developmental processes using four hypothesis of why someone develops hardiness. Each hypothesis was a possible explanation for why someone might develop hardiness and are not all required to develop hardiness. The first hypothesis described hardy individuals as

those who grew up experiencing frequent stressful changes and conflicts. The stressful circumstances could have included poverty, immigrant status, mental/physical illness of one or both parental figures or the emotional/physical absence of either parent (Khoshaba & Maddi, 1999). Hypothesis two describes persons who in their early years were subject to their families putting them in situations where they had to fulfill duties to appease the family's needs. An example of this sense of appease could include asking the child for help, admiration towards the child for superior qualities, and clear nomination to the compensatory role they are playing (Khoshaba & Maddi, 1999). The third hypothesis describes hardy children as those who received the stimulation provided by parents to make life seem full of opportunity. Stimulation could take the form of fantasy games, educational events, trips, literary emphasis and efforts at moving up in the world (Khoshaba & Maddi, 1999). The final hypothesis states that persons high in hardiness felt the need to strive for compensatory goals. Compensatory goals are goals that are set to make up for, or neutralize, the negative effects of goals not met. For example, a compensatory goal could involve setting a goal to go to the gym because an individual did not stick to their diet over the weekend, or working on a thesis for four hours the next day because an individual decided to play in the sun instead of working on it today. Compensatory goals subsequently lead the individual to evaluate and reflect on the processes they took in attempting the old goal to improve their attempt on the second goal (Khoshaba & Maddi, 1999.)

Each hypothesis mentioned above could act as a possible framework for understanding how hardiness is developed to varying levels on an individual basis. Khoshaba and Maddi (1999) examined high and low hardiness groups of participants and found that the way a family or individual *responded* to a stressful event was more important than the mere fact that a stressful event *happened* (Khoshaba & Maddi, 1999). Khoshaba and Maddi (1999) examined the

developmental theory of hardiness and suggested the four hypotheses above explaining why people can grow up with the attitudes of commitment, control and challenge. As an adult, it is suggested that hardy individuals have learned how to view stressful events as vital and important (commitment), capable of being influenced with effort (control), and opportunities to grow (challenge; Khoshaba & Maddi, 1999).

Building on this IBT and developmental research, Maddi (2004) designed the hardiness training program to be supportive and instructive. The program emphasized that stressful situations could be learning opportunities that can help an individual develop, change and find meaning if they are courageous enough to turn changes into opportunities (Maddi, 2004). In the beginning testing stages of the hardiness program, trainees attempted to learn how to cope effectively with stressful situations, improve their social interactions, and consistently use self-care that promotes health and social interactions (Maddi, 2004). Throughout the program participants were provided with feedback, which Maddi (2004) suggested that participants could use to increase their control, commitment, and challenge. In theory, this allowed them to deepen their hardiness attitudes (Maddi, 2004). Training focused on the three key areas of coping, social support, and self-care.

According to Maddi (2004) coping training involves re-interpreting stressful situations. To re-interpret stressful situations, the training program designed by Maddi (2004) was designed to teach participants to think about how the stressors could become worse or get better. Once the participants imagined how they could get worse or better, they were encouraged to think about how they could facilitate making a stressful situation better (Maddi, 2004). By encouraging this way of thinking about stressful situations, the training program attempts to promote a change in the individual on both a mental and behavioral action level. In theory, re-interpreting stressful

situations could create a broader perspective, making stressors more tolerable (Maddi, 2004). Theoretically, according to Maddi (2004), the transformation of a stressful situation into a more tolerable one on a cognitive level can transfer to a behavioral action. This transfer to a behavioral action occurs when the individual makes a decision and acts upon that decision to travel the route that renders the stressful situation less anxiety provoking. Making a change on both a cognitive level and behavioral level underlie the coping aspect of hardiness training.

Along with coping training, the social support part of hardiness training involves education about how to change the way participants approach social interactions (Maddi, 2004). In a study done by Maddi et al. (2009), exercises given to a class of undergraduate students were aimed at teaching participants to identifying existing conflicts with significant others, and subsequently resolve them. Strategies for resolving conflicts include learning listening approaches and improving communication. Instead of approaching an interaction controversially, participants in small groups led by a hardiness trainer were taught how to resolve them by giving assistance and encouragement (Maddi, 2004); the idea is if the conflict is solved, then they can expect to receive support and assistance from the other person in the future. According to Maddi (2004), by solving conflicts with others, participants can strengthen their feelings of social support, and reduces the anxiety surrounding change.

After social training, self-care training focuses on improving the life of the individual. Self-care focuses on maintaining proper arousal levels to carry out problem solving coping and socially supportive interactions (Maddi et al., 2009). The self-care portion of the training also teaches participants to utilize techniques such as relaxation, nutrition and physical activity to raise or lower their activation levels based on their own self-perception. Participants are shown

how to use the feedback they receive to deepen their sense of commitment, challenge and control.

By teaching individuals about coping, social support and self-care, hardiness training programs attempt to build and strengthen participant's sense of control, commitment and challenge (Maddi, 2004). The first evaluation of the training effectiveness of the hardiness program was done by using data from the original Illinois Bell Telephone (IBT) longitudinal study done by Maddi in 1975 (as cited by Khoshaba & Maddi, 1999). Khoshaba and Maddi (1999) compared the hardiness trained managers with managers on a wait-list for the program at IBT. Participants were chosen to be representative on the demographic variables of age, education, gender, marital status, income and job level of the management corps at IBT at the time (1975). Khoshaba and Maddi (1999) found that the group of trained managers showed a greater increase in hardiness attitudes, job satisfaction and feelings of social support than the managers on the waitlist. The hardiness trained managers also showed decreases in anxiety, depression, suspiciousness, and blood pressure compared to the wait-list managers (Khoshaba & Maddi, 1999). Khoshaba and Maddi's (1999) results, based on the data from participants in the original longitudinal study done at IBT, supported the positive influence of a hardiness training program can have on a person.

If taught properly, hardiness training programs appear to be very effective at increasing both hardy attitudes in subsequently, the hardiness personality trait. In a study by Maddi, Kahn and Maddi (1998), hardiness training was compared to relaxation/meditation and a placebo/social support condition. Participants included 54 managers in a utilities company that volunteered for stress management courses. Participants were split into three groups, with gender ratios of approximately 60% men and 40% women. The hardiness training included four parts.

The introductory portion included an opportunity for participants to describe their current stressful circumstances, and an opportunity for the trainer to present a course outline. In the next cluster of sessions participants were taught three ways to develop transformational coping. One method, situational reconstruction, stretches the imagination to reshape a stressor and provide a broader perspective to facilitate a deeper understanding (Maddi et al., 2009). The second, focusing, involves developing awareness of bodily sensations for personal and emotional insights. The third method, compensatory self-improvement, helps an individual accept permanent situations without becoming resentful or giving into self-pity (Maddi et al., 1998). Sessions following the initial training had participants conduct action plans created in class for effectively changing stressful situations. Feedback was given to help strengthen the self-perceptions of commitment, control and challenge (Maddi et al., 1998). The fourth and final part of the training encouraged participants to use what they had learned in the future. The participants that underwent the hardiness training showed greater increases in personality hardiness, job satisfaction, and perceived social support levels than the other two conditions. According to Maddi et al. (1998), the hardiness training enabled people to positively interact with the world and view their home and work lives as more meaningful and rewarding. From this study, it seemed that hardiness training is more effective at increasing the hardy attitudes of commitment, control and challenge, resulting in a more facilitative outlook when confronting stressors compared to a stress management approach and placebo/social support control. However, further research on participants in different demographic groups could increase validity of the program.

In addition the examining the effects of hardiness training on adults in the work force, hardiness training programs have also been studied with undergraduate students. Maddi et al.

(2009) implemented a hardiness training program with university students to test its effects on academic performance. The study involved over 600 students, 349 of which enrolled in the hardiness class, the remaining were in a control group class studying a general psychology topic (abnormal, clinical, etc.). The program involved lecture and team training. The hardiness class instructors covered the theory behind hardiness training and methods, and also attempted to teach how to utilize the particular techniques and develop hardy attitudes that encouraged the re-interpreting stressful situations in their lives from disasters into growth opportunities. The class focused on the five domains of functioning that were outlined in Khoshaba and Maddi (2001). These five domains of functioning include: hardy coping with stressful circumstances by building perspective and taking actions to resolve problems, hardy social support through interactions that decrease conflicts through patterns of mutual assistance and encouragement, hardy relaxation by practicing breathing and other relaxation techniques, hardy eating by following nutritional principles of balance and moderation, and hardy physical activity (Maddi et al., 2009). The HardiSurvey II-R (Maddi & Khoshaba, 2001) was used to measure hardiness. Students in the hardiness class had significantly higher GPAs following the class compared to the students in the control group class. More importantly, the higher GPA was maintained by the intervention students until the time of graduation, 6 to 24 months after their training. The relationship between hardy attitudes and GPA also reached statistical significance, denoting a significant increase in the GPA's of the intervention group compared to the control group. The relationship between hardy attitudes and GPA could suggest that the increase in hardy attitudes learned in the class raised levels of existential courage, facilitating college performance (Maddi et al., 2009). Additionally, analysis of the school support and coping scores showed a positive correlation with the hardiness training class, signifying an increase in feelings of school support

and coping skills for the hardiness training group. The resulting interaction between the hardy attitudes scores and existential courage scores and the effects on GPA, fits with the concept of existential courage allowing individuals to help recognize stress and deal with it in a facilitative matter (Maddi et al., 2009).

Additional research on the interaction between hardiness and stress could provide insight into the effectiveness of the hardiness training program. Judkins, Reid and Furlow (2006) examined the effectiveness of hardiness training program on reduced stress level in nursing managers. The hardiness training method was developed through testing at a nonprofit tertiary care hospital in the Dallas/Fort Worth, Texas, area. Judkins et al. (2006) designed the hardiness program to include key components from the hardiness literature including stress management, adaptive coping strategies, healthy communication, conflict management, and problem-focused resolution. The program involved initial training with follow up sessions over an 18 month time period. The Hardiness scale and the Perceived Stress scale were used in pretest/posttest design to measure hardiness and stress. The results showed that the hardiness training program led to an increase in hardiness scores and in sustaining levels over a six month period (Judkins et al., 2006). The training program also seemed to have had some influence of the turnover rates in the areas represented by the participating nurse managers. This training method included the coping strategies, communication, and possibly physical activity (stress management) that CrossFit includes, providing evidence that CrossFit may increase hardiness as well.

Beyond the various studies on the effectiveness of the hardiness training programs, positive relationships have been found between hardiness and a variety of effects in the army (Bartone, 1999; Florian, Mikulincer & Taubman, 1995), managers of a utility company (Kobasa et al., 1982), and undergraduate students (Allred & Smith, 1989). Some of the interactions

between hardiness and psychological characteristics include increased positive self-statements when presented with a threat (Allred & Smith, 1989), interaction with combat stress to predict fewer symptoms under stress (Bartone, 1999), health preserving effects in the face of stressful events (Kobasa et al., 1982), problem solving coping (Maddi, 1999) and socially supportive interactions with others (Maddi, Harvey, Khoshaba, Lu, Persico & Brow, 2006). In stressful situations, hardiness has also been linked enhancing effects on performance (Maddi, 2009). More specifically, positive relationships have been found between hardiness and performance in combat training (Florian, Mikulincer & Taubman, 1995; Johnsen et al., 2013), varsity basketball training (Maddi & Hess, 1992), firefighter performance (DE LE Vega, Ruiz, Gomez & Rivera, 2013), Israel Defensive forces course (Westman, 1990) and grade point average in college (Maddi et al., 2006).

Venturing into the arena of sport performance, Hanton et al. (2011) examined the interactive effects of hardiness and perceived anxiety direction (facilitative vs. debilitating) on performer's competitive anxiety responses, self-confidence levels and the frequency and effectiveness of coping usage. High hardiness intercollegiate and club sport athletes and performers reported lower levels of worry and anxiety with increased levels of self-confidence compared to those who scored low in hardiness. The same high hardiness participants reported using more planning, active coping, and increased effort, and found the use of coping strategies more effective in dealing with stressful situations during competition (Hanton et al., 2011). The findings of the Hanton et al. (2011) study suggests that hardiness could be an important individual factor when examining competitive trait anxiety as measured by the Modified Sport Anxiety Scale (SAS). Additionally, the results support past research (Kobasa, 1979) that indicated hardiness, and the interpretation of competitive anxiety as facilitative, is associated

with effective coping strategies. The results also could support the idea that elite athletes with high levels of hardiness view competition anxiety as beneficial to performance, thus allowing them to cope effectively and succeed. This current study could provide insight into how CrossFit, which is full of potentially stressful, HIIT workouts could possibly foster hardiness as a bi-product of the process of training. It could be argued that to improve performance in CrossFit, which can be stressful due to the inherent variability and novelty of the workouts and the constant challenging of what participants think they can physically do (challenge), an individual most likely will have to use planning strategies (commitment), active coping (commitment) and increased effort (control). Hanton et al. (2011) suggested that planning, active coping and increased effort were strategies used by individuals who scored high on a hardiness scale. These same strategies appear similar to what the hardiness training program incorporates in the attempt to increase hardiness (Maddi, 2004).

Hardiness in sport. Having adaptive responses or viewing stress as facilitative, appears to allow hardy individuals to cope better with stressful situations (Maddi, 2004). Elite-level sports have been described as environments that are inherently stressful nature due to the competitive environment they are built upon (Jones, 1995). This elite environment places many demands accompanied by stress on the athletes performing. Research supports that athletes who test high in hardiness, show increased facilitative interpretation of anxiety allowing them to cope better with stress and decrease their chances of burnout (Sheard & Golby, 2010). Hardiness has also been linked to many different factors of sport performance including decreased injury time-loss in high level sport performers (Sheard et al., 2010), prediction of male basketball performance (Maddi & Hess, 1992), performance in motorsports (Thomas et al., 2013), American football (Wieser & Thiel, 2012) and swimming (Goss, 1994). Hardiness has also been

linked to differentiating skill levels in a variety of sports (Sheard & Golby, 2010; Golby & Sheard, 2004; Thomas et al., 2013; Goss, 1994). In the study by Thomas et al. (2013), the authors examined the differences in hardiness scores between full-time professional motorcycle racers. Elite professional riders had significantly higher hardiness scores than club riders did. The different levels of hardiness in varying levels of motocross could suggest that higher levels of competition correlate with higher levels of hardiness.

A similar pattern to the Motocross study (Thomas et al., 2013) was found in the swimming hierarchy, as older swimmers who had competed longer tested higher in hardiness (Goss, 1994). Goss (1994) examined the relationship between hardiness and mood disturbances in swimmers who are over trained. Hardiness was positively correlated with age, and negatively correlated with mood disturbances. According to Goss (1994), this suggested that as swimmers progress through the various levels of swimming (recreational to higher competitive levels), their levels of hardiness increase, allowing them to effectively cope and appraise stressful events, allowing them to continue to participate.

Increasing levels of competition could bring about different stressful circumstances that may not exist in lower levels of completion. In a study by Sheard and Golby (2010), athletes from international, national and club levels of various sports were tested for hardiness to determine if it correlated with level of competition. International competitors scored significantly higher on hardiness assessments than national and club performers, and national players scored higher than club players. These results help support the claim that hardiness is something that distinguishes elite level athletes.

In higher levels of athletic competition, team to team variability of psychological characteristics could affect performance. Sheard (2009) examined mental toughness and

hardiness differences between elite university rugby league football teams from Australia and Great Britain. Rugby teams from Australia have a history of dominating teams from other countries to the extent of the national team winning six consecutive World Cup tournaments (Sheard, 2009). During the study, the Great Britain team reported a significantly higher control score, a subscale of hardiness, than the Australian team. According to Sheard (2009), a high score in control indicates a psychological profile of someone who has a predisposition to continue trying to influence the outcomes in which they are involved, instead of quitting. Sheard (2009) suggested the higher control scores seen for Great Britain team could be a reflection of their belief that despite being ranked lower than Australia, they could positively influence the outcome of the game. The Australian team scored higher on several scales including the challenge scale, suggesting that they had a pattern of being better at managing the demands of international competition. These findings support the literature suggesting that athletic performers' higher levels of hardiness are related to individuals' adaptive responses to stressors, and how these responses can positively affect performance (Sheard, 2009).

Golby and Sheard (2004) examined hardiness and mental toughness to see if personality style and mental skills ability could predict success in professional rugby. Players (N = 115) representing the three highest levels of professional rugby league competition in Great Britain were included in the study (International, Super League, and Division One). Hardiness was tested using the Personal Views Survey III-R, which contains the three subscales of commitment, control and challenge. There were significant group differences found in commitment, as International players scored higher than Super League and Division One players. There was also a significant difference found in control, where International players scored higher than division one players. International players also scored significantly higher in challenge than Super League

and Division One players. No significant differences were found between Super League and Division one players. Results indicated that International players had the highest levels of hardiness measured by the three subscales. Scoring higher in control suggested that International players were more likely to feel like they could influence the outcome of a game, while scoring higher in commitment and challenge suggested that they had more of an organizational commitment and viewed potentially difficult situations as opportunities to learn (Golby & Sheard, 2004). It appears that playing at a higher level of completion, a form of success, *could* be influenced by a player's level of hardiness.

In another study attempting to predict success in sport, Maddi and Hess (1992) hypothesized a positive relationship between hardiness and basketball performance. Maddi and Hess (1992) believed that basketball, like business and military training, involved the combination of individual and team effort and required turning disruptions or stressors into advantage or a learning experience. The researchers hypothesized that basketball players, however, would experience these disruptions or stressors at a much faster pace and individual players with an increased outlook of commitment control and challenge could maintain a performance edge over other competitors (Maddi & Hess, 1992). Personality hardiness was found to be positively related to overall basketball performance as measured by the Hardiness Test (Maddi & Hess, 1992). Maddi and Hess believed that this relationship between hardiness and basketball performance added to the construct validity of hardiness as general characteristic related to health and performance in a variety of contexts. Along with researchers previously mentioned (Sheard, 2009; Golby & Sheard, 2004), Maddi and Hess (1992) all studied the effect of hardiness on performance in team sports, not individual performance sports. It is unclear if the same relationships exist between performance and hardiness in individual sports outside of the

hierarchical hardiness scores found in motocross (Thomas et al., 2013) and swimming (Goss, 1994). Maddi and Hess (1992) even suggested that hardiness may only express itself especially in teamwork. The relationship between hardiness and individual sports remains unclear and warrants examination. CrossFit is primarily an individual sport. While there is a team competition at the CrossFit games, the present study will include an examination of the performance of individual athletes who participate in individual workouts in a group setting.

When competing individually, having adaptive responses or viewing stress as facilitative, could allow hardy individuals to cope better with stressful situations. Competitive sports have been described as naturally stressful circumstances, due to the competitive environment created during participation (Jones, 1995). This environment may place many demands due to stress on the athletes performing. Athletes who test high in hardiness seem to show increased facilitative interpretation of anxiety, allowing them to cope better with stressful situations and decrease their chances of burnout (Sheard & Golby, 2010). The empirical findings of studies like Sheard and Golby's (2010) suggest that athletes competing individually, such as CrossFit athletes, could exhibit high levels of hardiness in order to compete successfully through facilitative interpretations of stress.

Hardiness and HIIT. While there appears to be no research linking hardiness specifically to high intensity interval training, there are a few studies linking hardiness to exercise. Deuster and Silverman (2013) examined physical fitness as a pathway to resilience, and claimed hardiness to be an associated factor of resilience. The researchers claimed their unpublished data included a positive correlation ($r = 0.24$) between aerobic capacity and hardiness. Unfortunately, Deuster and Silverman (2013) did not disclose what study of theirs this information came from, nor did they explain how they obtained it, making this connection very

questionable. If the unpublished data they refer to has some significance and validity then it could provide evidence of hardiness resulting from physical activity through an association with resilience.

In a second study examining the potential relationship between hardiness and exercise, Oman and Duncan (1995) examined the mediator role of hardiness and self-efficacy in the relationship between social support and exercise behavior in a group of women recruited from local exercise programs. Participants, aged 20-86, were involved in aquatic and land aerobic exercise classes. Structural equation modeling was used to test the specific relationships among the variables. Hardiness and self-efficacy played mediating roles in the relationship between exercise and social support. Specifically, hardiness played a mediating role in the relationship between social support and self-efficacy, and self-efficacy was directly related to exercise behavior. In other words, social support influences hardiness, and hardiness then influences self-efficacy, which directly relates to exercise behavior. While Deuster and Silverman (2013) and Oman and Duncan (1995) did not find a direct link between hardiness and exercise, their research supports an interaction between hardiness and exercise.

CrossFit and hardiness. In reviewing the hardiness training program, CrossFit appears to cover four (active coping, social support, eating and physical activity) out of the five domains of functioning listed by Maddi et al. (2009). First, as described previously, the training for CrossFit workouts are based on improving individual performance, which may teach active coping. When a workout that once seemed impossible to an individual is completed, it could become cognitively less stressful for the individual. If that particular WOD is attempted again, the individual can cognitively reframe the once impossible WOD into a less stressful task that can be accomplished and improved upon through goal setting. In addition to goal setting to

improve performance, peer or instructor feedback could also be used to improve performance in the workouts. During workouts, Level 1 coaches are present and can provide individual feedback, much like the instructors in hardiness training programs. Receiving this feedback may increase participants feeling of control, commitment and challenge, which could translate outside of the gym into everyday life.

In addition to active coping and the use of feedback, it is possible that the social support created by the environment of CrossFit follows a similar pattern of mutual assistance and encouragement emphasized by the hardiness training program (Maddi, 2004). CrossFit participants may have the opportunity to learn how to support one another in potentially difficult, often stressful workouts. Through continued support from one another, participants may begin to re-interpret difficult WOD's from stressful, potentially identity threatening events to activities they can accomplish given their personal resources. As new participants are shown support by veterans, they can return the favor once they have more experience by showing the next group of new people the same support. The presence of social support can potentially reduce the anxiety around starting CrossFit, and at the same time, possibly teach participants the value of social support.

Along with social support, the concept of self-care is both a direct part (exercise) and a tenant of the beliefs of the CrossFit organization (i.e., nutrition; "What is Fitness?", 2002). As a form of high intensity interval training, physical activity is built into CrossFit training, allowing participants to receive that self-care benefit during participation. The creators of the CrossFit organization also stress the importance of nutrition as it is their belief that proper nutrition supports muscle growth and healthy body functions ("What is Fitness?", 2002). The combination

of physical activity and nutrition messages in CrossFit training may create learning opportunities similar to the self-care training in the hardiness program.

The hardiness training program (Maddi, 2004), although externally very different, seems to be fundamentally similar in interpretations of the CrossFit style of training. At first, due to the high intensity nature of the exercises, many could be very difficult for a new participant to complete; however, during the training process, a participant's perspective could change as to what they could do physically, which could generalize into other domains of their life such as socially, intellectually and so forth. Participants who accept challenges during exercise and re-interpreting physically stressful events into accomplishable tasks, could possibly use the same cognitive approach in other areas of their life. The similarities between CrossFit and hardiness training warrants an examination of the effect of CrossFit training on hardiness levels.

Summary

Hardy individuals have a strong sense of control, commitment and challenge (Kobasa, 1979) that manifests itself in an existential courage allowing them to view stress as facilitative rather than debilitating (Maddi, 2006). In the face of stressful situations, a person with a high level of hardiness believes that with persistent effort it is possible to influence the outcome of an event (control), and through doing so learn from a stressful event (challenge) and use it to grow (Maddi, 2002). With an endless combination of stressors and choices life can be difficult, but hardy individuals know that is important to always stay involved with events, family and friends (commitment) rather than slip into isolation (Maddi, 2002). This set of stress buffers (Maddi, 2002) allows individuals (e.g., athletes) who are exposed to extremely stressful situations in a competitive environment (Jones, 1995), to view their stress as facilitative and using effective coping strategies to overcome situations and thrive. While researchers have found that hardiness

may differentiate between competitive levels of athletes across several sports (e.g., Goss, 1994; Sheard, 2009; Golby & Sheard, 2004; Thomas et al., 2013), none have examined individuals who participate in the stressful environment of HIIT training. It is clear that there is lack of research into the psychological effects of HIIT, specifically CrossFit, and there appears to be a need to examine the effect of CrossFit on hardiness.

Chapter III

Methods and Procedures

Introduction

The purpose of this study was to investigate whether participating in CrossFit training affected novices' level of hardiness over the course of eight weeks. Results were compared to participants from boot camp classes, another high intensity interval training (HIIT) type program. Hardiness scores were measured via the Personal Views Survey III-R (PVS III-R; Maddi et al., 2006) and compared over time and between the groups.

Description of Study Population

Approximately 64 participants started the study and completed the pre assessment, and 37 (53.1 % attrition rate) completed both the pre and post-assessments. Seven participants from the boot camp group were excluded from inclusion because they self-reported that they did not attend at least one boot camp class per week over the eight week period; therefore, the final participants included in the study was 30. Participants were recruited from Whatcom and Skagit County CrossFit affiliate (n = 19; 10 female, 9 male), and two Whatcom county boot camp programs (n = 11; 10 female, 1 male). Participants' ages ranged from 22 to 60 years of age and consisted of 27 white/non-Hispanic/Latino, 1 Hispanic/Latino, and 5 American Indian/Alaskan/Native Hawaiians. Participants were volunteers and first time CrossFit training and boot camp participants. CrossFit training participants were enrolled in the beginning training sessions required of first time participants at each CrossFit affiliate. Participants for the boot camp and CrossFit training sample were chosen based on a convenience sample. Participants were at least 18 years old and first time CrossFit training and boot camp participants.

Design of the Study

This study was an applied, field-based study using a quasi-experimental method with a non-randomized, non-equivalent pre/post design examining hardiness and HITT. The study utilized a sample of convenience. The independent variables were type of HIIT training (CrossFit or boot camp) and time (baseline and eight weeks post) and the dependent variable was hardiness (total hardiness, control, commitment, and challenge).

Data Collection Procedures

Instrumentation. All participants were administered the questionnaire at their gym for convenience purposes. Each athlete/participant was given the questionnaire at some point during the first week of class participation and then again through an online version of the survey after eight weeks of participation in their designated program. Due to scheduling allowances, not every participant was given the pre-assessment before their very first CrossFit session, but all were completed within the first week of their respective intro camps.

Personal Views Survey III-R. The PVS III-R was developed and validated by Maddi et al. (2006) and was used to measure a total hardiness score (see Appendix A). The PVS III-R has three subscales: commitment, control and challenge. The 18-item scale includes a four-point Likert scale, ranging from *Not at all true* to *Very true*, with total scores ranging from 19-49 (with higher scores reflecting greater hardiness), with an average score of 38-41 (Maddi & Koshaba, 2001). Sample items include “I often wake up eager to take up life wherever I left off” (commitment); “Trying your best at what you do usually pays off in the end” (control); and “Changes in routine provoke me to learn” (challenge; Maddi & Khoshaba, 2001). The PVS III-R has been found to have moderate alpha coefficients of commitment, control and challenge with hardiness of .69, .57 and .73, respectively in a sample population of 1,239 college students and

working adults ranging in age from 17-85 (Maddi et al., 2006). Additionally, in terms of internal consistency, the Cronbach's alpha for total hardiness was .74, which has been reported as adequate and consistent with the findings of previous studies (Maddi et al., 2006). All participant responses were organized into an excel spreadsheet and sent to a third party, the Hardiness Institute, for scoring. Scores that were returned included total hardiness scores and totals for each subscale for each person pre and post-training.

Qualitative Questions: Attached to the PVS III-R survey were additional open-ended qualitative (see Appendix B) and demographics questions (see Appendix C). The purpose of using the qualitative questions was to gain additional information about participant's experiences participating in CrossFit training and boot camp. Questions included "Has the past 8 weeks of training affected you, if at all, mentally?", "How have the past 8 weeks of training affected your sense of commitment to any part of your life, if it all. If so, please explain.", "How have the past 8 weeks of training affected your sense of control to any part of your life, if at all. If so, please explain.", "How have the past 8 weeks of training affected your sense of challenge to any part of your life, if at all. If so, please explain." These qualitative questions were used to find out underlying themes/changes of the psychological characteristics of hardiness in the participants.

Measurement techniques and procedures. The Whatcom and Skagit county CrossFit affiliate gyms were found through a CrossFit affiliate locator on the CrossFit.com website. The two boot camp programs were found using an internet search for "boot camp fitness classes in Bellingham, WA". Correspondents at the locations from these lists were contacted to see if they were interested in participating in the study. There was coordination done with those gyms who agreed to have the researcher on site for the first session of their respective camps, whether that be the CrossFit training camp or the first boot camp session. Participants were addressed in

person in groups and were given consent forms prior to their initial assessment. The initial assessment occurred as close to the beginning of the class start date as possible. At these first assessments, the primary investigator distributed the survey packet to the participants before the workout. Arrangements were then made to distribute the survey packet again eight weeks later via email to the participants using the Snap Survey online assessment tool. Surveys sent to the boot camp participants included a qualifying question to make sure that participants had attended at least one boot camp class per week (see Appendix D).

During the first round of assessments, each of the survey packets were coded specifically to each individual within a particular gym. Participants were asked for their email addresses on the survey (separate from informed consent) so that the post-assessment could be emailed to them. No other identifying information was recorded, besides the demographic information that the Hardiness Institute researchers required in order for hardiness scores to be computed. An email/code list was constructed by the researcher from the pre-assessments and stored in a password protected computer file. Each email was matched with the individual's corresponding identification number. Only the researcher had access to this list and it was not shared with the third party scoring company, the Hardiness Institute. Once it was time to send out the post-assessment, an email was sent to each participant containing a link to an online version of the assessment. Once the post-assessment was received from the online survey system, the email address was used to match the test results to the pre-assessment, at which point the identifying code was added to the post assessment. The identification code was the only identifier used in the data, organized in an excel spreadsheet, and sent to the Hardiness institute for scoring. Once the study was concluded, the email list was destroyed.

Data Analysis

All data were analyzed using SPSS 20.0 and the results were evaluated for $\alpha = .05$. A 2-way mixed analysis of variance (ANOVA) was used to compare the hardiness scores between boot camp and CrossFit participants across time.

Results from the qualitative questions were examined to see if the thoughts of the individual participants reflected the three C's of hardiness, or if any other common themes emerged. Qualitative answers were examined by first recording whether participants indicated they noticed changes or not to any of the three C's or overall mental changes. Responses that had indicated yes were then organized into groups of re-occurring themes. Once the researcher completed grouping responses by themes, two other researchers reviewed the themes and responses for consistency. Qualitative comments and themes were used to illustrate the quantitative scores of the participants.

Chapter IV

Results and Discussion

The purpose of this study was to examine whether CrossFit training affected novice participants' level of hardiness over an eight week period. Results were then compared with participants in boot camp type classes, another form of high intensity interval training (HIIT). This study was an applied, field-based study using a quasi-experimental method with a non-randomized, non-equivalent pre/post design examining hardiness and HIIT. Hardiness was measured using the Personal Views Survey III-R (PVS III-R; Maddi et al., 2006). Results were compared over time and between groups using a mixed between-within analysis of variance (ANOVA). Additionally, qualitative questions surrounding the three C's of hardiness, commitment, control and challenge, were asked at the end of the post-assessment. Qualitative questions were used in conjunction with the quantitative data to examine if any thought patterns surrounding hardiness had developed.

Results

Hardiness. Means and standard deviations for CrossFit and boot camp participants can be found in Table 1. A mixed between-within subjects ANOVA revealed no statistically significant interaction effect between group and time, Wilks' Lambda = .96, $F(1, 28) = 1.04$, $p = .32$, $\eta_p^2 = .04$. Further, there was no statistically significant main effect for time, $F(1, 28) = .507$, $p = .48$, with a small effect size ($\eta_p^2 = .02$), nor group, $F(1, 28) = .01$, $p = .93$, with no effect size ($\eta_p^2 = .00$).

Table 1

Means and Standard Deviations for Total Hardiness Scores in Pre and Post Assessments for CrossFit and Boot Camp Groups

	<u>Mean (Standard Deviation)</u>
CrossFit Group	
Pre	40.21 (4.05)
Post	40.00 (5.03)
Boot Camp Group	
Pre	39.36 (4.06)
Post	40.55 (4.95)

An additional mixed between-within ANOVA was done for each subscale of the PVS III-R; means and standard deviations can be found in Table 2. There was no statistically significant interaction effect between group and time for challenge (Wilks' Lambda = 1.00, $F(1, 28) = .08$, $p = .77$, $\eta_p^2 = .003$), commitment (Wilks' Lambda = .945, $F(1, 28) = 1.63$, $p = .21$, $\eta_p^2 = .055$) or control (Wilks' Lambda = 1.00, $F(1, 28) = .01$, $p = .78$, $\eta_p^2 = .00$). No significant main effect of time was found for challenge [$F(1, 28) = .01$, $p = .94$, $\eta_p^2 = .00$], commitment [$F(1, 28) = 1.63$, $p = .21$, $\eta_p^2 = .06$] or control [$F(1, 28) = .01$, $p = .94$, $\eta_p^2 = .00$]. No significant main effect of group was found for challenge [$F(1, 28) = .03$, $p = .87$, $\eta_p^2 = .00$], commitment [$F(1, 28) = .67$, $p = .42$, $\eta_p^2 = .02$] or control [$F(1, 28) = .17$, $p = .69$, $\eta_p^2 = .01$].

Table 2

Means and Standard Deviations for Hardiness Subscale Scores in Pre and Post Assessments for Both CrossFit and Boot Camp Groups

		<u>Mean (Standard Deviation)</u>
CrossFit Group		
Challenge	Pre	12.63 (2.29)
	Post	12.47 (2.52)
Commitment	Pre	13.63 (1.77)
	Post	13.63 (2.14)
Control	Pre	13.94 (1.61)
	Post	13.90 (1.41)
Boot Camp Group		
Challenge	Pre	12.64 (1.80)
	Post	12.73 (2.28)
Commitment	Pre	12.64 (2.01)
	Post	13.63 (1.57)
Control	Pre	14.09 (1.22)
	Post	14.18 (1.89)

Discussion

Hardiness. In both the CrossFit group and boot camp group of this study, there were no interaction effects and no changes across time or group differences for total hardiness as well as any of the three subscales: commitment, challenge or control. It appears that HIIT does not affect

hardiness levels in participants. The consistency in hardiness scores over the course of the study could be due to a lack of effect of HIIT on hardiness or a ceiling effect. On the other hand, several additional reasons could explain why there were not detected differences in hardiness in this particular study including: measurement issues, other changes to control, commitment and challenge that do not affect hardiness, the influence of other variables, or the length of the study.

There could be several explanations as to why total hardiness, commitment, control and challenge did not increase over time in either the CrossFit training or boot camp group. First, HIIT may not be a type of treatment that affects hardiness levels. The two types of HIIT in the current study may not have been stressful enough, or the right modality of training to evoke a change in hardiness. The absence of change to hardiness levels may also have something to do with a difference between psychological and physical stress. While HIIT has been rated as less pleasurable or physically stressful (Oliveira et al., 2013), it may not have been interpreted as psychologically stressful. Hardiness has been conceptualized as the courage to grow from stress (Maddi, 2006). Maddi did not specify whether hardiness is a result from dealing with physical or psychological stress. An argument could be made that in the absence of psychological stress, hardiness would not develop. If HIIT is deemed as merely not enjoyable, rather than psychologically stressful, the difference between enjoyment and psychological stress could have been why participants did not see their levels of hardiness change over the eight weeks of training. The lack of perceived psychological stress may have been why HIIT training did not directly affect levels of hardiness.

Second, a ceiling effect may have prevented any measureable increases in hardiness. The 34 participants who did not complete the post assessment survey could have been the participants who ended up quitting their respective programs. The pre-assessment data of the participants

who did not fill out the post assessment were not sent to the Hardiness institute for scoring because the data was not initially relevant to a pre/post study design. Additionally, there was no way to know if the participants who did not fill out the post assessment did so because they had dropped out of their exercise program, or if they simply did not want to participate further in the study. However, the scores from these 34 participants could have been lower than those who completed the post assessments. The remaining 30 who did respond may have already had high levels of hardiness that helped them adhere to their respective exercise program; thus, causing a ceiling effect statistically. In statistics, a ceiling effect occurs when the treatment no longer affects the dependent variable because of already high baseline data (Hessling, Traxel & Schmidt, 2004). In this study, CrossFit or boot camp enrollees may have already had a high level of hardiness before enrollment, thus, HIIT training could not further increase hardiness by measureable amounts. Comparisons between those who dropped out and those who adhered may be interesting for future studies.

After considering conceptual reasons as to why hardiness levels were not affected by HIIT programs, it is important to note some measurement issues in the current study. The current researcher did not have access to the scoring methods, or any of the calculations done by the Hardiness Institute. All data were given to the Hardiness Institute for analysis. The Cronbach's alpha coefficient for pre-assessment hardiness was considered poor at .52 and acceptable for post hardiness at .69, meaning internal consistency was acceptable. However, pre-assessment commitment ($\alpha = .33$), control ($\alpha = .05$) and challenge ($\alpha = .25$) were all at unacceptable levels for internal consistency for the entire sample of the study. The same pattern occurred for the post assessment subscales as well with commitment ($\alpha = .32$) and control ($\alpha = -.26$) coming in at unacceptable levels and challenge ($\alpha = .55$) reporting poor internal consistency. The internal

consistency, or the extent to which all the items in a test measure the same concept or construct (Tavakol & Dennick, 2011), was extremely low for this study suggesting that the three subscales were not valid. The Hardiness Institute did not have a possible explanation for such low internal consistency scores (Maddi, personal communication, March 19, 2015). Other researchers who have used the PVS III-R reported internal consistencies as adequate for commitment (.71 to .74), control (.74 to .78) and challenge (.72 to .75; Sheard, 2009; Sheard & Golby, 2010). Despite other researchers reporting higher Cronbach's alphas, it could be assumed that the aforementioned studies were also not privy to the calculations by the Hardiness Institute and were simply given reliability statistics. To the researcher's knowledge, there is no study published to date that describes any process by which to calculate hardiness subscale scores or the reliability of those scores. It is unknown if there would have been detectable changes to hardiness if a valid measurement scale had been used.

Despite possible problems with the assessment, there may have been changes in hardiness concepts within the individual participants, but not to the overall concept of hardiness over the eight weeks of training. In terms of the three C's of commitment, challenge and control, CrossFit training participants qualitatively stated that the past eight weeks of training had affected their sense of commitment (79% of CrossFit group), control (63% of CrossFit group) and challenge (74% of CrossFit group). The same pattern was found amongst boot camp participants (81% for commitment; 54% for control; 63% for challenge). Participant responses to the qualitative questions indicated that individuals' sense of commitment, control and challenge may have changed; however, it appears that they changed differently than how Maddi (2002) would define.

While total hardiness quantitative scores did not change over time or across groups, several qualitative responses indicated some forms of cognitive alterations that could reflect changes in other psychological characteristics such as motivation, or general thought processes. Responses like, “I feel I can accomplish more” and, “...I was challenged mentally and physically”, suggested CrossFit participants noticed psychological changes over the eight weeks of training different than hardiness. While these changes may appear vague at the moment, more specific follow up questions in a future study could shed light into what exactly changed mentally for the participants.

In addition to indications from the qualitative responses that general cognitive changes took place, there appeared to be some perceived changes to the three C’s when participants answered open-ended questions. A review of specific comments on whether training affected commitment revealed that both CrossFit training and boot camp participants predominantly responded yes, but in terms of health and/or fitness. For example, responses such as, “I am way more committed to building strength and my overall health” or, “yes, staying in shape, eating right” suggested that participants noticed changes in their commitment to the specific context of their health, strength and eating habits. While part of the hardiness training involves improvement to diet as part of the self-care modality (Maddi et al., 2009), nutrition may not be important enough to drastically change an individual’s overall development of hardiness or any of the three C’s. For example, being committed to health, strength and nutrition may not transfer to the tendency to refuse to give up easily in stressful situations, a characteristic of individuals with high commitment (Maddi, 2002).

Thinking beyond health, strength and nutrition, Sheard and Golby (2007) found the commitment portion of hardiness to be positively correlated with academic performance.

However, Sheard and Golby's (2007) findings were simply correlational and do not suggest that improving commitment to schoolwork increases hardiness overall, it simply suggested that a sense of commitment is a moderator of academic success. In terms of the present study, it seemed that increasing a sense of commitment to health, strength or diet did not necessarily increase commitment or hardiness, as defined by the PVS III-R. But, the increase of commitment to health could have increased fitness performance or another aspect of the participant's life such as overall well-being.

Along with qualitative differences in commitment, participants noticed changes in their sense of control. When asked if training had affected their sense of control at all, participants responded yes, but in terms of their self-control of specific behaviors or health related control. Participants seemed to have made a distinction between self-control, or an understanding that they can control certain behaviors in their life (e.g., exercise or health), and an overall, global sense of control that indicates an understanding that they can influence all aspects and events in their life (Maddi, 2002). For example, one boot camp participant noted that, "It has made me realize that there are things I can control even if it's just how I interpret situations" and another stated, "I am in control of my health, training is proof of that." Responses such as these indicate that some feelings of control were affected by participation in a boot camp class. However, one participant noted that, "I don't really like my job at the moment and scheduling times for exercise keeps me feeling a bit in control whereas I don't feel that way at work." This response seems to indicate that while attending a boot camp class increased their sense of control, it did not transfer into other areas of their life, such as work.

CrossFit participants similarly noticed a change in control but seemed to comment mostly on the context of health or self-control. Responses varied from, "definite difference when I

exercise in terms of how calm and in control I feel and how not calm and out of control I feel when I don't get the exercise in" to, "I'm more in control of my health because I'm finally committed to taking better care of myself." Some responses, however, seemed to indicate a possible global sense of control. One participant noted that the past eight weeks of training, "helped provide better sense of perspective in looking at events and assessing what I can't control, and how best to control what I can." Responses like this one could suggest that CrossFit training increased a participant's ability to think about controlling the controllable variables in life. Now that specific thought change, or awareness, may not have led to an increase in a sense of control under the definition of hardiness, but should be noted as a significant change in thinking. It appears that qualitatively, participants in both boot camp classes and CrossFit training noticed differences the area of control. Some participants from boot camp and CrossFit training noticed changes in a global sense of control, while others for both groups related their sense of control to a health specific context. However, more participants from CrossFit noticed a change in both overall sense of control and health related control than the boot camp group.

Thirty three percent of the total participants who said they noticed a difference in their sense of control following both types of training, mentioned an increase of control in terms of health. This specific type of behavioral self-control was mentioned more than any other type of behavior specific control. While the traditional definition of hardiness has been linked to health preserving effects (Kobasa et al., 1982), Pollock (1999) constructed a health related hardiness scale that was developed to assess adaptation to chronic illness. Participants in this study may not have been referring to chronic health issues, however, they could have noticed changes in control that were more health specific rather than specific to overall life. Pollock (1999) viewed health hardiness as a response to health stressors through health specific control, commitment and

challenge. It may be that health hardiness is developed more in individuals suffering from major chronic illnesses, but the health oriented specific thoughts of control seen in the HIIT participants may have developed more health hardiness-related control than the traditional hardiness sense of control over life.

In addition to control and commitment, participants from both groups indicated that they felt their sense of challenge had changed over time. The majority of the qualitative responses for both the CrossFit training group and boot camp group, all centered on changes to their sense of challenge in the physical context. Qualitative responses such as, “makes me ready to challenge myself further now that spring is coming and there are challenging things to conquer like backpacking trips and climbing mountains”, and, “I feel challenged in the aspect of my physical fitness”, indicate participants felt their sense of challenge affected specific to physical challenges. It appeared that a majority of the participants did not make a transfer of their sense of challenge in the gym to other contexts in their life, as was hypothesized. Several participants in the CrossFit group did respond to the qualitative questions in a way that suggests some transfer may have occurred. For example, one participant mentioned that they noticed an, “increased confidence to face new challenges.” Another participant responded in a similar manner, saying that, “I feel like I'm more comfortable with and kind of look forward to challenges,” indicating that she may have started to perceive challenges differently than before. Responses that emulate the reframing of challenges may indicate that although, as a group, participants in this study did not perceive statistically significant changes in total hardiness, or challenge scores specifically, one or two participants might have experienced change.

While there may not have been evidence from this study that HIIT directly affects hardiness levels, there could have been mediating processes that influenced how participants

coped with the physical stress. In the literature, researchers such as Delahaij, Gaillard and van Dam (2010) examined mediating processes that influenced the relationship between hardiness and response to stressful situations. Specifically, Delahaij et al. (2010) examined coping style and coping self-efficacy, two processes that could influence the way hardy people respond to stressful situations. Delahaij et al. (2010) found that hardy people had more effective coping styles (i.e., more task-focused and less emotion-focused), and as a result showed more effective coping behavior. The mediating process of coping styles could have been where the current study missed the theoretical link between type of HIIT training and hardiness. In other words, HIIT could be positively influencing participants' coping styles, which in turn can increase hardiness. HIIT may not be affecting hardiness directly, rather through influencing coping styles, which may not be enough of a psychological influence to produce noticeable changes in overall hardiness scores. Partridge, Knapp and Massengale (2014) recently found that participants who underwent CrossFit training for less than six months had higher levels of mastery-based goals (goals focused on achieving interpersonal or task-based competence). One could argue then that CrossFit training, with an emphasis on mastery-based or task-specific goals, could influence task based coping styles, not an individual's sense of control or total hardiness. Responses from the qualitative analysis such as, "a realization that I do get results from hard work" and, "reminding me that I can only get out of it as much as I put in" suggest that participants may have learned through training that working hard at a task does produce results. This type of thinking could support the possible connection between training and coping styles. The purpose of this study was to explore whether CrossFit training affected hardiness, not to consider if CrossFit training affected coping styles, which in turn could mediate hardy responses to stressful situations.

Results from the current study indicate that HIIT training affected some participants' sense of control, commitment, and challenge in their qualitative responses, however, participants did not show statistically significant quantitative changes in total hardiness or the three subscales. The unchanged hardiness scores could have been due to a ceiling effect or lack of an effect of HIIT on hardiness. On the other hand, these results may have been due to a number of other reasons, including measurement issues, other changes to control, commitment and challenge that do not affect hardiness, the influence of other variables, or the length of the study. The majority of the participants identifying as female (20 out of 30) may have influenced the results as well, however, there is a lack of hardiness research that support significant gender differences. Despite the lack of quantitative results, the study did provide valuable insight as to what changes can be made to future research. The changes in cognitions observed in the qualitative responses suggest that something did occur during the eight weeks of training that influenced participants attitudes, what they may be exactly could be examined in future research.

Chapter V

Summary, Conclusion, and Recommendations

Summary

The purpose of this study was to examine whether CrossFit training affected novice participants' level of hardiness over an eight week period. A secondary purpose was to compare participants from CrossFit training with participants in another high intensity interval training (HIIT), specifically, boot camp type classes. It was hypothesized that, due to the similarities between hardiness training and CrossFit training, novice participants in CrossFit training would demonstrate increased levels of hardiness over an eight week period. It was also hypothesized that novice CrossFit training participants would show higher levels of increased hardiness than novice participants in boot camp classes at post-assessment. Prior research on HIIT, specifically CrossFit training and boot camp classes, has primarily included an examination of physiological effects (Smith et al., 2013; O'Hara et al., 2012). Therefore, the main purpose of this study was to evaluate whether participating in CrossFit training and boot camp training influenced the specific psychological characteristic of hardiness. To the researcher's knowledge, no prior research has been done empirically examining the construct of hardiness and HIIT.

Conclusion

Results from the current study are inconclusive as to whether HIIT training influences levels of hardiness in participants. In both CrossFit training and boot camp groups, hardiness levels did not change after eight weeks of training. Subscale scores of commitment, challenge and control also did not show statistically significant changes over eight weeks of training. Qualitatively, several participants noted changes in their thoughts surrounding control, commitment and challenge. However, responses or changes in thought appeared to be centered

on exercise and/or health-related cognitions in both groups as opposed to changes in hardiness. Several participant responses from the CrossFit training group, however, did note some transference of thoughts surrounding looking forward to new challenges, suggesting that some changes in perceptions did occur. These results could suggest that some sort of psychological change could have occurred, or began to occur, but might not be related to hardiness.

Recommendations:

The popularity of HIIT does not seem to be slowing down (Thompson, 2013). With some websites estimating the number of CrossFit gyms, in particular, doubling each year (“How Fast is CrossFit Growing?”, 2012), the number of participants will continue to rise. Physiologically, research on the effects of CrossFit training has begun to appear in the literature (O’Hara et al., 2012; Smith et al., 2013); however, limited research has been done on the psychological effects of CrossFit training.

It was proposed that due to the similarity between the structure of hardiness training and CrossFit training, CrossFit training would affect a novice participant’s level of hardiness, and subsequently, his/her sense of control, commitment and challenge. Results from this study did not support that hypothesis, but could provide some valuable information as to what future researchers should adjust when investigating psychological effects of HIIT. Future researchers in this area may benefit from increasing the time between pre and post assessments. Eight weeks may have been too short, as hardiness training in past studies has ranged from 10 weeks (Maddi et al., 1998) to 12 months (Judkins et al., 2006). Given more time in either form of HIIT may have produced more variability in the levels of hardiness measured in participants.

The actual measurement of hardiness is another area future researchers may want to improve upon. Reliability scores for the Personal Views Survey III-R (PVS III-R) in the current

study were extremely low. It was not disclosed by the Hardiness Institute how they calculate the scores as a third party, so reliability scores from other studies were used to make the decision to use the PVS III-R. Additionally, the relatively short length of the PVS III-R (18 questions), was a major factor in the selection of the PVS III-R for the current study in which limited time to pass out surveys at the various gyms was an obstacle. Future researchers may want to use a hardiness scale that can be scored by the researcher and not by a third party.

In addition to the quantitative hardiness scores, participants in the current study were asked to respond to a series of qualitative questions exploring their cognitions surrounding exercise, control, commitment and challenge. Some responses to these qualitative questions suggested that participants had noticed changes in their thoughts of control, commitment, and challenge. These changes in thought, however, seemed to be specific to training, nutrition or health. It appeared participants did not experience changes in thoughts in other areas of their life like the researcher believed they would. The additional qualitative questions may have not been comprehensive enough to reveal transferences in thought. A future study involving full qualitative interviews may be able to provide additional information surrounding thought changes. Additionally, future researchers should consider examining why thoughts surrounding exercise do not necessarily transfer to other areas in life. Participants who indicated their levels of commitment had increased and sought out new challenges seemed to have psychologically benefitted from more strenuous HIIT exercises. How to transfer these new thoughts and cognitive processes to other areas in life could be very beneficial to future fitness and overall mental well-being research.

Considering how some of the qualitative responses indicated thoughts did not transfer to other contexts in life, it may have been that hardiness was not affected at all through HIIT. It

could have been that participants who seek out HIIT are already high in hardiness. In further research on hardiness, it may be more important to determine how various types of exercises attract different types of participants compared to how various forms of classes affect personality characteristics. Knowing why certain people do and do not participate in various forms of exercise could provide helpful information for designing fitness classes that attract people who have a hard time committing to exercise. It can be inferred from the current results that hardy people may try HIIT because of their tendency to seek out new challenges.

Hardiness, at its core, deals with how individuals interpret stressful situations (Maddi, 2006). While HIIT may be perceived as more stressful than other forms of exercise (Oliveira et al., 2013), the type of stress felt in exercise may not be equivalent to stress felt in other areas of life. Future researchers may want to examine the difference between psychological and physical stress in terms of their effect on the individual. Each type of stress may influence the participant differently on a psychological level. Whichever form of stress was predominant in the current study, some cognitive changes were observed by the participants. Qualitative responses indicated that participants noticed some form of psychological change. Future researchers, therefore, should consider other constructs to measure besides hardiness. Constructs such as coping styles or self-efficacy (Delahaji et al., 2010) could have been influenced by HIIT, but were not measured in the current study. Knowing how HIIT affects participants psychologically could help promote benefits other than physiological fitness to future participants and provide a treatment to those seeking mental health through various forms of exercise.

In conclusion, in order to understand the psychological effects of the increasingly popular HIIT (Thompson, 2013), efforts must be directed at exploring various constructs beyond hardiness. Participants are reporting psychological effects of participating in HIIT, but what

psychological constructs those changes affect has yet to be determined. Determining how and why participants may or may not be psychologically affected by HIIT could shed light onto a host of mental benefits or detriments of HIIT that have previously gone unexplored. Researchers already suggest that CrossFit training, a form of HIIT, has numerous physiological benefits (Smith et al., 2013); yet potential psychological benefits or detriments have yet to be discovered. Participants may be able to benefit psychologically from HIIT in a capacity that affects perspectives or mental processes. On the other hand, it is equally important to understand if HIIT training causes psychological detriments so that training modalities can be adjusted for the best possible outcomes. Overall, there was a need to examine the psychological effects of a growing type of fitness training, CrossFit and HIIT, and it appears that some changes may be perceived by novice participants; however, additional evidence is needed.

References

- Alkahtani, S. A., King, N. A., Hills, A. P., & Byrne, A. M. (2013). Effect of interval training intensity on fat oxidation, blood lactate and the rate of perceived exertion in obese men. *SpringerPlus*, 2, 1-10. doi: 10.1186/2193-1801-2-532
- Allred, K. D., & Smith, T. W. (1989). The hardy personality: Cognitive and physiological responses to evaluative threat. *Journal of Personality and Social Psychology*, 56(2), 257-266. doi:10.1037/0022-3514.56.2.257
- Bartone, P. T. (1999). Hardiness protects against war-related stress in Army Reserve forces. *Consulting Psychology Journal: Practice and Research*, 51(2), 72-82. doi:10.1037/10614087.51.2.72
- Boot camp Workout: Is it right for you? (2013, April 16). *Mayoclinic.org*. Retrieved from February 23, 2014, from <http://www.mayoclinic.org/boot-camp-workout/art-20046363>.
- Burke, S. M., Shapcott, K. M., Carron, A. V., Bradshaw, M. H., & Estabrooks, P. A. (2010). Group goal setting and group performance in a physical activity context. *International Journal of Sport and Exercise Psychology*, 8(3), 245-261.
- Delahaij, R., Gaillard, A. K., & van Dam, K. (2010). Hardiness and the response to stressful situations: Investigating mediating processes. *Personality and Individual Differences*, 49(5), 386-390. doi:10.1016/j.paid.2010.04.002
- Cooperman, R. (2013, July 25). Six Crossfit stars to watch. Retrieved from <http://espn.go.com/espnw/athletes-life/article/9489102/espnw-six-stars-watch-yearcrossfit-games>

- Driller, M. W., Fell, J. W., Gregory, J. R., Shing, C. M., & Williams, A. D. (2009). The effects of high-intensity interval training in well-trained rowers. *International Journal of Sports Physiology and Performance*, 4(1), 110-121.
- Deuster, P., & Silverman, M. (Oct-Dec, 2013). Physical fitness: A pathway to health and resilience. *United States Army Medical Department Journal*, 24-35.
- Dunham, C., & Harms, C. (2012). Effects of high-intensity interval training on pulmonary function. *European Journal of Applied Physiology*, 112(8), 3061-3068.
- Fitness Bootcamp Power. (2011). *The benefits of fitness bootcamp for losing fat and staying focused*. Retrieved from <http://www.fitnessbootcamppower.com/the-benefits-of-fitness-bootcamp-for-losing-fat-and-staying-focused/>
- Florian, V., Mikulincer, M., & Taubman, O. (1995). Does hardiness contribute to mental health during a stressful real-life situation? The roles of appraisal and coping. *Journal of Personality and Social Psychology*, 68(4), 687-695. doi:10.1037/0022-3514.68.4.687
- Fragala, M. S., Kraemer, W. J., Denegar, C. R., Maresh, C. M., Mastro, A. M., & Volek, J. S. (2011). Neuroendocrine-immune interactions and responses to exercise. *Sports Medicine*, 41(8), 621-639.
- Gibala, M. J., Little, J. P., MacDonald, M. J., & Hawley, J. A. (2012). Physiological adaptations to low-volume, high-intensity interval training in health and disease. *Proceedings of The Physiological Society*, 252-259. doi:10.1113/jphysiol.2011.224725
- Gillen, J. (2012). Low-volume, high-intensity interval training: A practical fitness strategy. *Wellspring*, 23(4), 1-4.

- Golby, J., & Sheard, M. (2004). Mental toughness and hardiness at different levels of rugby league. *Personality and Individual Differences*, 37(5), 933-942.
doi:10.1016/j.paid.2003.10.015
- Goss, J. D. (1994). Hardiness and mood disturbances in swimmers while overtraining. *Journal of Sport and Exercise Psychology*, 16(2), 135-149.
- Hanton, S., Neil, R., & Evans, L. (2011). Hardiness and anxiety interpretation: An investigation into coping usage and effectiveness. *European Journal of Sport Science*, 13(1), 96-104.
doi:10.1080/17461391.2011.635810
- Hatle, H., Støbakk, P., Mølmen, H., Brønstad, E., Tjønnå, A., Steinshamn, S., ... Rognum, Ø. (2014). Effect of 24 sessions of high-intensity aerobic interval training carried out at either high or moderate frequency, a randomized trial. *Plos ONE*, 9(2), 1-7.
doi:10.1371/journal.pone.0088375
- Hessling, R., Traxel, N., & Schmidt, T. (2004). Ceiling effect. In M. S. Lewis-Beck, A. Bryman, & Ti. Futing Liao (Eds.), *The SAGE Encyclopedia of Social Science Research Methods* (p. 107). Thousand Oaks, CA: Sage Publications. doi:
<http://dx.doi.org/10.4135/9781412950589.n102>
- How Fast is CrossFit Growing? The Chart - Tabata Times. (2012, November 14). Retrieved March 28, 2015, from <http://www.tabatatimes.com/how-fast-is-crossfit-growing-the-chart-tells-the-story/>
- Iaia, F. M., & Bangsbo, J. J. (2010). Speed endurance training is a powerful stimulus for physiological adaptations and performance improvements of athletes. *Scandinavian Journal of Medicine and Science in Sports*, 20, 11-23.

- Jay, K., Jakobsen, M., Sundstrup, E., Skotte, J., Jørgensen, M., Andersen, C.H., ... Andersen, L. (2013). Effects of kettlebell training on postural coordination and jump performance: A randomized controlled trial. *Journal of Strength and Conditioning Research*, 27(5), 1202-1209. doi:10.1519/JSC.0b013e318267a1aa
- Johnsen, B., Bartone, P., Sandvik, A. M., Gjeldnes, R., Morken, A., Hystad, S., & Stornæs, A. V. (2013). Psychological hardiness predicts success in a Norwegian armed forces border patrol selection course. *International Journal of Selection and Assessment*, 21(4), 368-375. doi:10.1111/ijsa.12046
- Jones, G. (1995). More than just a game: Research developments and issues in competitive anxiety in sport. *British Journal of Psychology*, 86(4), 449-478.
- Judkins, S., Reid, B., & Furlow, L. (2006). Hardiness training among nurse managers: Building a healthy workplace. *Journal of Continuing Education in Nursing*, 37(5), 202-207.
- Karp, J. (2009). The three metabolic energy systems. *IDEA Fitness Journal*, 6(2), 26-29.
- Khoshaba, D. M., & Maddi, S. R. (1999). Early experiences in hardiness development. *Consulting Psychology Journal: Practice and Research*, 51(2), 106-116. doi:10.1037/1061-4087.51.2.106
- Khoshaba, D. M., & Maddi, S. R. (2001). *HardiTraining*. Irvine, CA: Hardiness Institute.
- King, A., Haskell, W., Young, D., Oka, R., & Stefanick, M. (1995). Long-term effects of varying intensities and formats of physical activity on participation rates, fitness, and lipoproteins in men and women aged 50 to 65 years. *Circulation*, 91(10), 2596-2604.
- Kolb, B., & Whishaw, I. Q. (2011). *An introduction to brain and behavior*. New York, NY: Worth Publishers.

- Kobasa, S. (1979). Stressful life events, personality, and health: an inquiry into hardiness. *Journal of Personality and Social Psychology*, 37(1), 1-11.
- Kobasa, S. C., Maddi, S. R., & Kahn, S. (1982). Hardiness and health: A prospective study. *Journal of Personality and Social Psychology*, 42(1), 168-177. doi:10.1037/0022-3514.42.1.168
- Kilgore, L. L., & Rippetoe, M. M. (2007). Redefining fitness for health and fitness professionals. *Journal of Exercise Physiology Online*, 10(2), 34-39.
- Laursen, P. B., & Jenkins, D. G. (2002). The scientific basis for high-intensity interval training: Optimising training programmes and maximising performance in highly trained endurance athletes. *Sports Medicine*, 32(1), 53-73.
- Little, J. P., Gillen, J. B., Percival, M. E., Safdar, A., Tarnopolsky, M. A., Punthakee, Z., ...Gibala, M. J. (2011). Low-volume high-intensity interval training reduces hyperglycemia and increases muscle mitochondrial capacity in patients with type 2 diabetes. *Journal of Applied Physiology*, 111(6), 1554-1560.
- Tavakol, M. & Dennick, R. (2011). Making sense of cronbach's alpha. [Editorial]. *International Journal of Medical Education*, 2, 53-55.
- Maddi, S. R. (1999). The personality construct of hardiness: I. Effects on experiencing, coping, and strain. *Consulting Psychology Journal: Practice and Research*, 51(2), 83-94. doi:10.1037/1061-4087.51.2.83
- Maddi, S. R. (2002). The story of hardiness: Twenty years of theorizing, research, and practice. *Consulting Psychology Journal: Practice and Research*, 54(3), 173-185.
- Maddi, S. R. (2004). Hardiness: An operationalization of existential courage. *Journal of Humanistic Psychology*, 44(3), 279-298.

- Maddi, S. R. (2006). Hardiness: The courage to grow from stresses. *The Journal of Positive Psychology, 1*(3), 160-168. doi:10.1080/17439760600619609
- Maddi, S. R. (2007). Relevance of hardiness assessment and training to the military context. *Military Psychology, 19*(1), 61-70. doi:10.1080/08995600701323301
- Maddi, S. R., Harvey, R. H., Khoshaba, D. M., Fazel, M., & Resurreccion, N. (2009). Hardiness training facilitates performance in college. *The Journal of Positive Psychology, 4*(6), 566-577. doi:10.1080/17439760903157133
- Maddi, S. R., Harvey, R. H., Khoshaba, D. M., Lu, J. L., Persico, M., & Brow, M. (2006). The personality construct of hardiness, III: Relationships with repression, innovativeness, authoritarianism, and performance. *Journal of Personality, 74*(2), 575-598. doi:10.1111/j.1467-6494.2006.00385.x
- Maddi, S. R., & Hess, M. J. (1992). Personality hardiness and success in basketball. *International Journal of Sport Psychology, 23*, 360-368.
- Maddi, S. R., Kahn, S., & Maddi, K. L. (1998). The effectiveness of hardiness training. *Consulting Psychology Journal: Practice and Research, 50*(2), 78-86.
- Maddi, S. R., & Khoshaba, D. M. (2001) *Personal Views Survey*. (3rd ed., rev.). Newport Beach, CA: The Hardiness Institute.
- Maddi, S. R., Khoshaba, D. M., Harvey, R. H., Fazel, M., & Resurreccion, N. (2011). The personality construct of hardiness, V: Relationships with the construction of existential meaning in life. *Journal of Humanistic Psychology, 51*(3), 369-388. doi:10.1177/0022167810388941
- Malina, R. M., & Little, B. B. (2008). Physical activity: The present in the context of the past. *American Journal of Human Biology, 20*, 373-391.

- McLeod, T. C. V., Armstrong, T., Miller, M., & Sauers, J. L. (2009). Balance improvements in female high school basketball players after a 6-week neuromuscular-training program. *Journal of Sport Rehabilitation, 18*, 465-481.
- Meyer, P., Guiraud, T., Gayda, M., Juneau, M., Bosquet, L., & Nigam, A. (2010). High-intensity aerobic interval training in a patient with stable angina pectoris. *American Journal of Physical Medicine and Rehabilitation, 89*(1), 83-86.
- Molmen-Hansen, H., Stolen, T., Tjonna, A., Aamot, I., Ekeberg, I., Tyldum, G., ... Stoylen, A. (2012). Aerobic interval training reduces blood pressure and improves myocardial function in hypertensive patients. *European Journal of Preventive Cardiology, 19*(2), 151-160.
- Nybo, L., Sundstrup, E., Jakobsen, M., Mohr, M., Hornstrup, T., Simonsen, L., ... Krstrup, P. (2010). High-intensity training versus traditional exercise interventions for promoting health. *Medicine and Science in Sports and Exercise, 42*(10), 1951-1958.
doi:10.1249/MSS.0b013e3181d99203
- O'Hara, R. B., Serres, J., Traver, K. L., Wright, B., Vojta, C., & Eveland, E. (2012). The influence of nontraditional training modalities on physical performance: Review of the literature. *Aerospace Medicine and Human Performance, 83*(10), 985-990.
- Oliveira, B. R., Slama, F. A., Deslandes, A. C., Furtado, E. S., & Santos, T. M. (2013). Continuous and high-intensity interval training: Which promotes higher pleasure? *Plos ONE, 8*(11), 1-6. doi:10.1371/journal.pone.0079965
- Oman, R. F., & Duncan, T. E. (1995). Women and exercise: An investigation of the roles of social support, self-efficacy, and hardiness. *Medicine, Exercise, Nutrition, and Health, 4*(5), 306-315.

- Partridge, J. A., Knapp, B. A., & Massengale, B. D. (2014). An investigation of motivational variables in CrossFit facilities. *Journal of Strength and Conditioning Research*, 28(6), 1714-1721.
- Percia, M., Davis, S., & Dwyer, G. (2012). Getting a professional fitness assessment. *American College of Sports Medicine (ACSM) Articles*. Retrieved from <http://www.acsm.org/access-public-information/articles/2012/01/10/getting-a-professional-fitness-assessment>
- Peterson, M. D., Sen, A., & Gordon, P. M. (2011). Influence of resistance exercise on lean body mass in aging adults. *Medicine and Science in Sports and Exercise*, 43, 249-258.
- Pollock, S. (1999). Health-related hardiness with different ethnic populations. *Holistic Nursing Practice*, 13(3), 1-10.
- Porcari, J., Hendrickson, K., & Foster, C. (2008). Drop and give me 20! *ACE Fitness Matters*, 14(4), 6-9.
- Rao, R., Cruz, V., Yan, P., Harker-Murray, A., Haley, B. B., Hong, Z., ... Euhus, D. (2012). Bootcamp during neoadjuvant chemotherapy for breast cancer: A randomized pilot trial. *Breast Cancer: Basic and Clinical Research*, (6), 39-46. doi:10.4137/BCBCR.S9221
- Sandbakk, Ø., Sandbakk, S. B., Ettema, G., & Welde, B. (2013). Effects of intensity and duration in aerobic high intensity interval training in highly trained junior cross country skiers. *Journal of Strength and Conditioning Research*, 27(7), 1974-1980.
- Sandvik, A. M., Bartone, P. T., Hystad, S., Phillips, T. M., Thayer, J. F., & Johnsen, B. (2013). Psychological hardiness predicts neuroimmunological responses to stress. *Psychology, Health and Medicine*, 18(6), 705-713.

- Sheard, M. (2009). A cross-national analysis of mental toughness and hardiness in elite university rugby league teams. *Perceptual and Motor Skills, 109*, 213-223.
doi:10.2466/PMS.109.1.213-223
- Sheard, M., & Golby, J. (2007). Hardiness and undergraduate academic study: The moderating role of commitment. *Personality and Individual Differences, 43*(3), 579-588.
doi:10.1016/j.paid.2007.01.006
- Sheard, M., & Golby, J. (2010). Personality hardiness differentiates elite-level sport performers. *International Journal of Sport and Exercise Psychology, 8*(2), 160-169.
doi:10.1080/1612197X.2010.9671940
- Shirayev, T., & Barclay, G. (2012). Evidence based exercise - Clinical benefits of high intensity interval training. *Australian Family Physician, 41*(12), 960-962.
- Sillanpaa, E., Hakkinen, A., Nyman, K., Mattila, M., Cheng, S., Karavirta, L., ... Hakkinen, K. (2008). Body composition and fitness during strength and/or endurance training in older men. *Medicine and Science in Sports and Exercise, 40*(5), 950-957. doi:
10.1249/MSS.0b013e318165c854
- Smith, J. A., Hauenstein, N. A., & Buchanan, L. B. (1996). Goal setting and exercise performance. *Human Performance, 9*(2), 141-154.
- Smith, M. M., Sommer, A. J., Starkoff, B. E., & Devor, S. T. (2013). Crossfit-based high intensity power training improves maximal aerobic fitness and body composition. *Journal of Strength and Conditioning Research, 27*(11), 3159-3172.
- Sperlich, B., De Marées, M., Koehler, K., Linville, J., Holmberg, H., & Mester, J. (2011). Effects of 5 weeks' high-intensity interval training vs. volume training in 14-year-old soccer

- players. *Journal of Strength and Conditioning Research*, 25(5), 1271-1278.
doi:10.1519/JSC.0b013e3181d67c38
- Talanian, J. L., Galloway, S. D. R., Heigenhauser, G. J. F., Bonen, A., & Spriet, L. L. (2006). Two weeks of high-intensity aerobic interval training increases the capacity for fat oxidation during exercise in women. *Journal of Applied Physiology*, 102, 1439-1447.
doi:10.1152/jappphysiol.01098.2006
- Thomas, S., Reeves, C., & Agombar, J. (2013). Personality hardiness at different levels of competitive motorcycling. *Perceptual and Motor Skills: Exercise and Sport*, 116(1), 315-321. doi:10.2466/30.06.PMS.116.1.315-321
- Thurston, M., & Green, K. (2004). Adherence to exercise in later life: How can exercise on prescription programmes be made more effective? *Health Promotion International*, 19(3), 379-387.
- Thompson, W. R. (2013). Now trending: Worldwide survey of fitness trends for 2014. *ACSM's Health and Fitness Journal*, 17(6), 10-20.
- Tomich, J. (2010). How to become a bootcamp instructor - A guide to fitness training certifications [blog post]. Retrieved from <http://bostonbootcamps.blogspot.com/2010/09/how-to-become-bootcamp-instructor-guide.html>.
- Tortora, G. J., & Nielsen, M. T. (2012). *Principles of human anatomy*. Jefferson City, MO: John Wiley and Sons, Inc.
- Tremblay, A., Simoneau, J. A., & Bouchard, C. (1994). Impact of exercise intensity on body fatness and skeletal muscle metabolism. *Metabolism*, 43(7), 814-818.

“What is Crossfit?” (n.d.) Retrieved February 3, 2014 from <http://www.crossfit.com/cf-info/what-is-crossfit.html>

“What is Fitness?” (October, 2002). CrossFit Journal. Retrieved March 5, 2014, from http://library.crossfit.com/free/pdf/CFJ_Trial_04_2012.pdf

Wieser, R., & Thiel, H. (2012). A survey of “mental hardiness” and “mental toughness” in professional male football players. *Chiropractic Evidence*, 15(2), 98-99.

Wisløff, U., Støylen, A., Loennechen, J., Bruvold, M., Rognum, Ø., Haram, P., ... Skjaerpe, T. (2007). Superior cardiovascular effect of aerobic interval training versus moderate continuous training in heart failure patients: A randomized study. *Circulation*, 115(24), 3086-3094.

Westman, M. (1990). The relationship between stress and performance: The moderating effect of hardiness. *Human Performance*, 3(3), 141-155.

Appendix A

Personal Views Survey III-R

Please answer the following 18 questions to the best of your ability, and as honestly as possible. This is important for report accuracy. There are no right or wrong answers.

0 = Not at all true 1 = A little true 2 = True 3 = Very True

1. By working hard, you can always achieve your goal.	0	1	2	3
2. I don't like to make changes in my everyday schedule.	0	1	2	3
3. I really look forward to my work.	0	1	2	3
4. I am not equipped to handle the unexpected problems of life.	0	1	2	3
5. Most of what happens in life is just meant to be.	0	1	2	3
6. When I make plans, I'm certain I can make them work.	0	1	2	3
7. No matter how hard I try, my efforts usually accomplish little.	0	1	2	3
8. I like a lot of variety in my work.	0	1	2	3
9. Most of the time, people listen carefully to what I have to say.	0	1	2	3
10. Thinking of yourself as a free person just leads to frustration.	0	1	2	3
11. Trying your best at what you do usually pays off in the end.	0	1	2	3
12. My mistakes are usually very difficult to correct.	0	1	2	3
13. It bothers me when my daily routine gets interrupted.	0	1	2	3
14. I often wake up eager to take up life wherever it left off.	0	1	2	3
15. Lots of times, I really don't know my own mind.	0	1	2	3
16. Changes in routine provoke me to learn.	0	1	2	3

- | | | | | |
|---|---|---|---|---|
| 17. Most days, life is really interesting and exciting
for me. | 0 | 1 | 2 | 3 |
| 18. It's hard to imagine anyone getting excited about
working. | 0 | 1 | 2 | 3 |

Reprinted with the permission of the Hardiness Institute.

Appendix B

(Qualitative Questions)

- 1. Has the past 8 weeks of training affected you, if at all, mentally?**
- 2. How have the past 8 weeks of training affected your sense of commitment to any part of your life, if at all. If so, please explain.**
- 3. How have the past 8 weeks of training affected your sense of control to any part of your life, if at all. If so, please explain.**
- 4. How have the past 8 weeks of training affected your sense of challenge to any part of your life, if at all. If so, please explain.**

Appendix C

Demographics Questions

Age: How old are you? _____

Gender Identity: Male: _____ ; **Female** _____ ; **Transgender** _____ ; **Other** _____ ; **Prefer not to respond** _____

Ethnicity with which you most identify (*place a check or x to the response that applies to you*):

- _____ White – not Hispanic/Latino(a)
- _____ Black/African-American – Not Hispanic
- _____ Hispanic/Latino(a)
- _____ Asian or Pacific Islander
- _____ American Indian, Alaskan Native or Native Hawaiian
- _____ Biracial or Multiracial
- _____ Other
- _____ Prefer not to respond

Appendix D

Boot camp survey qualifying questions

“In the past 8 weeks did you attend a boot camp class at least once a week?”

“If yes, on average, how many times per week did you attend a boot camp fitness class?”