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Assessment of High School Athletic Coaches Knowledge of the Prevention Recognition and Treatment of Heat Illnesses

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ASSESSMENT OF HIGH SCHOOL ATHLETIC COACHES KNOWLEDGE OF THE PREVENTION, RECOGNITION, AND TREATMENT OF HEAT ILLNESSES

by

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ABSTRACT

ASSESSMENT OF HIGH SCHOOL ATHLETIC COACHES KNOWLEDGE OF THE PREVENTION, RECOGNITION, AND TREATMENT OF HEAT ILLNESSES

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As evidenced by the current history of heat related deaths, heat-related illness is a vast problem in the United States. The purpose of this study was to assess the knowledge of high school athletic coaches' knowledge of the prevention, recognition, and treatment of exertional heat illnesses (EHI). A twenty-five question multiple choice assessment survey was developed to measure knowledge levels concerning the recognition, treatment, and prevention of EHI. In addition, a questionnaire was utilized to collect demographic characteristics that could have had an effect on knowledge scores. The instrument was reviewed by a panel of experts for face and content validity, and then pilot tested with a group of college coaches, undergraduate students in the physical education field, and certified athletic trainers to determine its test-retest reliability prior to distribution to subjects. Subjects scored a mean of 15.01 $\pm$ 2.79 with a range of 8.00 – 21.00. The mean score for the recognition section was 4.34 $\pm$ 1.35 (54%) with a range between 1.00 and 7.00. The mean score for the prevention section was 5.75 $\pm$ 1.62 (58%) with a range between 2.00 and 9.00. The mean score for the treatment section was 5.01 $\pm$ 1.25 (72%) with a range between 1.00 and 7.00. There was no difference in scores between male (15.05 $\pm$ 2.84) and female coaches (14.72 $\pm$ 2.69). There was no effect of highest level of degree obtained on knowledge levels. A 2 x 3 one-way ANOVA revealed an interaction for First Aid certification on treatment scores ($F_{1,80} = 7.38$, $p = .008$), with

coaches who had the certification scoring significantly higher ($5.38 \pm .91$) than those who did not (4.67 ± 1.4). There was a weak significant positive correlation between overall knowledge levels and years spent coaching at the high school level ($r= .260$, $p=.018$). This was also a weak positive correlation between coaches' knowledge in the area of preventing exertional heat illnesses and the number of years of high school coaching experience ($r=.264$, $p= .016$). There was no significant difference in knowledge level found between coaches who have personally suffered from EHI (20%) and those that have not (76.5%). There was a main effect for attendance at an informational session or workshop on the recognition section ($F_{1,80} = 3.961$, $p=.050$). The results suggest that high school athletic coaches may benefit from further education in the areas of recognition, prevention, and treatment of exertional heat illnesses. Further research should create educational materials for exertional heat illnesses and then examine their effectiveness on increasing knowledge levels as well as retention rates.

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CHAPTER I

INTRODUCTION

As evidenced by the current history of heat related deaths, heat-related illness is a vast problem in the United States. According to the American Academy of Family Physicians, heat illness causes 240 deaths annually (Barrow & Clark, 1998). The National Federation of High School reports that from 1995-2002, fifteen high school football players died from heatstroke (NFHS, 2005). Heat illness is also the third leading cause of death in United States high school athletes (Corris, Ramirez, & Van Durme, 2004).

Heat illness is defined by the National Athletic Trainers' Association as an umbrella term that encompasses five other conditions (Binkley, Beckett, Casa, Kleiner, & Plummer, 2002). Exercise-associated muscle cramps or heat cramps, heat syncope, exercise (heat) exhaustion, exertional heat stroke, and exertional hyponatremia are all included under this term (Binkley et al, 2002).

There are many predisposing factors involved with heat illness. Ethnicity and gender are two genetic factors that play a role in the incidence of heat illness (Carter, Cheuvront, Williams, Kolka, Stephenson, Sawka, & Amoros, 2005). Other risk factors are classified as either environmental or non-environmental. Ambient temperature, relative humidity, and the amount of equipment or clothing worn are examples of environmental risk factors. Hypohydration, previous exposure to heat illness, medications that interfere with the body's thermoregulatory system, chronic health conditions, and age are examples of non-environmental risk factors (CDC, 2000). Age in particular is an important risk factor to consider because children and young athletes are at an increased risk due to a number of physiological differences that do not allow them to regulate body heat as efficiently as adults (Casa & Yeargin, 2005).

Some of the pre-disposing factors, particularly the non-environmental ones, may be identified during the pre-participation physical (Bergeron et al, 2005). Athletes who are at risk may be withheld as needed according to the conditions. Environmental risk factors may be controlled for in a number of ways. The most important of these may be acclimatization (Bergeron et al, 2005). Practice modifications, such as changing the time of practice or rescheduling practice, changing the level of intensity of practice, and moving practice to an indoor, air-conditioned space are also recommended when conditions may be unsafe for athletes (Bergeron et al, 2005). Proper hydration also plays a key role in preventing heat illness (Casa & Yeargin, 2005). Athletes should consume fluids before, during and after practice. It is important for coaches to realize that as conditions become increasingly hotter and more humid, athletes should be allowed more drink breaks during practice. Athletes also need to be made aware of the relationship between replacing fluids lost from sweat and being properly hydrated for practice the next day (Convertino, Armstrong, Coyle, Mack, Sawka, Senay, & Sherman, 1996).

Fortunately, there are Certified Athletic Trainers (ATC) at the high school level that have the knowledge to prevent, recognize, and treat heat-illness (Binkley et al, 2002). There are currently 4,660 high school ATCs (NATA Membership Statistics, October 2005) who service no less than 2.8 million student athletes (NCAA Statistics on High School Athletes). Certified athletic trainers must cover many sports at one time, and they may not be immediately present to assist an athlete that has an injury. Therefore it is pertinent to have coaches who are trained and educated in certain aspects of injury prevention and recognition. The purpose of this study was to determine the heat-illness knowledge (knowledge of, recognition of signs and symptoms, and treatment options) of athletic coaches who are involved with athletes at the high school level.

Statement of the Problem

The purpose of this study was to determine the heat-illness knowledge (knowledge of, recognition of signs and symptoms, and treatment options) of athletic coaches who are involved with athletes at the high school level. Secondly, we compared the knowledge levels with various demographic characteristics.

Research Hypotheses

1. We hypothesize that coaches at the high school level will have obtain a score of less than seventy percent on the heat illness knowledge survey and therefore have inadequate knowledge of heat illness (knowledge of, recognizing signs and symptoms, and treatment options) (Bedgood & Tuck, 1983; Sossin, Gizis, Marquart, & Sobal, 1997; Cooney, Coleman, & Flynn, 1999; Parrott, Duggan, Cremo, Eckles, Jones, & Steiner, 1999).
2. There will be a significant positive relationship between level of education of athletic coaches and knowledge score of the prevention, recognition and treatment of heat illness. Athletic coaches with higher levels of education will score higher on the knowledge assessment.
3. There will be a significant positive relationship between years of experience in coaching and knowledge score of the prevention, recognition, and treatment of

heat illness. Athletic coaches with more years of experience will score higher on the knowledge assessment.

4. Athletic coaches with a first aid certification will have a greater knowledge of the prevention, recognition, and treatment of heat illness (Cooney et al, 1999)
5. Athletic coaches who have attended an informational session on heat illnesses will have a greater knowledge of the prevention, recognition, and treatment of heat illnesses than those coaches who have not (Parrott et al, 1999)
6. Athletic coaches who have had a previous experience with a heat-related illness will have increased knowledge of the prevention, recognition, and treatment of heat illness than those coaches who have not (Lehl, 2005).
7. Female athletic coaches will have a greater knowledge about the prevention, recognition, and treatment of heat illness compared to male subjects (Carter et al, 2005).

Null Hypotheses

1. Coaches at the high school level will have adequate knowledge of the prevention, recognition, and treatment of heat illness.
2. There will be no relationship between the level of education and the coaches' knowledge level of the prevention, recognition, and treatment of heat illness.
3. There will be no relationship between the number of years of experience in coaching and the coaches' knowledge level of the prevention, recognition, and treatment of heat illness.

4. There will be no difference in the knowledge level of the prevention, recognition, and treatment of heat illness between coaches that have first aid certification and those coaches who do not.
5. There will be no difference in the knowledge level of the prevention, recognition, and treatment of heat illness between coaches who have attended an informational session on heat illness and those coaches who have not.
6. There will be no difference in the knowledge level of the prevention, recognition, and treatment of heat illness between coaches who have had a previous experience with heat illness and those coaches who have not.
7. There will be no difference in the knowledge of the prevention, recognition, and treatment of heat illness and gender.

Independent Variables

- The first independent variable will be the sections of the survey with three levels. These sections include prevention, recognition, and treatment of heat illness.
- The second independent variable will be the subject characteristics as determined by the demographics questionnaire. These characteristics will include, but are not limited to, gender, level of education, years experience in coaching, first aid certification status, previous experience with heat illness, and attendance at an informational session or workshop on heat illness.

Dependent Variables

The dependent variable of this study will be the level of heat illness knowledge of coaches involved with athletes at the high school level as measured by the responses given on the survey.

Operational Definitions

Certified Athletic Trainer: An allied health care professional who, upon graduation from an accredited college or university, and after successfully passing the BOC certification examination, is qualified and appropriately credentialed according to state regulations to work with individuals engaged in physical activity in the prevention of injuries and illnesses, the recognition, evaluation, and immediate care of injuries and illnesses, the rehabilitation and reconditioning of injuries and illnesses, and the administration of this health care system. This individual must have current certification in CPR and be qualified in first aid and blood borne pathogens. Other health care professionals with equivalent certification and/or licensure would also meet this standard (Almquist, Pallay, Shields, Loud, Jenkinson, Hunter, Cavanna, Gilsenan, Barill, Lincoln, Rehberg, Rye, Mattey, Vodila, Beachy, Howe, Kalisiak, Peterson, Portwood, Reynolds, Robinson, Shultz, Woods, Diehl, Mallanda , Caracci, Spain, Cooper, Denehy, Fitzpatrick, & Iezzi, 2002).

Heat Illness: The NATA includes all of the following as components of heat-illness; heat cramps, heat syncope, heat exhaustion, heat stroke, and exertional hyponatremia.

Exercise-Associated Muscle (Heat) Cramps: Presents during or after intense exercise sessions as an acute, painful, involuntary muscle contraction (Rich, 1997; Casa, 1999; Brewster, O'Connor, & Lillegard, 1995).

Heat Syncope: Orthostatic dizziness typically occurring during the first five days of acclimatization, in persons with heart disease, or those taking diuretics. It often occurs after standing for long periods of time, immediately after cessation of activity, or after rapidly standing up after resting (Knochel, 1974; Hubbard, Gaffin, & Squire, 1995; Casa & Roberts, 2003).

Exercise (Heat) Exhaustion: Inability to continue exercise associated with any combination of heavy sweating, dehydration, sodium loss, and energy depletion. This condition occurs most frequently in hot, humid conditions (Rich, 1997; Brewster et al, 1995; Knochel, 1974; Amstrong, Hubbard, Kraemer, DeLuca, & Christensen, 1987; Casa & Roberts, 2003).

Exertional Heat Stroke: An elevated core temperature (>104 F) associated with signs of organ system failure due to hyperthermia (Casa & Roberts, 2003; Cabanac & White, 1995; Casa & Armstrong, 2003; Partin, 1990).

Exertional Hyponatremia: A relatively rare condition defined as serum-sodium level less than 130 mmol/L or 135 mmol/L. Affected athletes present with a combination of disorientation, altered mental status, headache, vomiting, lethargy, swelling of the extremities, pulmonary edema, cerebral edema, and seizures (Epstein & Armstrong, 1999; Armstrong, Curtis, Hubbard, Francesconi, Moore, & Askew, 1993; Garigan & Ristedt, 1999; Armstrong, Casa, & Watson, 2001; Hew-Butler, Almond, Ayus, Dugas, Meeuwisse, Noakes, Reid, Siegel, Speedy, Stuempfle, Verbalis, & Weschler, 2005).

Student Activities Coordinator (SAC): Responsible for the overall co-curricular program at the school, including but not limited to athletic and non-athletic activities. Provides resources to the organizations and coordinates their activities to ensure that a well-rounded program is offered to the student body (VBSchools.com).

Athletic Director (AD): Responsible for handling issues in athletics and activities from high schools, editing office publications, assisting with athletic bids, assisting in the development of athletic and activity budget, and coordinating the sportsmanship program. Some of the duties that will be handled in this position include but are not limited to organizing travel for teams, supervise activities and conferences, review policy, handbooks, or rulebooks, investigate athletic and academic eligibility, and develop budget proposals for new school athletic programs. Thorough knowledge of the principles, practices and procedures of school activities; ability to communicate ideas clearly and concisely, orally and in writing; ability to establish and maintain effective relationships with students, parents, staff and administration (VBSchools.com).

Athletic Coach: An individual who is employed full or part-time as a coach at the high school level by a school district in the Greater Tidewater Area (Virginia Beach, Norfolk, Suffolk, Chesapeake, Hampton, Newport News, and Portsmouth).

Assumptions

1. We assume that most spring coaches will be present at the coaches meetings.
2. We assume that either the Student Activities Coordinator or Athletic Director will distribute and correctly instruct the coaches in the participation of this study.

3. We assume that the subjects will answer all questions on the survey honestly and to the best of his/her ability.
4. We assume that all completed surveys will be returned to the researchers.

Limitations

1. The subjects cannot be randomly selected.
2. A standardized instrument to measure heat illness knowledge does not currently exist.
3. The researchers must rely on the Student Activities Coordinators or Athletic Directors at each school to correctly report the coaching staff at his/her school.
4. The researchers must rely on the Student Activities Coordinator or Athletic Director at each school to distribute and collect the surveys from the coaching staff at that school.

Delimitations

1. Subjects ($n \sim 85$) are employed athletic coaches at the high school level in the Greater Tidewater Area in the Commonwealth of Virginia.
2. Subjects were employed by public high schools.
3. Subjects were coaches of both indoor and outdoor sports.

CHAPTER II

REVIEW OF LITERATURE

This literature review focuses on exertional heat illnesses. Each condition that falls under the term of exertional heat illness is described in detail. It will highlight the epidemiology, contributing risk factors (environmental and non-environmental), prevention of, signs and symptoms of, and current trends in the treatment of exertional heat illnesses. Although athletic coaches' knowledge of exertional heat illnesses has not been assessed, the literature on the topics in which their knowledge has been is reviewed as well.

Epidemiology

Heat illness is responsible for approximately five thousand deaths annually in the general population (Buss, Kelly, Reinholtz, Roberts, & Fischer, 1990). Exertional heat illness affects more active populations such as athletes at all levels, especially in the sports of football and distance running. The military also sees a high incidence of exertional heat illness cases (Carter et al, 2005). Exertional heat illness is the third leading cause of death among high school athletes today (Corris et al, 2004). Bergeron et al (2005) reported that from 1995 to 2001, twenty-one young football players died of heat stroke. Soldiers are also affected by exertional heat illnesses. Between 1980 and 2002, five thousand two hundred forty-six soldiers from the U.S. Army were hospitalized. Of these cases, thirty-seven were fatal (Carter et al, 2005). During the Atlanta Olympic Games trials, there were a total of 62 heat related casualties over the eight days of competition, 19 occurring in the distance events. These illnesses occurred despite the

SHI (heat stress index) of 81.5 °F, which was well within the threshold of event delay of 87°F (Martin, 1998). During a four-day soccer camp, two thirds of the "tweens" (children age 8-15 years old) participating were found to be dehydrated, 29% seriously (urine specific gravity greater than 1.025), during the duration of the camp. Following activity, 57% of the children were still considered significantly dehydrated (USG of 1.030 or greater) (Casa & Yeargin, 2005).

The NCAA ISS (Injury Surveillance System) data for 2004-2005 reports that out of 73 schools (an 8% sample of 915 schools that have women's soccer), there were 72649 practice exposures which resulted in 15 reported cases of heat illness or asthma. During 25658 game exposures, there were seven reported cases. For men's soccer, 61 schools out of 739 (8.3%) reported a total of 10 cases of heat illness or asthma out of 72558 practice exposures. During 22654 game exposures, there were two reported cases. For football, 63 schools out of 616 (10.2%) reported 78 cases of heat illness or asthma during 370262 practice exposures, and 12 cases during 37579 game exposures. For field hockey, 23 out of 258 (8.9%) schools reported seven cases during the 21214 practice exposures, and three cases during 7288 game exposures. Surprisingly, data for cross-country and track and field were not included in this report. While these numbers seem relatively low, it must be noted that the response rate was very poor (average of 8.9%) and therefore these numbers are not representative of the entire population (NCAA ISS 2004-2005, www.ncaa.org/membership/ed_outreach/health-safety/iss/reports2004-05).

Definitions of Heat Illness

The NATA published a position statement on exertional heat illnesses in 2002 (Binkley et al, 2002). This document defines exertional heat illness as an umbrella term that contains the following five components; heat cramps, heat exhaustion, heat stroke, heat syncope, and exertional hyponatremia. In addition, the document outlines recommended protocols for the prevention and treatment of the conditions and describes the most common signs and symptoms seen in affected athletes.

Exercise-Associated Muscle (heat) Cramps

Exercise-associated muscle (heat) cramps are defined as a condition that presents during or after intense exercise sessions and presents as an acute, painful, involuntary muscle contraction. The most common causes include dehydration, electrolyte imbalances, and neuromuscular fatigue (Rich, 1997; Brewster, O'Connor, & Lillegard, 1995; Knochel, 1974; Bergeron, 1996; Casa & Roberts, 2003).

Heat Syncope

Heat syncope is defined as orthostatic dizziness typically occurring within the first week of acclimatization, generally after a person has been standing for a long period or transitions from a sitting to standing position too quickly. This condition most often affects people with heart diseases or those who take diuretics. (Knochel, 1974; Hubbard, Gaffin, & Squire, 1995; Casa & Roberts, 2003).

Exercise (heat) Exhaustion

Exercise exhaustion or heat exhaustion is found to occur mostly in hot, humid conditions. It is described as the inability to continue exercise due to the body's inability to keep up the cardiac output levels needed to meet thermoregulation and metabolic demands, but does not cause organ failure (Carter, 2005). Signs and symptoms associated with this condition may be any combination of heavy sweating, dehydration, sodium loss, energy depletion, headache, and hyperventilation. Core temperatures associated with exertional heat exhaustion range from 97F (36 C) to 104F (40C) (Rich, 1997; Brewster et al, 1995; Knochel, 1974; Armstrong, Hubbard, Kraemer, DeLuca, & Christensen, 1987; Casa & Roberts, 2003).

Exertional Heat Stroke

Exertional heat stroke is considered by many as the most fatal medical emergency of the five conditions (Adcock, Bines, & Smith, 2000; Binkley et al, 2002; Sandor, 1997). This condition presents with an extreme core temperature greater than 104 degrees F° (40 degrees C°) which is a result of the shutdown of the body's thermoregulatory center. This dysfunction may lead to global organ system failure. The signs and symptoms can include profuse sweating, hypotension, tachycardia, vomiting, diarrhea, hyperventilation, altered mental status, seizures, and coma (Rich, 1997; Knochel, 1974; Epstein, 2000). Fatal rhabdomyolosis has also been reported as a result of heat stroke (Carter et al 2005; Bergeron, McKeag, Casa, Clarkson, Dick, Eichner, Horswill, Luke, Mueller, Munce, Roberts, & Rowland, 2005).

Exertional Hyponatremia

Exertional hyponatremia is a rare condition defined as serum-sodium level less than 130 mmol/L (Casa & Roberts, 2003). This is slightly lower than the serum-sodium level defined by the Exercise-Associated Hyponatremia Consensus Panel, which considers a serum-sodium level of 135 mmol/L as acceptable (Hew-Butler, Almond, Ayus, Dugas, Meeuwisse, Noakes, Reid, Siegel, Speedy, Stuempfe, Verbalis, & Weschler, 2005). Affected athletes present with a number of symptoms that can be very similar to those of exertional heat stroke. These include disorientation, altered mental status, headache, vomiting, lethargy, swelling of the extremities, pulmonary edema, cerebral edema, and seizures (Convertino, Armstrong, Coyle, Mack, Sawka, Senay, & Sherman, 1996; Armstrong, Casa, & Watson, 2003) A differential diagnosis may be made by determining if the athlete is experiencing either altered mental status or seizures without also experiencing hyperpyrexia or hypoglycemia (Backer, Shopes, Collins, & Barkan, 1999).

Contributing Factors for Heat Illness

There are a number of contributing risk factors that influence an athlete's chance of suffering from a heat related illness. These factors are divided into two separate categories, environmental and non-environmental (Binkley et al, 2002). While the environmental factors are often more obvious, it is very important that the non-environmental factors be identified to ensure the safety of the athlete. The following section discusses both categories of contributing factors in detail.

Environmental Factors

There are many factors that can help contribute to heat related illness. The NATA position statement on heat related illness states that playing temperatures should be the first consideration in preventing these conditions. A wet bulb globe temperature (WBGT) of 23-28°C presents a high- risk environment, and it is recommended that athletes that are considered high risk should be withheld. This can be determined by using a sling psychrometer or consulting a heat stress risk temperature and humidity graph (see Appendix B). While the sling psychrometer requires instruction to use, the graph only requires users to know the temperature and humidity for the day. Users then match these numbers and see what zone they cross in. Athletes that are considered to be at high risk for suffering a heat illness include those that have an increased body mass index (BMI), are in poor physical condition, have not been adequately acclimatized, have asthma or another respiratory condition, have recently been ill, suffer from a renal dysfunction or disease, are on certain medications, and have a history of heat illness (Bergeron et al, 2005). When temperatures are above 28°C, it is recommended to delay or reschedule the event until the temperatures become safer (Department of the Army, 1980; Hughson, Staudt, & Mackie, 1983; American College of Sports Medicine, 1987; Armstrong, Epstein, & Greenleaf, 1996; Rozycki, 1984; Knight, Casa, McClung, Caldwell, Gilmer, Meenan, & Goss, 2000). Several variations of this policy are found in the literature due to the differences in acceptable WBGT ceilings under which activity may still occur. The range of values were found to be from 27C – 32.2C (Casa & Yeargin, 2005; Rav-Acha, Hadad, Epstein, Heled, & Moran, 2004; Wallace, Kriebel, Punnett, Wegman, Wenger, Gardner, & Gonzalez, 2005). The study populations included active subjects in all age ranges from children to Marine Corps. Wallace et al (2005) concur with the NATA position statement that current environmental conditions should be included when predicting risk of heat illness, but suggest using a formula including the previous day's average temperature as well as the current conditions to help improve prediction of risk. The researchers warn that this formula has not been validated.

Non-Environmental Factors

While environmental factors should certainly be of importance when assessing an athlete's risk for heat illness, non-environmental factors may play an equally important role. Therefore, it is extremely important for coaches, athletes, and athletic trainers to be aware of these risk factors and know how to control and reduce them. It has also been shown that the more risk factors that an athlete has, the greater possibility the episode of heat illness has to be fatal. In a series of case studies of fatal exertional heat stroke episodes in the Israeli defense forces, a significant correlation between the number of predisposing factors and mortality was found. Fifteen factors were identified in this case series, and were very similar to the non-environmental risk factors listed by Binkley et al (2002), with the addition of absence of proper medical care and improper treatment. In the fatal cases of exertional heat stroke, the victims were all found to have seven or more of these risk factors present. In this same series of case studies, the non-fatal cases of exertional heat stroke reported were all found to have five or fewer of these factors present (Rav-Acha et al, 2004).

Non- environmental risk factors that could place an athlete at risk for a heat related illness include dehydration, barriers to evaporation such as equipment and rubber suits for weight loss, current or recent illness, history of heat illness, increased body mass index (thick fat layer or decreased surface area), poor physical condition, excessive or dark colored clothing or equipment, attempting to perform beyond physical abilities, lack of acclimatization, medication and drugs, and electrolyte imbalances (Armstrong, 1998; Mathews, Fox, & Tanzi, 1969; Armstrong, 1992; Armstrong et al, 1990; Armstrong, Hubbard, & Askew, 1993; Armstrong, Szlyk, DeLuca, Sils, & Hubbard, 1992; Brechue & Stager, 1990; Cooper, 1994; Desruelle, Boisvert, & Candas, 1996; Epstein, 1990; Gardner, Kark, & Karnei, 1999; Kalant & Le, 1983; Kark, Burr, Wenger, Gastaldo, & Gardner, 1996; Kubica, Nielsen, Bonnesen, Rasmussen, Stoklosa, & Wilk, 1983; Mendyka, 1992; Melby, 1986; Mitchell, Senay, Wyndham, van Rensburg, Rogers, & Strydom, 1976; Maughan & Shirreffs, 1997; Noakes, Myburgh, & du Plessis, 1991; Wetterhall, Coulumbier, Herndon, Zaza, & Cantwell, 1998; Vanakoki & Seppala, 1998; Non-environmental factors that can cause an athlete to be at risk specifically for hyponatremia include low body weight, being female, exercise lasting longer than four hours, a slow running pace, race inexperience, excessive fluid intake, and impaired renal function in relation to water excretion (Hew-Butler et al, 2005).

Increased use of dietary supplements and coaching staffs that are not trained in the prevention or treatment of heat illnesses have also been included as factors that not only place athletes at risk but increase the likelihood that a heat illness episode may be fatal (Carter et al, 2005). However, a study comparing injury incidence in collegiate football players found that those who took creatine supplementation had a significantly lower case incidence of heat related illness than those who did not (Greenwood, Kreider, Greenwood, & Byars, 2003). This is believed to be the case due to the properties of creatine that promotes fluid retention. This is further supported by recent research that has found that heat stress during exercise may be reduced and hydration may be maintained by creatine supplementation (Greenwood et al, 2003). It must be noted that this study was only one year in duration due to the August 2000 NCAA restrictions that no longer allow institutions to distribute muscle building supplements to their athletes. However, these researchers reported that similar results were found by Greenwood, Kreider, & Melton et al (1998) during a similar study with duration of three years (Greenwood et al, 2003).

Although not widely discussed within the literature, one epidemiology study of heat illness in soldiers found that ethnicity and state of origin could have an impact on the likelihood of sustaining a heat illness (Carter et al, 2005). Based on this data, it was found that Hispanic women were the least likely to develop a heat illness, while Caucasian women were the most likely. African American men had a significantly lower chance of developing heat illness when compared to their Caucasian counterparts. State of origin was defined as the home of record, and was found to have a significant impact on risk of developing a heat injury. Soldiers from northern states were almost twice as likely to develop heat illness as compared to their southern counterparts (Carter et al, 2005).

There are also a number of medical conditions that can predispose athletes to heat illness. The first of these is malignant hyperthermia. This condition is characterized by muscle rigidity that results in increased body temperature, which is a product of accelerated metabolic rate in the skeletal muscle (Bourdon & Canini, 1995; Dixit, Bushara, & Brooks, 1997; Hunter, Rosenberg, Tuttle, DeWalt, Smodie, & Martin, 1987). Neuroleptic malignant syndrome is a condition often seen in athletes that are on neuroleptic agents and antipsychotic drugs who experience an unexpected rise in core temperature during exercise for which no other cause can be identified (Lazarus, 1989; Rampertaap, 1986; Addonizio, Susman, 1984; Martin, Lucid, & Walker, 1985). Another condition that places an athlete at risk is arteriosclerotic vascular disease. This disease jeopardizes cardiac output and blood flow due to thickening of arterial walls (Wetterhall et al, 1998; Virmani & Robinowitz, 1987). The fourth condition is scleroderma. This places the athlete at risk due to a decrease in sweat production, which in turn decreases heat transfer (Rampertaap, 1986; Buchwald & Davis, 1967). Sickle cell trait is another condition that places an athlete at risk by decreasing the ability of red blood cells to carry sufficient oxygen to the body. The decreased atmospheric oxygen levels found at higher altitudes can compound this problem during activity (Kerle & Nishimura, 1996; Gardner & Kark, 1994). The final condition that places an athlete at risk is cystic fibrosis. This condition specifically increases risk of the athlete becoming hyponatremic due to this disease's symptom of increasing the salt content of sweat (Smith, Dhatt, Melia, & Dickinson, 1995; Andrews, Mango, & Venuto, 1978). However, this disease has not been conclusively proven to be a risk factor for heat related illness. The Consensus Statement of the 1st International Exercise-Associated Hyponatremia Consensus Development Conference, Cape Town, South Africa (2005) states that there is only one reported case of cystic fibrosis in relation to hyponatremia. Therefore, more research needs to be done in order to determine the relationship between the disease of cystic fibrosis and hyponatremia (Hew-Butler et al, 2005). A study by the CDC that tracked data of heat related illnesses, deaths, and risk factors from 1979 – 1997 agreed that these conditions were risk factors for hyperthermia and heat-related deaths (Morbidity and Mortality

Weekly Report, Centers for Disease Control and Prevention, 2000). Lastly, Corris et al (2004) adds upper respiratory and gastrointestinal illnesses, and sweat gland dysfunction to the list of predisposing medical conditions.

In addition to the previously discussed risk factors, children are at an increased risk for heat related illness. The Committee on Sports Medicine and Fitness (American Academy of Pediatrics) attributes this increased risk to a number of physical and physiological factors that are specific to children. Due to having a greater surface area to body mass ratio, children absorb greater amounts of heat on hot days and lose greater amounts of heat on a cold day. Also, during physical activity including walking and running, children produce more metabolic heat per mass units than adults.
To compound this problem, it is more difficult for children to dissipate heat by evaporation due to a decreased sweating capacity. Children are also more susceptible to voluntary dehydration because they often do not feel the need to drink enough fluid to replace what is lost during exercise (Committee on Sports Medicine and Fitness, 2000).

Prevention of Heat Illness

The literature contains many similar recommendations for the prevention of heat related illnesses. The first step in preventing heat illness is a thorough pre-participation physical exam that identifies or rules out predisposing conditions (Bergeron et al, 2005). The next most important prevention measure in heat illness is acclimatization. Acclimatization is the process the body undergoes in its adaptation to repeated heat stress (Epstein, 2000; Haymes & Wells, 1986; Shapiro, Pandolf, & Goldbanks, 1982; McArdle, Katch, & Katch, 1991). This is accomplished by transitioning to full intensity practice by a series of increasingly intense practices (Bergeron et al, 2005). This period should last 10-14 days, with practices ranging 30-45 minutes each every day or every other day (Casa, 2000; Committee on Sports Medicine, 2000). It should be noted however that while this period will acclimatize most athletes fully, some might take longer (up to 3 months) (Armstrong, & Maresh, 1991; Morimoto, Miki, Nose, Yamada, Hirakawa, & Matsubara, 1981; Pandolf, Cadarette, Sawka, Young, Francesconi, & Gonzalez, 1998). During the acclimatization period, in specifically high school football, practices can go marginally longer (60-90 minutes) (Bergeron et al, 2005). Athletes should not be allowed to practice more than six days in a row, regardless of level, and two-a-day practices should not fall on consecutive days.

There are also a number of steps that may be taken to modify practices when the outdoor conditions are considered to be of risk to the athletes. These include increasing the number of drink breaks, changing practice to a time of day when conditions would improve, decreasing the amount of equipment and clothing the athletes wear during activity, decreasing the intensity level of practice, and moving practice to an indoor, air-conditioned facility (Bergeron et al, 2005). For example, when the conditions are considered to be of mild risk, it is recommended that athletes be allowed more drink breaks and that they be taken in the shade (Casa & Yeargin, 2005). When conditions are considered to be of moderate risk, athletes should wear the least amount of equipment possible, and wear light colored clothing. This may cause the intensity level of practice to be decreased as well. For example, if a team was to practice hitting against football sleds that day, but the conditions dictate that they may only wear their helmets, then they will be limited to activities that can be performed with helmets only. When conditions are considered to be high-risk or unsafe, it is recommended that practices be either moved indoors to an air-conditioned facility or rescheduled (Bergeron et al, 2005).

Proper hydration is also an important component of heat illness prevention. This can be done prior to events as well as during competition. Athletes should be sure to ingest adequate amounts of fluid for twenty-four hours prior to practice or competition. At least two hours before the start of practice or competition, approximately 500 mL of fluids should be consumed (Convertino, Armstrong, Coyle, Mack, Sawka, Senay, & Sherman, 1996). The NATA and AAP have issued fluid consumption guidelines for younger athletes that state drink breaks should be given every twenty minutes during which children weighing less than 90 lbs should consume 3 – 5 oz of fluid while those weighing more than 90 lbs around 7 oz of fluid (Casa & Yeargin, 2005). After activity, these children should be consuming 8 oz or 12 oz of fluid per half pound of body-weight lost to replenish sweat losses (Casa & Yeargin, 2005). In high school or collegiate level athletes, it is suggested that rates of fluid consumption during activity be approximately one pint per pound of body weight lost (Convertino et al, 1996). However, it has been shown that this amount of fluid may cause gastric discomfort for the athlete. In that case, the athlete should consume as much as can be tolerated to prevent dehydration (Convertino et al, 1996). Timing of fluid intake during exercise is also important. It has been demonstrated that when activity lasts less than 40 – 60 minutes, any fluid ingested during this time will not be beneficial to the athlete (Coyle, 2003). This emphasized the importance of pre-practice and pre-competition hydration protocols. Athletes' hydration status can be monitored with the use of weight checks before and after practice (Bergeron et al, 2005). For example, if an athlete weighs in at 125 pounds prior to practice, he or she may weigh three to four pounds less at the end of practice due to fluid losses. When they return the next day, they should have consumed enough fluids to be back to their starting weight the day before. Athletes that do not meet these criteria are at a higher risk for suffering a heat-illness and should be monitored closely or withheld from activity until they have regained the lost fluid weight (Binkley et al, 2002; Bergeron et al, 2005; Convertino et al, 2006).

Athletes of all ages experience voluntary dehydration. This occurs when they do not consume fluids while under heat distress although they are provided (Brake & Bates, 2003). It is thought that athletes allow this to happen because they do not feel thirsty. However, it is vastly supported in the literature that thirst is not a reliable measurement of dehydration, and it has been shown that it does not begin until approximately two percent of total body water has been lost (Brake & Bates, 2003). Many researchers have concluded that voluntary dehydration may be avoided by making the water more palatable (Convertino et al, 1996; Casa & Yeargin, 2005; Brake & Bates, 2003).

Pre-cooling is another method that is thought to help reduce the risk for heat illness. Pre-cooling is thought to lower skin temperature and to possibly cause small reductions in core body temperature (Duffield, Dawson, Bishop, Fitzsimmons, & Lawrence, 2002). Thus far, pre-cooling has been attempted using a number of different methods, such as cold water immersion, resting in a climate chamber with cold ambient temperatures, water perfused suits and wet towels, and more recently, cooling jackets (Schmidt & Bruck, 1981; Marsh & Sleivert, 1999; Sjodin, Forslund, & Webb, 1996; Duffield et al, 2002). The results of these previous trials have shown that the effects of hyperthermia can be limited when pre-cooling is used as a prevention tool (Marsh &

Sleivert, 1999; Yates, Ryan, & Martin, 1996; Smith, Yates, & Lee, 1997; Lee & Haymes, 1995).

Treatment of Heat Illness

The literature currently describes various methods of treating heat illness. The National Athletic Trainer's Association position statement on heat illness describes a treatment protocol that should be followed for all five conditions (Binkley et al, 2002).

Exercise-Associated Muscle (Heat) Cramps

In the case of heat cramps, the athlete should be removed from activity and begin to re-hydrate with an electrolyte containing fluid, particularly sodium. Gentle stretching and light massage should also be administered while the athlete is re-hydrating. If cramps are not relieved or the athlete is unable to consume fluids orally, intravenous fluids may be necessary (Rich, 1997; Casa, 1998; Casa, Armstrong, & Hillman, 2000; Casa et al, 2000; Noakes, 1995; Sandor, 1997). If commercial sports drinks or electrolyte solutions are not available, a mixture of 1tsp of salt in 500mL of water would be effective as well (Wexler, 2002).

Heat Syncope

In the case of heat syncope, the athlete should be moved to a cool, shaded area, the legs should be elevated above heart level, the vital signs should be monitored, and any water deficiency should be corrected. Other conditions such as postural orthostatic tachycardia should also be considered if an athlete has frequent episodes of syncope (Binkley et al, 2002; Sandor, 1997).

Heat Exhaustion

Heat exhaustion treatment involves assessment of the central nervous system and cognitive functions, along with vital signs and rectal temperature in order to rule out more serious conditions such as heat stroke (Casa & Roberts, 2003). Athletes found to have a core temperature of 102°F should be moved to a cool area, re-hydration should be started, and excess clothing should be removed. Then, the athlete should be cooled with evaporative cooling using fans and wetting the skin (Glazer, 2005). It should be noted that the hydration status of the athlete should be monitored in order to make sure the athlete does not become hypernatremic (Wexler, 2002). Sandor (1997) adds that raising the legs to help prevent and reduce postural hypotension can be helpful in the treatment of heat exhaustion. One study found that in recreational hikers with heat exhaustion, fluid replacement administered orally and/or intravenously was effective at relieving the symptoms (Backer, Shopes, Collins, & Barken, 1998).

Heat Stroke

While there is much discussion and debate over the most effective way to treat the heat stroke victim, the literature does come to the consensus that treatment should begin with determining rectal temperature and assessing the athletes ABC (airway, breathing, circulation) status and cognitive state. In the case of heat stroke, the goal is to lower the patients' temperature as quickly as possible to a goal temperature of 38°C (Glazer, 2005).

This is crucial for survival because patients who spent a shorter amount of time in a hyperthermic state have been shown to have a decrease in rates of morbidity and mortality (Smith, 2004). Immersion of the trunk and extremities in ice water (approx 35°F – 59°F) is the preferred external method of cooling (Noakes, 1995; Deschamps, Levy, Coslo, Marliss, & Magder, 1992; Armstrong, Crago, Adams, Roberts, & Maresh, 1996; Marino & Booth, 1998; Clements, Casa, Knight, 2002; Smith 2004). This method has been shown to have one of the shortest cooling times. This quick return to stable temperatures may decrease the need for intravenous fluid replacement in some patients (Sandor, 1997). However, this method may not be the best option for those patients that are in an altered state of consciousness (Smith, 2004). Furthermore, many people being immersed in ice water may be extremely uncomfortable. Also it may not be possible or practical, such as when transporting a patient, for immersion to take place (Brodeur, Dennett, & Griffin, 1989; Roberts, 1989). It is also interesting to note that there are some possible negative aspects of ice water immersion treatment (Glazer, 2005). These include peripheral vasoconstriction and shivering if the skin is cooled below 30° C. Immersion can also make it difficult to get to the patient in case of any complications such as cardiac arrest (Glazer, 2005).

Placement of ice bags in the axillae, groin, and neck is a popular on the field method of initial treatment of heat illnesses. A literature review found that this method was even more effective when coupled with an evaporative technique (Smith, 2004). Binkley et al (2002) stated that when heat stroke is suspected, ice bags should be placed all over the body, but should be focused in these areas (Brodeur et al, 1989; Roberts, 1989).

There are also a number of evaporative techniques to be considered. The spraying of water over the body along with airflow provided by a fan is one method. An advancement of this concept was described by Khogali and Weiner (1980) in a series of case studies using water cooled to 15° C and a warm airflow (Smith, 2004). It has been determined that this method is also very efficient for the treatment of heat stroke as it has been shown to decrease temperatures by .31°C per minute (Glazer, 2005). The idea behind this is to facilitate loss of heat by minimizing peripheral vasoconstriction while maintaining skin temperature (Smith, 2004). Another technique using the downdraft of a helicopter was described by Smith (2004) to be effective, with a mean cooling time of twenty-four minutes for three patients. However, while this may be useful and more available to military personnel, it is not practical for use in athletics.

Invasive cooling is another category of methods that may be used to rapidly cool temperature. Ice or cool water lavage is one of the most commonly used techniques, with treatment taking place in the gastric tract, bladder, and over the peritoneum (Smith, 2004; Glazer, 2005). Cardiopulmonary bypass has been successfully used, however, the effectiveness of this treatment is still in question, and is only recommended in extreme conditions (Glazer, 2005). However, it is interesting to note that while Smith (2004) describes these techniques, he cites that the only data with human subjects comes from a case series in a single case report, and that the effectiveness of this treatment has yet to be proven.

Another potential cooling method is by the use of chemical agents, most commonly Dantrolene. Dantrolene is currently used in malignant hyperthermia and neuroleptic malignant syndrome as a cooling agent through muscle relaxation (Ward, Chaffman, & Sorkin, 1986). Although studies have tested the effectiveness of Dantrolene, the literature does not include significant evidence that it decreases cooling time when compared with traditional methods (Channa, Seraj, & Saddique, 1990; Bouchama, Cafege, & Devol, 1991). Further research is needed before use of this drug is widely accepted (Smith, 2004; Binkley et al, 2002; Wexler, 2002).

The patient should be transported to a hospital facility where cooling should be continued until the patient's rectal temperature reaches 101-102°F (38°C). Cooling should be discontinued at this time in order to avoid over correction that could cause the patient to then go into hypothermia (Damman & Boden, 2004; Sandor, 1997; Binkley et al, 2002).

Exertional Hyponatremia

In the case of exertional hyponatremia, there are different methods of treatment depending upon how and where the athlete is diagnosed as hyponatremic and include asymptomatic, symptomatic- on site, and symptomatic- in the hospital. (Hew-Butler et al, 2005). In asymptomatic hyponatremia, the first step in treatment should be to limit fluid intake until the athlete voids his/her bladder. The athlete should be advised to seek medical attention if the hyponatremia becomes symptomatic. It is imperative to note that asymptomatic hyponatremia is contraindicated for intravenous normal saline as this can worsen the hyponatremic condition (Hew-Butler et al, 2005).

In symptomatic-onsite hyponatremia, it is a must that intravenous fluids are administered immediately. Simultaneous administration of oxygen and transportation to a medical facility should occur. The emergency room physician should be notified of the hyponatremic state of the patient. However, if the medical staff onsite is qualified, the intravenous treatment can be carried out onsite prior to transport so that the athlete will be stable (Hew-Butler et al, 2005).

In symptomatic- in hospital hyponatremia, the first step is to establish intravenous access so that sodium chloride may be administered. There are several protocols that can be followed to accomplish the goal of raising sodium levels in the blood and reducing brain edema (Hew-Butler et al, 2005). Treatment should subside when the athlete regains consciousness and is stable. It is also recommended that a nephrologist and endocrinologist be consulted following the stabilization of the athlete (Hew-Butler et al, 2005).

Other literature does not widely employ the delineation of hyponatremia into asymptomatic, symptomatic- onsite, and symptomatic- in hospital. Therefore, the treatment protocols found in the remaining literature are for hyponatremia in general. In the case of hyponatremia, the first step is to differentiate between hyponatremia and other heat related illnesses. The most obvious differentiations are altered level of consciousness, combativeness, major confusion, and seizures (Backer et al, 1999). It is recommended that a sodium analyzer be kept onsite in order to determine if the athlete has a plasma-sodium level less than 130mEq/L, which is indicative of hyponatremia (Binkley et al, 2002). Fluid intake is discontinued until a physician is consulted. Emergency Medical Services should be called and intravenous access should be obtained in order to administer hypertonic fluids, which will increase sodium levels, cause the athlete to urinate, and control seizures (Binkley et al, 2002).

Assessing Athletic Coaches Knowledge

Athletic coaches' knowledge of the prevention, recognition, and treatment of heat illness has not been assessed. However, their knowledge, attitudes, and beliefs on topics such as asthma, nutrition, sun exposure risk, serious neck injury, rugby headgear, and oro-facial/dental trauma has been assessed (Sossin, Frances, Marquart, & Sobal, 1997; Bedgood, & Tuck, 1983; Parrott, Duggan, Cremo, Eckles, Jones, & Stenier, 1999; Cooney, Coleman, & Flynn, 1999; Petterson, 2001; Lehl, 2005; Wilson, Van Lunen, Ridinger, & Dowling, 2005).

Bedgood and Tuck (1983) surveyed ninety coaches and two athletic trainers (62% response rate) on their knowledge of nutrition in the areas of general nutrition information, nutrient supplementation, special dietary considerations, pre-event meals, and fluids and hydration. Their demographics questions revealed that sixty-nine percent had majored in physical education, health, and recreation and forty-nine percent held master's degrees. Despite this, only fourteen respondents scored above the seventy percent average marker set, with scores ranging from twenty-eight to eighty-four percent. Coaches scored the best on the areas of general nutrition information and fluids and hydration, but still scored significantly below seventy percent. It should be noted that of these respondents, only eleven percent studied nutrition as a separate course in college and twenty-three percent had no formal instruction in the subject at all, yet seventy-three percent felt they had been adequately prepared to advise high school athletes in the matter.

Sossin et al (1997) had similar results when they surveyed a total of 311 (45.7% response rate) high school wrestling coaches from the state of New York. Coaches were asked questions on their beliefs, attitudes, and resource use concerning the areas of weight loss, weight class, dehydration, training diet, and eating disorders. The questionnaire included sixty-six questions that were scored using a Likert scale format (Sossin et al, 1997). This is similar to the format used by Bedgood and Tuck (1983) but contains more questions. The data suggested that although these coaches were not adequately equipped, either with personal knowledge or resources, to give recommendations or advice on nutrition and weight loss, they were somewhat knowledgeable in other areas. For example, 91% of coaches believed that wrestlers did not need to limit their intake of carbohydrates and eighty-five percent thought that levels of stored glycogen can affect available energy for performance. Also, eighty percent of the coaches said they were cognizant of the signs of bulimia and felt confident they would recognize if one of their athletes were suffering from an eating disorder. It is interesting to the current investigation that 93% of coaches understood the signs of dehydration, although thirty-seven percent incorrectly included thirst as an adequate indicator of the condition (Sossin et al, 1997; Brake & Gates, 2003). However, less than half were aware that a fluid loss of two percent of body mass can impair performance, and only fifty-percent were aware of the fluid replacement rate needed to avoid dehydration. In addition, only thirty percent of the coaches surveyed were in favor of having hydration status checked by a urine specificity test at the time of weight certification (Sossin et al, 1997). While only twenty-nine percent of the coaches surveyed had attended a sport nutrition workshop in the preceding twelve months, almost all showed interest in learning more about the topics they were questioned about. Most coaches also reported that they received their information from magazines, textbooks, journals, and professional publications (Sossin et al, 1997).

Cooney et al (1999) studied Irish Senior Cup Team rugby coaches' knowledge of the prevention, recognition, and treatment of serious neck injuries. The format of the survey used was not reported. They found that most coaches (97.2% of respondents, n=36) reported following preventative measures in regards to serious neck injuries. However, forty-four percent did not match athletes by skill, size, or strength as recommended by the Irish Rugby Football Union, but by age. They also found that almost half of the respondents did not follow the guidelines for proper length of preseason training, and although eighty-one percent of coaches reported using neck-strengthening exercises with their athletes, only 16.8% were aware that these exercises were for the prevention of serious neck injury. Although fifty percent of the coaches possessed a first aid qualification, they were only able to recognize only slightly more symptoms than their non-qualified counterparts on average (1.9 symptoms versus 1.6 symptoms). Most of the coaches (87%) knew that athletes with suspected neck injuries should not be moved, but only 78.4% would seek medical attention, and even fewer (19.6%) would immobilize the neck. Alarmingly, only two of the coaches indicated that they would check the athlete's airways and no coaches recognized unconsciousness as a sign of a serious neck injury. Further, only twenty-five percent of coaches were aware that neck pain is an indication of a neck injury. In the area of treatment, it was found that of the seven coaches who were trained in neck immobilization, only three of them had access to a neck collar. Eighty three percent of rugby facilities did not have stretchers available, while fifty two percent did not have a neck collar. However, forty-eight percent of coaches did carry a neck collar with them, and seventeen percent carried a stretcher (Cooney et al, 1999). Overall, the coaches surveyed were found to have insufficient knowledge regarding the prevention, recognition, and treatment of serious neck injuries. However, ninety-four percent of the respondents reported they were willing to attend a course on the recognition and emergency management of injuries (Cooney et al, 1999). Thus far, the literature has shown that while high school and youth coaches overall may have some knowledge of the topics they are surveyed on, they generally fall below the standards set for them and need additional training and education in order to be adequately prepared for the situations that may arise when medical personnel is not available (Bedgood & Tuck, 1983; Sossin et al, 1997, Cooney et al, 1999; Wilson et al, 2005).

While it is evident in the current literature that coaches do not have the knowledge to handle medical situations on their own, the question must be asked as to why this is the case. One reason may be that they are not held responsible by their employers to be educated in topics other than the rules and regulations of their sport. Bell et al (2005) concluded that role of a well prepared coach is key in the continuum of care in high school athletic injuries (Bell, Prendergast, Schlichting, Mackey, & Mackey, 2005). However, in their study, which examined the medical preparedness of Illinois high schools, it was discovered that the majority of coaches cannot possibly be prepared for such situations. Of the 316 schools that responded to their survey, only 125 (41%) required their coaches to be certified in first aid, while only 111 (36%) require their coaches to be certified in CPR. Further, only 57 (19%) schools require that their coaches be certified to use an automated external defibrillator (AED). These numbers are particularly discouraging in light of the fact that the study also found that there were 27 (8.6%) schools that reported having no other type of medical provider present at practices or games to care for athletic injuries (Bell et a, 2005). Of these schools, 12 (7.6%) also reported that they did not require coaches to possess any First Aid, CPR, or AED certifications (Bell et al, 2005). It was interesting to note however that 15 (4.9%) of the schools surveyed required their coaches to be American Sport Education Program (ASEP) certified (Bell et al, 2005). These results are similar to those found by Aukerman, McManama Aukerman, and Browning (2006) in their study of medical coverage of high school athletics in North Carolina. They found that out of 139 schools, 65 (48%) did not have access to a NATABOC certified athletic trainer, and only 29 (20%) of schools had an athletic trainer that also held the North Carolina state certification. 72 (51%) of the schools surveyed reported having no licensed, certified sports medicine provider, and therefore relied on non-licensed, non-certified providers, such as head and assistant athletic coaches (Aukerman et al, 2006). However, 109 (78%) of the schools surveyed reported having either an orthopaedic physician (n = 72, 52%) or a primary care physician (n = 49, 35%) on hand for some athletic events. Most of these events were football games, and the researchers found a significant disparity in coverage between football and all other men's and women's sports (Aukerman et al, 2006). Of the schools surveyed, 67 (49%) felt that their medical coverage was inadequate while 70 (51%) felt their medical coverage was at least adequate, with the presence of a nationally certified athletic trainer being the only predictor of perception status found to be independently significant (Aukerman et al, 2006). However, most of the surveys were completed by high school athletic directors, who the researchers postulated may or may not be the best person to determine whether or not current medical care is sufficient (Aukerman et al, 2006). The researchers concluded that this lack of appropriate medical coverage may possibly be putting student-athletes at risk for receiving improper treatment for their injury which could lead to unnecessary complications and morbidity later in life. They also suggested that the practice of allowing unlicensed, uncertified individuals provide medical coverage for these athletes may place the school at an increased assumed liability (Aukerman et al, 2006). They proposed that high schools should make every possible effort to obtain the proper medical coverage for their athletic events, whether it is by a paid, full-time employee or by medical and allied health professionals who are willing to volunteer their time (Aukerman et al, 2006).

It should be noted that a number of professionals and educators in the field have favored the opinion that coach certification should be made mandatory in every state (JOPERD, 2003). They sight the fact that historically, most high school coaches were also physical education teachers, which meant they would have taken courses that covered at least some of the content that comprises the National Standards for Athletic Coaches. However, today high school athletic programs are larger and more competitive than ever which has increased the number coaches each school needs. This means that coaches may not even be teachers at the school, let alone have a background in physical education, and therefore come equipped with no formal training in interscholastic athletics (JOPERD, 2003). Although the ASEP reports that thirty-six states at least require coach education for non-teaching coaches, there are 14 states that require no formal education at all (Aeby, Overton, & Manlinauskas, 2006). Also, it should be noted that it cannot be assumed that a coach possesses the knowledge to be compliant with all of the National Athletic Coaches Standards simply because he or she is employed as a teacher, just as one would not assume that an English teacher would be have the knowledge to teach math simply because he or she has a teaching degree (Koch, 2004).

Coach certification has been, and remains, a "hot topic" in the world of high school and youth sports. Coaches are asked to function in a capacity beyond that of just making sure their athletes are good at the sport they play (Sullivan, 1996). They may take on the role of surrogate parent, counselor, friend, role model, and minor medical caregiver, and often with little or no formal education or training. For example, Seefeldt & Ewing estimated that over 90% of youth sport coaches have no formal training at all (Seefeldt & Ewing, 1997). It has been postulated that between youth and high school coaches, formal education and training programs would be in high demand, but that has not been the case (Seefeldt & Ewing, 1997). This lack of interest cannot be mistaken for lack of coach education programs, as there are at least four programs sponsored by national agencies, a number of sport-specific certifications, and at least one state-created program (Seefeldt & Ewing, 1997; Stewart, 2006). Also, the Directory of College and University of Coaching Education Programs currently reports that currently there are a total of 179 institutions in the United States that offer undergraduate or graduate degrees in coaching education, which adds to the variety of sources that coaches or future coaches could obtain their certification (Aeby, Overton, & Malinauskas, 2006).

More important than the number of coach education programs is their content. In 1995, the National Association of Sport and Physical Education (NASPE) released their National Standards for Athletic Coaches. There are a total of thirty seven standards divided into eight domains: 1) injury prevention, care, and management; 2) risk management; 3) growth, development, and learning; 4) training, conditioning, and nutrition; 5) social and psychological aspects of coaching; 6) skills, tactics, and strategies; 7) teaching and administration; and 8) professional preparation and development (Sullivan, 1996). These standards provide the basis that modern coach education programs are built upon, whether the program is presented in a collegiate classroom or the distance education forum. They also provide administrators with a way to define qualifications and evaluate their staff (Sullivan, 1996).

Despite this considerable number of resources, it is interesting to note that currently only forty states have required or recommended the ASEP program or an equivalent for high school coaches (DeRenne, Morgan, Hetzler, and Taura, 2007). Another interesting point is that currently only nine states absolutely require that their coaches be at least be certified in both First Aid and CPR, with another six states only requiring certification in one or the other. One state recommends that coaches be certified in both (DeRenne et al, 2007). More specifically, in their study of Hawaii head baseball coaches, DeRenne et al (2007) found that while the Hawaii High School Athletic Association (HHSAA) does not require coaches to have a coaching certification in order to obtain a job as a head coach, the league did offer coaching education or training seminars that a coach could take if he or she wanted to (DeRenne et al, 2007). However, only 34% of HHSAA athletic directors required coaches to attend an annual coach education seminar and only 35.59% required their coaches to pass a rules/regulations exam upon employment (DeRenne et al, 2007). Taking a closer look at the state of Virginia, the only requirement made by the Virginia High School League (VHSL) of their coaches is that they complete the National Federation of High Schools

(NFHS)/ASEP Coach Education Program. Coaches are required to take the program and then pass a test for the coaching principles and sport first aid sections as well as the VHSL rules/regulations sections concerning their particular sport. However, the state does not require that its coaches be CPR or First Aid certified in order to be employed as a head or assistant coach (National Association of State Boards of Education, 2007). This is in contrast to other states such as Colorado and Arkansas that require extensive coach education activity, including but not limited to the initial certification, CEU requirements and documentation, and perhaps a background in anatomy, physiology, kinesiology, coaching theory, and athletic injury prevention and care (NASBE, 2007). It is interesting to note also that the state of Utah fines schools that employs coaches who are considered ineligible for not completing the NFHS/ASEP Coach Education Program approximately two hundred dollars per coach (NASBE, 2007).

While the solution may seem simple enough as mandating that every coach become certified, there are a number of factors that have hindered the implementation of such a policy. The first and probably foremost is the cost of the education (Stewart, 2006). Today's average size high school athletic department may have any where from 40 – 60 coaches (between head and assistant coaches). With programs such as ASEP, this alone could cost upwards of tens of thousands of dollars in registration fees for the current coaching staff (Stewart, 2006). Add in the fact that if the coaches are teachers in the school system, then substitutes would have to be found and paid for and the coaches attending the education seminars would have to receive per diem. Also, if the coaches are not teachers in the school system, they would either have to miss work or attend the seminars on their weekend time, and they would need to receive some kind of per diem as well (Stewart, 2006). The other factor that should be taken into consideration is that most high school athletic departments have an annual turnover rate of approximately 40%, so each year a significant amount of money would have to be spent ensuring that the new coaching staff is certified as well (Stewart, 2006). The other option for coach education is going through a U.S. educational institute to obtain a degree in coach education. This can be done either through attending classes on campus or going through a regionally accredited distance education program (Aeby et al, 2006). However, cost can be prohibitive here as well with the Valdosta State University in Georgia being the most affordable option, with a tuition rate of $3,294 (in-state) and $13,176 (out-of-state) for their distance education program (www.valdosta.edu/distance/).

Another option for coach education may be online certification programs. As of 2005, the number of internet users had reached one billion, and that number is expected to double by 2011 (Computer Industry Almanac, 2006). This has made distance education programs an even more attractive option for those individuals trying to fit continuing education into their already busy lifestyle. The population of distance education programs often consists primarily of part-time students that are employed full-time, which is consistent with the situation that most high school coaches are in (Taylor, 1999). This format also allows students to work through the materials at their own pace, which adds to the flexibility that the high school coach may need in a continuing education program (Taylor, 1999). Online programs also give the students the unique ability to interact with their instructors in a forum that facilitates reflection and comprehension of the materials throughout the discussion, which is different from the traditional face-to-face lecture class (Taylor, 1999). Another facet of online programs that makes the concept viable is that the cost of these programs tends to be more of a start-up or developmental expenditure (Taylor, 1999). Once the material is online, students may access the material at no cost to the sponsoring agency (Taylor, 1999; Stewart, 2006). A minimal fee may be charged to the student however, this should be considerably less than the cost of traditional education (Taylor, 1999). In addition, the United States Sports Academy offers a number of online courses. In 1999, a distance learning course evaluation was published in *The Sport Journal,* which is published by the USSA. The results of the course evaluation indicated that overall students (n = 693) were satisfied with this method of learning (Ryder, 1999). 92.4% were content with the communication they had with distance learning office during their class and 81.7% of students indicated that they planned to take additional distance learning courses offered by the USSA (Ryder, 1999). While more research needs to be done to truly evaluate the effectiveness of such programs, it could one day be a suitable way to ensure that the majority of high school coaches participate in coach education programs.

Stewart (2006) examined the practicality of such a program during the implementation of the Montana Model. In this study, the administrators of the Montana High School Association worked in conjunction with the author to construct a program based on the NASPE guidelines and the coach education needs that were identified by athletic directors in Montana (Stewart, 2006). The resulting program contains ten chapters of text (Stewart, 2006). The chapters cover topics including, but not limited to injury prevention, care, and rehabilitation, risk management, teaching and administration in sport, and training, conditioning, and nutrition. At the beginning of each chapter, there is a section of hyperlinks to related public websites as well as a section of new articles on topics of interest similar to the chapter's content (Stewart, 2006). Eight of the ten chapters require that the coach pass a twenty-five question test before he or she can move onto the next chapter. Once the coach finishes a test, his or her score is sent to the test taker, an administrator of the test-taker's choosing (often the principal or athletic director), the Montana High School Association's home office, and the author of the article, which could theoretically ensure compliance (Stewart, 2006). However, when coaches received their score, they were not able to see which questions they missed (Stewart, 2006). This could theoretically ensure that a coach taking these tests would reread all the materials in order to pass the test if they had to retake it rather than just reviewing the material pertaining to the questions missed (Stewart, 2006).

Since the program's unveiling in 2000, the author has administered two separate curriculum evaluations to a total of approximately one hundred and fifty coaches, and a third curriculum evaluation to just over half of the state's high school athletic directors (Stewart, 2006). These evaluations have resulted in a number of modifications to the web page and the chapter exams, with more changes to come in the future. Athletic directors reported that they wanted their coaches to be more accountable and to take the tests more often, which would suggest that the athletic directors expect that the coaches were keeping current on the material covered in the course (Stewart, 2006). It is interesting, yet unfortunate that seventy percent of the coaches reported that once they had completed the course, they did not return to the website, which conflicts with wishes of the athletic directors (Stewart, 2006). It should be noted that these views cannot be generalized for two reasons; one being that Montana most likely presents an atypical population due to the fact that is one of the least populated and most rural states in the country, and therefore may have different concerns when it comes to coaching, and the second reason being that this model was not tested on any other population. However, Stewart (2006) concluded that a model such as this could be effective for large scale coach education.

Other governing bodies of sports have recently made their coach education program available online. The National Federation of High School (NFHS) launched its Coach Education Program on January 3rd, 2007 (Flannery & Gillis, 2007). The program consists of two courses; Fundamentals of Coaching and First Aid for Coaches, and has already been adopted by fourteen state athletic associations as the required coach education course (Flannery & Gillis, 2007).

Heat illnesses are a rising problem within athletic and other active populations. However, the literature describes a number of ways that the condition may be prevented. The key is educating the athletic coaches and other personnel who are responsible for ensuring the safety of these populations. They need to be aware of the risk factors, the signs and symptoms, and the treatment protocols to be prepared for an incidence of heat illness. While there is extensive literature on prevention, recognition, and treatment of heat illness, very little information is available on athletic coaches' knowledge of the condition. Once athletic coaches' knowledge of heat illnesses has been assessed, athletic trainers will be able to tailor educational workshops, presentations, and literature to be effective in providing the information that athletic coaches are lacking in order to be fully prepared to handle a heat illness episode.

CHAPTER III

METHODOLOGY

Design

Subjects were asked to complete an Exertional Heat Illness (EHI) Knowledge Assessment and Demographics Questionnaire during their school's spring athletic department meetings. The independent variables were the subjects' characteristics as determined by the demographics questionnaire and the levels of the survey (3). The dependent variables consisted of the scores produced on the survey for each of the three sections (prevention, recognition, and treatment). Descriptive statistics were used to calculate the means and standard deviations, and to inspect the normalcy of the data. ANOVA's and t-tests were used to detect differences between groups. Pearson's correlation coefficients (r) were used to determine any correlation between knowledge levels and years of coaching experience and highest degree level. A 2 x 3 ANOVA was used to compare sectional scores.

Subject Characteristics

Subjects consisted of fifty-one male (age = 39.08 $\pm$ 10.41 yrs) and thirty-two female (age = 34.84 $\pm$ 9.36 yrs) high school level athletic coaches that are employed by a public school district in the Hampton Roads Area (Hampton, Suffolk, and Virginia Beach). Two respondents did not indicate gender. Subjects had a mean of 11.40 $\pm$ 9.35 years of overall coaching experience. Subjects were instructed on the procedures of the survey and explained how their data would remain confidential. Completion of the survey by a respondent was considered their consent to participate in the study. Each survey was given a number and the subjects name was not attached to the number on his/her survey. Only the research team had access to individual data which was kept in a locked cabinet and all data was reported based on group results. The investigation was approved by the College Human Investigation Committee at the University.

Instrumentation

Due to the lack of a pre-existing instrument to assess high-school coaches' knowledge of the prevention, recognition, and treatment of exertional heat illnesses, one was created by the research team (APPENDIX A). This instrument consisted of a demographics questionnaire and a multiple choice assessment survey. The multiple choice questions were developed from information and recommendations available in the current literature. Each question had one correct response and the coaches' score on the assessment was calculated by giving one point for the correct response and zero points for an incorrect response. This way, a higher score on the assessment indicated a higher level of knowledge concerning exertional heat illnesses. The assessment was divided into the three sections mentioned above, and scores for each section were also tabulated. The recognition section consisted of 8 questions, the prevention section of 10 questions, and the treatment section of 7 questions, giving the assessment a total of 25 questions. The demographics questionnaire (APPENDIX B) requested information related to gender, highest degree earned, major and minor field of study, current occupation, years of coaching, years of coaching at the high school level, coaching experience at other levels (college/university, professional, recreational league, club level), sports coached, and job status (full-time/part-time). It also requested information related to the subject's personal experience with heat-illness (personal incidence or having an athlete suffer from heat-illness) attendance at a workshop or information session on heat-illness, current certifications in CPR and First Aid, and other certifications held (Paramedic, Lifeguard, Professional Rescuer, etc) if any.

The instrument was evaluated for face and content validity by a panel of experts who were identified by the various position statements on exertional heat illnesses and from other published literature reviewed by the research team. The input received from their review was valuable in refining the first drafts of the instrument into the final version distributed for data collection. The test-retest reliability was determined via pilot testing the instrument with a group of collegiate athletic coaches, undergraduate students majoring in physical education, and certified athletic trainers. A number of changes were made to the instrument, which was then re-piloted using a different sample of those groups. The Cronbach's Alpha for all questions included on the final instrument that was distributed to subjects ranged from .667 to 1.00. All values are displayed in Appendix H.

Testing Procedure

We received permission to perform research from intended school districts by way of formal application to the school districts' office of research and assessment. The researchers then contacted all possible Student Activities Coordinators, Athletic Directors, and Principals by email to state the purpose of the study and to seek the school's participation in the study. Once the school's administration agreed to participate in the study a packet from the researchers was sent to the contact person via postal mail. All of the school's addresses were obtained from their respective websites. Each packet contained surveys, a self-addressed stamped envelope, a script of survey procedures (APPENDIX C) and a letter that explained the instructions for the distribution and collection of the surveys for the distributor to follow (APPENDIX D). The script and instructions were included to help ensure that the predetermined testing procedures were followed during testing. The surveys were sent to schools with the intention that they would be distributed during each school's spring athletic coaches or athletics department meetings. However, the research team was informed by several of the Athletic Directors and Student Activities Coordinators that although they wished to participate in the study, their school was not holding such a meeting. Therefore, they handed out the surveys to coaches individually, asking that the coach return the survey when he or she had completed it. This could be considered a limitation of the study as it is unknown if the coaches answered the survey without outside help. If the survey was distributed during a meeting, the survey distributor read and explained the directions before handing out the survey at the beginning of each meeting. It was expected the respondents would take approximately fifteen to twenty minutes to complete the surveys. All completed surveys were collected by the contact person and then returned to the researchers for scoring and data analysis via a self-addressed stamped envelope. The Student Athletic Coordinators and Athletic Directors were asked to return the surveys within two weeks following the original date of package receipt. A follow-up email was sent one week after the package with two purposes; 1) in order to confirm that they had received it, and 2) in order to remind them of the requested return date. However, this method was not effective with most of the schools with a great number of packages received up to three weeks after the requested date. In these cases, the research team sent multiple emails and made multiple phone calls before the completed surveys were returned. In two cases, the research team traveled to the school in order to obtain the packet.

Data Analysis

Descriptive statistics were performed to calculate the mean and standard deviation, and to inspect the normalcy of the data. ANOVA's and t-tests were used to detect differences between groups. Pearson's correlation coefficient (*r*) was used to determine any correlation between knowledge levels and years of experiences and highest degree level. A 2 x 3 ANOVA was used to compare sectional scores. Results were considered statistically significant at *a priori* of 0.05 or less. All statistical analyses were performed on a personal computer using SPSS 14.0 for Windows software (SPSS, Inc. Chicago, IL).

CHAPTER IV

RESULTS

Results

The EHI contained a total of twenty-five questions with each question being worth one point for a correct response, and zero points given for an incorrect response. The respondents' knowledge level was measured by how many points were achieved on the assessment, with more points indicating higher knowledge levels. The mean overall score on the EHI Assessment Survey was 15.01 $\pm$ 2.79 (60%) with a range of 8.00 and 21.00 (Figure 1).The mean score for the recognition section was 4.34 $\pm$ 1.35 (54%) with a range of 1.00 and 7.00. The mean score for the prevention section was 5.75 $\pm$ 1.62 (58%) with a range of 2.00 and 9.00. The mean score for the treatment section was 5.01 $\pm$ 1.25 (72%) with a range of 1.00 and 7.00. Table 1 shows the mean score for each of the three sections and the total assessment. Tables 2, 2a, and 2b provide the means and standard deviations for each group as per demographic variable.

Gender

There was no significant difference in overall scores found between male coaches (15.05 $\pm$ 2.84) and female coaches (14.72 $\pm$ 2.69). There was also no significant difference found between genders in sectional scores (Table 2, Figure 2).

Educational Background

There was no significant relationship found between highest degree level and overall knowledge levels. There was no significant difference in overall knowledge level between those coaches that possessed a current First Aid certification (47.1%) and those that did not (49.4%). Three respondents did not indicate whether or not they held the certification. However, a 2 x 3 one-way ANOVA compared sectional scores between coaches who possessed a First Aid certification and those that did not. A Tukey's post-hoc analysis revealed an interaction for First Aid certification on treatment scores ($F_{1, 80}$ = 7.38, p= .008), with coaches who had the certification (5.38 $\pm$ .91) scoring significantly higher than those who did not (4.67 $\pm$ 1.4) (Table 3, Figure 3). The effect size (.50) indicates that the change in treatment scores were of moderate clinical significance as well as being statistically significant.

Coaching Experience

A Pearson Correlation revealed a weak positive correlation between knowledge level and overall years spent coaching but was not significant (r = .213, p = .055)(Table 4, Figure 4). A second Pearson's correlation revealed a weak significant positive correlation between knowledge levels and years spent coaching at the high school level (r= .260, p=.018)(Table 5, Figure 5). The number of years spent coaching at the high school level was also found to have a weak positive correlation with coaches' knowledge in the area of preventing exertional heat illnesses (r=.264, p= .016) (Table 6, Figure 5). There was no significant difference in coaches' knowledge level between sports. Scores on the prevention section (5.823 $\pm$ 1.574) were found to have a weak positive correlation to scores on the treatment section (5.047 $\pm$ 1.204) (r=.318, p=.003).

Personal Experience with EHI

For the purpose of this study, a personal experience with heat illness was defined as 1) having personally suffered from an EHI; or 2) having had an athlete suffer from an EHI. There was no significant difference in knowledge level found between coaches who have personally suffered from EHI (20%) and those that have not (76.5%). Three respondents did not indicate whether or not they had suffered from an EHI. No significant difference was found in knowledge levels between coaches who had an athlete suffer from an EHI (32.9%) and those who had not (63.5%). Three respondents did not indicate if they had an athlete who had suffered from an EHI or not.

Attendance at an Information Session/Workshop

There was no significant difference found in overall knowledge levels between coaches who had attended an informational session or workshop (33%) on EHI and those who had not (69%). Three respondents did not indicate whether or not they had attended one. However, there was an interaction for attendance at an informational session or workshop on the recognition section ($F_{1, 80}$ = .064, p=.050), with coaches who had attended a session or workshop scoring significantly higher (4.555 $\pm$ 1.187) than those coaches who had not (3.927 $\pm$ 1.412) (Table 6, Figure 6). The effect size (.44) indicates a moderate educational significance as well as statistical significance.

Table 1. Coaches' Knowledge of EHI Mean Scores for All Subjects

EHI Component	Mean	Standard Deviation
Recognition Section	4.34	1.35
Prevention Section	5.75	1.62
Treatment Section	5.01	1.25
Total EHI Score	15.01	2.79

Table 2. Means and Standard Deviations per Demographic

		N	Mean	SD
Total Population		85	15.01	2.79
Gender	Male	51	15.05	2.83
	Female	32	14.71	2.69
Personal Experience A[1]	Yes	17	14.76	2.58
	No	65	14.92	2.83
Personal Experience B[2]	Yes	28	15.17	2.31
	No	54	14.74	2.98
First Aid Certification	Yes	42	15.33	2.80
	No	40	14.42	2.67
Informational Session	Yes	27	15.48	2.76
	No	55	14.60	2.74
Highest Degree	Bachelor's	29	15.34	2.84
	Bachelor's + 15	7	15.28	3.63
	Bachelor's + 30	14	15.28	1.85
	Master's	21	14.09	2.32
	Master's + 15	7	14.85	4.81
	Master's + 30	4	15.00	1.41

[1] Personally suffering from a heat illness is referred to as Personal Experience A
[2] Having an athlete suffer from a heat illness is referred to as Personal Experience B

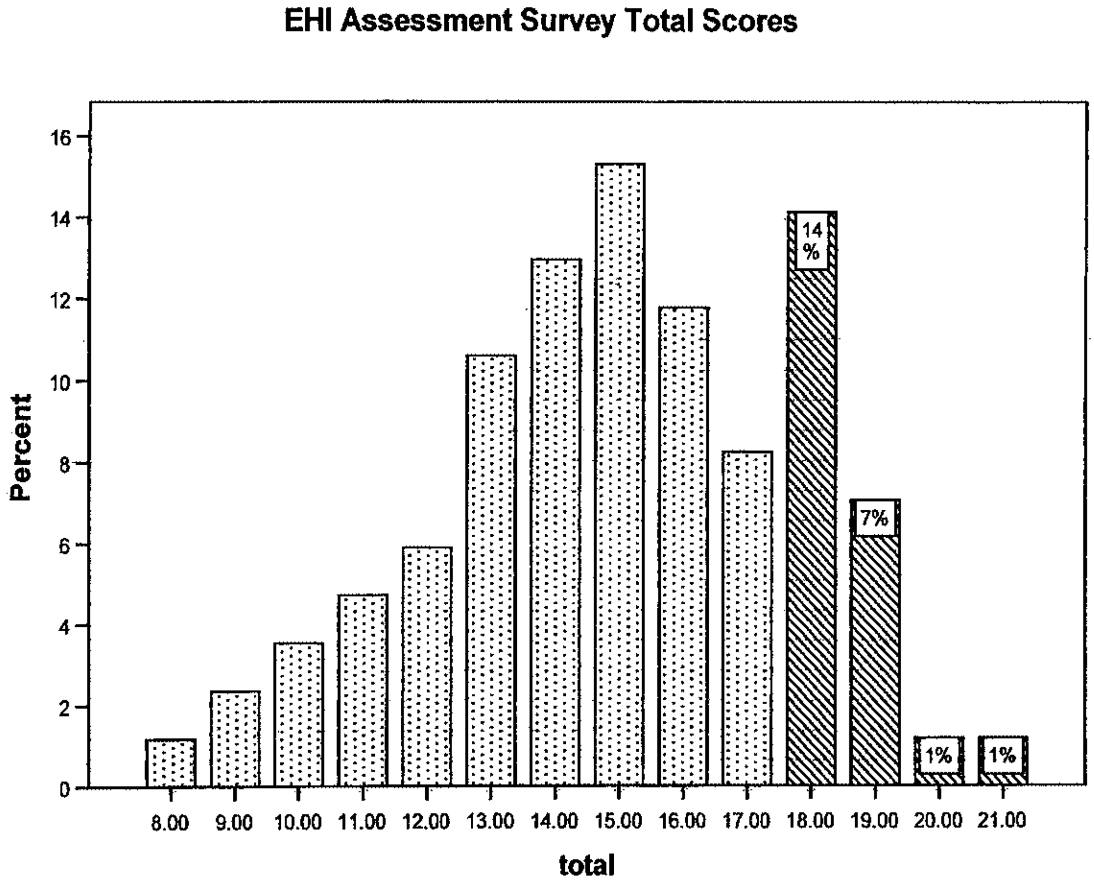
Table 2a. Means and Standard Deviations for Overall Years of Coaching Experience by Year

Number of Years	Mean	N	SD
1.00	14.2000	5	1.92354
2.00	14.4286	7	2.99205
3.00	11.8000	5	1.64317
4.00	13.1667	6	2.99444
5.00	15.0000	9	3.93700
6.00	14.0000	6	1.26491
7.00	17.0000	2	1.41421
8.00	17.0000	1	.
9.00	14.6667	3	1.52753
10.00	16.5000	2	4.94975
11.00	16.5000	2	2.12132
12.00	16.0000	1	.
13.00	15.3333	6	2.58199
14.00	15.0000	1	.
15.00	16.6667	3	.57735
16.00	15.3333	3	2.51661
18.00	15.3333	3	5.50757
19.00	14.0000	1	.
20.00	17.3333	3	1.15470
23.00	16.0000	1	.
25.00	14.0000	2	1.41421
28.00	16.5000	2	.70711
29.00	17.5000	4	2.64575
30.00	13.5000	2	.70711
35.00	13.0000	2	4.24264
Total	14.8902	82	2.76667

Table 2b. Means and Standard Deviations for Years of High School Coaching Experience by Year

Number of Years	Mean	N	SD
1.00	14.7778	9	2.22361
2.00	13.4444	9	2.78887
3.00	12.7500	8	2.31455
4.00	13.6667	6	3.38625
5.00	15.6250	8	3.96187
6.00	14.2500	4	.95743
7.00	14.0000	1	.
8.00	17.0000	1	.
9.00	14.7500	4	1.25831
10.00	17.0000	3	2.64575
11.00	15.0000	1	.
13.00	15.4286	7	2.37045
15.00	16.5000	4	.57735
16.00	15.5000	2	3.53553
18.00	15.3333	3	5.50757
20.00	19.0000	3	1.73205
22.00	17.0000	1	.
25.00	14.0000	2	1.41421
26.00	16.0000	1	.
28.00	16.0000	1	.
29.00	16.5000	2	2.12132
30.00	13.5000	2	.70711
Total	14.8902	82	2.76667

Figure 1.



* A score of 18/25 or higher achieved the mark of 70%

CHAPTER V

DISCUSSION AND CONCLUSIONS

The existing literature does not contain research that has assessed coaches' knowledge of heat illness, so the results of this study must be compared to those found in the assessment of coaches' knowledge of other topics, as well as other groups' knowledge in their respective fields. In one such study, Bedgood and Tuck (1983) established a level of seventy percent as the mark that was considered to be an acceptable score for coaches' knowledge surveys. This mark of seventy percent was chosen the mean total score of 15.01 that was achieved by subjects in this study fell well below this at 60%, perhaps indicating that coaches have only a low to moderate level of overall knowledge concerning exertional heat illnesses. The scores found when sections were examined individually were even more dismal with coaches' averaging 52% on the recognition section and 58% on the prevention section, perhaps indicating that they lack the knowledge to properly identify when an athlete is suffering from an EHI as well as the knowledge to prevent the condition in the first place. However, it is interesting to note that the coaches' mean score on the treatment section was 5.03, which was a 72% correct response rate for the section. These results are similar to those found in other studies. Bedgood and Tuck (1983) found that only fourteen respondents scored above the seventy percent marker, indicating that their sample population overall did not have adequate knowledge of nutrition. Interestingly, they found that when their section scores were analyzed independently, the scores were slightly better but still fell below the seventy percent marker. This is slightly different from the sectional scores in the current study, which were worse than the overall mean with the exception of the treatment section, which surpassed the overall mean. Sossin et al (1997) also found that although overall the wrestling coaches they surveyed did not possess adequate knowledge of weight loss, training diet, weight class, dehydration, and eating disorders, the coaches did demonstrate adequate knowledge in the areas of training diet and eating disorder recognition. In a study of Nigerian coaches' view about oro-facial injuries and mouthguard use in sport, Onyeaso and Adegbesan (2003) found that while most coaches (95.2%) knew that mouthguards prevented oral injuries, 71.4% of coaches indicated that boxing was the only sport in which athletes need mouthguards, and 11.9% of coaches felt that mouthguards were not needed by athletes of any sport or did not know which sports should use the appliances. They also found that only 81% of coaches felt that mouthguards should be worn during both practice and games, with hockey coaches being the only group that indicated this unanimously (Onyeaso and Adegbesan, 2003). In addition, Valovich McLeod, Schwartz and Bay (2007) found that only 64.7% of coaches (n = 156) surveyed correctly identified athletes' described in written scenarios as possibly having a concussion. They also found that 42% of coaches thought that loss of consciousness was necessary for an athlete to be concussed, while 32% of coaches surveyed did not feel that an athlete who suffered a Grade I concussion needed to be removed from the game. Another 26% of coaches indicated that it was acceptable to allow a symptomatic athlete to return to play, which was very concerning to the authors (Valovich McLeod et al, 2007). Cooney et al (1999) also found that overall coaches surveyed held insufficient knowledge in the areas of prevention, recognition, and treatment of serious neck injuries and that further education was warranted in their study of Irish Senior Cup Team rugby coaches. These results are very similar to those of the current study, and perhaps indicate that there is a need for additional coach education in a wide variety of topics.

There was no relationship found between knowledge levels and degree levels, which did not support the hypothesis made by researchers. In addition, there was no significant difference in sectional scores degree level. These results are contrary to those found in a study done by Smith-Miller (2006) that examined graduate nurses' comfort and knowledge level regarding tracheostomy care. They concluded that although the mean knowledge level of the nurses' surveyed was 53%, nurses' who held a Bachelor's Degree in Nursing (BSN) degree scored slightly higher than those who held an Associates Degree in Nursing (ADN) /Diploma degree, and that Registered Nurses (RNs) scores were higher than those of those that held the BSN degree. It should be noted however, that this difference was not found to be statistically significant. Watkins and Gray (2006) also found a difference in knowledge scores across degree levels when they surveyed registered nurses in Texas on their knowledge, attitude, and beliefs concerning human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS). They reported that those nurses who held a Master's Degree in Nursing (MDN) scored significantly higher ($M = 8.05$) on the knowledge assessment than those nurses who held the ADN degree ($M = 7.00$) when a post hoc analysis was executed (Dunnet $C = -1.05$, $p < .05$). Perhaps the results of the current study indicate that while the level of degree is usually associated with increased knowledge of a topic, subjects who are tested on topics that they have little or no specific training or study in will demonstrate low knowledge scores regardless of the degree level.

To that end, it was determined in this investigation that although there was no significant difference in overall knowledge levels between coaches that possessed a current First Aid certification (47.1%) and those that did not (49.4%), having a First Aid certification did have a significant impact on treatment section scores. Those coaches that indicated yes to the query averaged 78% on the section while those that indicated no averaged 66%. It should be noted that this was a difference of approximately .71 of a point. These results could indicate that the First Aid certification may have provided the coaches with the information they would need to properly treat an athlete suffering from a heat illness. This finding is congruent with the study done by Valovich McLeod et al (2007). The researchers developed an original survey instrument that assessed the coaches' ability to recognize symptoms and properly manage the injury. They found that participation in a coaching education program was significantly predictive of scores on the symptom recognition section. One interesting aspect of this study was that the researchers included a check box that allowed respondents to indicate if they did not know whether or not something was true or false in an attempt to eliminate guessing. This is of interest to our study due to the high possibility that a number of respondents simply guessed when attempting to answer questions, particularly those containing terminology that the coaches may have never heard or saw before. An attempt was made to decrease the incidence of guessing by including a brief description of the term in parentheses directly to the right of the term on the assessment.

The idea that presence or absence of education of the specific topic is more important when determining knowledge levels is further supported by the findings of Dorhn, Miller, and Bakken (2006) when they assessed South African nurse-midwives knowledge in antiretroviral treatment before and after a short-term education program. The authors found that total years of midwifery experience was not positively correlated with a higher total knowledge score on the pretest, but there was a significant positive correlation between pretest scores and the presence of a Prevention of Mother-to-Child Transmission program at their particular jobsites, which meant that these midwives were accessing the information relevant to the topic of study more often than those who did not have such a program at their jobsite (Dorhn et al, 2006). The authors also found that having a protocol for occupational exposure on the jobsite was positively and significantly correlated to pretest scores (Dorhn et al, 2006). This could be likened to whether or not high schools had an active protocol for the treatment of athletes suffering from a heat illness, although it is highly unlikely that would be found as frequently if at all. The authors also found that after the short-term educational program midwives' scores on the assessment survey improved from a mean of 11.6 to 15.6 post-test, indicating that the program was effective in increasing their knowledge (Dorhn et al, 2006). This type of success should be noted when considering the implementation of a coach education program.

In order to examine the effect that years of coaching experience has on EHI knowledge levels, the researchers asked the respondents to list the following: total number of years of coaching experience, years spent coaching at the high school level, and if they had coached at any other level. If respondents indicated yes to this question, they were asked to check off either professional, collegiate, club/youth, or other, and then list the number of years spent coaching at the level indicated. Respondents reported an average of 11.4 years of overall coaching experience, which was shown to have a weak relationship to an increase in overall knowledge scores (r = .213) Although this relationship was not quite significant (p = .055) it may indicate a trend towards the idea that coaches with more experience may acquire knowledge over time. For years of high school coaching experience respondents reported an average of 9.4 years, which was shown to have a significant relationship to increased overall knowledge scores (r = .260, p = .018). Further, the years of high school coaching experience had a significant positive relationship to increased prevention section scores(r = .264, p = .016), with those coaches with more years of high school experience having higher scores in the treatment section of the assessment. These results could perhaps indicate that the more time a coach spends at the high school level, the more knowledge he or she will have of the prevention, recognition, and treatment of exertional heat illnesses. This could be due to the fact that at the high school level, there usually is only one athletic trainer on staff, if there are any at all (Bell et al, 2005; Aukerman et al, 2006). Therefore, it is impossible for that one person to be on every field at once, and more responsibility may be placed on coaches to monitor the athletes during practices and begin the initial management of exertional heat illnesses until the certified athletic trainer arrives. It will also fall on the coaches, with the help of the certified athletic trainer, to attempt to prevent this condition, which may lead to coaches being more aware of the guidelines for preventing exertional heat illnesses.

However, it is interesting to note that in the current literature of knowledge assessment in subjects across a variety of topics, years of experience is most often found to not have a significant impact on knowledge levels. For example, years of coaching experience (5.88 $\pm$ 3.16) was a demographic investigated by Valovich McLeod et al

(2007) for its use as a predictor of a coach's ability to recognize concussion symptoms, but was found to be insignificant upon regression analysis. Smith-Miller (2006) found that experienced registered nurses only had only slightly better scores on a knowledge assessment of tracheostomy care when compared to new graduates, but found that the relationship between the years of experience and knowledge levels was insignificant. The author concluded that the results of the study further indicated that nursing experience alone was not influential on knowledge levels (Smith-Miller, 2006). In their study of nurse-midwives knowledge of antiretroviral treatment before and after a short-term education program, Dohrn et al (2006) found that years of experience did not have an impact on the pre-test scores. In another pre- and post-test knowledge study, Considine et al (2005) found that years of experience did not have an effect on scores on either side of the educational intervention when they examined Australian emergency room nurses' knowledge of assessment of oxygenation and use of supplemental oxygen (Considine, Botti, and Thomas, 2005).

For the purpose of our study, personal experience with exertional heat illnesses was considered to be 1) having personally suffered from the condition or 2) to have had an athlete suffer from the condition. In the current investigation, neither incident of personal experience was found to have an impact, significant or otherwise on the knowledge levels of prevention, recognition, or treatment of exertional heat illnesses. Coaches who indicated yes to having personally suffered from the condition (20%) scored an average of 14.7 points overall while coaches that indicated no (76.5%) scored an average of 14.9 points overall. Three respondents did not indicate whether or not they had personally suffered from the condition. This finding does not support the hypothesis made by researchers, which was based on the idea that an individual would have more knowledge of a condition that he or she personally suffered from. This was the case in a study on the perceptions of athletic coaches in the Chandigarh province of India concerning oro-facial injuries and their prevention, where 87.8% of coaches reported gaining their information from interaction with medical personnel and 51.4% of these coaches stated that this interaction came from having to see these medical personnel during their own training (Lehl, 2005).

Scores between genders were almost equal with male coaches averaging 15.05 points overall and female coaches averaging 14.72 points, both of which fall below the seventy percent mark. These results do not support the researcher's hypothesis that female coaches would have higher knowledge levels of exertional heat illness when compared to male coaches. This hypothesis was drawn from the idea that females would have higher knowledge levels due to increased personal experience with exertional heat illness as they are more at risk to suffer from these conditions than compared to males (Carter et al, 2005). However, in the current study, only seven of the seventeen respondents that indicated "yes" to the demographic question concerning personally suffering from an EHI were female.

One aspect of this instrument that must be taken into consideration is the uneven number of questions in each section. When determining section scores, coaches could three questions and still achieve a seventy-percent on that section while they could only miss two questions on the prevention section in order to not fall below that mark. Therefore, coaches could possibly have had higher knowledge levels of prevention, but scored better on the treatment section simply because there were more questions. This may indicate that their percentage scores for each may not be reflective of their knowledge level of that section. In the future, instruments should have an even number of questions per section to avoid this quandary.

The correct response to each question along with the percentage of respondents who chose the correct answer is depicted in Table 9. Questions 3, 12, 16, 17, 18, 19, 20, 23, and 24 all had correct response rates above seventy percent, most likely indicating that the majority of the coaches surveyed were able to understand what the question was asking and the answers choices provided. In addition, they were most likely somewhat familiar with the topic of the question. However, it could also indicate that these questions were too easy and therefore not a true test of the coaches' knowledge. Questions 1, 6, 11, and 22 all had correct response rates between sixty and seventy percent, indicating that these questions were more difficult for coaches to answer. One possible reason for this could be that the coaches were not familiar with the terminology in either the question or answer choices provided and therefore not knowing what the question was asking, as what seemed to be the case in questions 1 and 6. Both of these questions included answer choices relating to the exertional heat illness subcondition hyponatremia, which would be unfamiliar to the coaches in this sample unless they had received specific information or education regarding it, as this sub-condition is not frequently seen outside of the Southwest United States (Backer et al, 1999; Binkley et al, 2002). The researchers knew this when creating the survey instrument but felt that it was important to include hyponatremia in the knowledge assessment if the results of this study were going to possibly one day aid in serving as a basis in creating a survey instrument that could be used to measure coaches' knowledge on a national level.

However the information that coaches would need to answer questions 11 and 22 correctly is provided in a number of materials that can be easily accessed in either a hard copy or online format. The questions were concerning proper hydration for athletes (Gatorade Sports Science Institute, 2006) and the treatment of heat illnesses (American Red Cross First Aid, 2006).

Questions 13, 15, and 25 had a correct response rate between fifty and fifty-nine percent, showing that these questions were more challenging to coaches. For question 13, 58.8% of respondents chose the correct answer. However, each of the other possible answers had response rates of between ten and seventeen percent, indicating that the answer choices available were fairly similar to one another and the respondents that did not know the correct answer were most likely choosing the answer that seemed to make the most sense to them. Question 15 had a correct response rate of 52.9%. Respondents then chose answer B and C almost evenly at twenty percent and twenty-one percent respectively. It is likely respondents chose their answer for one of the following reasons; a) they had seen the correct answer in educational material; b) they chose the answer that matched the rule imposed by their school or c) they chose the answer that looked like a long enough time between practices to them. It is also likely that indoor sport coaches answered very differently from outdoor sport coaches as the demands and restraints placed on their athletes by their playing and practicing environments would dictate different courses of action. This question could possibly have been made clearer by asking about each environment separately (indoor vs. outdoor) or by just inquiring about the outdoor sports. Question 25 also had a correct response rate of 58.8%, with the answer B being chosen by approximately thirty-one percent of remaining respondents.

This is most likely due to the fact that respondents may not be aware that recent history of a heat illness is actually a risk factor for suffering another heat illness (Armstrong, 1998). This would indicate an area of where more education is needed.

Questions 2, 5, 7, and 9 had a correct response rate between forty and forty-nine percent. For question 2, the correct response was chosen 49.4% of the time, with answer C being chosen second most often, at approximately 32% of the time. The first part of the two answer choices were worded exactly the same, which could have caused some confusion to respondents. However, answer choice C included a second half that added information of the athlete's temperature being above one hundred and three degrees Fahrenheit, which is the lower temperature threshold that indicates heat stroke (Binkley et al, 2002). This indicates that coaches may not know the difference between heat stroke and heat exhaustion, which is an area of concern as the consequences of these two conditions very significantly. For question 5, the correct response was chosen 43.5% of the time, with answer choice D being chosen second most at 34.4% of the time. This is most likely indicates that the question was unclear, as it asked about signs and symptoms that are part of both heat syncope (answer B) and heat stroke (answer D). However, sufferers of heat syncope usually experience signs and symptoms that are limited to those that were listed, while heat stroke sufferers experience an increased number as well as more severe signs and symptoms. The question could have been clearer by using the word only to indicate that these were not part of greater list of signs and symptoms, and only these should be considered when making a decision about how to treat the athlete. Question 7 had a correct response rate of 45.5%, with answer choice D being chosen second most often at approximately twenty-nine percent. This was most likely the result of respondents not being familiar with hyponatremia and therefore not knowing the signs, symptoms and how to differentiate between that and heat stroke. This is similar to the response pattern that was with questions 1 and 6. Question 9 had a correct response rate of 47.1 %, with answer choice C being chosen second most frequently at approximately twenty-nine percent, and answer choice D following at a response rate of approximately twenty percent. This fairly even distribution in responses is most likely the result of the answers B and C being similar in temperature and humidity (see APPENDIX B). Respondents also would have chosen answer choice D if they were not familiar with the process used to calculate heat index, and they allowed the temperature listed to a play a large role in their decision.

Questions 4, 8, 10, 14, and 21 all had a correct response rate between twenty and thirty-nine percent. This indicates a high level of difficultly for coaches. This may have been the case for a number of reasons. In the case of question 4, the signs and symptoms listed are on their own indicative of heat or muscle cramps. However, only 36.5% of respondents chose correctly, with answer choice B (heat exhaustion) being chosen most often at 53.6%. This is similar to the problem respondents had with question 5, where they did not realize they were being asked about those signs and symptoms separately, not as part of a greater list. Again, the problem could be solved by adding only the question stem. In the case of question 8, the correct answer was chosen by only 20% of respondents, while answer choices B and C were chosen by 40% and 36.5% of respondents respectively. Here, it is most likely that respondents simply were not aware that taking a rectal temperature was the best option for measuring core temperature, and therefore they chose either oral or tympanic temperature. This also could have been a result of some respondents being unfamiliar with rectal temperature, and choosing either oral or tympanic simply because they were familiar with the terminology even though they may have been unsure if that was the best method of measuring core temperature. It should be noted that oral and tympanic were clarified for respondents by placing short definitions in parentheses to the right of the term, whereas rectal was not clarified further. In the case of question 10, respondents chose the correct answer 36.5% of the time, while answer choice C was chosen by 58.8% of respondents. In this case, it is possible respondents' most likely chose the answer that corresponded with the rule imposed by their individual schools or athletic directors. For question 14, 29.4% of respondents chose the correct answer, while 30.6% chose answer choice A and 31.8% chose answer choice B. Again, this distribution of responses is most likely the result of respondents' choosing the answer that most likely corresponded to the rule that is followed at their school. It is also possible that indoor sport coaches chose answers on a more random basis as they do not have to be as concerned with the acclimatization process as their outdoor counterparts do. However, it should be noted that a number of coaches that participated in this study were involved with more than one sport at the time, although researchers only used their primary sport (the sport they were either head coach of or spent the most time with) for demographic purposes. Question 21 had a correct response rate of 30.6%, with answer choice C being chosen by more respondents at 40%, and answer choice A being chosen by 23.5%. It is likely that more respondents chose answer choice C because that is the treatment protocol that is currently taught in American Red Cross First Aid certification courses, which 47.1% of study population possessed. While answer choice D (having the athlete sit in a cold ice bath) has been shown to be the best way to decrease the core temperature of a heat stroke victim (Smith, 2004), it may not be practical depending on the location the team is practicing, nor safe depending on the condition of the athlete (Smith, 2004). Therefore, it is important that coaches are educated on the next best protocol.

A limitation of this study is the difficulty the researchers had with survey distribution and collection. Stage I of survey distribution consisted of researchers mailing packets to seven area high schools. From this initial mailing twenty-one surveys were returned out of seventy-five that were distributed to coaches, giving Stage I a response rate of 28%. Researchers then applied for permission to assess coaches in another area school district, indicating Stage II of survey distribution. Eight schools agreed to participate in the study. From this second mailing, sixty-four surveys were returned out of two hundred that were distributed to coaches, giving Stage II a response rate of 32%. Overall, eighty-five surveys were returned, giving this study a response rate of 30%.

There are a number of factors that may have influenced such a low response rate. One could have been the time frame in which the packets were mailed out. The first stage of survey distribution took place in early February, when high schools in the area are ending their winter sports seasons and beginning their spring sport seasons. This could have attributed to athletic departments being too busy with winter sport championships and spring sport pre-seasons taking place at the same time. Another factor could have been the lack of a point person at each of the schools. Although the athletic directors were considered the person of contact by the researchers as per the school board request, it is unlikely the athletic directors had the time to undertake such a project, as they are usually teachers during the day and have additional duties besides those of the athletic director position. A third factor that played a part in the low response rate was most likely how the surveys were distributed. In the letter contained in the packet, researchers expressed that the surveys should be handed out to coaches during an athletic department or coaches' meeting. This would ensure completion of the surveys as well as their return to the point person for return to the researchers. However, many schools responded that they would like to participate in the study but would not be holding such a meeting. Therefore, the surveys were handed out to coaches individually, and for the most part were likely lost or forgotten about.

Perhaps for future coaches' knowledge studies the survey distribution process should be modified to ensure a better response rate. One way to do this would for a member of the research team to personally administer the surveys to coaches at the school's athletic department meeting. This process was not carried out due to time and resource constraints on the researchers. Another way could be to offer an incentive for participation such as a chance to win a drawing for gift certificates or other prizes that may appeal to the subject population. Distributing the survey as part of registration materials for a large-scale coaches' conference or meeting (state or district-wide) may be an even more effective method, as Chey et al (2005) found a 97% response rate when they did this to assess primary-care physicians' perceptions and management practices for gastroesophageal reflux disease (Chey, Inadomi, Booher, Sharma, Fendrick, Howden, 2005).

Another possible limitation that must be considered is that the study population may not be a true representation of the sample, as perhaps only those coaches who perceived themselves to have knowledge of exertional heat illnesses chose to participate.

Conclusions

The purpose of this study was to first assess the knowledge levels of high school athletic coaches' concerning the areas of recognition, treatment, and prevention of exertional heat illnesses (EHI). The second purpose was to determine what demographic characteristics, if any, had an effect on these knowledge levels. Considering the results of this study, there is a definite need for the further education of high school athletic coaches in the subject of EHI, with a focus placed on knowing the differences between each of the five sub-conditions listed under the term of EHI as well as the recognition of their signs and symptoms. The information provided by this study is beneficial to not only high school athletic coaches but also to certified athletic trainers and school administrators in identifying this lack of the knowledge that is necessary to properly identify and manage an EHI. This is particularly important in the geographical area in which this study was conducted due to the high ambient temperatures and high humidity that this region often experiences in the months of July, August, and September when fall sports are in pre-season or the start of their regular season. The results of this study further indicated that informational sessions may be an effective way to educate coaches on how to recognize an EHI. This aspect of managing an EHI is remarkably important as improper symptom recognition may lead to mistreating the athlete, which with some of the sub-conditions of EHI can have serious sequelea and can possibly be fatal. Certified athletic trainers would be an excellent source for presenting such a session to coaches as they possess the knowledge and skills to properly recognize, prevent, and treat the condition. In addition, it is likely that to set up such a session would be convenient as it could be held at each school or one school per district. It is also indicated by the results of this study that coaches may benefit from being required to possess at the very least a First Aid certification so that they may know how to properly treat an EHI. At this time such a certification is not required by many states, but perhaps further study will continue to support the need for it. A coaches' ability to begin the basic care for a student athlete who is suffering from an EHI is very important as there may be a situation where the certified athletic trainer cannot be on all fields at one time. Unfortunately not all EHI incidences can be prevented. However, with proper education, it is likely that coaches will be able to ensure the safety of playing conditions and also be more aware of how to modify a number of factors that may put student athletes at risk for suffering an EHI, which could reduce the number of EHI that student athletes experience each year. Therefore it is important that all coaches, especially those that are new to the profession and those that have their educational background in a field other than health and physical education be informed on these procedures from the start of their coaching careers.

This study provides an initial evaluation of the knowledge coaches possess about EHI, which is important as the current literature in that area is almost non-existent. The results should serve to raise the concern and awareness of coaches, administrators, and athletic trainers alike as to the lack of knowledge that coaches possess. It should be noted however that this study is merely a starting point and additional research needs to be completed. Future research should include the creation of educational materials that are easily accessible to coaches. In addition, once these materials are created, a pre- and post-intervention knowledge test should be given to measure the materials' effectiveness. Future research should also investigate knowledge retention by coaches who have participated in informational sessions or workshops. Further, future research should explore which modes of learning are most appropriate for educating coaches about EHI (ie, interactive classroom experiences vs. on-line course materials and exams) as well as which modes of learning are most effective on retention rates.

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APPENDIX A

Exertional Heat Illness Assessment Survey

Heat Illness Knowledge Survey

Please answer the questions below to the best of your knowledge. Please circle the **BEST** answer.

Recognition of Heat Illness

1. All of the following are signs of heat stroke **EXCEPT**?
    a. Confusion
    b. Reddish skin
    c. Swollen hands and feet
    d. Vomiting/diarrhea

2. An athlete may be suffering from heat exhaustion if he or she is:
    a. Playing hard and full of energy
    b. Complaining of a headache and movement appears slow and sluggish
    c. Complaining of a headache and movement appears slow and sluggish AND has a temperature above 103° F.
    d. Complaining of being cold

3. Which of these heat-related illnesses requires immediate emergency medical attention?
    a. Heat cramps
    b. Heat exhaustion
    c. Heat stroke
    d. Heat rash

4. Muscle tightening, thirst, and fatigue are signs of which heat related illness?
    a. Heat cramps
    b. Heat exhaustion
    c. Heat stroke
    d. Hyponatremia

5. If an athlete is complaining of dizziness, "tunnel vision", and appears pale and sweaty he or she is **MOST LIKELY** showing signs of:
    a. Heat cramps
    b. Heat syncope (fainting)
    c. Hyponatremia (severe loss of electrolytes)
    d. Heat stroke

6. Aggressiveness, irritability, irrational behavior, confusion, and seizures are all signs that an athlete is suffering from which heat related illness?

   a. Heat cramps
   b. Heat syncope (fainting)
   c. Hyponatremia (severe loss of electrolytes)
   d. Heat stroke

7. An athlete that seems disoriented, confused, lethargic, has a headache, is vomiting, but does
NOT have an extreme temperature (>102 F) is most likely suffering from:

   a. Heat cramps
   b. Heat syncope (fainting)
   c. Hyponatremia (severe loss of electrolytes)
   d. Heat stroke

8. The best way to determine an athlete's core temperature is to take:

   a. Rectal temperature
   b. Oral (mouth) temperature
   c. Tympanic (in the ear) temperature
   d. Skin surface temperature by placing a hand to the athlete's forehead

Prevention of Heat Illness

9. The signs of heat illness may first show up at a temperature and humidity level of

   a. 65 degrees + 0% humidity
   b. 70 degrees + 50% humidity
   c. 75 degrees + 25% humidity
   d. 80 degrees + 10% humidity

10. The **most** dangerous time of day for athletes to practice during hot weather is

   a. Before 10 am and after 6 pm
   b. Before 12 pm and after 2 pm
   c. Between the hours of 12 and 2 pm
   d. Between the hours of 10 am and 4 pm

11. How long before practice should an athlete begin consuming fluids to avoid becoming dehydrated?

   a. 30 minutes
   b. 1 hour
   c. 1 ½ hours
   d. 2 hours

12. When weather conditions are **80 degrees with 25% humidity**, how often should athletes have a drink break to avoid becoming dehydrated?
    a. Every 20-30 minutes
    b. Every 30-40 minutes
    c. Every 40-50 minutes
    d. Every hour

13. In order to avoid becoming dehydrated, athletes must drink enough fluids after practice to:
    a. Not feel thirsty
    b. Replace body weight that is lost through sweat
    c. Cool down their body temperature
    d. Feel like they need to go to the bathroom

14. When pre-season practices for FALL SPORTS begin, how many days should athletes spend going through acclimatization (the gradual increase in the level and length of exercise in the heat)?
    a. 1 – 4 days
    b. 5 – 9 days
    c. 10 – 14 days
    d. 15 – 19 days

15. When a team practices two times in one day, approximately how many hours of rest should they have between the first and second practice?
    a. 1 hour
    b. 2 hours
    c. 3 hours
    d. 4 hours

16. What is the recommended number of days a team should be allowed to practice before they get a day off?
    a. 2 days
    b. 6 days
    c. 10 days
    d. 14 days

17. A pre-participation physical is important in preventing heat illness because it identifies:
    a. An athletes grades from last year
    b. If the athlete has ever broken any bones or had any surgeries
    c. What their blood pressure is
    d. If the athlete has had any illnesses or conditions that may put them at risk

18. When conditions are unsafe for a practice/game to be held, it would be best for coaches to do which of the following to protect the athletes?
    a. Delay or postpone the practice/game
    b. Pour a cup of water over the athlete at every time out
    c. Put huge fans that athletes may stand in front of next to each bench
    d. Give the athletes sports drinks during the practice/game

Treatment of Heat Illness

19. If you thought one of your athletes was suffering from a heat illness, when should you
begin treatment?
    a. Immediately
    b. After practice/game
    c. Wait 20 minutes to see if the athlete gets better
    d. If the athlete does not feel better the next day

20. The first step in treating an athlete who begins to appear to be suffering from a heat related illness is:
    a. Place the athlete on his/her back with his/her feet above the heart
    b. Check to make sure the athlete is breathing and has a pulse
    c. Have the athlete drink a large amount of water
    d. Move the athlete into shade or air conditioning

21. Which of the following is the best way to decrease the core temperature of an athlete who
is suffering from heat stroke?
    a. Have the athlete lie down in the shade
    b. Pour buckets of cold water on the athletes head
    c. Wipe the athletes skin with cold clothes
    d. Have the athlete sit in a cold ice bath

22. If ice bags are being used to cool an athlete, where should they be placed?
    a. On the head, stomach, palms of hands, and soles of feet
    b. On the shoulders, feet, wrists and stomach
    c. Armpits, groin, back of neck, and back of knees
    d. The athlete should decide where to put the ice bags

23. What should **NOT** be done to relieve the cramping caused by heat cramps?
    a. Give the athlete water or sports drink
    b. Gentle stretching
    c. Squeeze the cramping muscle until the pain is gone
    d. Light massage

24. Emergency Medical Services should be called if an athlete is showing which signs and symptoms?
    a. An athlete has nausea, vomiting, is confused, and is in and out of consciousness
    b. An athlete has reddish skin and muscle cramps
    c. An athlete is complaining that they are hungry and have a headache
    d. An athlete is complaining of being very thirsty and is nauseous

25. In cases of heat illness that were **NOT** treated by a physician (heat cramps, heat syncope, some cases of heat exhaustion), how quickly can an athlete return to full participation?
    a. Immediately after the symptoms have stopped
    b. The following day after sleeping in a cool environment
    c. After consulting a physician and gradually building up to full activity
    d. After a week of rest and recovery

APPENDIX B

Demographics Questionnaire

Exertional Heat Illness (EHI) Knowledge Assessment
Demographic Questionnaire

Gender: ____ Male ____ Female

Age: _____ years

What is your highest degree obtained?

______ Bachelor's Degree
______ Bachelor's + 15 credits
______ Bachelor's + 30 credits
______ Master's Degree
______ Master's + 15 credits
______ Master's + 30 credits
______ Other: ________________

If you have a higher education degree, what was your major field of study? (ie, Biology, Education, Chemistry)

____

____

If you have a higher education degree, did you complete a minor field of study?
______ Yes ______ No

If you answered Yes, what was your minor?

____

What is your current occupation? __________________________________

How many years have you been coaching overall? _________

How many years have you coached at the high/middle school level? _________

Have you coached at other levels? ______ Yes _______ No

If yes, at what level and for how long?

	YEARS	
College/University	________	
Professional	________	
Club Sports	________	
Other	________	Please list: __________________________

What sports do you currently coach? ___________________________________

Are you currently coaching middle or high school sports? ________________

Are you employed as a full- or part-time coach by the school? __________

Do you have a certified athletic trainer (ATC) on your staff?

_____ Yes _____ No

Have you discussed Exertional Heat Illness with your certified athletic trainer (ATC)?

______ Yes _______ No

Are you currently certified in CPR ?

______ Yes ______ No

Have you been certified in CPR within the last 5 years?

______ Yes _______ No

Are you currently certified in First Aid?

______ Yes ______ No

Have you been certified in First Aid within the last 5 years?

_______ Yes ______ No

Do you hold any other certifications? (ie; EMT, Lifeguard, Professional Rescuer)

______ Yes ______ No

If Yes, please list: ____________________________________

Have you ever attended an information session on Exertional Heat Illness?

_____ Yes _______ No

Have you ever suffered from Exertional Heat Illness?

______ Yes ______ No

Have you ever had an athlete suffer from Exertional Heat Illness?

_____ Yes ______ No

APPENDIX C

Script for Survey Distribution

Script for Student Activities Coordinator and Athletic Directors for Distribution of the Survey

We have been asked to take part in a research study that is determining the level of heat illness knowledge of middle and high school coaches in the Hampton Roads area. This research is being conducted by a graduate student from Old Dominion University and has been approved by the Institutional Review Board at the University. Your participation in the study is voluntary. If you wish to not participate, please leave your survey blank. By filling out this survey, you are consenting to the use of your data in the final report. Your answers will be kept anonymous and confidential. Please do not write your name anywhere on the survey.

This survey contains two parts, one concerning your knowledge of prevention, recognition, and treatment of heat illness; and once concerning your demographics. Again, these will be kept confidential. (Hand out the survey).

Please complete the survey to the best of your ability. Please do not share answers, as this could cause the data to be inaccurate. The researchers thank you in advance for your participation.

APPENDIX D

Letter of Instruction

Dear ______________,

My name is Erica Borgia and I am a student in the Graduate Athletic Training Program at Old Dominion University. I am currently conducting research under the supervision of Dr. Bonnie Van Lunen. The topic of this research is *Assessment of High School Athletic Coaches' Knowledge of the Prevention, Recognition, and Treatment of Heat Illnesses.* This packet has been sent to a number of area high schools to be completed by coaches of any sport that are employed as full-time coaches by the school district.

Enclosed you will find several copies of the Heat Illness Assessment Survey. The survey contains twenty-five questions and a demographics questionnaire. It will require 15 – 20 minutes of your coaches' time and their answers will be kept confidential. In order to ensure a high return rate, we request that the surveys be completed by coaches during an athletic department meeting if possible. However, if your school does not hold athletic department meetings or it has already taken place, please distribute the surveys to your coaches so that they may complete the survey and return it to you. Once all of the surveys are completed, they can be returned to the researchers via the self-addressed stamped envelope also enclosed in this packet. Our goal is to have all of the surveys returned by ________________.

Participants will also be given the opportunity to receive the results of the study once the research has been completed. Your help with this study is greatly appreciated and will allow certified athletic trainers to evaluate area coaches' knowledge base of heat related illnesses. Any questions regarding the format or the results of this study can be directed to Erica Borgia at .

Sincerely,

Erica L. Borgia, ATC
Graduate Athletic Training Program
Dept. of ESPER
Spong Hall, Rm 113
Old Dominion University
Norfolk, VA 23529

Table 3. Effects of First Aid Certification on Mean Sectional and Total EHI Score

		Yes (n = 42)	No (n = 40)
Recognition Score	Mean	4.119	4.150
	SD	1.517	1.210
	F	.010	
	p	.919	
	Levene's *F*, *p*	.793, .376	
	Effect size	.02	
Prevention Score	Mean	5.881	5.625
	SD	1.549	1.580
	F	.548	
	p	.461	
	Levene's *F*, *p*	.456, .502	
	Effect size	.162	
Treatment Score	Mean	5.381	4.675
	SD	.909	1.403
	F	7.380	
	p	.008*	
	Levene's *F*, *p*	6.253, .014	
	Effect size	.50	
Total EHI Score	Mean	15.333	14.425
	SD	2.808	2.67
	F	2.242	
	p	.138	
	Levene's *F*, *p*	.099, .754	
	Effect size	.323	

* indicates significance at $p \leq .05$

Table 4. Effect of Overall Years of Coaching on Mean EHI Scores

	Mean	Standard Deviation	Pearson Correlation	Sig.($p \leq .05$)
Total EHI Score	15.011	2.792	.213	.055
Overall Years of Coaching Experience	11.402	9.356		

Table 5. Effect of Years of High School (HS) Coaching Experience on Mean EHI Scores

	Mean	Standard Deviation	Pearson Correlation	Sig. ($p \leq .05$)
Total EHI Score	15.011	2.792	.260	.018*
Years of HS Coaching Experience	9.414	8.307		

* indicates significance at the .05 level

Table 6. Effects of Years of High School (HS) Coaching Experience on Mean Sectional Scores

	Mean	Standard Deviation	Pearson Correlation	Sig. ($p \leq .05$)
Years of HS Coaching Experience	9.414	8.307		
Recognition Score	4.176	1.364	.159	.153
Prevention Score	5.823	1.574	.264*	.016*
Treatment Score	5.047	1.204	.065	.559

* Correlation is significant at the .05 level

Table 7. Effects of Attendance to Information Session or Workshop on Mean EHI Scores

		Yes (n = 27)	No (n = 55)
Recognition Score	Mean	4.555	3.927
	SD	1.187	1.412
	F	3.961	
	p	.050*	
	Levene's *F, p*	.064, .801	
	Effect size	.44	
Prevention Score	Mean	5.703	5.781
	SD	1.682	1.511
	F	.045	
	p	.833	
	Levene's *F, p*	.807, .372	
	Effect size	.046	
Treatment Score	Mean	5.185	4.963
	SD	1.270	1.201
	F	.593	
	p	.444	
	Levene's *F, p*	.393,.533	
	Effect size	.174	
Total EHI Score	Mean	15.480	14.600
	SD	2.764	2.746
	F	1.858	
	p	.177	
	Levene's *F, p*	.018,.894	
	Effect size	.318	

- indicates significance at $p \leq .05$

Table 8. Correct Response Rate per Question

Question	Correct Answer	% Correct Responses
1	C (3)	67.1
2	B (2)	49.4
3	C (3)	96.5
4	A (1)	36.5
5	B (2)	43.5
6	D (4)	61.2
7	C (3)	45.5
8	A (1)	20.0
9	B (2)	47.1
10	D (4)	36.5
11	D (4)	64.7
12	B (2)	76.5
13	B (2)	58.8
14	C (3)	29.4
15	D (4)	52.9
16	B (2)	87.1
17	D (4)	88.2
18	A (1)	92.9
19	A (1)	95.3
20	D (4)	74.1
21	D (4)	30.6
22	C (3)	69.4
23	C (3)	72.9
24	A (1)	95.3
25	C (3)	58.8

Figure 2.

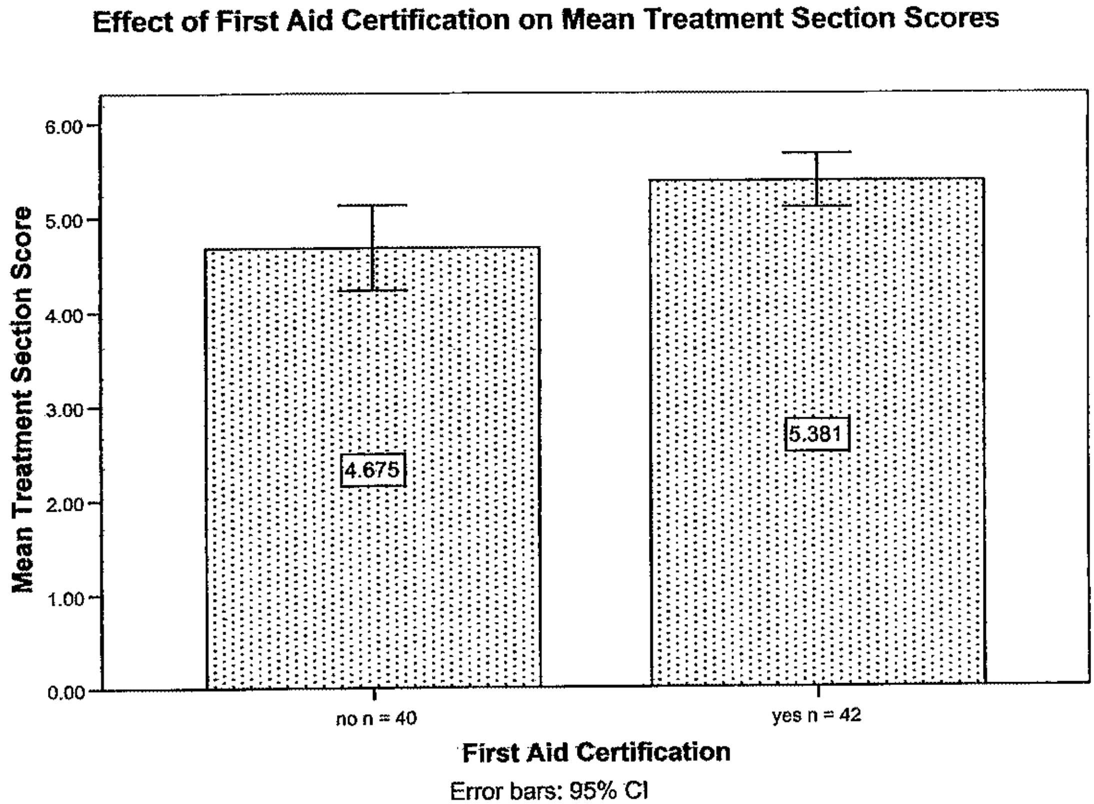

Effect of First Aid Certification on Mean Treatment Section Scores
Mean Treatment Section Score
6.00
5.00
4.00
3.00
2.00
1.00
0.00
4.675
5.381
no n = 40
yes n = 42
First Aid Certification
Error bars: 95% CI

Figure 3.

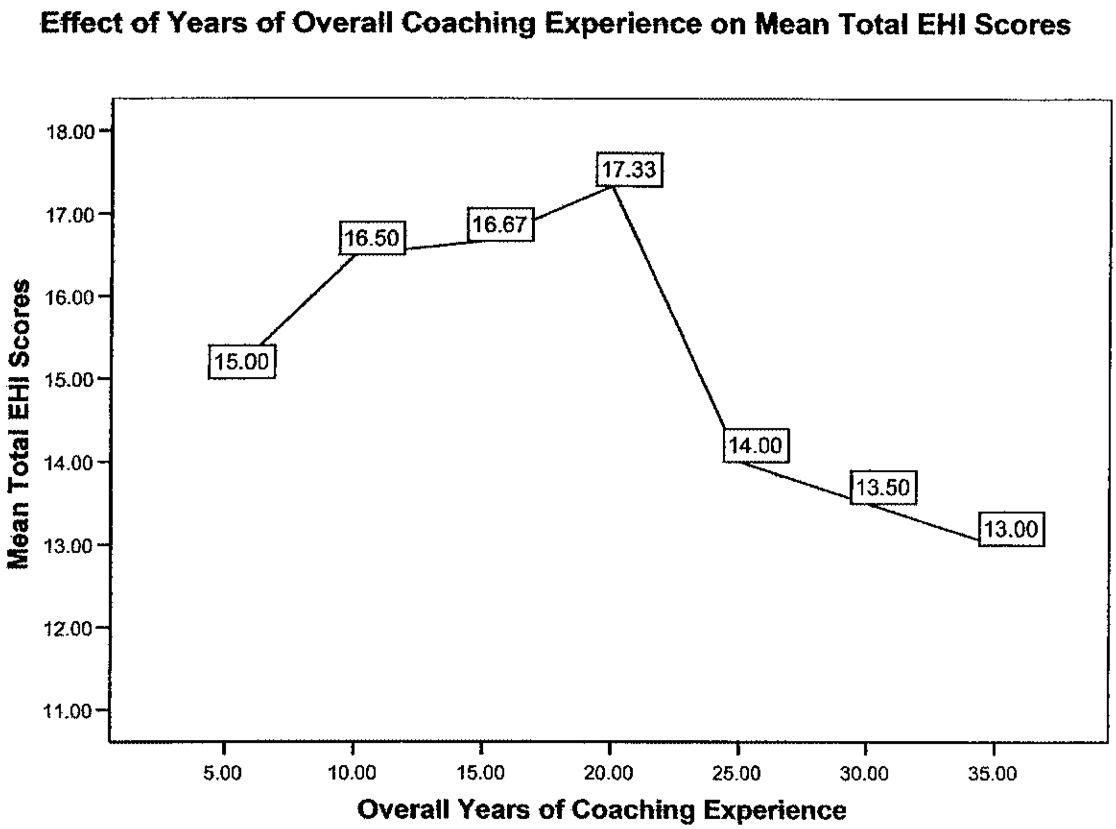

Effect of Years of Overall Coaching Experience on Mean Total EHI Scores
18.00
17.00
16.00
15.00
14.00
13.00
12.00
11.00
Mean Total EHI Scores
17.33
16.50
16.67
15.00
14.00
13.50
13.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
Overall Years of Coaching Experience

Figure 4.

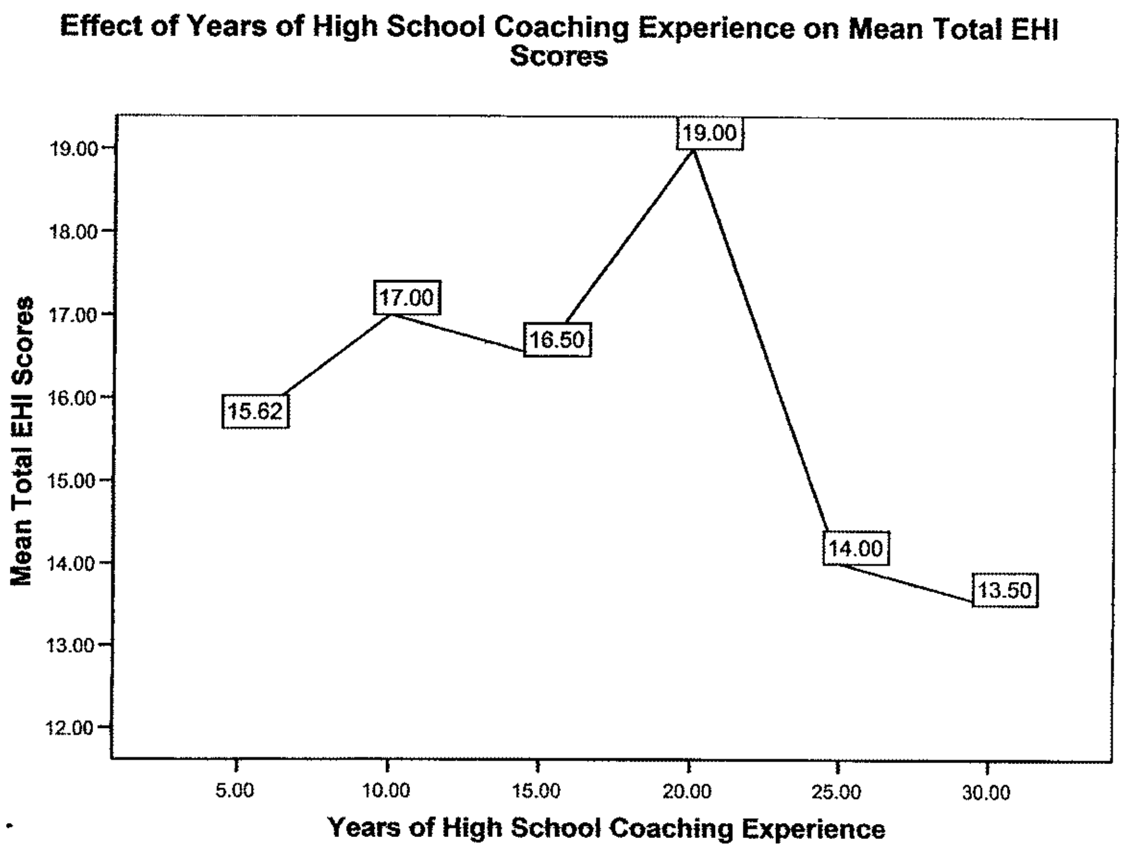

Effect of Years of High School Coaching Experience on Mean Total EHI Scores
Mean Total EHI Scores
19.00
18.00
17.00
16.00
15.00
14.00
13.00
12.00
15.62
17.00
16.50
19.00
14.00
13.50
5.00
10.00
15.00
20.00
25.00
30.00
Years of High School Coaching Experience

Figure 5.

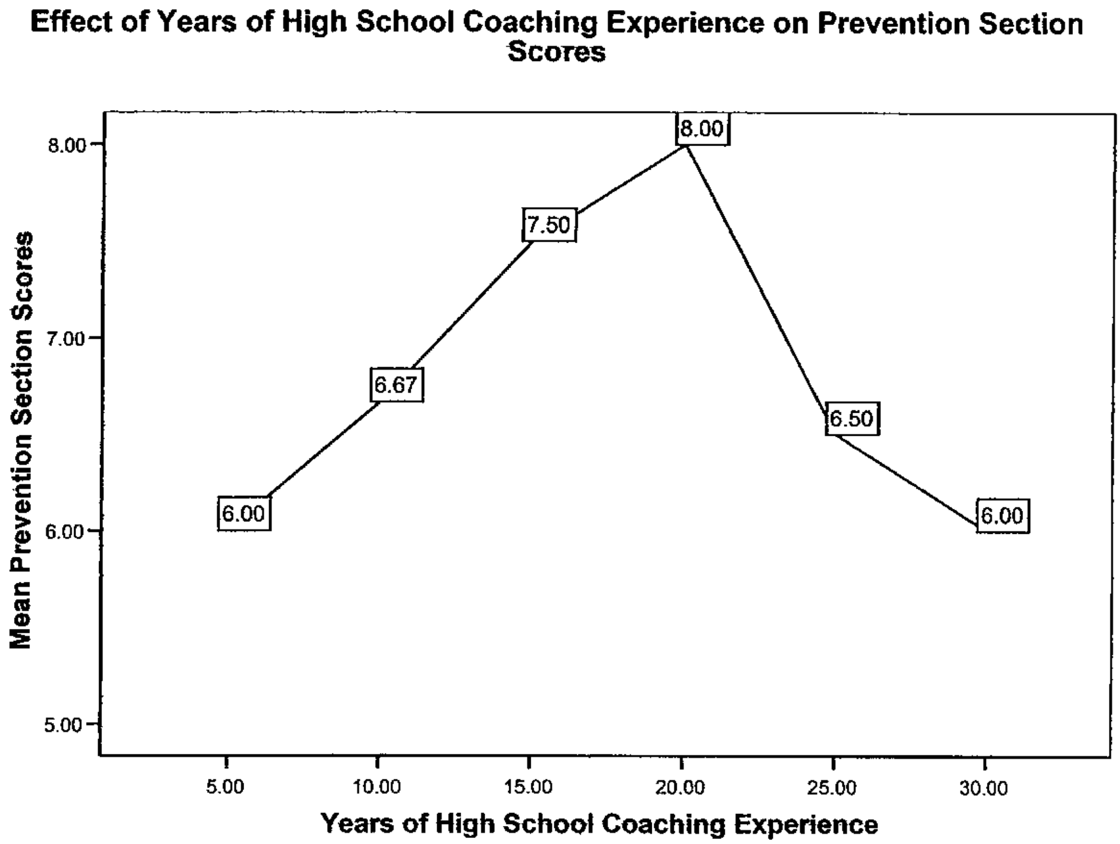
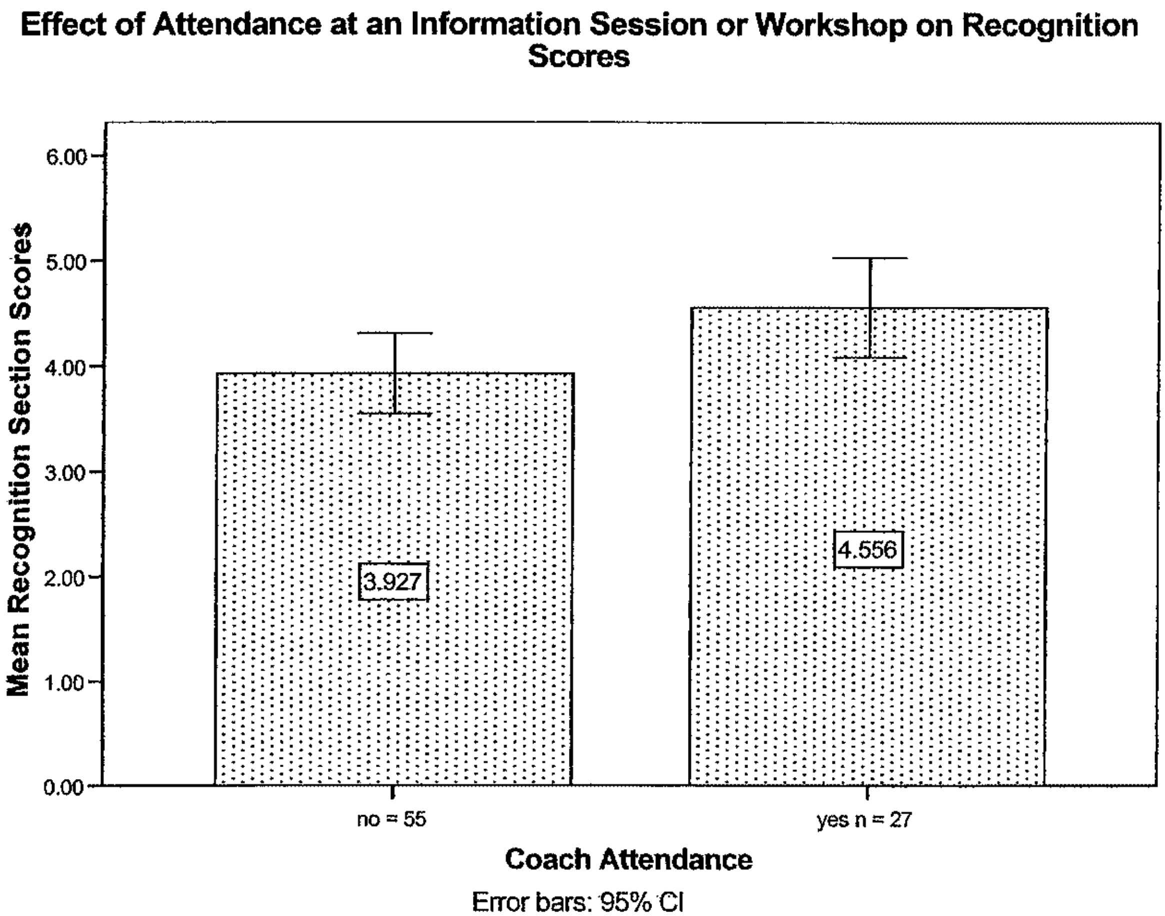

Effect of Years of High School Coaching Experience on Prevention Section Scores
Mean Prevention Section Scores
8.00
7.00
6.00
5.00
6.00
6.67
7.50
8.00
6.50
6.00
5.00
10.00
15.00
20.00
25.00
30.00
Years of High School Coaching Experience

Figure 6.


Effect of Attendance at an Information Session or Workshop on Recognition Scores
Mean Recognition Section Scores
6.00
5.00
4.00
3.00
2.00
1.00
0.00
3.927
4.556
no = 55
yes n = 27
Coach Attendance
Error bars: 95% CI

APPENDIX G

Item Frequency Tables (Questions 1 – 25)

Item Frequency Tables (Questions 1 – 25)

*Note that the correct responses are in bold and italics.

q1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	3	3.5	3.5	3.5
	2.00	13	15.3	15.3	18.8
	3.00	***57***	***67.1***	***67.1***	***85.9***
	4.00	12	14.1	14.1	100.0
	Total	85	100.0	100.0	

q2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	8	9.4	9.4	9.4
	2.00	***42***	***49.4***	***49.4***	***58.8***
	3.00	27	31.8	31.8	90.6
	4.00	8	9.4	9.4	100.0
	Total	85	100.0	100.0	

q3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	2	2.4	2.4	2.4
	3.00	***82***	***96.5***	***96.5***	***98.8***
	4.00	1	1.2	1.2	100.0
	Total	85	100.0	100.0	

q4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	***1.00***	***31***	***36.5***	***36.9***	***36.9***
	1.80	1	1.2	1.2	38.1
	2.00	45	52.9	53.6	91.7
	3.00	3	3.5	3.6	95.2
	4.00	4	4.7	4.8	100.0
	Total	84	98.8	100.0	
Missing	System	1	1.2		
Total		85	100.0		

q5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	2	2.4	2.4	2.4
	2.00	***37***	***43.5***	***43.5***	***45.9***
	3.00	17	20.0	20.0	65.9
	4.00	29	34.1	34.1	100.0
	Total	85	100.0	100.0	

q6

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	3	3.5	3.5	3.5
	3.00	30	35.3	35.3	38.8
	4.00	***52***	***61.2***	***61.2***	***100.0***
	Total	85	100.0	100.0	

q7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	10	11.8	11.8	11.8
	2.00	13	15.3	15.3	27.1
	2.90	1	1.2	1.2	28.2
	3.00	***37***	***43.5***	***43.5***	***71.8***
	4.00	24	28.2	28.2	100.0
	Total	85	100.0	100.0	

q8

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	***1.00***	***17***	***20.0***	***20.0***	***20.0***
	2.00	34	40.0	40.0	60.0
	3.00	31	36.5	36.5	96.5
	4.00	3	3.5	3.5	100.0
	Total	85	100.0	100.0	

q9

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	2	2.4	2.4	2.4
	2.00	***40***	***47.1***	***47.1***	***49.4***
	2.70	2	2.4	2.4	51.8
	3.00	24	28.2	28.2	80.0
	4.00	17	20.0	20.0	100.0
	Total	85	100.0	100.0	

q10

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	2	2.4	2.4	2.4
	2.00	2	2.4	2.4	4.7
	3.00	50	58.8	58.8	63.5
	4.00	***31***	***36.5***	***36.5***	***100.0***
	Total	85	100.0	100.0	

q11

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	8	9.4	9.4	9.4
	2.00	20	23.5	23.5	32.9
	3.00	2	2.4	2.4	35.3
	4.00	***55***	***64.7***	***64.7***	***100.0***
	Total	85	100.0	100.0	

q12

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	***1.00***	***65***	***76.5***	***76.5***	***76.5***
	2.00	18	21.2	21.2	97.6
	3.00	1	1.2	1.2	98.8
	4.00	1	1.2	1.2	100.0
	Total	85	100.0	100.0	

q13

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	11	12.9	12.9	12.9
	2.00	***50***	***58.8***	***58.8***	***71.8***
	3.00	15	17.6	17.6	89.4
	4.00	9	10.6	10.6	100.0
	Total	85	100.0	100.0	

q14

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	26	30.6	30.6	30.6
	2.00	27	31.8	31.8	62.4
	3.00	***25***	***29.4***	***29.4***	***91.8***
	4.00	7	8.2	8.2	100.0
	Total	85	100.0	100.0	

q15

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	5	5.9	5.9	5.9
	2.00	17	20.0	20.0	25.9
	3.00	18	21.2	21.2	47.1
	4.00	***45***	***52.9***	***52.9***	***100.0***
	Total	85	100.0	100.0	

q16

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	3	3.5	3.5	3.5
	2.00	***74***	***87.1***	***87.1***	***90.6***
	2.10	1	1.2	1.2	91.8
	3.00	2	2.4	2.4	94.1
	4.00	5	5.9	5.9	100.0
	Total	85	100.0	100.0	

q17

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	1	1.2	1.2	1.2
	2.00	2	2.4	2.4	3.5
	3.00	7	8.2	8.2	11.8
	4.00	***75***	***88.2***	***88.2***	***100.0***
	Total	85	100.0	100.0	

q18

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	***1.00***	***79***	***92.9***	***92.9***	***92.9***
	3.00	2	2.4	2.4	95.3
	4.00	4	4.7	4.7	100.0
	Total	85	100.0	100.0	

q19

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	***1.00***	***81***	***95.3***	***95.3***	***95.3***
	2.00	3	3.5	3.5	98.8
	3.00	1	1.2	1.2	100.0
	Total	85	100.0	100.0	

q20

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	3	3.5	3.5	3.5
	2.00	15	17.6	17.6	21.2
	3.00	1	1.2	1.2	22.4
	3.50	3	3.5	3.5	25.9
	4.00	***63***	***74.1***	***74.1***	***100.0***
	Total	85	100.0	100.0	

q21

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	20	23.5	23.5	23.5
	2.00	5	5.9	5.9	29.4
	3.00	34	40.0	40.0	69.4
	4.00	***26***	***30.6***	***30.6***	***100.0***
	Total	85	100.0	100.0	

q22

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	15	17.6	17.6	17.6
	2.00	9	10.6	10.6	28.2
	2.50	1	1.2	1.2	29.4
	3.00	***59***	***69.4***	***69.4***	***98.8***
	4.00	1	1.2	1.2	100.0
	Total	85	100.0	100.0	

q23

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	12	14.1	14.1	14.1
	2.00	5	5.9	5.9	20.0
	2.70	1	1.2	1.2	21.2
	3.00	***62***	***72.9***	***72.9***	***94.1***
	4.00	5	5.9	5.9	100.0
	Total	85	100.0	100.0	

q24

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	***1.00***	***81***	***95.3***	***95.3***	***95.3***
	3.00	1	1.2	1.2	96.5
	4.00	3	3.5	3.5	100.0
	Total	85	100.0	100.0	

q25

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	4	4.7	4.7	4.7
	2.00	26	30.6	30.6	35.3
	3.00	***50***	***58.8***	***58.8***	***94.1***
	4.00	5	5.9	5.9	100.0
	Total	85	100.0	100.0	

Cronbach's Alpha Values for All Questions

Question	Cronbach's Alpha
1	1.00
2	1.00
3	.667
4	1.00
5	1.00
6	1.00
7	1.00
8	.888
9	1.00
10	.842
11	1.00
12	1.00
13	1.00
14	1.00
15	1.00
16	.807
17	.857
18	.866
19	.939
20	1.00
21	.857
22	.960
23	1.00
24	1.00
25	1.00

VITA

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Professional Experience

2006 – 2007	Old Dominion University *Graduate Teaching Assistant – HE 224*
2005- 2007	Virginia Wesleyan College, Norfolk, VA *Graduate Assistant Athletic Trainer*
2003 – 2005	School of Health and Rehabilitation Sciences, Department of Sports Medicine and Clinical Dietetics, University of Pittsburgh, Pittsburgh, PA *Athletic Training Student*

Professional Memberships:

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Virginia Athletic Trainers Association
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