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Title: AN analysis of the Hydration Status of 15 to 18 year old Adolescent Males of the W-Connection Football Club

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AN ANALYSIS OF THE HYDRATION STATUS OF 15 TO 18 YEAR OLD ADOLESCENT MALES OF THE W-CONNECTION FOOTBALL CLUB

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Abstract

Levels of minimal dehydration are capable of decreasing athletic performance and many athletes have not been found to adhere to recommendations in order to maintain a hydrated state. The aim of this case study was to identify the hydration status of adolescent males between 15 and 18 years of the W-Connection football club with objectives to state the hydration status of the population, assess their percentage adherence to fluid recommendations, create a dehydration index and calculate sweat rate. Seventeen (n=17) individuals of good perceived health within the age range of 15 to 18 from the football club were assessed for hydration status using indices of percentage weight loss, urine colour and thirst over a 3 day period. Fluid consumption and type of beverage consumed were assessed through the use of recall questionnaires and relevant parameters were identified through Cronbach's Alpha test and used to ultimately predict a score of degree of dehydration. Results revealed that the overall hydration status of the study population was minimal dehydration but showed overall urine colour indices of serious dehydration (6±0.79). Additionally at least 60 percent of the population was unable to achieve percentage adherence to fluid requirements over 59 percent, 3 hours before, 20 minutes before and during exercise. An index was created using thirst before training over 3 days, urine colour over 3 days and mode thirst during exercise with a maximum score of 20 indicating the highest degree of dehydration. Sweat rates were calculated and the average found to be greater than the norm (1.59 ± 0.87 L/h). It is recommended that fluids be consumed in adequate amounts before training so that maximum hydration can be achieved pre- exercise, to minimise the degree of dehydration post exercise. Additionally, an electrolyte containing drink should be consumed during training.

Introduction

Background

Water is essential for life and is the major component of the human body (Casa, et al. 2000). It accounts for 40% to 70% of total body mass and its importance is credited to its function as the medium through which all biological processes take place (Casa, et al. 2000, Byars 2008). Additionally water is an active substrate in many biological reactions (Kleiner 1999). Water functions as a transport medium for gasses, nutrients and waste; as a joint lubricant, and as a cushion for organs. Furthermore, water absorbs considerable heat created by environmental stress and exercise without creating extreme variation in body temperature and, because of its high heat of vaporization, it is able to help regulate body temperatures (Byars 2008). Heat loss through evaporation is the major form of releasing heat from the body when under stressful conditions. At this point, the body's response to heat is critical and uses sweat production for cooling. When the body is cool, water moves between the major water containing compartments of the body: plasma, intersticial spaces and intra-cellular spaces. Such movements are possible due to hydrostatic pressures and osmotic-oncotic gradients. During the sweat response, since sweat is hypotonic relative to water, the water contained in the fluid compartments of the body move outward towards extracellular spaces (Casa, et al. 2000). Sweat rates have been reported to be between 0.8 to 1.4 Litres per hour for a typical athlete and larger athletes sweating up to 2 Litres an hour (Kreider, et al. 2009). This movement of water out of these compartments, if not replaced by ingested fluids, will result in dehydration (Casa, et al. 2000).

Dehydration is arguably the most important physiological disturbance that can cause fatigue during exercise (Murray 1995). It is defined as a decrease in body water content (Wildman and Miller 2004) and can either be acute (as from intense exercise) or chronic (due to inadequate rehydration of daily losses over time) (Kleiner 1999). Mild dehydration is regarded as a 1% to 2% decrease in total body weight. It is universally known that a lack of sufficient water in the body, or dehydration, negatively affects the body's health and performance (Kleiner 1999). Dehydration has the ability to affect all systems in the body, mainly the muscular skeletal, thermoregulatory and cardiovascular systems (González-

Alonso, et al. 1997). In the world of sport, the effects of dehydration on the athletic human body have extensively been explored through research. Emphasis on importance in the athletic world is attributed to the potential of dehydration to reduce performance, cause heat related illness and to, in extreme cases, end in fatality (Murray 1995). Studies have shown that a 1% decrease in body weight, as a result of sweat losses, can cause impaired physiological responses, while losses of 3% -5% of body weight can decrease endurance and strength (Kleiner 1999). For an athlete, even levels of mild dehydration can make the difference between winning the gold and settling for second place silver, or the split second it takes to score a winning point for your team and muddling a golden opportunity to score the win. Additionally dehydration can cause serious physical damage in the form of heat injury where an athlete can experience heat cramps, weakness, headache, dizziness, low blood pressure, elevated pulse, body temperature increases, a shut-down of the body's cooling mechanisms, and deliria or coma (Kjaer, et al. 2003).

Furthermore, psychological changes are associated with dehydration. Impaired mental function, increased rate of perceived exertion, decreased motivation to perform exercise and decrease in time taken to become exhausted are some such psychological consequences of dehydration (Casa, et al. 2000).In the United States of America dehydration, in association with heat illness during practice or competition, has been reported to be the leading cause of death and disability among high school athletes, (Mueller and Cantu 2008) highlighting the seriousness of a dehydrated state. Exercise, especially performed in the heat, can end in measurable dehydration if sweat losses are not adequately replaced (Wilk, Timmons and Bar-Or 2010). In order to prevent these negative effects of dehydration, it is crucial to promote fluid intake among athletes to maintain hydration (Wilk, Timmons and Bar-Or 2010). However, studies have shown that voluntary hydration among both child and adult athletes is inadequate for hydration in hot climates and is as a result of voluntary dehydration (Greenleaf and Sargent 1965, Bar-Or, et al. 1980). Few studies have extensively investigated the adequacy of drink consumption among both male and female adolescent athletes.

It is important to consider the factors that help contribute to dehydration. Such factors include intensity, duration of exercise, temperature and whether or not the individual was properly pre-hydrated.

Increases in intensity, duration and temperature are associated with increased risk of dehydration. Intensity, a measure of how hard one works, though difficult to gauge, can be measured using the Borg 15 point scale of perceived intensity rating while duration of exercise and temperature are usually measured in hours and wet bulb globe temperature respectively (Casa, et al. 2000).

It should be noted that to combat against dehydration in the athlete, beverage choice is crucial. All fluids, except for alcohol contribute to the total hydration of the athlete but not all beverages are equal as it pertains to exercise. High sugar beverages such as carbonated drinks, energy drinks and fruit juices are not recommended for consumption before and during exercise. The rate at which fluids normally empty into the stomach during exercise is 0.8 to 1.2 L per hour (Kreider, et al. 2009). These drinks take a long time to move from the stomach to the intestine where water is absorbed. Such a delay in movement slows the rate at which the body could be hydrated. Electrolyte containing drinks such as sports drinks and water are the preferred drinks where hydration before and during exercise is concerned. These beverages empty quickly into the gut so that water can be absorbed and transported to the muscle where it is needed. Of the two beverages, electrolyte containing drinks are considered the better of the two. Electrolytes such as potassium, sodium and chloride, when dissolved, become charged particles that help to regulate the flow of water molecules across cell membranes and ultimately regulate fluid balance. Beverages containing both carbohydrates and electrolytes are better able to result in absorption of water molecules by muscle than water consumption alone (Bonci 2009).

Statement of the Problem

Due to increased physical activity and long duration of activity, athletes are a group that are commonly and constantly at risk of becoming dehydrated. Studies on athletes have shown that fluid intake in amounts to maintain hydration before, during and after exercise is often not met, resulting in dehydrated athletes (Iuliano, et al. 1998, Bar-Or, et al. 1980). Within research most studies on hydration status are conducted on adults leaving a need for studies to be carried out on children and adolescents. Of the many sports that exist, endurance sports are usually associated with dehydration risk. Dehydration and the inability to maintain hydration is frequently associated with the endurance sport of football due to the duration, intensity and limited opportunity to consume fluids during the game.

Little is known of the hydration status of football athletes in Trinidad and Tobago and even less is known of the hydration status of adolescent footballers. In Trinidad and Tobago,W-Connection is one of the members of the Trinidad and Tobago Professional Football League and is sponsored by Mr. David John-Williams (CEO). Within the club exist the Under 18 and Under 16 teams which collectively consist of a group of 30 young men between the ages of 14 to 18. These teams, coached by Mr. Brian Williams, have been in existence for 5 years with the members of the teams training together three times a week at varying intensities. The hydration status of the members of these teams had not been assessed and the members were unaware of their hydration status before and after exercise.

The purpose of this case study is to assess the hydration status of adolescent athletes of the W-connection football team between the ages 15 to 18; are adolescent football athletes in Trinidad and Tobago hydrated before and after training?

Purpose

To assess the hydration status of adolescent athletes of the W-connection football team between the ages 15 to 18.

Research Questions

1. How hydrated are adolescent male athletes of the W-connection football team between the ages 15 to 18 before and after training?

2. Can an index for measuring degree of dehydration after training be developed for male athletes of the W-connection football team between the ages 15 to 18?

3. How adequately do athletes of the W-connection football team between the ages 15 to 18 adhere to fluid recommendations for before and during training?

4. How much do athletes of the W-connection football team between the ages 15 to 18 sweat after training in litres per hour?

Objectives

1. To determine the hydration status of adolescent males of the W-connection football team between the ages 15 to 18 before and after training.

2. To develop an index to investigate the degree of dehydration after training for adolescent male athletes of the W-Connection football team who are between the ages of 15 to 18 years old.

3. To compare actual intake of fluids before and during exercise, of members of the W-connection football team between the ages 15 to 18, to that of the recommended standard for athletes.

4. To determine individual and overall sweat rate of adolescent males of the W-connection football team between the ages 15 to 18.

Hypothesis

1. Adolescent males of the W-connection football team between the ages 15 to 18 will be well hydrated before and during training.

2. An index to measure degree of dehydration after training for adolescent males of the W-connection football team between the ages 15 to 18 would be developed.

3. Members of the W-connection football team between the ages 15 to 18 would adhere to fluid recommendations before and during exercise.

4. Individual and overall sweat rate of adolescent males of the W-connection football team between the ages 15 to 18 would be determined.

Key Terms

Adolescent- a young person within teenage years

Dehydration- reduced body water content (Wildman, Robert, Barry 2004)

Fluid- consumable liquid substance

Hydration- water status of the body (Wildman, Robert, Barry 2004)

Hyperhydration- consuming and retaining fluid in excess of body needs

Sweat rate- the rate at which sweat is produced in litres per hour

Literature Review

Dehydration has several negative effects on the athletic body, the major one being an increase in core temperature. Core temperature can increase between 0.15 to 0.20^{o}C for every 1 % of weight that is lost due to sweat during activity (González-Alonso, et al. 1997). When a dehydrated person begins to exercise, changes in temperature manifest as delayed onset of skin vasodilatation and sweating. Since sweat is considered hypotonic in relation to body water, the elevation of extracellular tonicity (osmotic pressure) results in water movement from intracellular to extracellular spaces consequently all water compartments (plasma, interstical fluid and intracellular fluid) contributing to dehydration. In such a dehydrated state, heat tolerance is reduced and exercise time to exhaustion occurs at low core temperatures (Casa, et al. 2000). Additionally, physiological advantage from fitness level and acclimatization are negated (Casa, et al. 2000). In a study on the influence of hydration status and fluid replacement on heat tolerance, and exercise intensity, conducted on adult males, it was observed that a 2.2% body mass loss of fluid negatively influences heart rate, stroke volume and exercise tolerance time in both light and heavy exercise intensities in the heat (Cheung and McLellan 1997). Other studies have shown that if, for example, a 150 lb athlete loses 2% body weight then physical capacity would decrease by 20% (Armstrong, Costill and Fink 1985). Therefore, 1% to 2% losses in body mass can affect athletic performance.

Additionally, cognitive and mental performance has been found to be affected by dehydration. In a study by Gopinathan et al which investigated variations in mental performance in 11 acclimatized subjects at different heat stress-induced dehydration levels, it was found that subjects had a decrease in the capacity to perform simple arithmetic, a decrease in short term memory recall and visuomotor tracking. Such decreases were found to occur at 2% decrease in body weight (Gopinathan, Pichan and Sharma 1998), the same level at which dehydration affects performance. Animal studies have also identified a link between dehydration and a lack of the enzyme nitric oxide synthase; a critical enzyme in facilitating learning and memory (Wilson and Morley 2003).

Through several studies of both adults and children, fluid consumption recommendations have been established. Adults are estimated to have a fluid turnover rate of 2 to 3 litres per day (Leiper, Carnie and Maughan 2006) and are recommended to consume 1mL / kcal of energy expenditure for the day (Kleiner 1999). Daily fluid recommendations for children have been set at 1.5mL/kcal per day which is greater than that for adults. However, few research studies identifying fluid turnover values for children and adolescents exist. A study by Ballauf et al has been able to estimate water in children between ages 6-11 by measuring fluid intake versus fluid output (Ballauff, Kersting and Manz 1988). Though, not the most accurate method of measurement, the findings revealed a reported turnover of approximately 1.6 litres per day, meaning that roughly 1.6 litres are depleted and replaced each day. In spite of the observed hydration rate, researchers of the study suggested that turnover should be greater for children based on an average urine volume of 22g per kilogram per day and the expected volume of fluid needed per kilocalorie of energy per day. However, the children involved in this particular study were not involved in sport at the time of measurement. Therefore, the approximated turnover rate can only be considered a baseline number for active athletes. Other studies investigating sweat rates for child and adolescent athletes have indicated that fluid needs may increase above baseline needs by 0.5 to 1.0 litres per day, or greater than (Petrie, Stover and Horswill 2004).

When compared to adults, children may experience greater heat stress when exercising in hot climates. Children tend to absorb more environmental heat due to their greater surface area to body mass ratio. Additionally, children who are non-athletes faster generate heat and have increased metabolic rate during activity when compared to adults doing the same relative workload. Whether or not child athletes have the same physiological differences to adults as non-athlete children is unknown (Casa, et al. 2000). It has been theorised that child athletes may have more muscle control than non-athlete children; therefore, they may conserve energy more readily because of the ability to relax antagonist muscle (Casa, et al. 2000). Though energy needs and heat production increase, sweating capacity is reported to be lower in children but is said to increase with maturation to adolescence (Rowland 2011). It is theorised that one would expect adolescents to follow the same fluid consumption patterns as adults (Casa, et al. 2000).

Fluid requirements for the adult athlete are majorly influenced by timing of fluid consumption. It is recommended that athletes consume a well balance diet with adequate fluid consumption within the 24 hours before exercise and begin exercise well hydrated (Casa, et al. 2000, Kleiner 1999). Being hypohydrated before exercise can result in several negative effects for the athlete where physiological mechanisms are compromised and the extent of dysfunction is related to thermal stress. It is recommended that athlete ingest 500mL to 600mL of fluid (water or sports drink) 2 to 3 hours before an event and 200mL to 300mL of fluid (sports drink or water) 10 to 20 minutes before an event which has been proven to be physiologically advantageous to the athlete (Casa, et al. 2000, Kleiner 1999). Studies suggest that hyperhydration before activity is most beneficial when fluid intake cannot meet sweat losses during the same activity but only in extreme cases (Casa, et al. 2000). Such a recommendation is due to the conflicting evidence regarding the benefits of hyperhydration. In a study conducted on cyclists to test for effects on performance as a result of consuming pre exercise glycerol hydration fluid, it was found that hyperhydration with or without glycerol containing beverages, reduced dehydration during exercise- a benefit to the athlete (Wingo, et al. 2004). However, a study on the effect of hyperhydration on thermoregulatory system found that hyperhydration has no thermoregulatory benefit for an athlete (Latzka 1997).

According to the Fluid Guidelines for Exercise (Covertino, et al. 1996) hydration during exercise should consist of palatable fluids at a rate of 4 to 8 oz every 15 to twenty minutes. The document further specifies that athletes exercising longer than an hour should consume beverages that consist of electrolyte containing fluids to assist in fluid absorption and retention in the body. For the child athlete it is recommended that fluids during exercise should be consumed at a rate of 13 mL/kg (6 mL/lb) every hour (Rowland 2011). Proper hydration during exercise enhances heat dissipation through increased skin blood flow and sweating rate, limits plasma hypertonicity, and helps sustain cardiac output. “Rehydration during exercise conserves the centrally circulating fluid volume and allows maximal physiologic responses to intense exercise in the heat” (Casa, et al. 2000).

Following exercise, individuals are recommended to consume fluids in excess of sweat losses (Maughan and Shirreffs 1997). Some literature suggests consuming 16oz to 20oz of fluid per pound lost (Kleiner 1999) while others suggest consuming 1.5 times the amount of fluid than the amount of sweat lost (Davies 2000). Whether one recommendation is better than the other has not been investigated. It can then be assumed that either regime is adequate. Whatever the recommendation, it is important that sweat losses be replaced, especially in sports where a second exercise bout occurs. It has been found that if sweat losses have not been replaced, optimum performance is hindered (Maughan and Shirreffs 1997). Athletes should therefore be encouraged to consume fluids in adequate amounts.

Several factors contribute to motivation of fluid consumption and influence rehydration to varying degrees. Factors can be environmental factors or psychological factors, and also include physical characteristics of the beverage, accessibility to fluids, or a combination of these. Environmental factors such as temperature, humidity and wind speed influence physiological processes within the body to negatively affect the degree of dehydration and ultimately positively affect fluid consumption with increase in each parameter (Kleiner 1999). For example, studies have shown that fluid intake increases when ambient temperatures rise above 25^{o}C (Casa, et al. 2000) and greater humidity increases water loss in individuals (Kleiner 1999). With regards to psychological factors, studies have reported that temperature increases within the environment psychologically stimulates an individual to drink (Kleiner 1999). Flavour, composition and temperature of the rehydrating beverage also influence rehydration. In a 1999 study conducted on 13 year old boys, it was found that flavoured carbohydrate containing drinks prevent voluntary dehydration in trained athletes in the heat when compared to the choice of drinking unflavoured water alone (Rivera-Brown, et al. 1999). In a similar study, on boys between the ages of 9 and 12, it was also found that flavoured drinks promoted hydration and also found that flavoured drinks containing a combination of sodium chloride and carbohydrates not only reduced voluntary dehydration but prevented dehydration (Wilk and Bar-Or 1996). Another study regarding composition of beverages looked at carbohydrate and electrolyte containing drinks versus water in adolescent tennis players. This study concluded that water was not as effective as carbohydrate and electrolyte containing drinks in minimizing fluid losses (Bergeron, Waller and Marinik 2006). This shows that flavour and drink composition are highly influential to voluntary hydration as well as hydration status. Studies have also revealed that beverage temperature affects motivation to consume fluids. In a study by Khamnei, Hosseinlou and Zamanlu, optimum beverage temperature to promote fluid consumption was concluded to be at a cool temperature of 16^{o}C (Khamnei, Hosseinlou and Zamanlu 2011). However, the US Track and field Advisory recommends that a beverage be between 10^{o}C-15^{o}C. Fluid availability also plays a part in fluid consumption. It is theorized that accessibility to fluids is the reason why athletes in certain sports like cycling consume more liquids than in other sports (Kleiner 1999).

Other influencers of hydration status include those which influence urine output; both excretion rate and volume. Caffeine and alcohol are natural diuretics. The consumption of either of these beverages can therefore result in increased volume and rate of fluid output. A study investigating the effects of caffeine on urine output found that a negative fluid balance, increased 24 hour urine excretion, decreases in total body water and weight loss resulted after consuming a daily dosage of six cups of coffee (642 mg of caffeine) (Neuhauser-Berthold, et al. 1997).

Literature existing on voluntary fluid intake is conflicting. In a study by Wilk, Timmons and Bar-Or, adolescent male runners were observed in order to identify whether or not fluid needs were being met. It was found that during exercise, the runners appropriately met fluid needs (irrelevant to the type of beverage available) (Wilk, Timmons and Bar-Or 2010). Other studies have found that fluid intake practices during exercise are inadequate to maintain hydration and optimum performance. Such evidence is found in a 1998 study conducted on both male and female adolescent cyclists. Significant body mass losses were recorded for both groups of adolescents indicating a degree of dehydration and confirming that fluid needs were not met (Iuliano, et al. 1998). Other studies performed on children further confirm lack of hydration. Such a study focused on voluntary dehydration among preadolescent boys (10-12 years old). The children were found to only drink voluntarily when thirsty and progressively decreased fluid consumption during the course of exercise (Bar-Or, et al. 1980). This conflicting evidence is possibly due to the different types of sports reviewed in each study.

According to Kleiner (1999), there is no universally accepted laboratory method to assess hydration status. The most frequently used method to assess hydration, euhydration and hypohydration are urine specific gravity, urine osmolatity, plasma sodium and haematocrit level (Kleiner 1999). However, none of these tests are useable in the field therefore other methods have been established as more practical measures for field use. Armstrong and colleagues have been able to show that urine colour is interchangeable with urine specific gravity and urine osmolarity (Armstrong, Maresh, et al. 1994). Through the use of a urine colour chart, formulated by Armstrong et al, urine colour is now used in situations where urine specific gravity and osmolality cannot.

The field body mass test is another method of assessing hydration status. Though considered crude, this method is still regarded as "relatively accurate (Kleiner 1999)." For this procedure, the athlete is weighed before and after exercise (Casa, et al. 2000). Weight lost during the course of exercise (not attributed to tissue losses), is considered fluid loss - 2.2kg is equivalent to 470mL fluid loss (Casa, et al. 2000).

Thirst is also considered an indication of dehydration (Casa, et al. 2000). The feeling of thirst is a response to already being dehydrated. It has been found that while thirsty a person can have experienced between 0.8% to 2.0% weight losses as a result of dehydration (Kleiner 1999) and is not considred a good indicator of dehydration. It has been found that thirst response to dehydration becomes less sensitive with increasing age. However, much of this data is on the elderly and young adults. Little data has been collected with regard to children but it has been suggested that difference in thirst response may also exist between children and young adults (Kenny and Chiu 2001).

Dehydration is able to affect both mental and physical performance of an athlete. A body percentage weight loss of 2% can negatively affect both mental capacity to think and physical performance by 20%. Athletes therefore should adhere to fluid consumption guidelines in order to maintain hydration. Fluid requirements have been found to be greater in children than in adults and studies have revealed that daily recommendations have been set at 1.5ml per kg of body weight. Adolescents have been said to have similar fluid requirements to those of adults. As it pertains to training, the athlete should consume a balanced diet 24 hours before training and consume approximately 500mL of fluid 2 hours before exercise. During exercise, athletes should drink a minimum of 4 oz of fluid every 15 to 20 minutes. Several factors including, environmental and psychological factors influence voluntary hydration. Beverage composition, flavour and temperature are also a major factors governing fluid consumption while other influences of hydration include substances like caffeine and alcohol that have a diuretic effect and increase urine output. To assess athletes' adherence to guidelines, urine specific gravity, urine osmolatity, plasma sodium and haematocrit levels, can be used to determine hydration status. However, these methods are not very useful in the field. Other methods such as indication of thirst, urine colour and weight change (as a result of sweat losses) can be alternately used.

Methodology

The main objective of this study was to identify the hydration status of adolescent males of the W-Connection football club. The study sample was a convenience sample which included 20 members of the club who volunteered to participate in this study. The criteria for enrolment required that the subjects be males between 15 and 18 years of age, members of the under 16 or under 18 W-connection football team, of good perceived health, training for more than 2 times per week and involved in the sport for at least 1 year.

This study was an observational case study where data was collected for three days over a two week period (dependent on team training schedule). Informed consent was obtained from both parents and football club members before the start of the study. A questionnaire geared towards collection of demographics, recall of fluid consumption, type of beverage consumed and thirst perception was used as the major assessment tool. This questionnaire consisted of 2 parts and was distributed before training and completed after training of each day. Questions regarding demographics included age, ethnicity, education level, form of study, and occupation. The first part of the questionnaire focused on pre exercise hydration and fluid consumption. The second section of the questionnaire focused on conditions during training and the fluid consumed during training. Additionally, the questionnaire included the Borg's Scale for rating of perceived exertion. Examples of cup measurements and millilitres were brought on site to educate study participants on the definition of 1 cup and other units of measure used for liquid measurement. On day one of testing, height, BMI and body fat percentage were collected using a Charder height measurement stadiometer and a Full Body Sensor Bioelectrical Impedance Machine.

Each participant as assigned an ID number and questionnaires were distributed. After completing the fist section of the questionnaire, participants were weighed using a Full Body Sensor. They were instructed not to use the bathroom during training to exclude loss of urine as a possible explanation for any weight loss that may have occurred after training. Participants were allowed to consume fluids either from water provided in a water-cooler or from self provided fluids in individual containers. Individual containers were weighed before and after training and the difference calculated to be fluid consumed during training. Study participants drinking from the cooler were provided with cups capable of holding 1 cup (240mL) measures of water and were asked to report the number of cups consumed during training.

Following training, questionnaires were redistributed for completion. After completion of the second section of the questionnaire, study participants were again weighed. Subsequent to the second weighing, subjects were asked to provide a urine sample in white disposable urine collection cups. Urine colour was matched, by the researcher, to that of the urine colour chart and corresponding number noted. The same researcher interpreted colour matching for each day of study.

Percentage adherences to fluid recommendation 3hrs before exercise, 20minutes before exercise and during exercise were calculated using the equation: (actual intake/ recommendation)*100. Recommendations for fluid during exercise were calculated to be [exercise duration (min)/ 15(min)]*120mL and used for calculation of percentage adherence to fluid requirements during exercise.

Microsoft Office Excel 2007 and Statistical software SPSS 12 for Windows were used to calculate frequencies and means. From the data collected, percentage weight loss was calculated using the equation [pre-exercise body weight – post-exercise body weight] / pre-exercise body weight) x 100.

A score of the degree of dehydration was formulated from data collected from the questionnaire. To formulate the dehydration score indices of dehydration were scored higher than those that were not associated with a dehydrated state. Using Statistical software SPSS 12 for Windows Cronbach's Alpha was used to conduct analysis on categorical data to find the strongest consistencies and correlations among parameters. Parameters that had a "Corrected Item-Total Correlation" above 0.3 were used to create an index for degree of dehydration.

Additionally, individual sweat rate was calculated using the equation, sweat rate = pre-exercise body weight – post-exercise body weight + fluid intake - urine volume/exercise time in hours. Microsoft Office Excel 2007 and Statistical software SPSS 12 for windows were used for computation of all calculations.

Results

Of the 20 males enrolled in the study, 2 did not return questionnaires and one participant was absent for 2 days of the study. These participants were excluded from further analysis (n=17).

Table 1: *Demographic data of adolescent male members between 15 to 18 years old of the W-Connection Football club*

Parameter	Units	Results
Number of Adolescent males enrolled	N	17
Mean Age (x ± SD)	Years	16.41 ± 0.94
Ethnicity	%	
Indian		5.9
African		64.7
Caucasian		5.9
Chinese		0
Mixed		23.5
Education	%	
Primary		0
Secondary		100
Tertiary		0
Form	%	
Upper 6		5.9
Lower 6		29.4
Form 5		41.2
Form4		23.5

Table 1 is a table showing demographics of the study population. Additionally, all participants were students at secondary level of education with the majority being of African decent. All participants were considered healthy by self report and did not report any medical conditions that would affect fluid consumption or hydration status. Mean height, BMI and Total Body Fat of the population were found to

be 173.75 ± 7.45 c.m., 22.2 ± 2.2 Kg/m^2 and 15.17 ± 5.68 % respectively. Average length of time spent being involved in the sport of football was found to be 7.05 ± 3.37 years while average number of times spent training per week was 3.53 ± 0. 94. Also mean duration of exercise was calculated to be 108.1±13.78 minutes per training session. Average exercise intensity of the population, as indicated by the Borg rating of perceived intensity, was 13.67±1.53 and interpreted as "somewhat hard" exercise (Refer to *Figure 2*). Three hours before exercise, 70.6% of participants reported to have not consumed anything while 17.6 consumed juice or a juice drink and 11.8% consumed water. Twenty minutes before exercise, 70.6% reported having drunk nothing while 23.5% drank water and 5.9% drank juice or a juice drink. All participants either drank water or nothing during training. Overall percentage weigh-loss and urine colour of the population was revealed to be 1.7±0.83% and 6±0.79 respectively, which can be interpreted as minimal and significant dehydration accordingly (Refer to *Figure 3*).

Table 2: *Average percent adherence to fluid recommendations 3 hours before, 20 minutes before and during exercise*

	Average Percent adherence 20 min before training		**Average percent Adherence 3 hours Before training**		**Average percent Adherence during exercise**	
	Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
>100%	4	23.5	1	5.9	2	11.8
80-100%	2	11.8	0	0	1	5.9
60-79%	1	5.9	2	11.8	3	17.6
40-59%	1	5.9	3	17.6	9	52.9
20-39%	2	11.8	6	35.3	2	11.8
0-19%	7	41.2	5	29.4	0	0
Total	17	100.0				

*Recommendations: 500mL 3hrs before activity, 300mL 20mins before activity, 120mL every 15 minutes during exercise ([exercise duration (min)/15]*120).
** % adherence= [actual consumption/recommended consumption]*100

Average fluid intake among the participants 3 hours before exercise, 20minutes before exercise and during exercise were found to be 213.56 ± 254.27 mL, 397.16 ± 343.97 mL and 560 ± 603.99 mL respectively. *Table 2* shows average percentage weight losses of study participants within intervals of 20 percentage units. With regards to percentage adherence to recommendations 20 minute before training, the majority of the population (41%) were found to fall within the range of 0-19% adherence, while the second greatest majority (23.5%) were found to exceed intake of the recommended amount (*Table 2*). For percentage adherence to recommendations 3 hours before exercise, most participants (64.7%) were found to adhere to recommendations to the degree of 0-39% (*Table 2*). No participants fell within the 80-100% adherence range and only 1 participant's consumption exceeded the amount recommended (*Table 2*). Adherence to recommendations during training mostly fell within the 40-79% range (70.5%) (*Table 2*). The least number of participants was found to fall within the adherence range of 80 to 100% while a few participants (11.8%) were found to exceed recommendations (*Table 3*).

Overall, adherence levels over the three parameters did not exceed 59% for at least 60% of the population. Approximately one fifth of the population was able to adhere to fluid requirements during exercise. However, the majority did not achieve recommendation adherence over 60% during exercise.

Table 3: *Frequency and Percentage of population within parameters for assessing hydration status; urine colour, percentage weight loss and thirst before and during exercise*

Parameter		Frequency	Percent (%)	Parameter		Frequency	Percent (%)
Average Urine Colour	minimal dehydration	1	5.9	Thirst Before exercise	Yes	6	35.3
					No	11	64.7
	significant dehydration	8	47.1	Thirst During exercise	Yes	10	58.8
					No	7	41.2
	Serious dehydration	8	47.1				
Average percent weight loss	Well hydrated	2	11.8				
	Minimal dehydration	14	82.4				
	significant dehydration	1	5.9				

*%Wgt loss = [(pre-exercise body weight – postexercise body weight)/pre-exercise body weight] x 100.

Table 3 shows the percentage weight loss and urine colour within the population as categorized to reflect hydration status. Within the study population, with regards to percentage weight loss, the majority of the population fell into the "minimally dehydrated" category. A total of 88.3% of the study population showed some degree of dehydration (*Table 3*). *Table 3* also shows urine colour categorized to reflect hydration status. Results showed that 94.2% of the study population experienced dehydration, falling in to the significant and serious dehydration categories, half of whom experienced severe dehydration, according to urine colour (*Table 3*). In addition most of the population did not report thirst before exercise

(64.7%), but during exercise, the majority of the population (58.8%) reported that they were thirsty (*Table 3*).

Table 4: *Dehydration Score frequency and percentage within the population*

Dehydration score	Frequency	Percent
12.00	2	11.8
13.00	1	5.9
14.00	3	17.6
15.00	1	5.9
16.00	1	5.9
17.00	3	17.6
18.00	2	11.8
19.00	1	5.9
20.00	3	17.6
Total	17	100.0

Cronbach's Alpha test revealed a relationship between urine colour on days one through 3, thirst before training for days one through 3 and mode thirst during training. Overall alpha was calculated to be 0.811 showing a strong internal consistency among the parameters. The corrected item correlation for each item was above 0.30 indicating a strong correlation between parameters. These parameters were used to formulate an index of dehydration with the maximum score of 20 and a minimum of 7; urine colour parameters carried a maximum score within parameter of 4 and a minimum of 1while all others had a maximum of 2 and a minimum of 1.

Total scores among the population were varied. Within the population, scores ranged from 9 to 20. Participants with scores closest to the maximum score of 20 would have a higher risk of becoming dehydrated while those with a score closer to 7 have a lower risk. *Table 4* shows scores achieved by the population and the percentage and number of participants with each score. The lowest calculated score was 12 and the highest 20. Most participants (9) scored 17 and above while 3 scored the lowest score of 12.

Table 5 shows calculated sweat rates for each participant and includes the average overall sweat rate of the population. Average overall average seat rate was found to be 1.59 ± 0.87 L/h.

Table 5: *Individual sweat rates of participants and total average sweat rate*

Participant ID	Average Sweat Rate (L/h) (x±SD)		Participant ID	Average Sweat Rate (L/h)
1	1.53± 0.52		11	1.71±0.12
2	1.41±0.19		12	1.42±0.32
3	1.35±0.58		13	2.97±3.9
4	1.49±0.65		14	2.2±0.69
5	1.61±0.27		15	1.73±0.72
6	1.47±0.61		17	1.49±0.18
7	1.5±0.47		18	1.21±0.13
8	1.31±0.36		20	1.53±0.83
10	1.15±0.38			
			Overall Average	1.59±0.87

*sweat rate= pre-exercise body weight (kg)– post-exercise body weight (kg)+ fluid intake(L) - urine volume/exercise time (hours).

Discussion

The greatest limitation of this study was the small sample size. The entire population of 15 to 18 year olds of the W-Connection football club were unable to be tested because of conflicting practice and sample test days; therefore a convenience sample was used. Due to the small size statistical analysis on relevant data could not be performed. Within the conduct of the study, the most limiting factor was the participants' self report of fluid consumption. As with all self reported recall procedures there is room for error in recall usually due to lack of knowledge of exact quantities consumed and the inability to remember how much was consumed. Furthermore, the contribution of food to fluid ingestion was not accounted for.

When using at least one dehydration assessment indices, the overall study population was found to have at least minimal dehydration and it was revealed that the majority did not adhere to fluid requirements before and during exercise. Overall percentage weight loss and overall average urine colour of the population indicated mild dehydration and significant dehydration respectively.

The majority of participants did not achieve recommendation adherence over 60% 3 before or during training. These results are similar to some studies in the body of research found, such as that by Iuliano et al. (1998) that revealed cyclists were unable to meet fluid needs. The lack of adherence to fluid recommendations during exercise can be suggested to be due to the nature of the sport. Football only has one break in exercise activity which can facilitate drinking. During training, this one break norm was established. When compared to other sports like marathon running which allows for more frequent fluid consumption during training, it is expected that footballers, who only have a small window to consume fluids will consume fluid in less than adequate amounts (Davies 2000). Additionally, water was the only beverage drunk during training. Water is not the most effective hydrating fluid, when compared to beverages containing electrolytes or sodium (Bonci 2009).

No comparative literature was found on adherence to requirements before training; either 3 hours or 20 minutes before training. Within the study it was found that 82.3% of the population were unable to adhere to recommendations 3 hours before training while 58.9% were unable to meet fluid requirements 20 minutes before exercise. Reasons for this limited adherence can only be speculated. Considering factors that influence fluid consumption, the environmental conditions before training may have been such that did not encourage hydration, for example a cool room with little wind. Beverage availability and personal preference may also have influenced the consumption of fluids before practice (Kleiner 1999, Casa, et al. 2000).

According to percentage overall average weight loss, most of the population, 82.4% ,was minimally dehydrated but when urine colour indices were investigated, 94.2% of the population was found to have significant dehydration. These two indices are usually used together to interpret hydration status by corresponding ranges from both indices to arrive at one hydration status conclusion (Casa, et al. 2000) (See Figure 3 of Appendix). It is evident that the ranges do not correspond to give one such final hydration status conclusion. This can possibly be a result of the poor hydration before the first weighing. If participants were dehydrated before the first weighing, sweat losses may have occurred pre-weighing resulting in a less accurate percent weight loss at the end of the training session. Indication of dehydration before exercise was measured using indication of thirst. However, only 35.3% of the population reported thirst before exercise. Thirst is not the most accurate measure of hydration status since it only is apparent when the body is already in a dehydrated state which can range from 0.8% to 2.0% weight losses (Kleiner 1999). Thirst sensitivity has also been reported to decrease with age (Kenny and Chiu 2001) and individuals have been reported to become used to minimal states of dehydration (Davies 2000). Additionally, most of the population did not adhere to fluid recommendations 3 hours before and 20 minutes before exercise, further indicating that there was a degree of dehydration before the first weighing in the study.

A dehydration score was successfully created using parameters from the questionnaire. Only the parameters of urine colour of days 1 to 3, thirst before exercise of days one to 3 and mode thirst during exercise were useable. All other indices that could have contributed to dehydration indices such as consumption of fluid 20 minutes before exercise, consumption of fluid 3 hours before exercise and percentage weight loss had corrected item correlation for below 0.30 indicating a weak correlation between parameters when Chronbach Alpha test was used.In order to achieve significant corrected item correlation for these parameters, data should be collected for a longer period of time. Most participants within the study either achieved the maximum dehydration score, or a number within four units away, indicating high degrees of dehydration.

Overall sweat rate averaged 1.59L/h±0.87. This sweat rate is above the normal reported sweat rate of 0.8-1.4 L/hr (Kreider, et al. 2009). Increases in overall sweat rate can either be due to environmentl factors such as increased humidity and temperatures, or can be as a result of varing exercise intensity among the days of training. Individual sweat rate calculations can be used to calculate fluid needs for post exercise hydration (Davies 2000). Fluid recommendations after exercise are highly individualised and should be guided by sweat rate calculations.

Conclusion/Recommendations

The adolescent males between ages 15 to 18 of the W-Connection football club were found to be dehydrated following training practice. According to percentage weight loss the subjects were at least minimally dehydrated but according to urine colour indices, the team experienced serious to severe dehydration. The dehydration was due to the lack of adherence to fluid recommendations and possibly due to other contributing environmental factors. Future studies should investigate the effects of environmental conditions on the athletes. An index of dehydration was successfully created using the parameters of thirst before training, urine colour and mode thirst during training. Participant's results from this index showed that most participants were close to the maximum score of 20 indicating an increased degree of dehydration. Participants were also found to have been dehydrated before training, since most reported thirst and they are speculated to have had sweat losses before beginning the study.

It is recommended that the participants of the study engage in routine hydration practices before exercise so that exercise is started in a well hydrated state. This would minimise the degree of dehydration experienced at the end of exercise. It is recommended that, due to the nature of the sport of football, water breaks should be habitually taken at least every 45 minutes during training to establish a regime for official game days. Water was the only beverage drunk during training but is not the most rehydrating fluid (Bonci 2009). Since only one break is recommended to be scheduled during training practice, the beverage should contain electrolytes such as sodium and potassium to maximise rate of hydration (Bonci 2009). Additionally, following exercise, individual athletes should rehydrate according to calculated sweat rate guidelines, in order to replenish fluid that was lost. Individual sweat losses should be replaced through drink consumption in excess of sweat lost. It is suggested that individuals consume 1.5 times the amount of fluid of that lost through sweat (Davies 2000).

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Appendices

University of the West Indies, St Augustine Campus
Faculty of Science and Agriculture
Department of Agriculture, Economics and Extension
Human Nutrition and Dietetics

Fluid Consumption Questionnaire Day 1

The purpose of this questionnaire is to determine the fluid intake of team members of a competitive sporting team before training sessions. The questionnaire consists of eighteen questions. Please answer all questions where applicable.

1. Name: ___________________________________

2. Age: ______

3. Gender: □ male □ female

4. Ethnicity: □ Indian □ African □ Chinese □ Caucasian □ Mixed

5. Education: □ Primary □ Secondary □ Tertiary

6. Form/ Standard/ Year of study: _________________

7. Occupation: ______________________________

8. Type of Sport: ______________________________

9. Length of time involved in sport: _______________

10. How often do you train per week: 2/wk □ 3/w □ 4/wk □ 5/wk □ 6/wk □

11. Do you perceive yourself as healthy?
    □ yes □ no

12. Do you have any notable medical conditions?
    □ yes □ no

    If yes please state: ___________________________

13. Are/were you thirsty before training?
    □ yes □ no

14. Did you consume any fluid within the 3 hours before training?
    □ yes □ no
    (If no go to Question 16)

15. What type of beverage(s) did you consume within the 3 hours before training?
    □ tea □ coffee □ juice/juice drink

    □ water □ milk □ sports dink (Eg: Gatorade)

    □ energy drink (Eg: Redbull, Monster) □ carbonated beverage (Eg Coca Cola)

    □ Other ____________________

16. How much of each drink did you consume within the 3 hours before training? (Please consult researcher and specify amount E.g.: cups, ounces, millilitres)

    ____

17. Did you consume any fluid within the 20 minutes before training?
    □ yes □ no
    (If no End)

18. What type of beverage(s) did you consume within the 20 minutes before training?
    □ tea □ coffee □ juice/juice drink

    □ water □ milk □ sports dink (Eg: Gatorade)

    □ energy drink (Eg: Redbull) □ carbonated beverage (Eg Coca Cola)

    □ Other________________

19. How much of each drink did you consume within the 20 minutes before training? (Please consult researcher and specify, E.g.: cups, ounces, millilitres)

    ____

Thank you

Post- Training

1. Were you thirsty during training?
   □ yes □ no

2. How much did you drink during training? (Eg: cups, millilitres, ounces)
   ____

3. How long was your training session?
   ____________hour/s

4. How long was your break?
   ____________ minute/s

5. What type of beverage did you drink ?
   □ water □ milk □ sports dink (Eg: Gatorade)

   □ energy drink (Eg: Redbull) □ carbonated beverage (Eg Coca Cola)

   □ Other________________

6. How intense was your activity? (please circle a number in the table below)

6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
No exertion			Very light (walking slowly)		light		Somewhat hard (but ok to continue)		hard		Very hard		Extremely hard (most strenuous ever)	Max exertion

Thank you

For Researcher Use Only

Height	
Weight before	
Weight after	
Body Fat	

BMI	
Urine colour	

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Fluid Consumption Questionnaire Day 2/3

The purpose of this questionnaire is to determine the fluid intake of team members of a competitive sporting team before training sessions. The questionnaire consists of fifteen questions. Please answer all questions where applicable.

1. Name: ______________________________________

2. Are/were you thirsty before training?
   □ yes □ no

3. Did you consume any fluid within the 3 hours before training?
   □ yes □ no
   (If no go to Question 7)

4. What type of beverage(s) did you consume within the 3 hours before training?
   □ tea □ coffee □ juice/juice drink

   □ water □ milk □ sports dink (Eg: Gatorade)

   □ energy drink (Eg: Redbull, Monster) □ carbonated beverage (Eg Coca Cola)

   □ Other ____________________

5. How much of each drink did you consume within the 3 hours before training? (Please consult researcher and specify amount E.g.: cups, ounces, millilitres)

   ____

6. Did you consume any fluid within the 20 minutes before training?
   □ yes □ no
   (If no go to question 9)

7. What type of beverage(s) did you consume within the 20 minutes before training?
   □ tea □ coffee □ juice/juice drink

   □ water □ milk □ sports dink (Eg: Gatorade)

   □ energy drink (Eg: Redbull) □ carbonated beverage (Eg Coca Cola)

   □ Other________________

8. How much of each drink did you consume within the 20mins before training? (Please consult researcher and specify, E.g.: cups, ounces, millilitres)

   ____

Post Training

1. Were you thirsty during training?
   □ yes □ no

2. How much did you drink during training? (Eg: cups, millilitres, ounces)
   ____

3. How long was your training session?
   ____________hour/s

4. How long was your break?
   ____________ minute/s

5. What type of beverage did you drink ?
   □ water □ milk □ sports dink (Eg: Gatorade)

   □ energy drink (Eg: Redbull) □ carbonated beverage (Eg Coca Cola)

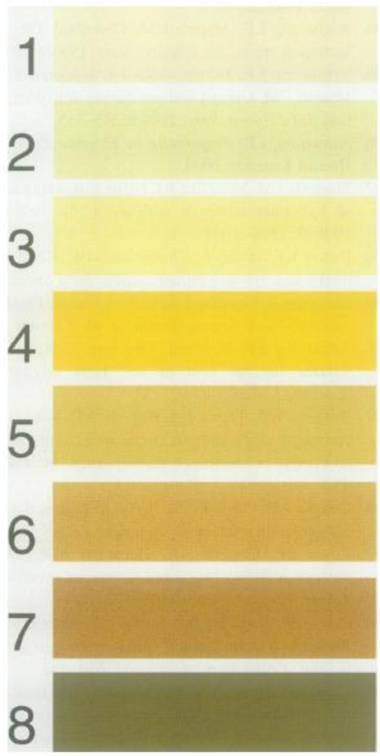
   □ Other________________

6. How intense was your activity? (please circle a number in the table below)

6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
No exertion			Very light (walking slowly)		light		Somewhat hard (but ok to continue)		hard		Very hard		Extremely hard (most strenuous ever)	Max exertion

For Researcher Use Only

Weight before	
Weight after	
Urine colour	



The Urine Color Chart shown here will assess your hydration status (level of dehydration) in extreme environments. To use this chart, match the color of your urine sample to a color on the chart. If the urine sample matches #1, #2, or #3 on the chart, you are well hydrated. If your urine color is #7 or darker, you are dehydrated and should consume fluids.

Figure 1: *Urine Colour Chart*

*****The scientific validation of this colour chart may be found in the International Journal of Sport Nutrition, Volume 4, 1994, pages 265-279 94 and Volume 8, 1998, pages 345-355.

Borg's RPE scale

6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Figure 2: *Borg's 15 grade scale for rating (R) of perceived (P) exertion (E)*

***** The scientific validation of this scale can be found in the Scandinavian Journal of Rehabilitation Medicine, Volume 2, Issue 2, 1970, pages 92-98.

Condition	% Body Weight Change*	Urine Color
Well hydrated	1 to 1	1 or 2
Minimal dehydration	1 to 3	3 or 4
Significant dehydration	3 to 5	5 or 6
Serious dehydration	>5	>6

*% Body weight change = [(pre-exercise body weight − postexercise body weight)/pre-exercise body weight] × 100.

Figure 3: *Indices of Hydration Status*

***** The scientific validation of this figure of hydration indices can be found in the Journal of Athletic Training, Volume 32, Issue 2, 2000, pages 212-214.