Weighing the Options:

Assessing Two-A-Day Practices in Collegiate Football

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Abstract

The following study examined the effectiveness and administrative implications of Virginia Tech football's two-a-day practice schedule changes. More specifically, the research examined the relationship between weight loss and hydration as associated with two-a-day practices and studied the deviation with relations to practice patterns. Participants included members of the Virginia Tech Football team for the years 2001, 2002, 2003, and 2004. All participants were examined by the team physician and declared fit to participate in Division IA NCAA collegiate football. Measures included the amount of weight loss and the number of heat related incidences (i.e. heat illness and IV fluid administration) from 2001 through 2004 seasons to determine if a change in practice patterns could reduce or minimize heat related illnesses.

There were numerous findings from the study to suggest that the changes in NCAA and Virginia Tech two-a-day practice policies were successful in the prevention of heat related incidences and improving the overall safety for the participants. This study concluded that the overall weight loss among players decreased in accordance with the mandated practice changes. In addition, the number of heat related illnesses decreased from 2001 to 2004. Upon examination of these factors, it can be concluded that the practice schedule changes have in fact, been effective at decreasing weight loss/hydration among players and preventing heat related illness.

These findings can be used by athletic administrators to further develop athletic policies that will ensure the safety of student athletes involved in collegiate football during extreme environmental conditions. In addition, this study displays the cost effectiveness of both medical personnel and hydration supplies in the reduction of heat related illnesses during two a day practice sessions.

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TABLE OF CONTENTS

INTRODUCTION………………………………………………………………... 1

Purpose………………………………………………………………………… 3
Significance……………………………………………………………………. 3
Limitations of the Study…………………………………………………...... 4
Assumptions………………………………………………………………… 4
Definition of Terms…………………………………………………………... 5

REVIEW OF LITERATURE……………………………………………….. 8

It's Getting Hot In Here: The Body's Response to Heat……………………… 8
Heat Illnesses: Exercise Associated Heat Cramps……………………………. 11
Heat Exhaustion……………………………………………………………….. 12
Exertional Heat Stroke……………………………………………………..... 13
Heat Syncope………………………………………………………………….. 15
Exertional Hyponatremia…………………………………………………..... 16
Heat Illnesses Prevention Reccomendations………………………………….. 17
Football Responds: Passing the HEAT………………………………………. 20
Virginia Tech Responds……………………………………………………….. 26

METHODOLOGY…………………………………………………………….. 30

Selection Criteria……………………………………………………………… 30
Measures………………………………………………………………………. 31
Instrumentation……………………………………………………………….... 31
Sample………………………………………………………………………… 35
Variables………………………………………………………………………. 39
Data Collection and Analysis………………………...……………………… 39

RESULTS……………………………………………………………………… 44

Average Weight Lost per Player from the Start to End of Camp…………….. 45

Average Weight Lost per Player per Session of Camp……………………….. 47
Average Weight Lost per Player on Two Session Days………………………. 49
Episodes of 3% or More Loss of Body Weight……………………………….. 51
Multiple Episodes of 3% Loss of Body Weight………..…………………… 53
Weather Conditions…………………………………………………………. 55
Number of Players Suffering from Heat Related Conditions………………….. 57

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER RESEARCH ………………………………………………………………………. 59

Average Weight Lost per Player from the Start to End of Camp and per Session 59
Average Weight Lost per Player on Two Session Days……………………….. 60
Episodes of 3% or More Loss of Body Weight……………………………… 60
Multiple Episodes of 3% or More Loss of Body Weight………………………. 61
Number of Players Suffering from Heat Related Conditions…………………... 61
Additional Variables…………………………………………………………. 62
Number of Medical Staff……………………………………………………….. 62
Gatorade Budget……………………………………………………………… 65
Recommendations for Future Research……...………………………………….. 67
Conclusions…………………………………………………………………… 69

REFERENCES……………………………………………………………………… 72

APPENDICES……………………………………………………………………… 79

Appendix A, 2002 Football Preseason Weights………………………………… 79
Appendix B, 2002 Entrance Weights, Exit Weights and Weight Loss….……… 84
Appendix C, 2002 Average Weight Lost per Session……………………….. 88
Appendix D, 2002 Players Who Lost at Least 3% of their Body Weight……… 89
Appendix E, Virginia Tech Sports Medicine…………………………………… 91
Appendix F, Average Daily Temperatures During Preseason Football Camp and Average Temperature for Camp in 2002……………………………………… 92
Appendix G, Average Daily Relative Humidity During 2002 Preseason FB Camp and Average Relative Humidity for Camp……………………………….. 93
Appendix H, 2002 Classification of Days……………………………………… 94

VITAE………………………………………………………………………………. 95

LIST OF FIGURES

FIGURE 1	Temperature recording template…………………………………......	32
FIGURE 2	Weight recording template……………………………………...	34
FIGURE 3	Sample size…………………………………………………….	36
FIGURE 4	Data for each year for quarterbacks……………………………….	38
FIGURE 5	Heat stress indicator chart…………………………………………	41
FIGURE 6	Experimental protocol…………………………………………….	43
FIGURE 7	Average weight lost per player from the start to end of camp……	46
FIGURE 8	Average weight lost per player per session of camp……………...	48
FIGURE 9	Average weight lost per player on two session days………………	50
FIGURE 10	Episodes of 3% or more loss of body weight……………………..	52
FIGURE 11	# of players who suffered multiple episodes of 3% loss of BW….	54
FIGURE 12	Weather conditions……………………………………………….	56
FIGURE 13	# of players suffering from heat cramps/administered IV fluids…	58
FIGURE 14	# of medical staff present during preseason practices……………	64
FIGURE 15	Gatorade budget………………………………………………….	66

CHAPTER 1
INTRODUCTION

In the summer of 2001, three football players lost their lives to heat related injuries. Minnesota Vikings tackle Korey Stringer collapsed during practice on July 31 and died the next day, as did Travis Stowers, a high school player near Michigantown, Ind. Less than a week earlier, Eraste Autin, an incoming freshman at the University of Florida, died of complications of heatstroke. He collapsed at the end of a voluntary summer conditioning session, was in a coma for six days and died (ESPN, 2002).

According to the listed causes of death, each year since 1995 an average of three football players-high school, college, or professional died because of heat stroke (Binkley 2002; Eichner 2002; GSSI 2002; Maughan, Leiper, & Shirreffs, 1996; Sparling & Stafford, 1999). The National Federation of State High School Associations reported that from 1995 through the 2001 football season there were 15 high school heat stroke deaths among players (NFHS, 2003). Additionally, estimates suggest more heat related incidents are under- reported by football players such as cramping, heat exhaustion, and heat syncope (dizziness). The severe environmental conditions coupled with uniforms that include protective padding and helmets often expose these athletes to significant heat stress.

Traditional approaches to determining “safe” environmental conditions for football have either relied on guesswork or simply noting the conditions in which fatalities have occurred and assumed that less extreme conditions are safe (Kulka & Kenney, 2002). The combination of exercise and high environmental heat stress can produce dehydration or loss of body fluids. The body regulates heat by transferring metabolic heat from the core to the skin, which is dissipated to the environment via sweating. According to Sparling and Stafford (1999), the sweat-rate determination may be the best approximation of individual fluid requirements in the heat. Sweat loss is easily estimated in the field by measuring the difference between pre-exercise and post exercise body weight. Studies have shown that weight loss can be a marker for dehydration or excess loss of fluids during intense environmental conditions (Sauka, Montain & Latzka, 2001; Binkley et al, 2002).

Several incidents occurred during the 2001-2002 academic year, which prompted the Big East Conference to identify prevention of heat related illnesses as a primary objective. Consequently, the Big East Conference requested a comprehensive review of each school's protocol for avoiding environmental injuries.

In 2003, the National Collegiate Athletic Association (NCAA) implemented rule changes for preseason football practices in response to heat-injury related deaths of collegiate football players. These deaths were felt to be secondary to dehydration and heat stress that occurred during the "two-a-day" preseason practices. Virginia Tech Football adopted these principles in 2002, a year prior to the new NCAA legislation. From the administrative perspective, our practice structure is in place to protect the student athlete from heat injury and the university liability. None of the changes suggested by the NCAA or implemented by our University are based upon anything more than common sense.

Prior to 2002, Virginia Tech football players participated in two practices daily for the three-week preseason period every summer. Since 2002, two daily practices have not been held on consecutive days. In addition, the times of practices have been scheduled to avoid the hottest hours of the day (12 noon to 4 p.m.). These changes were implemented in order to protect unaccommodating football players from developing heat related injuries. Currently there is no administrative gauge in place to monitor weight loss and hydration for collegiate football players during the two-a-day practice regimen.

Purpose

This study was designed to determine the effectiveness and administrative implications of Virginia Tech practice schedule changes. More specifically, the research examined weight loss and hydration associated with the two-a-day practices and their relationship to practice patterns and the findings will be used to develop athletic policies necessary to ensure safety of student athletes involved in collegiate football during extreme environmental conditions. This study answers the following research questions: What is the effectiveness of the revised practice schedule? What are the implications for Virginia Tech? It is hypothesized that the revised practice schedule (two-one-two-one) regimen is overall better for collegiate athletes and lower weight loss and a lower number of heat related conditions will be observed under the new practice guidelines.

Significance

From an administrative perspective, the results of this study facilitate the development of preseason practice protocols to ensure player safety under extreme environmental conditions as well as highlight the need to monitor player's weight and hydration during preseason practices. In addition to providing direct comparisons in weight loss and other heat related conditions between the two-two-two practice sessions and the two-one-two sessions, the proposed study benefits athletic administrators, coaches, and sports medicine personnel by establishing the validity of the NCAA rule changes. In addition, the study provides an administrative framework for tracking its effectiveness at preventing heat related illnesses in student athletes.

Limitations of the Study

The study has the following limitations:

-There is only one year worth of data in the old practice regime (two-two-two) compared to three years worth of data in the new practice regime (two-one-two).

-Lack of pre and post preseason practice athlete body mass index measurements.

-The results of this study are limited to participating varsity football players at Virginia Tech. Therefore, generalizations can only be made about these particular athletes participating in this study.

Assumptions

The study was based on the following assumptions:

- That student athlete weight loss and hydration status is dependent on the practice regime and weather conditions.
- That the student athlete has given consent to have their weight loss analyzed, since the sports medicine staff requires all athletes to weigh-in and weigh-out for each practice to ensure their safety during preseason.
- Dietary and caloric intake is consistent throughout the preseason.
- Adjustments in weight (loss or gain) are in response to the practice regime.
- Weight loss equates to water weight loss versus body mass.
- The opportunity for athletes to rehydrate and replenish electrolyte stores is consistent each day of preseason practice.

Definition of Terms

For the purpose of this study, the following terms are defined to bring about a better understanding of what is written in this investigation.

1. Acclimation: To adjust to a different climate, especially to changes in altitude and weather.
2. Adipose Tissue: Connective tissue in which fat is stored and which has the cells distended by droplets of fat.
3. Core Temperature: The temperature deep within the body.
4. Core Temperature Sensor: A small thermometer located within an ingestible capsule that is used to monitor the actual core body temperature of the taker.
5. Dehydration or hypohydration: The large loss of water from the body tissues.
6. Dry Bulb Temperature: The ambient air temperature measured with a standard thermometer.
7. Electrolyte: Any of the ions (as of sodium, potassium, calcium, or bicarbonate) that in a biological fluid regulate or affect most metabolic processes.
8. Endogenous Heat Product: heat that is generated from within the body by normal processes.
9. Euhydrated: A state of hydration in which the body is optimally hydrated.
10. Exertional Hyponatremia: A deficiency of sodium in the blood due to increased physical exertion placed on the body (usually influenced by a loss of plasma sodium and exacerbated by hyperhydration with plain water.

11. Heat Cramping: Any cramp in the arm, leg or stomach caused by too little water and salt in the body due to physical exertion that causes heavy sweating and fluid loss.
12. Heat Exhaustion: A condition marked by weakness, nausea, dizziness, and profuse sweating that result from physical exertion in a hot environment.
13. Heat Stress: Exposure to a hot environment that reduces the capability for sustained activity and speeds up fatigue.
14. Heat Stroke: A severe and sometimes fatal condition that results from the failure of the body to regulate its temperature. A condition marked especially by cessation of sweating, extremely high body temperature, and collapses that result from prolonged exposure to high temperature.
15. Heat Syncope: A loss of consciousness resulting from insufficient blood flow to the brain due to over exposure to a heated environment.
16. Lactic Acidosis: A condition characterized by the accumulation of lactic acid in bodily tissues as a product of the anaerobic metabolism of glucose and glycogen.
17. Morbidity: The incidence of disease: the rate of sickness.
18. Mortality: The number of deaths in a given time or place.
19. Pallor: Deficiency of color especially of the face.
20. Sling Psychrometer: A hygrometer consisting essentially of two similar thermometers with the bulb of one being kept wet so that the cooling that results from evaporation makes it register a lower temperature than the dry one and with the difference between the readings constituting a measure of the dryness of the atmosphere.

21. Tachycardia: Relatively rapid heart action whether physiological (as after exercise) or pathological.

22. Wet Bulb Temperature: Measured using a standard mercury-in-glass thermometer, with the thermometer bulb wrapped in muslin, which is kept wet. One of the two thermometers apart of a sling psychrometer.

CHAPTER 2
REVIEW OF LITERATURE
It's Getting Hot in Here: The Body's Response to Heat

The human body, when exposed to excessive heat or overexertion, experiences dehydration. Studies have shown that during exercise in the heat, sweat output often exceeds water intake, resulting in a body water deficit (hypohydration) and electrolyte losses (Alonso, Teller, Andersen, Jensen, Hyldig, & Nielsen 1999; Cheung, McLellan, 1998; Sawka & Montain 2000; Sawka, Montain, & Latzka 2001). Fluid balance is essential in maintaining organ functions and ensuring optimum health. According to Sawka and Montain (2000) water provides the medium for biochemical reactions within cell tissues and is essential for maintaining an adequate blood volume and thus the integrity of the cardiovascular system. Electrolytes aid the body in moving fluids between intracellular and extracellular compartments, which maintain membrane electrochemical potentials. Heat stress coupled with physical exercise can result in fluid and electrolyte imbalances causing stress on internal organs and body functions.

Sawka and Montain (2000) maintain that to support the contraction of skeletal muscles, physical exercise routinely increases total body metabolism to five to 15 times the resting rate and approximately 70-90% of this energy is released as heat. Daily fluid requirements for sedentary to very active persons range from 2- 4 L/d in temperate climates and from 4-10 L/d in hot climates (Sawka & Montain, 2000). The exchange of heat (radiative and conductive) varies according to climatic conditions. Residents of desert climates often have sweating rates of 0.3-1.2 L/h while performing occupational activities (Adolph, 1947). In addition to climatic conditions, clothing and exercise influences the sweating rate. Studies have found that persons wearing protective garments often have a sweating rate of 1-2 L/h while performing light-intensity exercise in the heat (Levine, Quigley, Cadarettem, Sawka, & Pandolf, 1990). For athletes performing high intensity exercise in the heat sweating rates of 1-2.5 L/h are common (Sawka & Montain, 2000). For football players the presence or absence of the full practice uniform can have a significant influence on sweating rates. According to Kulka and Kennedy (2002), when compared with shorts only and practice uniforms, the pants in the full gear ensemble allow even less skin surface for evaporation and drive the core temperature up faster in less extreme environments.

In August of 2005, a scientific panel aimed at reducing the incidence of heat illnesses for High School Players was formed under the American College of Sports Medicine's guidance. The result was a set of guidelines emphasizing fluid replacement and acclimatization to the heat, as well as practice uniform and other modifications in order to reduce the risk for heat exhaustion and exertional heat stroke in young football players. The members of the panel suggests the overwhelming majority of serious heat illnesses occur in the first four days of preseason football practice when players are not acclimatized to the heat (Bergeron, McKeag, et al., 2005). Chairman of the Roundtable panel Michael F. Bergeron, Ph.D., FACSM added, findings are indicating that the primary reasons for a football player to overheat on the field are intensity and duration of practice, the environment and the uniform (Bergeron, 2005).

While studies have shown that fit individuals adapt more rapidly to heat exposure (Cheung and McLellan, 1998) the addition of protective clothing can create heat stress. Givoni and Goldman (1972) found that wearing protective clothing in the heat could result in a situation of uncompensable heat stress, where evaporative heat loss is limited and less than that to maintain thermal equilibrium. In these situations, increased aerobic fitness or heat acclimation may be of limited effectiveness in decreasing physiological strain or prolonging tolerance. Because of the limited water vapor permeability through the clothing, it is possible that the increased sweat production in trained or heat acclimated subjects may increase physiological stain by promoting a faster rate of dehydration rather than increasing evaporative heat loss (Nunnely, 1989). A critical deficit of 1% of body weight elevates core temperature during exercise (Rivera-Brown, Gutierrez, Guitierrez, Frontera, & Bar-Or, 1999). As the magnitude of water deficit increases, there is a concomitant graded elevation of core temperature during exercise heat stress (Sawka & Montain, 2000). During situations of stress and prolonged high sweat loss, adults will dehydrate by 2-8% BWL. Since water constitutes 45-70% of body weight, the average male is approximately 60% water weight (45 L). Adipose tissue is approximately 10% water whereas muscle is 75% water. Hence, trained athletes have relatively greater total body water than their sedentary counterparts by virtue of a smaller percentage of body fat and a higher concentration of skeletal muscle.

Dehydration can negatively influence aerobic power and physical work capacity (Sawka & Montain, 1996; 2000). Studies suggest that for a euhydrated person, climatic heat stress alone decreases maximal aerobic power by approximately 7%. It is believed that during exercise and a heat intense environment, maximal power is further decreased because of the change in cardiac output and oxygen delivery. It also has been shown to impair endurance performance. In a study of runners competing in the 1500, 5000 and 10,000m races, Armstrong et al.(1985) found that running performance was impaired at all distances but more in longer races (approx. 5% for the 5,000 and 10,000m) than in the shortest race (3% for the 1500m). Studies have shown that dehydration reduces the average body power by 5% (Burge, Carey, & Payne 1993; Armstrong 1985, Sawka & Montain, 2000). Therefore, body water imbalances can affect athletic performance.

Heat Illnesses: Exercise Associated Heat Cramps

Not only is performance compromised during heat exposure, but also some physiological damage can occur if proper precautions are avoided. The traditional classification of health illness defines three categories: heat cramps, heat exhaustion, and heat stroke. Other illnesses include heat syncope and exertional hyponatremia. Exercise associated heat cramps are present during or after intense exercise sessions as an acute, painful, involuntary muscle contraction. Proposed causes of the condition include fluid deficiencies, electrolyte imbalances, neuromuscular fatigue, or any combination of these factors. (Rich 1997; Binkley, Beckett, Casa, Kleiner & Plummer, 2002). Symptoms of heat cramps include dehydration, thirst, sweating, transient muscle cramps, and fatigue. The National Athletic Trainer's Association (NATA) suggests the following treatments for heat cramps:

- To relieve muscle spasms, the athlete should stop activity, replace lost fluids with sodium-containing fluids, and begin mild stretching with massage of the muscle spasm.
- Fluid absorption is enhanced with sports drinks that contain sodium. A high-sodium sports product may be added to the rehydration beverage to prevent or relieve cramping in athletes who lose large amounts of sodium in their sweat. A simple salted fluid consists of two 10-grain salt tablets dissolved in 1 L (34 oz) of water.

Intravenous fluids may be required if nausea or vomiting limits oral fluid intake; these must be ordered by a physician.

- A recumbent position may allow more rapid redistribution of blood flow to cramping leg muscles.

Heat Exhaustion

Heat exhaustion is the inability to continue exercise associated with any combination of heavy sweating, dehydration, sodium loss, and energy depletion. At its worst authors suggests that it is difficult to distinguish from exertional heat stroke. Other signs include pallor, persistent muscular cramps, urge to defecate, weakness, fainting, dizziness, headache, hyperventilation, nausea, diarrhea, decreased urine output and a body core temperature that generally ranges between 36°C and 40°C (Rich 1997; Brewster et al., 1974; Knochel, 1974). NATA recommends the following treatments for heat exhaustion:

- Cognitive changes are usually minimal, but assess central nervous system function for bizarre behavior, hallucinations, altered mental status, confusion, disorientation, or coma
- If feasible, measure body-core temperature (rectal temperature) and assess cognitive function and vital signs. Rectal temperature is the most accurate method possible in the field to monitor body-core temperature. The ATC should not rely on the oral, tympanic, or auxiliary temperature for athletes because these are inaccurate and ineffective measures of body-core temperature during and after exercise.

- If the athlete's temperature is elevated, remove his or her excess clothing to increase the evaporative surface and to facilitate cooling.
- Cool the athlete with fans, ice towels, or ice bags because these may help the athlete with a temperature of more than 38.8°C (102°F) to feel better faster.
- Remove the athlete to a cool or shaded environment if possible.
- Start fluid replacement.
- Transfer care to a physician if intravenous fluids are needed, or if recovery is not rapid and uneventful.

Exertional Heat Stroke

The most common cause of heat related fatalities is heat stroke in which organ systems fail because of an elevated core body temperature (usually > 40 °C or 104°F). Exertional heat stroke occurs when the temperature regulation system is overwhelmed due to excessive endogenous heat production or inhibited loss in challenging environmental conditions and can progress to complete thermoregulatory system failure (Casa & Roberts, 2003; Casa & Armstrong, 2003). This is a life threatening condition and symptoms include tachycardia, hypertension, sweating, hyperventilation, altered mental status, vomiting diarrhea, seizures, and coma. The risk of morbidity and mortality is greater the longer an athlete's body temperature remains above 41 °C or 106°F and is significantly reduced if the body temperature is lowered rapidly. Unlike classic heat stroke, exertional heat stroke occurs during physical activity and can cause other system malfunctions such as severe lactic acidosis in which lactic acid builds up in the blood or hyperkalmeria in which excessive potassium accumulated in the blood. Other conditions that can result from exertional heat stroke and can cause death include acute renal failure, rhabdomyolysis (destruction of skeletal muscles) and intravascular coagulation (Binkley, Beckett, Casa, Kleiner & Plummer, 2002). NATA suggests the following treatments for exertional heat stroke:

- Measure the rectal temperature if feasible to differentiate between heat exhaustion and heat stroke. With heat stroke, rectal temperature is elevated (generally higher than 40° C [104° F]).
- Assess cognitive function, which is markedly altered in exertional heat stroke
- Lower the body-core temperature as quickly as possible. The fastest way to decrease body temperature is to remove clothes and equipment and immerse the body (trunk and extremities) into a pool or tub of cold water (approximately 18°C to 15° C [35° F to 59° F]). Aggressive cooling is the most critical factor in the treatment of exertional heat stroke. Circulation of the tub water may enhance cooling.
- Monitor the temperature during the cooling therapy and recovery (every 5 to 10 minutes). Once the athlete's rectal temperature reaches approximately 38.3° C to 38.9° C (101°F to 102°F), he or she should be removed from the pool or tub to avoid overcooling.
- If a physician is present to manage the athlete's medical care on site, then initial transportation to a medical facility may not be necessary so immersion can continue uninterrupted.
- If a physician is not present, aggressive first-aid cooling should be initiated on site and continued during emergency medical system transport and at the hospital until the athlete is normothermic.

- Activate the emergency medical system.
- Monitor the athlete's vital signs and other signs and symptoms of heat stroke During transport and when immersion is not feasible, other methods can be used to reduce body temperature: removing the clothing; sponging down the athlete with cool water and applying cold towels; applying ice bags to as much of the body as possible, especially the major vessels in the armpit, groin, and neck; providing shade; and fanning the body with air.
- In addition to cooling therapies, first-aid emergency procedures or heat stroke may include airway management. In addition, a physician may decide to begin intravenous fluid replacement.
- Monitor for organ-system complications for at least 24 hours.

Heat Syncope

Heat syncope or orthostatic dizziness can occur when an individual is exposed to high environmental temperatures. This condition usually occurs during the first 5 days of acclimation. Heat syncope is attributed to peripheral vasodilation, postural pooling of blood, diminished venous return, dehydration, reduction in cardiac output and cerebral ischemia. Symptoms include dehydration, fatigue, tunnel vision, fainting, light-headedness, pale sweating skin, dizziness, and decreased pulse rate coagulation (Binkley, Beckett, Casa, Kleiner & Plummer, 2002). The National Athletic Trainer's Association (NATA) recommends the following guidelines for recognizing and treating heat syncope.

- If an athlete experiences a brief episode of fainting associated with dizziness, tunnel vision, pale or sweaty skin, and a decreased pulse rate but has a normal rectal temperature (for exercise, 36°C to 40°C [97°F to 104°F]), then heat syncope is most likely the cause.

- Move the athlete to a shaded area, monitor vital signs, elevate the legs above the level of the head, and rehydrate.

Exertional Hyponatremia

Exertional hyponatremia is a relatively rare condition in which the serum sodium levels in the body are less than 130mmol/L, which results from a combination of excessive fluid intake and inappropriate body water retention. Affected athletes present with a combination of disorientation, altered mental state, headache, vomiting, lethargy, and swelling of the extremities (hands and feet), pulmonary edema, cerebral edema, and seizures. Death can result if not properly treated. The condition may be prevented by matching fluid intake with sweat and urine losses and by rehydration with fluids that contain sufficient levels of sodium (Covertino, Armstrong, & Coyle, 1996). NATA recommends the following in the treatment of exertional hyponatremia:

- Attempt to differentiate between hyponatremia and heat exhaustion. Hyponatremia is characterized by increasing headache, significant mental compromise, altered consciousness, seizures, lethargy, and swelling in the extremities. The athlete may be dehydrated, normally hydrated, or over hydrated.
- Attempt to differentiate between hyponatremia and heat stroke. In hyponatremia, hyperthermia is likely to be less (rectal temperature less than 40°C [104°F]). The plasma sodium level is less than 130 mEq/L and can be measured with a sodium analyzer on site if the device is available.

- If hyponatremia is suspected, immediate transfer to an emergency medical center via the emergency medical system is indicated. An intravenous line should be placed to administer medication as needed to increase sodium levels, induce diuresis, and control seizures.
- An athlete with suspected hyponatremia should not be administered fluids until a physician is consulted.

Heat Illnesses Prevention Recommendations

In addition to recognition and treatment of heat related illnesses, the National Athletic Trainer's Association offers several core prevention guidelines, which include the following:

1. Ensure that appropriate medical care is available and that rescue personnel are familiar with exertional heat illness prevention, recognition, and treatment.

2. Conduct a thorough, physician-supervised, pre-participation medical screening before the season starts to identify athletes predisposed to heat illness based on risk factors and those who have a history of exertional heat illness.

3. Adapt athletes to exercise in the heat (acclimatization) gradually over 10 to 14 days. Progressively increase the intensity and duration of work in the heat with a combination of strenuous interval training and continuous exercise.

Well-acclimatized athletes should train for 1 to 2 hours under the same heat conditions that will be present for their event. In a cooler environment, an athlete can wear additional clothing during training to induce or maintain heat acclimatization. Athletes should maintain proper hydration during the heat-acclimatization process.

4. Educate athletes and coaches regarding the prevention, recognition, and treatment of heat illnesses and the risks associated with exercising in hot, humid environmental conditions.

5. Educate athletes to match fluid intake with sweat and urine losses to maintain adequate hydration. Instruct athletes to drink fluids containing sodium to keep their urine clear to light yellow to improve hydration and to replace fluids between practices on the same day and on successive days to maintain less than 2% body-weight change. These strategies will lessen the risk of acute and chronic dehydration and decrease the risk of heat-related events.

6. Encourage athletes to sleep at least six to eight hours at night in a cool environment, eat a well-balanced diet that follows the Food Guide Pyramid and United States Dietary Guidelines, and maintain proper hydration status. Athletes exercising in hot conditions (especially during twice-a-day practices) require extra sodium from the diet or rehydration beverages or both.

7. Develop event and practice guidelines for hot, humid weather that anticipate potential problems encountered based on the wet-bulb globe temperature (WBGT) or heat and humidity as measured by a sling psychrometer, the number of participants, the nature of the activity, and other predisposing risk factors. If the WBGT is greater than 28°C (82°F, or ‘‘very high), an athletic event should be delayed, rescheduled, or moved into an air-conditioned space, if possible. It is important to note that these measures are based on the risk of environmental stress for athletes wearing shorts and a T-shirt; if an athlete is wearing additional clothing (i.e. football uniform, wetsuit, helmet), a lower WBGT value could result in comparable risk of environmental heat stress. If the event or

practice is conducted in hot, humid conditions, then use extreme caution in monitoring the athletes and be proactive in taking preventive steps. In addition, be sure that emergency supplies and equipment are easily accessible and in good working order. The most important factors are to limit intensity and duration of activity, limit the amount of clothing and equipment worn, increase the number and length of rest breaks, and encourage proper hydration. Modify activity under high-risk conditions to prevent exertional heat illnesses. Identify individuals who are susceptible to heat illnesses. In some athletes, the prodromal signs and symptoms of heat illnesses are not evident before collapse, but in many cases, adept medical supervision will allow early intervention.

8. Check the environmental conditions before and during the activity, and adjust the practice schedule accordingly. Schedule training sessions to avoid the hottest part of the day (10 AM to 5 PM) and to avoid radiant heating from direct sunlight, especially in the acclimatization during the first few days of practice sessions.

9. Plan rest breaks to match the environmental conditions and the intensity of the activity. Exercise intensity and environmental conditions should be the major determinants in deciding the length and frequency of rest breaks. If possible, cancel or postpone the activity or move it indoors (if air-conditioned) if the conditions are ‘‘extreme or hazardous’’ or ‘‘very high.” General guidelines during intense exercise would include a work: rest ratio of 1:1, 2:1, 3:1, and 4:1 for ‘‘extreme or hazardous’’ or ‘‘very high’’ ‘‘high,’’ ‘‘moderate,’’ or ‘‘low’’ environmental risk, respectively. For activities such as football in which equipment must be considered these ratios may differ. Rest breaks should occur in the shade if possible, and hydration during rest breaks should be encouraged.

10. Implement rest periods at mealtime by allowing two to three hours for food, fluids, nutrients, and electrolytes (sodium and potassium) to move into the small intestine and bloodstream before the next practice.

11. Provide an adequate supply of proper fluids (water or sports drinks) to maintain hydration and institute a hydration protocol that allows the maintenance of hydration status. Fluids should be readily available and served in containers that allow adequate volumes to be ingested with ease and with minimal interruption of exercise. The goal should be to lose no more than 2% to 3% of body weight during the practice session (due to sweat and urine losses). (See the ''National Athletic Trainers' Association Position Statement: Fluid Replacement in Athletes.'')

12. Weigh high-risk athletes (in high-risk conditions, weigh all athletes) before and after practice to estimate the amount of body water lost during practice and to ensure a return to prepractice weight before the next practice. Following exercise athletes should consume approximately 1–1.25 L (16 oz) of fluid for each kilogram of body water lost during exercise.

Football Responds: Passing the HEAT

Dehydration and intense exercise can have catastrophic results. Not only does it inhibit personal performance, but it can also result in permanent physiological damage and even death. Athletes that perform in heat intense environments are more susceptible to heat related illnesses, especially football players who must wear protective clothing that can suppress evaporative heat loss and raise the core body temperature. In an effort to reduce heat related illnesses among football players, the National Collegiate Athletic Association, the American Football Coaches Association, the National Athletic Trainer's

Association, and Gatorade Sports Science Institute recently launched, (HEAT) Helping Educate Athletes in Training, an educational initiative to assist coaches and players in preparation for the two-a-day workouts. The Gatorade Sports Science Institute maintains that injury rates increase during the two a day workouts whether athletes are in peak condition or not. In fact, many athletes do not make it to the starting line up because of injuries incurred during preseason training (GSSI, 2002).

The two-a-day practice sessions are often a part of early-season conditioning in American football and yearlong training in many other sports. The extra practice time helps accelerate physical conditioning, allows time for strength training and skill development, and helps develop camaraderie among teammates. The very nature of two-a-day practices stresses survival of the fittest. Athletes are frequently placed under additional stress by the heat and humidity that often accompany summer practices. A panelist of experts found that in a study of varsity football players during two-a-day practices in August experienced a 24-lb fluid-loss from a water-turnover. Observers found that during a 24-hour period, players were turning over about 11 quarts (11 liters) of fluid. This occurred day-in and day-out for five days straight. The players, who ranged in weight from 200 to 300 lb (90 to 135 kg), often lose the most sweat. Hence, there is a need for football players to be acclimated to the environment as well as adequate rehydration and sodium and electrolytic replacement during the practice regime (Davis et al., 1997).

Old practice guidelines allowed coaches to hold two-a-days consecutively for up to three weeks whereas the new guideline state that two- a-days cannot be held consecutively, but must happen in a two-one-two-one framework. Likewise new guidelines call for the first five days of preseason practice to be limited to single practices with gradual use of equipment. The Division II President's Council of the NCAA amended the NCAA Constitution regarding heat related illnesses and upon the advice of sports medicine, experts advocated an approach to gradually acclimate athletes to the full-scale workout regime. According to the 2003-2004 academic-calendar the first permissible practice date is August 7 and conditioning, speed, agility, and strength test may not be conducted prior to this date. During the five-day acclimation period, institutions may conduct one practice per day not to exceed three hours in length. Only helmets are permitted during the first two days. During days, three and four student athletes may wear helmets and shoulder pads. The last day of the five-day period and every day thereafter may include full pads. Once the five a day acclimation period has concluded, an institution may not conduct multiple practices on consecutive days. On days where multiple practices occur there must be at least three hours of recovery time between the end of the first practice and the beginning of the last practice. During the recovery period, student-athletes may not participate in meetings or other athletically related activities; however, sports medicine rehabilitation is permitted during this time. A maximum of five hours of on-field practice is permitted on any day in which multiple practices occur. If an athlete should join the team after the five-day acclimation period, the student-athlete must complete a separate five day acclimation period (NCAA, 2003).

Changes to the NCAA policies were based on information provided by the NCAA Football Oversight Committee, which included input from student athletes, coaches, medical personnel and administrators. According to the 2001-2002 NCAA Injury Surveillance System (ISS) during the preseason there was four times higher the risk of time loss injuries compared to the regular season. In Divisions I and II that allowed shoulder pads during the first three days of fall practice there was a three to four times greater risk of heat illness than was reported for Division III which only allowed helmets during the same time period (Weber, 2003). Hence, the new guidelines are expected to minimize the risk of heat related illnesses and prevent injuries.

The rules for prevention of heat illness have steadily changed overtime. The current NCAA rules were revised from 1975 and call for constant surveillance and education to prevent heat-related problems (NCAA, 2002). The guidelines state that the following should be practiced:

1. An initial complete medical history and physical evaluation, followed by the completion of a yearly health-status questionnaire before practice begins, should be required. A history of previous heat illness, and the type and duration of training activities for the previous month, also are essential.
2. Encourage aerobic conditioning for heat acclimation.
3. Schedule frequent rest periods and be aware of the dangers of protective gear and dark clothing. During acclimation, it may be advisable to use minimum protective gear and to practice in T-shirts and shorts.
4. Regularly measure the heat stress conditions. Use ambient temperature and humidity to assess heat stress
5. Dehydration (hypohydration) must be avoided not only because it hinders performance, but also because it can result in profound heat illness. Fluid replacement must be readily available. Student-athletes should be encouraged to drink as much and as frequently as comfort allows. They should drink one to two

cups of water in the hour proceeding practice or competition, and continue drinking during activity (every 15-20 minutes). For activity up to two hours in duration, most weight loss represents water loss, and that fluid loss should be replaced as soon as possible. Following activity, the athlete should rehydrate with a volume that exceeds the amount lost during the activity. A two-pound weight loss represents approximately one quart of fluid loss. Urine volume and color can be used to assess hydration. If output is plentiful and the color is “pale yellow of straw colored”, the athlete is probably not dehydrated. Carbohydrate/electrolyte drinks enhance fluid intake, and the electrolytes aid in the retention of fluids. In addition, the carbohydrate provides energy; help maintain immune and cognitive functions.

6. By recording the body weight of each student-athlete before and after workout or practice, progressive hypo hydration or loss of body fluids can be detected, and the potential harmful effects of hypohydration can be avoided. Those who lose five percent of their body weight or more over a period of several days should be evaluated medically and their activity restricted until rehydration has occurred.
7. Some student-athletes may be more susceptible to heat illness. Susceptible individuals include those with: inadequate acclimatization or aerobic fitness, excess body fat, a history of heat illness, a febrile condition, inadequate rehydration, and those who regularly push themselves to capacity. In addition, substances with a diuretic effect or that act as stimulants may increase risk of heat illness. These substances may be found in some prescription and over-the-counter drugs, nutritional supplements and foods.

8. Student-athletes should be informed of and monitored for signs of heat illness such as cessation of sweating, weakness, cramping, rapid and weak pulse, pale or flushed skin, excessive fatigue, nausea, unsteadiness, disturbance of vision and incoherency. If heat illness is suspected, prompt emergency treatment is recommended. When training in hot and/or humid conditions, athletes should train with a partner or be under observation by a coach or athletic trainer.

Likewise the Gatorade Sports Science Institute have offered guideline specific for two-a-day trainings (GSSI, 2002). These rules recognize the need for proper hydration and promote general safety during intense heat training.

- Encourage athletes to begin conditioning in the heat two weeks before official practice begins. This allows athletes' bodies to cool more efficiently by increasing sweat production sooner than when they are not acclimated to the heat.
- Practice sessions during unusually hot and humid conditions should be limited to very moderate workouts, postponed until cooler times of the day or brought inside to avoid the heat.
- Before, during and after competition, be sure to consume adequate amounts of fluid. Athletes can make sure they are properly hydrated by checking their urine color: lighter urine color indicates athletes are better hydrated. The longer the workout session, the more frequently fluids need to be replaced. Research shows that a sports drink containing a 6% carbohydrate solution, like Gatorade, can be absorbed as rapidly as water. However, unlike water, a sports drink can provide energy, delay fatigue and improve performance.

- Before practice, warm up in the shade and be sure to rest in the shade during breaks. Even during rest, exposure to heat can raise the body temperature, increase fluid loss and decrease the blood available to the muscles during workouts.
- Cotton blend, loose fitting clothing can help promote heat loss. The rule: the less clothing, the better.
- Always have a cell phone on hand and be familiar with emergency numbers. Also, keep ice and ice towels on hand in case of heat-related emergencies.

The Gatorade Sports Science Institute maintains the need to keep athletes hydrated and to weigh athletes before and after exercise. Research indicates that for every pound of weight lost, athletes should drink at least 20 ounces of fluid to optimize rehydration. Maintaining proper hydration and monitoring athletes before, during, and after exercise is essential to preventing heat related illnesses and fatalities. Despite emerging literature on the effects of strenuous exercise on the body during extreme temperatures; lack of research on the changing weight patterns and environmental heat changes of athletes during the two-a-day practice exists. Studies on this phenomenon could benefit university administrators, student athletes, coaching and training staff.

Virginia Tech Responds

Virginia Polytechnic Institute and State University, like all universities and colleges, is responsive to rules and guidelines that are established by the NCAA. Regarding preseason training, Virginia Tech implemented the following changes:

- A five-day Acclimation Period for both first time participants and returning student athletes. During this period, there is a limit of one on the field practice per day, which cannot exceed three hours. Permissible equipment during the 5 day Acclimation period include:

- Day 1 and 2: Helmets only
- Day 3 and 4: Helmets and shoulder pads
- Day 5: Full pads
- After day 5: Full pads may be used at the team's discretion

- All team members regardless of when they join the team must complete the 5 day Acclimation Period.
- During the entire preseason practice period a maximum of 29 on-field practices are permitted. Some days may include multiple practices (two or three); however, multiple practices cannot occur consecutively.
- No more than five hours of on field practice time is permitted on multiple practice days and no more than three hours of on the field practice time is permitted on single practice days.
- Team meetings, film work, weight –room activities and walk throughs do not count against the three-hour or five hour on field practice time.
- On every multiple practice day, three hours of continuous recovery time must be provided between practices, which can include training room treatment and meals.
- Meetings, film work, weight room activities and walk throughs may not occur during the three hour down time on multiple practice days.
- As defined by the January 20, 2003 AFCA letter to head coaches, walk throughs may not include balls, helmets, equipment, or physical conditioning.

- The summer conditioning period is determined by counting back nine weeks from the preseason reporting date. One week during the nine-week period will be the student athlete discretionary time in which strength and conditioning training may be monitored but voluntary workouts are prohibited.

Prior to these rule changes, the University could hold multiple practices on consecutive days. Likewise, there was not a mandated Acclimation Period. At the beginning of the preseason, entering freshmen and other football players could have multiple practices in full pads. The length and formats of practice sessions were left to the discretion of school coaches and administrators. Furthermore, the monitoring of hydration levels and the provision of equipment such as cool tubs were optional according to the school.

Although the new rules changed how practices were administered, Virginia Tech had already implemented some changes to multiple practice sessions. In August 2002, the Big East Football Athletic Directors were sent copies of an environmental illness program created by Virginia Tech. Included in this information was a weather conditions log that is used to assess the level of heat related danger and an excel spreadsheet that measures pre and post practice weights of student athletes (Memo to Big East Football Athletic Directors, 2002). Likewise, the Sports Medicine program at Virginia Tech researched policies practiced by various NCAA and NFL clubs in 1999 and implemented the hydration program and other policies in 2000.

Not only were changes implemented regarding the training of the student athlete but also, there were also broad sweeping changes in the approach to address heat related illnesses. New policies called for the collaboration between coaches, trainers, and nutritionists in educating the student athlete. Pre-participation examinations include traditional assessments of cardiovascular endurance and the identification of risk factors (i.e. hypertension, weight problems, and sickle cell anemia, etc.) as well as the identification of athletic supplementation and medication usage, which could negative impact hydration levels such as caffeine intake. In addition cold towels, fans and cold tubs are encouraged and made available to the athletes during pre-season activities. Players are required to take in pre-activity fluids (a minimum of 20 oz. of Gatorade or Water). Regarding weight loss, for every pound lost, the athlete is required to drink at least 20 oz. of fluids. Urine analysis determines the dilution capacity and if necessary, the specific gravity of the urine is measured. If fluids are not regained and/or cramping persists, intravenous fluids may be administered. Prior to clearance for return to participation, a Certified Athletic Trainer using a heat illness questionnaire assesses student athletes. The team physician and nutritionist review this document if abnormalities are detected. Additionally, there has been an investment in treatment equipment and a reevaluation of emergency protocols such as early detection screenings for heat related illnesses and identification of key personnel and contacts in cases of an emergency.

CHAPTER 3
METHODOLOGY

The purpose of this study was to determine the effectiveness and administrative implications of practice schedule changes as they relate to weight loss and hydration of Virginia Tech football athletes. The study examined weight loss and hydration as they relate to practice patterns of two-a-day practice sessions used during football preseason. The findings of the study will help in the development of athletic policies necessary to ensure safety of student athletes involved in collegiate football during extreme environmental conditions. The study attempts to examine the effectiveness of the revised practice schedule. Additionally, it attempted to define the implications for Virginia Tech. Finally, it looked to support the hypothesis that the revised schedule (two-one-two-one) regimen is overall better for collegiate athletes and that lower weight loss and a lower incidence of heat related conditions are seen using these new guidelines.

Selection Criteria

The study was completed using data collected from members of the Virginia Tech Football team for the years 2001, 2002, 2003 and 2004. The student athlete must be eligible according to NCAA guidelines to participate in collegiate football in order to be included in the sample population. All study participants were examined by the team physician and were declared fit to participate in collegiate football. Underlying health conditions that would predispose players to heat related injuries have been excluded. It is assumed that dietary and caloric intake is consistent throughout the study and adjustments in weight (loss or gain) are in response to the practice regimen.

Measures

Heat related illnesses are defined as excessive increases in core body temperature resulting from an imbalance between heat production and heat loss (Kulla & Kennedy, 2002). Temperature and humidity are measured according to wet bulb and dry bulb prior to practice. The wet bulb measures the relative humidity and the dry bulb refers to the standard air temperature. The wet bulb globe-temperature index takes into account the air temperature, relative humidity, and solar radiation by measuring three temperatures (wet and dry bulbs, and the global temperature or temperature from radiation).

The individual athlete's body weight was measured using a standard scale that has been calibrated prior to the beginning of preseason practices. The athletes weighed in prior to the start of practice and weigh out at the conclusion of practice. The athlete will weigh in and weigh out in the same clothing (shirt, shorts, and socks) for both measures in order to accurately calculate and weight loss or weight gain.

Instrumentation

The following excel spreadsheets were used to collect and examine the athlete's weight and the temperature measures. Figure 1 shows the format for collection of the temperature measures.

Date	**Time**	**Temp**	**WB Temp**	**RH%**	**Surface**

Figure 1. Temperature recording template

The athletes were broken up according to position and then listed separately under each position creating multiple smaller tables. Figure 2 shows the format for collection of the weight measures for one group.

Quarterbacks			**August 9, 2001**		
Name	**Initial Weight**	**Weigh-In**	**Weigh-Out**	**Difference**	**% Lost**

Figure 2. Weight recording template

The instruments used to measure the variables included weight scales to measure the body weights of the players and a sling psychrometer to measure relative humidity and ambient air temperature.

Sample

For the four years of data collection, weights were collected from a total of 425 student football players. In 2001 and 2002, 104 student athletes were weighed and in 2003, the number measured grew to 112. In 2004, the number of student athletes was decreased to 105 (Figure 3). The weight of each student was recorded before and after training days. On two-a-day practices, weights were recorded a total of four times (i.e. morning weigh-in and weigh-out and evening weigh-in and weigh-out).

Year	Sample Size (N)
2001	N= 104
2002	N= 104
2003	N= 112
2004	N=105
Total	N=425

Figure 3. Sample size

Figure 4 is comprised of a sample group from each year of data recorded. For this sample of players, each person was assigned a generic number in order protect their identity. However, each player number from year to year represents the same player (i.e. Player 3 played for Virginia Tech in all three years of the study, where as Player 6 began playing in 2002).

Quarterbacks

2001

	Practice: August 14			
	Weigh-In	Weigh-Out	Diff	% lost
Player 1	189	185.6	3.4	1.80%
Player 2	201	200.6	0.4	0.20%
Player 3	221	219	2	0.90%
Player 4	202	198.7	3.3	1.63%

Quarterbacks

2002

	Practice: August 14			
	Weigh-In	Weigh-Out	Diff	% lost
Player 2	197	195.4	1.6	0.81%
Player 5	188.2	183.4	4.8	2.55%
Player 3	222	221	1	0.45%
Player 4	218.7	215.8	2.9	1.33%
Player 6	188.1	185.4	2.7	1.44%

Quarterbacks

2003

	Practice: August 14			
	Weigh-In	Weigh-Out	Diff	% lost
Player 4	225	222	3	1.33%
Player 7	203	201	2	0.99%
Player 6	201	199	2	1.00%

Quarterbacks

2004

	Practice: August 9, 2004			
	Weigh-In	Weigh-Out	Diff	% lost
Player 8	200	200	0	0.00%
Player 9	205	200	5	2.44%
Player 10	223	222	1	0.45%
Player 4	224.1	223	1.1	0.49%

Figure 4: Data for each year for quarterbacks

Variables

The variables are a student athlete's weight loss, the practice regime (two-a-day weight loss versus regular practices), temperature and relative humidity. Additional variables include the number of players who suffered cramps and the number of players who were given intravenous fluids. Dependent variables are weight loss and temperature, and the independent variable is the practice regimes (regular practice and two-a-day practices).

Data Collection and Analysis

Data was collected during the college football pre-season from 2001-2004. Players were weighed before and after practices. During two-a-day practices, each player's entrance and exit weights will be collected for both the AM and PM practice session. Weight information was entered into an excel spreadsheet by a member of the sports medicine staff and monitored to determine player weight loss. Notations were made on players that have lost three percent or more of their body weight. At the end of camp, an analysis was performed to determine if these players regained the weight loss during camp.

At the start of each practice session, a member of the sports medicine staff used a sling psychrometer to record the relative humidity and ambient air temperature. These measures were recorded at one-hour intervals in the practice. This data was entered into an excel spreadsheet along with plotted on a heat stress indicator chart. The temperatures were categorized as safe, alert, danger and emergency. These categories take into account the dry bulb temperature and the relative humidity. Figure 5 shows how the temperature data is entered and analyzed to determine the safety levels in which the team practices.

Date	Location	Lane Stadium	Lane Stadium	Lane Stadium		
8/23/2003	Time	3pm	4pm	5pm		
	Temperature	85	85	87		
	Wet Bulb	73	70	73		
	Relative Hum.	60%	52%	70%		

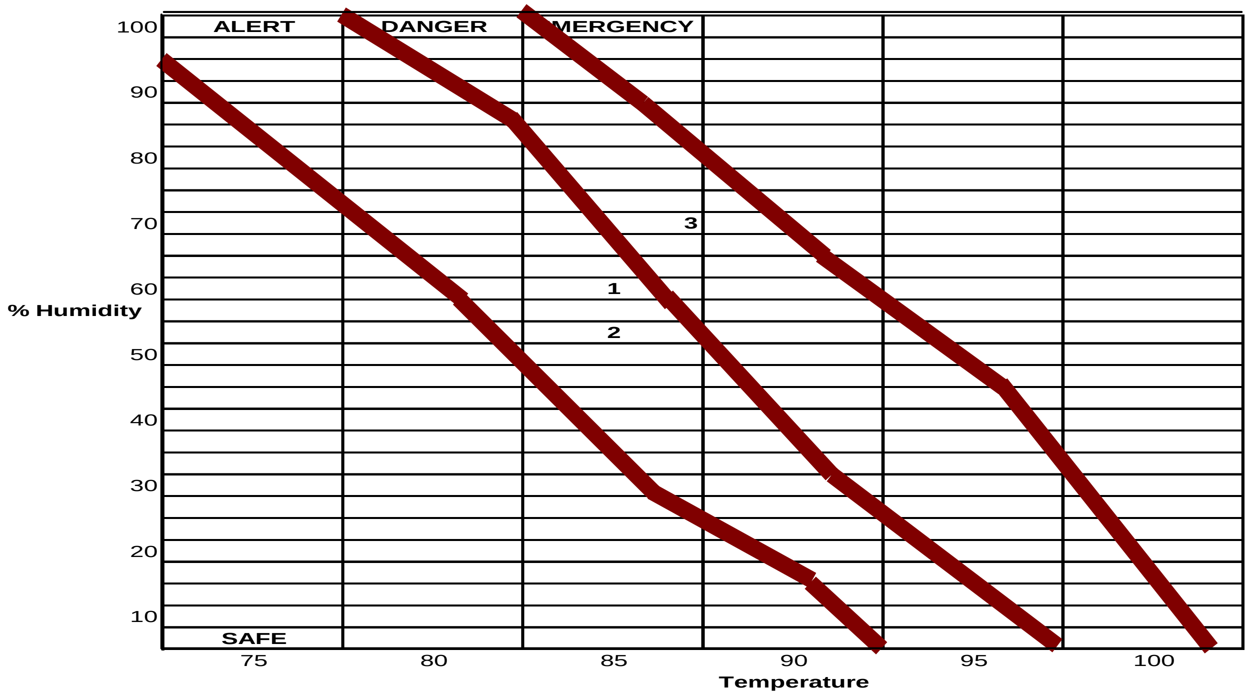


Figure 5. Heat stress indicator chart

Average weight loss was calculated to determine overall weight loss during the camp for all four years. In addition, the data examines the average weight loss per session and average weight loss on the two session days for all four years. Likewise, the average temperature and relative humidity were averaged and reported.

Variables: Weight Loss
Temperature

↓

Data Recording Template:
Temperature Data

Date	Time	Temp	WB Temp	RH%	Surface

Player Weight Recording

Name	Initial Weight	Weigh-In	Weigh-Out	Difference	% Lost

↓

Preseason Camp Recording Process:

- Weights were recorded in the football locker room pre and post practice using a standard scale
- Temperature readings were taken in between the two football fields at the start of practice with a sling psychrometer
- The measures were recorded for each session of practice for each individual player participating that day.

↓

Record Access:

- Records were examined after each session by the Sports Medicine Staff to determine if there is $\geq$ 3% decrease in body weight
- It was also noted when a player suffers from cramps or is given intravenous fluids
- At the conclusion of the preseason practices the data was analyzed to determine average weight changes amongst players, individual sessions, 2-a-day sessions
- The data from the years 2001, 2002, 2003, and 2004 were compiled and analyzed.

↓

Example of Actual Data:

Date	Time	Temp	WB Temp	RH%	Surface
8/14/2001	9:00	81	73	42.6	Grass

Quarterbacks

2001	**Practice: August 14**			
	Weigh-In	**Weigh-Out**	**Diff**	**% lost**
Player 1	189	185.6	3.4	1.80%
Player 2	201	200.6	0.4	0.20%

Figure 6. Experimental protocol

CHAPTER 4
RESULTS

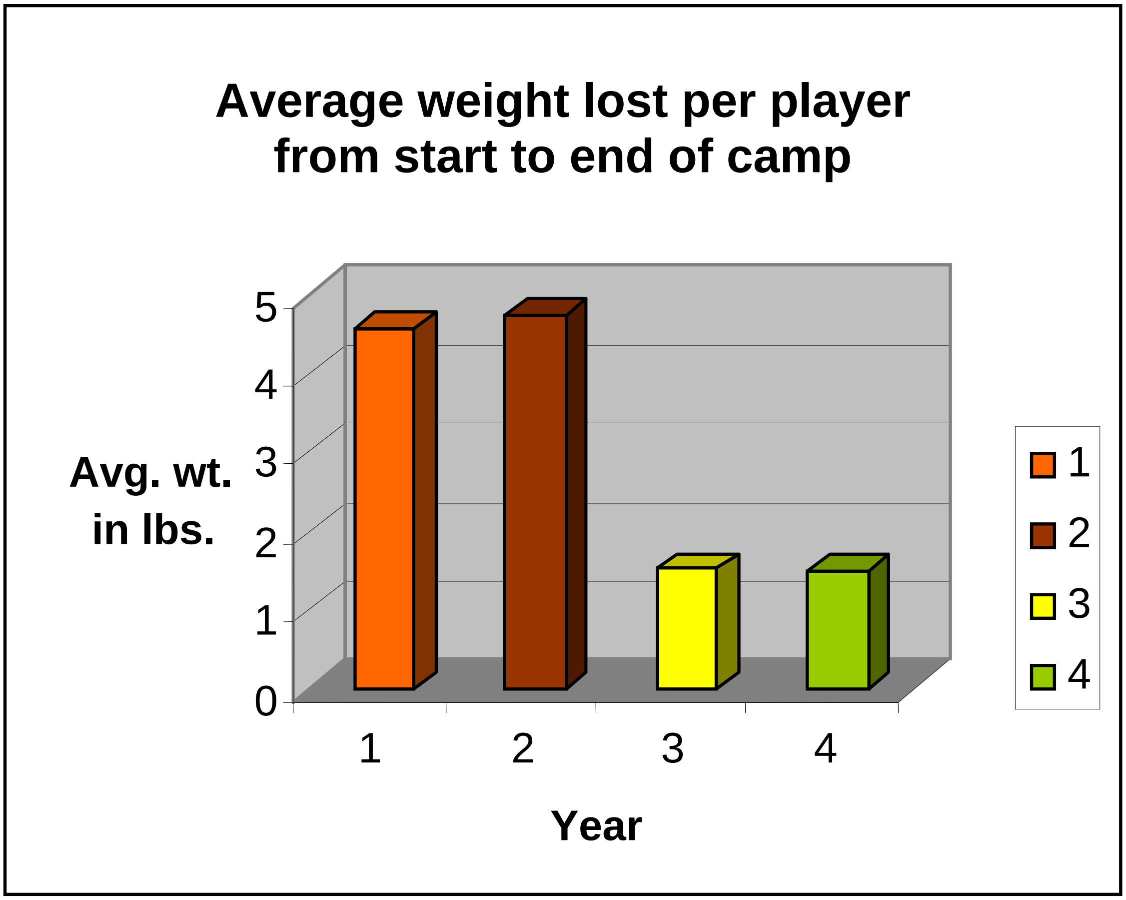
This study was based on four years of data collection, in which the weight of football players at Virginia Tech was monitored and recorded. The averages of weight loss, weight gained, and percentage body weight changes were calculated and arranged in an Excel spread sheet. Also, weather temperatures were closely observed. In addition, the number of players suffering from cramps, and the number of players who were administered intravenous fluids were recorded. A sling psychrometer was utilized to monitor the environmental conditions and activity was charted on a daily log with safe, alert, danger, and emergency conditions noted. Practice attire and practice times were altered as dictated by environmental conditions. Data collection commenced in the preseason of 2001 and ended in 2004.

Data regarding weight loss among players suggest that the new policies implemented by the NCAA are effective. A decrease in weight loss was observed between the first two seasons (2001 and 2002) and the last two seasons (2003 and 2004) of the study. As illustrated in Figure 7 there was a decrease in weight loss among the players' throughout the four years of the study, with a substantial decrease in weight loss from 2002 to 2003. This phenomenon is also observed across sessions at camp (see Figure 8) and for multiple practice sessions (see Figure 9).

Virginia Tech's rehydration program includes mandatory pre and post activity weigh-ins with calculations to determine the percentage of body weight lost during activity. A loss of greater than 3% of body weight is used as a red flag for disqualification if the player does not return to within 1% of pre-activity body weight. As seen in Figure 6 several players witnessed multiple episodes of 3% body weight loss.

Average Weight Lost Per Player from the Start to End of Camp

Figure 7 illustrates the average weight lost per player from the start of camp to the end of camp. As Figure 7 shows, there was a slight increase in weight loss between 2001 and 2002 (this phenomenon will be discussed later). However, between the 2002 and 2003 seasons, there was a retention in weight among players. The 2004 data is not substanially different from the 2003 data, however, player weight loss in 2004 was still lower than player weight loss during 2001 and 2002.

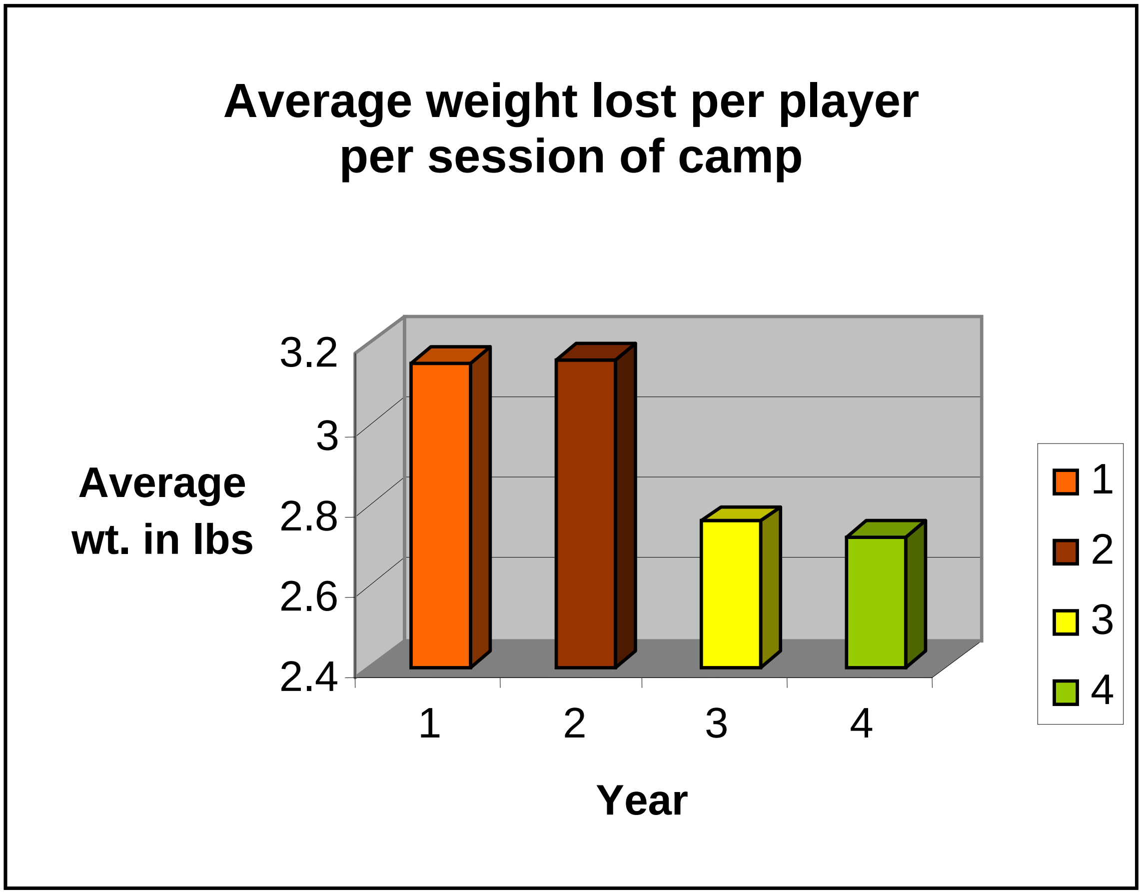


Year	Amount of Weight Lost
2001	4.56 lbs.
2002	4.76 lbs.
2003	1.52 lbs.
2004	1.50 lbs.

Figure 7. Average weight lost per player from start to end of camp

Average Weight Lost per Player per Session of Camp

Figure 8 shows the average weight lost per player per session at the camp. The highest average weight losses occurred during the 2001 and 2002 seasons (also to be discussed later). Although there was a slight increase in the average weight lost per session of camp between the 2001 and 2002 seasons, there was a decrease in the weight lost per session between the 2002 and 2003 seasons. In 2004, there was only a slight decrease in the average weight lost per session when compared to 2003, however, it was substantially lower than the average weight lost per session when compared to 2001 and 2002.

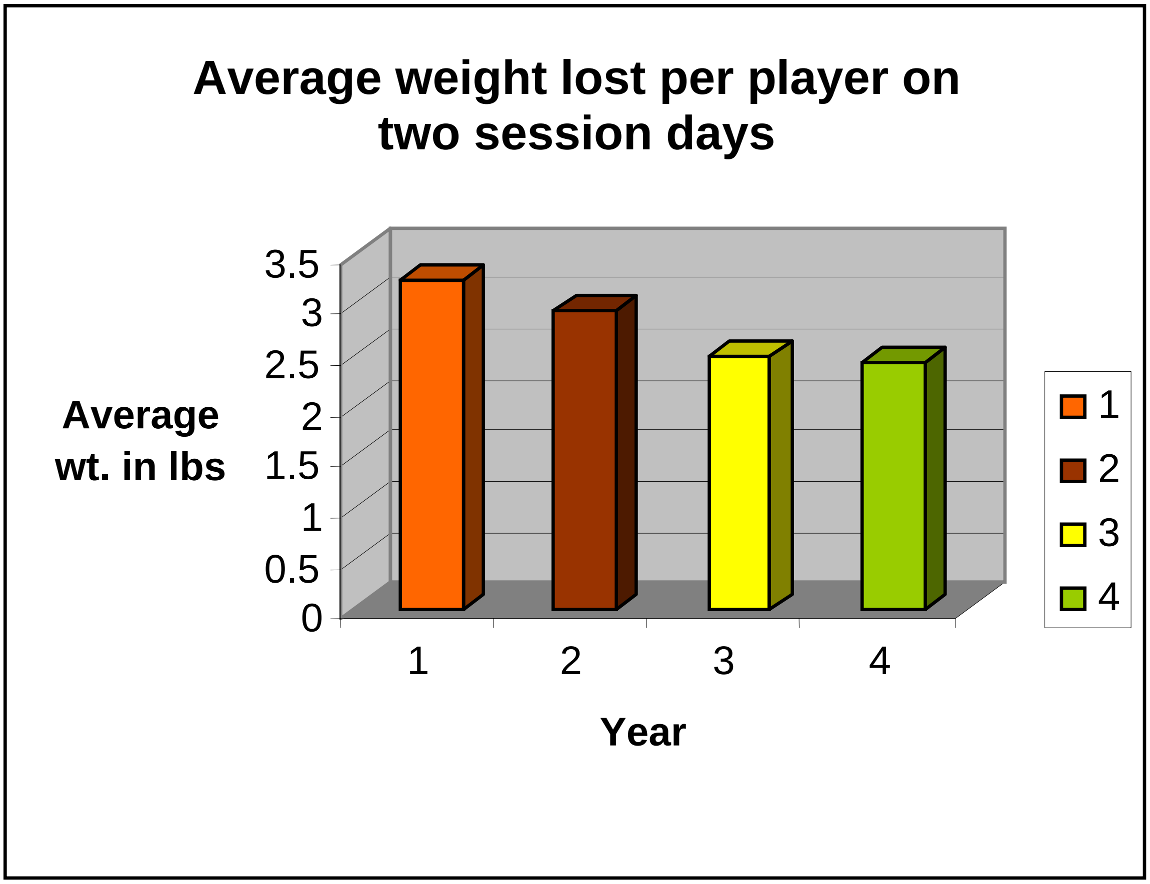


Year	Amount of Weight Lost
2001	3.15 lbs.
2002	3.16 lbs.
2003	2.76 lbs.
2004	2.72 lbs.

Figure 8. Average weight lost per player per session of camp

Average Weight Lost per Player on Two Session Days

The most rigorous training during the preseason involve multiple training sessions. Figure 9 illustrates the average weight lost on two session days. There was a steady decline in weight lost since 2001 with the lowest average weight loss occurring in the 2004 preseason. Although there was, only a slight decrease in the average weight lost on two session days between each year, the average weight lost on two session days was substantially lower when comparing 2001 to 2004.

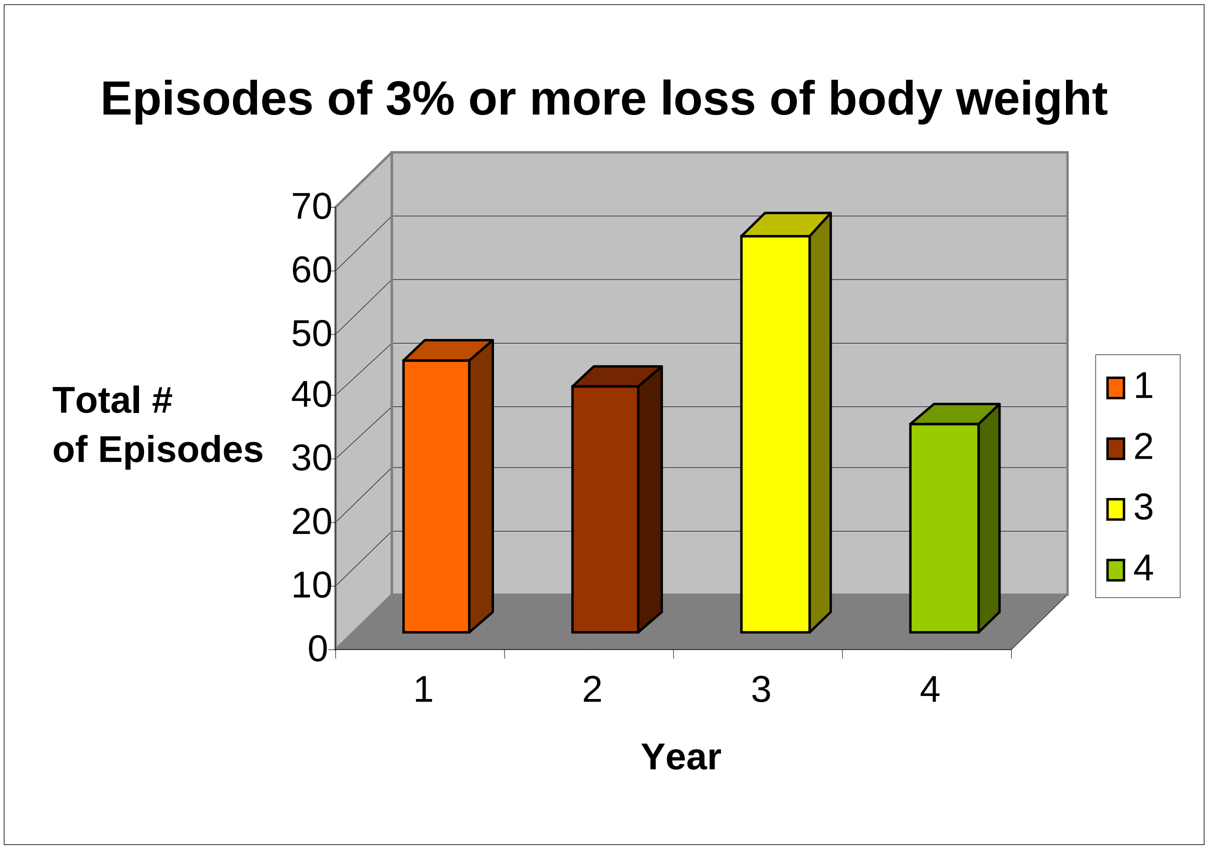


Year	Average of Amount of Weight Lost
2001	3.24 lbs.
2002	2.94 lbs.
2003	2.48 lbs.
2004	2.42 lbs.

Figure 9. Average weight lost per player on two session days

Episodes of 3% or More Loss of Body Weight

Figure 10 shows the number of episodes in which a player lost 3% or more of their body weight during one practice session. As Figure 10 illustrates, this variable did not compliment the previously mentioned variables. Although there was a slight decrease in the episodes of 3% loss of BW from 2001 to 2002, there was an increase in the episodes in the preseason of 2003. The number of episodes, however, dropped substantially in 2004 when compared to the previous three years.



Year	Episodes of 3% Loss of BW
2001	43
2002	39
2003	63
2004	33

Figure 10. Episodes of 3% or more loss of body weight

Multiple Episodes of 3% Loss of Body Weight

Figure 11 shows the number of players who suffered multiple episodes of 3% body weight loss. There was a decrease in the number of players who suffered from multiple episodes of 3% BW loss when comparing 2001 to 2002. The number of episodes went back up in 2003, however, and then dropped again in 2004.

Year	Number of Players affected
2001	12
2002	8
2003	11
2004	5

Figure 11. # of players who suffered multiple episodes of 3% loss of BW

Weather Conditions

Weather conditions can affect weight loss during strenuous activity. Below is a chart that illustrates the average weather temperatures and average relative humidity during the preseason 2001-2004. During the 2001 preseason, conditions remained safe with an average temperature of 78.40 degrees and average humidity of 58.90%. In 2002, temperatures reached alert status as the average temperature rose by five degrees to 83.67 degrees. In 2003, the average temperature was slightly lower than the previous year at 80.95 degrees, however, the relative humidity average increased 19% up to 66.13%. In addition, some conditions during this year were recorded as dangerous when temperatures increased to 87 degrees with the relative humidity at 70%. In 2004, the average temperature remained below 80 degrees and the relative humidity was 51%, making that year moderately milder that the previous three. (Refer to Appendix for detailed graphic of weather conditions)

Year	Average Temperature	Average Relative Humidity
2001	78.40 degrees	58.90 %
2002	83.67 degrees	47.29%
2003	80.95 degrees	66.13%
2004	77.05 degrees	51%

Figure 12. Weather conditions

Number of Players Suffering from Heat Related Conditions

Finally, Figure 13 displays the number of participants who suffered heat cramps and the number of participants who were administered intravenous fluids during each of the four years of the study. As Figure 13 illustrates, the number of episodes of players suffering from heat cramps and the number of players who were administered intravenous fluids did not change substantially from year to year.

Year	# of Episodes of Players Suffering from HeatCramps	Number of Players Administered IV Fluids
2001	5	2
2002	5	3
2003	6	2
2004	5	2

Figure 13. # of players suffering from heat cramps/administered IV fluids

CHAPTER 5
DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER RESEARCH

Almost all of the variables supported the initial hypothesis that the revised two-one-two-one practice schedule is better overall and will result in a lower average body weight loss for players. There were decreases over the four years of the study in each of the following: 1) The average weight lost per player from start to end of camp; 2) The average weight lost per player per session of practice; and 3) The average weight lost per player on two session days.

Average Weight Lost per Player from the Start to End of Camp and per Session

The average weight lost per player from start to end of camp decreased drastically from 2001 to 2004. There was, however, a slight increase from 2001 to 2002, probably attributable to the higher average temperature of the second year. After all, the temperature and relative humidity of 2002 did combine on a number of days for the most alarming conditions of the study. This may also explain why the average weight lost per player per session of camp also increased from 2001 to 2002, but decreased from 2001 to 2004. The most impressive number in this category is the decrease in average weight lost from start to end of camp when comparing the 2001 and 2004 seasons. This comparison makes clear that the change in practice regimens does in fact; make quite a difference for weight lost per player during preseason practices. In the old two-two-two-two practice regimen, a player may lose a certain amount of weight on the first day and, because they have two practices again on the next day, never has sufficient time or energy to rehydrate to the original body weight before the next practice. In the new two-one-two-one regimen, because they no longer have to endure successive days of two or more practices, the players have more time to effectively rehydrate themselves to a level that is closer to their pre-practice weight.

Average Weight Lost per Player on Two Session Days

Although the changes were not drastic from year to year of the study, there was a decrease each year in the average weight lost per player on two session days. There was a decrease when comparing 2001 to 2004. Because of the changes in practice regimen there were fewer two session days in the last three years of the study than in 2001. This may suggest that a fewer number of back to back two session days would allow each player to recover more effectively and have sufficient time to reestablish their normal body weight before they were to take on another two session day.

Episodes of 3% or More Loss of Body Weight

There were decreases in the episodes of 3% or more loss of body weight when comparing 2001 to 2004. However, there was a drastic increase in episodes between the 2002 and 2003 seasons. The higher number of episodes in the 2003 season may be attributable to a number of factors: 1) The highest average relative humidity of the four year study; 2) The largest number of participants (112) during the four years of the study, which would mean a larger chance for an episode to occur; or 3) A lower number of participants in the summer workout program which would mean that a lower percentage of athletes would be acclimated to the higher temperatures at the beginning of camp. The last scenario is purely speculative, since the number of players' participating in summer workouts was not a recorded variable. In addition, it should be noted, although there was a higher number of episodes of 3% or more body weight loss in the 2003 season when compared to 2001 and 2002, the average weight lost per player from start to end of camp, average weight lost per session and average weight lost per two session day was substantially lower in 2003. The higher number of episodes of 3% or more body weight loss and lower average weight lost per player from start to end of camp may be attributable to the ability of the players to recover after each practice. With the two-one-two-one revision of practices, the players that lose 3% or more of their body weight were given more of an opportunity to rehydrate and recover to a body weight that is closer to their pre-practice state than with the old two-two-two-two regimen.

Multiple Episodes of 3% or More Loss of Body Weight

Other than a decrease in the number of players who had multiple episodes of 3% or more loss of body weight from 2001 to 2004, there was no detectable pattern to discuss. There was a decrease in episodes in 2002, however, the number increased again in 2003. Once again, this increase may be attributable to the factors mentioned in the last section. The higher average relative humidity of 2003 may have caused the increase in multiple episodes of 3% or more body weight loss. In addition, the higher number of participants during preseason camp or a lower number of participants in summer workouts may have also contributed to this increase in multiple episodes in 2003. The lower number of multiple incidences in 2002 and 2004 would suggest, however, that the change in practice regimen to two-one-two-one was effective in reducing this number.

Number of Players Suffering from Heat Related Conditions

The number of players who suffered from heat cramps and the number of players who were administered intravenous fluids remained consistent throughout the four years of the study. These numbers did not support the hypothesis that the revised practice regimen is better overall and will result in lower weight loss and a lower number of heat related conditions. It should be noted, however, that the number of these incidences is particularly low. The low number of incidences may be attributable to the fact that, even before the NCAA regulations were put into effect in 2003, Virginia Tech has been proactive in implementing a hydration program that is effective at maintaining player hydration status throughout preseason camp. Virginia Tech has also employed a two-one-two-one preseason practice schedule and has modified practices according to environmental conditions since 2002. As many of the studies in the review of literature suggest, a hydration program that supplies unlimited access to cold fluids, pre and post-practice mandatory weigh-ins and modification of practice schedules due to atmospheric conditions will reduce the incidence of heat related conditions.

Additional Variables

At the conclusion of the study, two other variables were examined to identify their respective effects on the results of the study. The number of medical staff and the budget allocated for *Gatorade* products were the two additional variables that were examined.

Number of Medical Staff

Figure 14 shows the number of medical staff that was present during preseason camp in 2001-2004. The medical staff that was on hand was responsible for ensuring pre and post-practice hydration of the athletes. During practice, they were responsible for hydration and monitoring of the athletes that were participating. As Figure 14 illustrates, the number of staff present during preseason practices increased during each year of the study. When compared with the earlier weight loss figures for each year, this number is helpful in determining that the number of staff present to hydrate and "keep an eye on the players" has a positive effect on ensuring the proper hydration and weight maintenance of the players during practice.

Year	Full Time ATC's	Grad. Asst. ATC	Student Trainers	Total Staff
2001	1	2	8	11
2002	2	2	8	12
2003	2	2	10	14
2004	2	3	12	17

Figure 14. # of medical staff present during preseason practices

Gatorade Budget

Another variable that was examined at the completion of the study was the amount of money that was allocated for the purchase of *Gatorade* products during the four years of the study. As Figure 15 illustrates, the budget for *Gatorade* also increased each year from 2001-2004. Over the four years, the budget for *Gatorade* increased from $20,000 in 2001 to $32,000 in 2004. This increase in *Gatorade* product allowed for more unlimited access to *Gatorade* product used for hydration and probably contributed to the decrease in overall weight loss during preseason camp.

Year	Gatorade Budget
2001	$20,000
2002	$23,000
2003	$27,000
2004	$32,000

Figure 15. Gatorade budget

Recommendations for Future Research

Research in this area should not stop here. There are many other variables that could be examined in an attempt to make preseason collegiate football camp safer for student athletes. The author of this study would hypothesize that a higher number of participants in summer workouts would result in lower weight loss during preseason football camp. The players that stay at school over the summer and participate in strength and conditioning activities, especially those activities held out of doors should be more acclimated to the higher temperatures during preseason football camp and would therefore lose less weight during these practices.

Along the same lines of the study at Virginia Tech, studies that examine the relationship between the NCAA changes of 2003 and their relationship with the number of preseason practice injuries would also be of value when determining the effectiveness of the mandated changes. According to one coach at Virginia Polytechnic Institute and State University, in speaking with our medical staff, there was a significantly lower rate, and duration of lower extremity muscular injuries (i.e. quads, groins, hamstrings and hip flexors) sustained during our preseason workouts and our players are very positive with their comments concerning the practice format changes and our hydration program. The author of this study would suggest that there would be a decreased amount of injuries and time lost from those injuries relative to the NCAA changes.

A limitation of the study at Virginia Tech is the assumption that weight loss equates with water weight loss versus body mass. Future research may document body mass index data with weight loss information. Naturally, players with a higher body mass index should lose more weight during a preseason practice session. The relationship between body mass index, and weight lost and regained before the next practice session could give some interesting results to examine. In addition, it could be examined whether or not these players with a higher body mass index have a higher incidence of heat related injuries and/or musculoskeletal injuries during preseason football camp.

Another limitation of this study is the fact that the results do not take into consideration the uncontrollable variable of atmospheric conditions. Almost certainly, the temperature and relative humidity played a significant role in shaping the results of the study. In retrospect, it would have been beneficial to separate the results into categories of mild, moderate and severe temperature and relative humidity days to examine what effect these conditions had on the weight loss of players during preseason practices. Future studies may take a closer look at these variables, and how they affect the amount of weight lost and the number of players suffering from heat related conditions. In the same respect, it could also be beneficial to design a study to determine if the average temperature or relative humidity has more of a relationship with the amount of weight lost among players during preseason practices.

Currently, there are a small number of studies out there that are taking heat related illness research one-step further. Researchers Douglas Casa and Larry Armstrong, at the University of Connecticut, have been using encapsulated sensors ingested by football players to monitor the players' exact core body temperature during practice. Armstrong believes the data collected from the study will help show which positions on a football team are at the highest risk for developing heat related illnesses and which drills affect players adversely (Palmer, 2003). While most of the studies on heat related illness have been conducted in laboratories, this is one of the first to take the study out onto the actual field of play and should serve as a model for future research on this topic.

Conclusions

Heat related illnesses are preventable. Collaboration between colleges and universities, administrators, policy makers, medical staff and student athletes has propelled changes in the way preseason practices occur. Prior to the new rules implemented by the NCAA in 2003, multiple practices could occur consecutively and acclimation periods were suggested, however, never mandated. These changes in 2003 have positively affected collegiate football. According to the results based on four years of data collection, player weight loss was reduced from 2001-2004, with the most notable results observed between the 2002-2003 pre-seasons. Additionally, there has been a drastic decrease in the numbers of heat related injuries during preseason football camps.

This study at Virginia Tech mirrored the results of the NCAA's data collection in that the most noticeable decreases in weight lost occurred between the 2002 and 2003 seasons. These findings profoundly suggest that the change from the old practice regimen to the new practice regimen contributed to the decrease in weight loss during preseason collegiate football practices. These findings should be noted as evidence that the new practice regimen set forth by the NCAA has helped to curb weight loss during preseason practices. The study also showed that the number of medical staff that was present during preseason football practices and the Gatorade budget might have had a positive influence on decreasing weight loss during these practices. These are two of the many administrative variables that can help to make preseason football practice safer for student athletes.

While most of the changes have been widely accepted, some coaches are less enthusiastic about the changes and even suggest that these changes may not enhance the health of student athletes. For example, former University of Pittsburgh coach Walt Harris stated the following, “I believe in protecting the welfare of student athletes but I’m not sure that these rules do that…When we would conduct three practices in a day, the total time we would be on the field was about four hours, now because of all the restrictions, we have to maximize every opportunity so we’ll be out there for five hours on multiple practice days, and we will have three hour practices, which is never good” (Zeise, 2003, p. 2). Harris also suggests that the new guidelines limit freshmen orientation to the football program. He states that, “In the past they (freshmen) were able to report three days before the veteran players allowing them to adjust to the pace of camp…The new players also had the undivided attention (of the coaching staff) which helped them get a jump on learning the schemes and playbook” (Zeise, 2003, p. 2). With the new regulations, freshmen and veteran players begin the season in unison with a five day Acclimation Period. Former Indiana coach, Gerry DiNardo, echoes concerns about freshmen orientation. He states, “I’ll be curious of the attrition rate that we’ll have when a young freshmen comes in who is intimidated by the situation and hasn’t had a chance to meet with his academic advisor and all of that kind of stuff” (Spencer, 2003, p. 2).

The most substantial change implemented by the NCAA is the way two-a-day practices are executed. The elimination of consecutive two-a-day trainings has caused great concern among some coaches. Coach Jim Tressel from Ohio State University maintains, “I think they (NCAA) are considering this to be somewhat of an NFL type of model, because I guess the NFL does a lot of that with two-one-two-one alternate practice days…Their training camp is very long, so I can understand why they do that… And they have exhibition games, so they have a chance to get their work done" (Spencer, 2003, p. 2). With these changes comes a reduced practice schedule. Coaches can plan on at least 29 preseason practices with two-one-two-one practice regimes. NCAA rules enacted a reduction in pre-season practices in order to adjust for the five-day acclimation period as well as strict time limitations.

Many coaches and football administrators around the nation share these same views as the coaches that were previously mentioned. These concerns are valid, however, it must be maintained that it is the overall health and well-being of the student athlete, not their early retention of football knowledge and skill that has fueled the changes in preseason practice policies. Administrators, coaches and medical personnel alike must continue to strive to develop safe policies that will continue to improve the safety of preseason football camp.

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Appendix A
2002 Football Preseason Weights (August 5-7)

Quarterbacks

	PM Practice: August 5				Practice: August 6				AM Practice: August 7			
	Weigh-In	Weigh-Out	Diff	% lost	Weigh-In	Weigh-Out	Diff	% lost	Weigh-In	Weigh-Out	Diff	% lost
Player 1	196.5	194.6	1.9	0.9669%	198.4	195.4	3	1.51%	198.6	197.4	1.2	0.60%
Player 2	187	184.6	2.4	1.2834%	185	183.6	1.4	0.76%	187	185.7	1.3	0.70%
Player 3	222	220	2	0.9009%	222	218	4	1.80%	223	219	4	1.79%
Player 4	215.9	DNWA	#VALUE!	#VALUE!	217.1	215	2.1	0.97%	220.6	217.8	2.8	1.27%
Player 5	187	184.6	2.4	1.2834%	185	183.3	1.7	0.92%	186	185.1	0.9	0.48%

Running Backs

	PM Practice: August 5				Practice: August 6				AM Practice: August 7			
	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost
Player 6	227.9	225	2.9	1.2725%	231.2	227	4.2	1.82%	229	225.1	3.9	1.70%
Player 7	203.5	200.6	2.9	1.4251%	207.2	202.1	5.1	2.46%	208.4	203.5	4.9	2.35%
Player 8	235.9	233.2	2.7	1.1446%	235.1	234	1.1	0.47%	237.7	233.2	4.5	1.89%
Player 9	209	205.2	3.8	1.8182%	211	207	4	1.90%	213.3	210	3.3	1.55%
Player 10	218.1	216.5	1.6	0.7336%	219.7	217.9	1.8	0.82%	221.9	219.9	2	0.90%
Player 11	209.5	206.3	3.2	1.5274%	209	207.6	1.4	0.67%	211	209.3	1.7	0.81%
Player 12	226.1	220	6.1	2.6979%	226	223.2	2.8	1.24%	226.8	223.7	3.1	1.37%
Player 13	201.2	199.2	2	0.9940%	202	200	2	0.99%	205	202.5	2.5	1.22%

Wide Receivers

	PM Practice: August 5				Practice: August 6				AM Practice: August 7			
	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost
Player 14	166	163	3	1.8072%	166.6	165	1.6	0.96%	167	167	0	0.00%
Player 15	192	188.9	3.1	1.6146%	192.4	188.9	3.5	1.82%	194	DNWA	#VALUE!	#VALUE!
Player 16	199.2	195.7	3.5	1.7570%	197.6	196.7	0.9	0.46%	198.4	197.4	1	0.50%
Player 17	194	191.7	2.3	1.1856%	193.6	188.5	5.1	2.63%	190.3	188.8	1.5	0.79%

Football Preseason Weights-Page 2

Player 18	178	172.6	5.4	3.0337%	177.9	173.5	4.4	2.47%	180	175.5	4.5	2.50%
Player 19	181.4	177.5	3.9	2.1499%	182	178.5	3.5	1.92%	184.8	181.9	2.9	1.57%
Player 20	175.5	173.5	2	1.1396%	176.2	173.8	2.4	1.36%	176	173	3	1.70%
Player 21	193.7	192.5	1.2	0.6195%	192.9	191	1.9	0.98%	194.5	192.5	2	1.03%
Player 22	190.2	189.4	0.8	0.4206%	192.2	189.5	2.7	1.40%	195.5	DNWA	#VALUE!	#VALUE!
Player 23	190.7	190	0.7	0.3671%	193.3	189.9	3.4	1.76%	193.9	192.2	1.7	0.88%
Player 24	182	179.8	2.2	1.2088%	184.9	183.4	1.5	0.81%	185.5	184	1.5	0.81%
Player 25	189.1	184.6	4.5	2.3797%	189.2	184.6	4.6	2.43%	187.9	186	1.9	1.01%
Player 26	168.7	165.4	3.3	1.9561%	169.8	166.3	3.5	2.06%	169.3	168.3	1	0.59%
Player 27	216.6	210.4	6.2	2.8624%	216.7	212.8	3.9	1.80%	219.8	DNWA	#VALUE!	#VALUE!
Player 28	194	192.3	1.7	0.8763%	197.8	192	5.8	2.93%	195	192.8	2.2	1.13%

Tight Ends

	PM Practice: August 5				Practice: August 6				AM Practice: August 7			
	Weigh-In	**Weigh-Out**	**Diff**	**% Lost**	**Weigh-In**	**Weigh-Out**	**Diff**	**% Lost**	**Weigh-In**	**Weigh-Out**	**Diff**	**% Lost**
Player 29	225.1	221.3	3.8	1.6881%	226.7	223.3	3.4	1.50%	225.5	223	2.5	1.11%
Player 30	256.5	251	5.5	2.1442%	259.1	254.3	4.8	1.85%	263.5	257.3	6.2	2.35%
Player 31	257	255	2	0.7782%	259.7	255.3	4.4	1.69%	261	256.5	4.5	1.72%
Player 32	253.8	248	5.8	2.2853%	255.5	253	2.5	0.98%	259.2	DNWA	#VALUE!	#VALUE!

Offensive Line

	PM Practice: August 5				Practice: August 6				AM Practice: August 7			
	Weigh-In	**Weigh-Out**	**Diff**	**% Lost**	**Weigh-In**	**Weigh-Out**	**Diff**	**% Lost**	**Weigh-In**	**Weigh-Out**	**Diff**	**% Lost**
Player 33	330.7	327.8	2.9	0.8769%	332	328.5	3.5	1.05%	334.5	332.1	2.4	0.72%
Player 34	260	257	3	1.1538%	261	258	3	1.15%	260	257	3	1.15%
Player 35	324	322	2	0.6173%	322	321	1	0.31%	322	320	2	0.62%
Player 36	325	321	4	1.2308%	330	325	5	1.52%	329.8	326.9	2.9	0.88%
Player 37	299.3	297	2.3	0.7685%	301	298	3	1.00%	302	301	1	0.33%
Player 38	331	325.9	5.1	1.5408%	327.5	325.2	2.3	0.70%	328.7	325.5	3.2	0.97%
Player 39	294.3	287.8	6.5	2.2086%	289.8	287.4	2.4	0.83%	297	293	4	1.35%
Player 40	221.5	219.5	2	0.9029%	224	220.7	3.3	1.47%	227.3	222.7	4.6	2.02%
Player 41	270	263	7	2.5926%	273.5	267.2	6.3	2.30%	274.7	268.5	6.2	2.26%

Football Preseason Weights-Page 3

Player 42	294.8	291.8	3	1.0176%	293.3	292.5	0.8	0.27%	292.9	291	1.9	0.65%
Player 43	304.9	302.5	2.4	0.7871%	306.2	304.5	1.7	0.56%	305.5	305.1	0.4	0.13%
Player 44	294.4	288	6.4	2.1739%	293.3	287.4	5.9	2.01%	293.5	289.8	3.7	1.26%
Player 45	334	329.2	4.8	1.4371%	332.9	328	4.9	1.47%	DNWB	DNWA	#VALUE!	#VALUE!
Player 46	299	291	8	2.6756%	294.9	290.7	4.2	1.42%	296.2	291.2	5	1.69%
Player 47	315	312	3	0.9524%	313	311	2	0.64%	315	314.5	0.5	0.16%
Player 48	259	255.5	3.5	1.3514%	260.2	256.6	3.6	1.38%	260	256.2	3.8	1.46%
Player 49	295.4	288.4	7	2.3697%	297.1	290.1	7	2.36%	299.5	291.8	7.7	2.57%

Whips/Rovers

	PM Practice: August 5				Practice: August 6				AM Practice: August 7			
	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost
Player 50	204.9	203.2	1.7	0.8297%	213.1	213.8	-0.7	-0.33%	210	209.9	0.1	0.05%
Player 51	199	197.9	1.1	0.5528%	201.7	198.2	3.5	1.74%	200.5	200.2	0.3	0.15%
Player 52	211	207	4	1.8957%	211	207.9	3.1	1.47%	212	211	1	0.47%
Player 53	196.9	194.6	2.3	1.1681%	197.7	195.1	2.6	1.32%	198.8	194.7	4.1	2.06%
Player 54	189.5	185	4.5	2.3747%	188.6	188.2	0.4	0.21%	188	184	4	2.13%
Player 55	204.9	204.2	0.7	0.3416%	207.4	205.9	1.5	0.72%	207.3	205	2.3	1.11%

Linebackers

	PM Practice: August 5				Practice: August 6				AM Practice: August 7			
	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost
Player 56	220.7	216.4	4.3	1.9483%	221.4	218.2	3.2	1.45%	220.4	217.6	2.8	1.27%
Player 57	222.2	219	3.2	1.4401%	222	219.7	2.3	1.04%	225.5	222	3.5	1.55%
Player 58	DNWB	223.1	#VALUE!	#VALUE!	DNWB	227.4	#VALUE!	#VALUE!	226	DNWA	#VALUE!	#VALUE!
Player 59	237.3	230.8	6.5	2.7391%	239	232.7	6.3	2.64%	237.3	231.7	5.6	2.36%
Player 60	214.3	210.9	3.4	1.5866%	215.7	214	1.7	0.79%	216.9	214.7	2.2	1.01%
Player 61	219.9	218.9	1	0.4548%	224.3	222.3	2	0.89%	223.6	221.2	2.4	1.07%
Player 62	201.3	196.2	5.1	2.5335%	201.8	197.3	4.5	2.23%	204	201.6	2.4	1.18%
Player 63	240	237.6	2.4	1.0000%	241.7	237	4.7	1.94%	241.3	238	3.3	1.37%
Player 64	245.6	241	4.6	1.8730%	244.1	240.7	3.4	1.39%	244.2	242.9	1.3	0.53%
Player 65	239.6	234.2	5.4	2.2538%	242.4	237.5	4.9	2.02%	242.2	238.1	4.1	1.69%

Football Preseason Weights-Page 4

Defensive Ends

	PM Practice: August 5				Practice: August 6				AM Practice: August 7			
	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost
Player 66	257.6	254	3.6	1.3975%	256.2	252.5	3.7	1.44%	259.2	257.3	1.9	0.73%
Player 67	240.6	239	1.6	0.6650%	238.5	237.9	0.6	0.25%	242	239.7	2.3	0.95%
Player 68	265.7	261	4.7	1.7689%	261.6	259.8	1.8	0.69%	266.2	262	4.2	1.58%
Player 69	233.1	229.4	3.7	1.5873%	236.4	232.7	3.7	1.57%	238.5	233.3	5.2	2.18%
Player 70	238	DNWA	#VALUE!	#VALUE!	239	239	0	0.00%	243	DNWA	#VALUE!	#VALUE!
Player 71	265.6	263.6	2	0.7530%	267.4	264	3.4	1.27%	267	265.3	1.7	0.64%
Player 72	260.2	257	3.2	1.2298%	263.3	258.8	4.5	1.71%	262	DNWA	#VALUE!	#VALUE!
Player 73	262.5	258.6	3.9	1.4857%	264.5	259.5	5	1.89%	265.5	DNWA	#VALUE!	#VALUE!
Player 74	251	247.7	3.3	1.3147%	252.1	248.1	4	1.59%	251.2	248.3	2.9	1.15%
Player 75	261	257.4	3.6	1.3793%	259.5	257	2.5	0.96%	263	261.1	1.9	0.72%
Player 76	254	252	2	0.7874%	255.5	252.9	2.6	1.02%	256.5	253	3.5	1.36%
Player 77	300.1	298.1	2	0.6664%	303.6	298.6	5	1.65%	301.1	300.4	0.7	0.23%
Player 78	286.1	284.4	1.7	0.5942%	286.4	285.5	0.9	0.31%	288	285	3	1.04%
Player 79	284.5	284	0.5	0.1757%	288	285.5	2.5	0.87%	292.4	288.6	3.8	1.30%
Player 80	269.2	268.4	0.8	0.2972%	269.6	269.1	0.5	0.19%	270.3	268.8	1.5	0.55%
Player 81	276	274.5	1.5	0.5435%	276.2	274.5	1.7	0.62%	276.9	274.5	2.4	0.87%
Player 82	241.5	232	9.5	3.9337%	240.3	236.2	4.1	1.71%	243.2	237.4	5.8	2.38%

Defensive Backs

	PM Practice: August 5				Practice: August 6				AM Practice: August 7			
	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost
Player 83	198.2	195.5	2.7	1.3623%	199.9	DNWA	#VALUE!	#VALUE!	198	197	1	0.51%
Player 84	180.7	180.1	0.6	0.3320%	183.7	181.5	2.2	1.20%	182.3	180.6	1.7	0.93%
Player 85	198.6	194	4.6	2.3162%	199	196.7	2.3	1.16%	200.9	197.5	3.4	1.69%
Player 86	182.4	182.1	0.3	0.1645%	183	180.4	2.6	1.42%	184.5	181.1	3.4	1.84%
Player 87	208.3	206.2	2.1	1.0082%	208	DNWA	#VALUE!	#VALUE!	210	208	2	0.95%
Player 88	170	167.1	2.9	1.7059%	169.2	167.7	1.5	0.89%	170	169	1	0.59%
Player 89	196.5	194	2.5	1.2723%	198.1	195.5	2.6	1.31%	199.2	196	3.2	1.61%

Football Preseason Weights-Page 5

Player 90	190	188.7	1.3	0.6842%	192	189.7	2.3	1.20%	193.3	191.1	2.2	1.14%
Player 91	183.7	183.3	0.4	0.2177%	181.9	180.9	1	0.55%	182.7	183	-0.3	-0.16%
Player 92	194.6	188.3	6.3	3.2374%	192.7	189.3	3.4	1.76%	DNWB	DNWA	#VALUE!	#VALUE!

Special Teams

	PM Practice: August 5				Practice: August 6				AM Practice: August 7			
	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost
Player 93	199	197.4	1.6	0.8040%	200.5	198.2	2.3	1.15%	202.6	198.9	3.7	1.83%
Player 94	241	237.2	3.8	1.5768%	240.7	237.6	3.1	1.29%	243.1	240.5	2.6	1.07%
Player 95	218.8	217.2	1.6	0.7313%	219.7	217	2.7	1.23%	218.3	216.9	1.4	0.64%
Player 96	186.7	183.2	3.5	1.8747%	187	186.8	0.2	0.11%	187.4	187.6	-0.2	-0.11%
Player 97	199.5	196.5	3	1.5038%	200	198	2	1.00%	200	199	1	0.50%
Player 98	238.5	233.5	5	2.0964%	237.2	233.3	3.9	1.64%	238.7	236.7	2	0.84%
Player 99	188.5	188.1	0.4	0.2122%	188.8	188.3	0.5	0.26%	188.5	188.4	0.1	0.05%

115 list:

	PM Practice: August 5				Practice: August 6				AM Practice: August 7			
	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost	Weigh-In	Weigh-Out	Diff	% Lost
Player 100	162.2	161.2	1	0.6165%	164.1	160.7	3.4	2.07%	162.9	161.3	1.6	0.98%

***DNWB=Did not weigh before practice**
***DNWA=Did not weigh after practice**
Lost 3 or more % of body weight
Suffered
Cramps

Appendix B
2002 Entrance Weights, Exit Weights and Weight Loss

Quarterbacks

	Enter Weight	Exit Weight	Weight Lost
Player 1	199	195	4
Player *2*	181	186	-5
Player 3	222	220	2
Player 4	221	214	7
Player *5*	185	185	0

Running Backs

	Enter Weight	Exit Weight	Weight Lost
Player *6*	224	224	0
Player 7	207	199	8
Player 8	235	227	8
Player 9	209	204	5
Player 10	220	217	3
Player 11	213	206	7
Player 12	228	223	5
Player 13	201	196	5

Wide Receivers

	Enter Weight	Exit Weight	Weight Lost
Player 14	166	168	-2
Player 15	193	190	3
Player 16	198	196	2
Player 17	189	188	1
Player 18	177	175	2
Player 19	185	180	5
Player 20	175	173	2
Player 21	190	197	-7
Player 22	192	190	2
Player 23	192	192	0
Player 24	184	182	2
Player 25	186	184	2
Player 26	169	165	4
Player 27	216	215	1

Tight Ends

	Enter Weight	Exit Weight	Weight Lost
Player 29	226	216	10
Player 30	258	248	10
Player 31	262	252	10

Entrance Weights, Exit Weights and Weight Loss-Page 2

Offensive Line

	Enter Weight	Exit Weight	Weight Lost
Player 33	331	324	7
Player 34	260	252	8
Player 35	333	316	17
Player 36	326	322	4
Player 37	303	291	12
Player 38	333	334	-1
Player 41	269	263	6
Player 42	294	282	12
Player 43	310	295	15
Player 44	298	284	14
Player 45	334	323	11
Player 46	298	285	13
Player 47	317	311	6
Player 48	254	257	-3
Player 49	296	290	6

Whips/Rovers

	Enter Weight	Exit Weight	Weight Lost
Player 50	209	202	7
Player 52	210	205	5
Player 54	185	184	1
Player 55	201	203	-2

Linebackers

	Enter Weight	Exit Weight	Weight Lost
Player 56	220	219	1
Player 57	222	215	7
Player 58	235	222	13
Player 59	237	228	9
Player 60	216	211	5
Player 61	222	215	7
Player 62	208	197	11
Player 63	245	238	7
Player 64	245	238	7
Player 66	232	222	10

Defensive Ends

	Enter Weight	Exit Weight	Weight Lost
Player 67	259	251	8
Player 68	235	231	4
Player 69	268	265	3

Entrance Weights, Exit Weights, and Weight Loss-Page 3

Player 70	235	232	3
Player 71	239	233	6
Player 72	264	265	-1
Player 75	263	253	10
Player 76	260	258	2
Player 77	257	248	9
Player 78	298	296	2
Player 79	290	279	11
Player 80	288	281	7
Player 81	271	265	6
Player 82	274	270	4
Player 83	239	233	6

Defensive Backs

	Enter Weight	Exit Weight	Weight Lost
Player 85	199	192	7
Player 86	200	196	4
Player 89	177	179	-2
Player 90	198	191	7
Player 91	192	191	1
Player 93	181	182	-1

Special Teams

	Enter Weight	Exit Weight	Weight Lost
Player 94	199	195	4
Player 95	242	236	6
Player 96	219	212	7
Player 97	183	186	-3
Player 98	199	197	2
Player 99	238	234	4
Player 100	188	185	3

115 list:

	Enter Weight	Exit Weight	Weight Lost
Player 101	204	202	2
Player 102	289	293	-4
Player 103	193	190	3
Player 104	166	163	3

Entrance Weights, Exit Weights, and Weight Loss-Page 4

Average weight loss 4.769230769

The following players did not weigh out at the end of last session

Player 28	Player 65
Player 32	Player 73
Player 39	Player 74
Player 40	Player 84
Player 51	Player 87
Player 53	Player 88
Player 92	

Appendix C
2002 Average Weight Lost Per Session

7/31/02 am	7/31/02 pm	8/1/02 am	8/1/2002 pm	8/4/2002	8/5/02 am	8/5/2002 pm	######	8/7/02 am	8/7/2002 pm	#####
3.06	3.23	2.13	2.75	4.16	2.53	3.21	2.93	2.61	3.21	3.65

8/9/2002 am	8/9/2002 pm	8/10/2002	8/11/2002	8/12/2002 am	8/12/2002 pm	8/13/2002	######	8/16/2002	8/17/2002
3.02	3.01	3.59	2.88	2.89	3.56	3.12	3.48	3.19	4.1

Average Lost per Session of Camp
3.15761905

Average Lost on Two Session Days
2.93416667

Average Lost on One Session Days
3.45555556

Average Lost on Alert Days
3.192

Average Lost on Danger Days
3.205

Appendix D
2002 Players Who Lost at Least 3% of their Body Weight

Date	Name	Amount Lost	Did They Get it Back
7/31/2002 AM	Player 53	3.20%	yes
	Player 100	4.40%	no
8/4/2002	Player 1	3.10%	no
	Player 10	3.50%	no
	Player 30	3.00%	yes
	Player 31	3.40%	no
	Player 58	3.30%	no
	Player 62	4.20%	no
8/5/2002 AM	Player 10 (2)	2.80%	yes
8/5/2002 PM	Player 10 (3)	3.00%	yes
	Player 82	3.90%	yes
	Player 92 (1)	3.20%	no
8/7/2002	Player 7 (1)	3.50%	no
	Player 61	3.50%	no
8/8/2002	Player 20	3.40%	yes
	Player 27 (1)	3.10%	did not weigh in before next session
	Player 50(1)	3.70%	no
	Player 82 (2)	3.50%	yes
8/9/2002 AM	Player 57 (1)	3.00%	yes
8/10/2002	Player 49 (1)	3.00%	no
	Player 82 (3)	3.00%	no
8/11/2002	Player 84 (1)	3.10%	yes
8/12/2002 PM	Player 38 (1)	3.20%	no
	Player 49 (2)	3.70%	yes
	Player 59 (1)	3.30%	yes
8/13/2002	Player 27 (2)	3.20%	no
	Player 30 (2)	3.00%	yes
	Player 62 (2)	3.30%	no

Players Who Lost at Least 3%-Page 2

8/14/2002	Player 37 (1)	3.00%	yes (had extra day off due to illness)
	Player 82 (4)	3.00%	yes (had extra day off due to illness)

8/16/2002	Player 19 (1)	3.20%	no
	Player 62 (3)	3.30%	no

8/17/2002	Player 7 (2)	3.20%	no
	Player 10 (4)	3.40%	yes
	Player 37 (2)	3.20%	no
	Player 43 (1)	3.30%	no
	Player 49 (3)	3.50%	yes
	Player 62 (4)	3.40%	no
	Player 82 (5)	4.40%	no

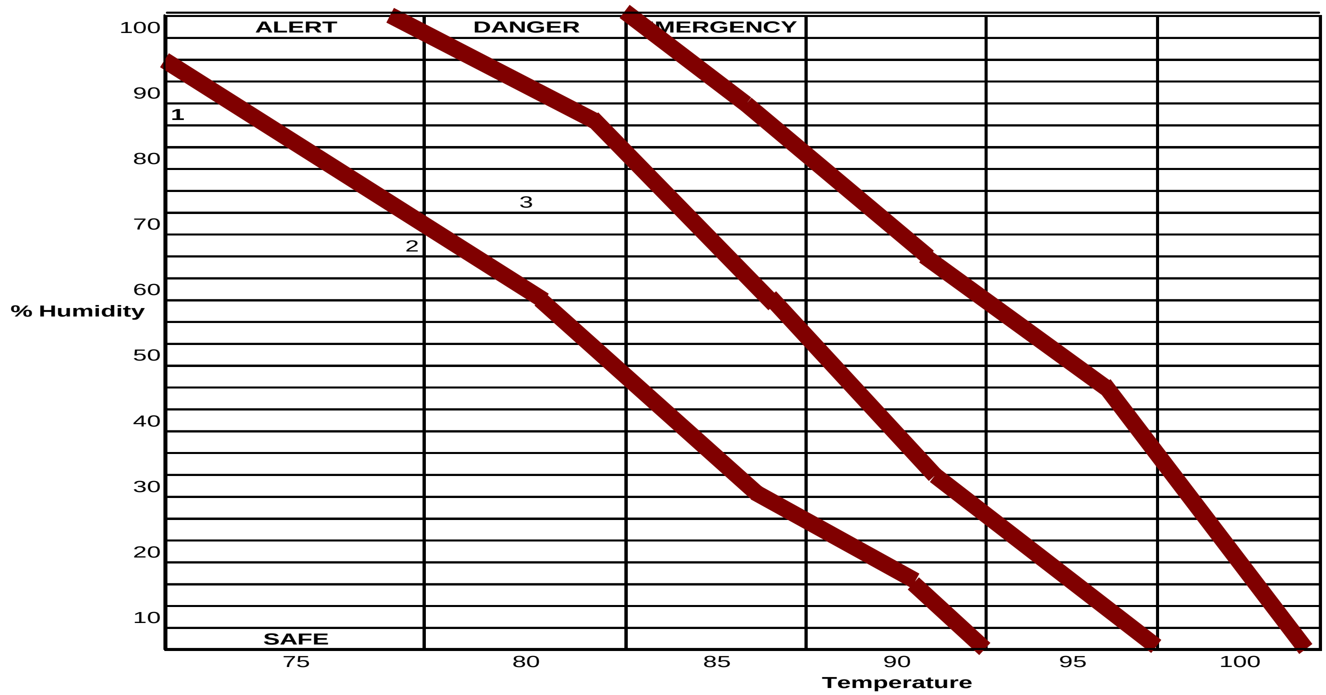
Average Temp on these days
84.2
degrees

Average Relative Humidity on these days
47.50%

Appendix E
Virginia Tech Sports Medicine

Date
8-12-02 am

Location	Practice Field 1	2	3	4	
Time	8:41	9:43	11:01		
Temperature	71	77	82		
Wet Bulb					
Relative Hum. %	88%	69%	74%		



Appendix F
Average Daily Temperatures During Preseason Football Camp and Average Temperature for Camp in 2002

	31-Jul	1-Aug	4-Aug	5-Aug	6-Aug	7-Aug	8-Aug	9-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	16-Aug	17-Aug
	82	75	82	70	83	72	81	66	84	90	71	91	91	84	81
	85	80	92	75	82	78	82	72	86	88	77	93	91	84	82
	85	84	90	74	79	77	82	75	85	88	82	91	90	82	81
			91	80				84			90				81
				81				84			91				
				90				82			90				
				89											
				93											
				92											
AVG Daily	84	79.6667	88.75	82.6667	81.3333	75.6667	81.6667	77.1667	85	88.6667	83.5	91.6667	90.6667	83.3333	81.25

AVG during camp
83.66667

Appendix G
Average Daily Relative Humidity During 2002 Preseason FB Camp and Average Relative Humidity for Camp

######	8/1/02	8/4/02	8/5/02	8/6/02	8/7/02	8/8/02	8/9/02	####	######	######	#####	######	#####	#####
70	70	55	57	26	24	42	68	48	41	88	39	30	55	70
66	62	39	47	26	36	37	50	43	46	69	36	30	53	66
74	53	40	72	40	35	37	47	41	49	74	36	28	48	74
74		37	57				35			41				74
			65				35			43				
			38				40			41				
			40											
			30											
			37											
Average 71	61.6667	42.75	49.2222	30.6667	31.6667	38.6667	45.8333	44	45.3333	59.3333	37	29.3333	52	71

Average for Camp 47.2981

Appendix H
2002 Classification of Days

	Safe	Alert	Danger	Emergency
7/31/2002		X		
8/1/2002	X	X		
8/4/2002	X	X	X	
8/5/2002	X	X	X	
8/6/2002	X			
8/7/2002	X			
8/8/2002	X			
8/9/2002	X			
8/10/2002		X		
8/11/2002		X	X	
8/12/2002	X	X	X	
8/13/2002		X		
8/14/2002		X		
8/16/2002		X		
8/17/2002		X		

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