



THE UNIVERSITY OF THE WEST INDIES
AT ST. AUGUSTINE, TRINIDAD AND TOBAGO

A Research Paper
Submitted in partial requirements
for HUEC 3012
of
The University of the West Indies

Title: An investigation of the Effect of Exercise on Hydration Status in the UWI
Students Athletes: Urine Colour and Percentage Weight Loss

Student Name: Sinead Salandy

Project Supervisor: Dr. Marquitta Webb

Year Submitted:

Department of Agricultural Economics & Extension
Faculty of Food and Agricultural

An Investigation of the Effect of Exercise on Hydration Status in the UWI Student Athletes:
Urine Colour and Percentage Weight Loss

A Research Paper

Submitted in Partial Requirements for HUEC 3012

Of

The University of the West Indies

Sinead Salandy

I.D. #: 810100164

PROGRAM: Human Nutrition and Dietetics

SUPERVISOR: Dr. Marquitta Webb

ACKNOWLEDGEMENTS

I would like to thank my Lord and Saviour Jesus Christ for His continued mercies and guidance throughout my university career. To my parents and my sister, you all are my support system and I thank you. To my supervisor, Dr. Marquitta Webb for your patience and guidance, I thank you. To my peers, I thank you all for your encouragement, assistance and friendliness during our academic stay at the university. Finally, I thank all the participants from the various sporting disciplines, the UWI SPEC administrators and the coaches of the sporting teams.

Table of Contents

CHAPTER I.....	6
INTRODUCTION	6
1.1 Statement of the Problem:	6
1.2 Purpose:.....	8
1.3 Objectives:	8
1.4 Hypotheses:.....	8
1.5 Significance of the Study:	9
 CHAPTER II.....	 11
LITERATURE REVIEW	11
2.1 Introduction.....	11
2.2 Hydration status and physical performance	12
2.3 Status and athletic performance	15
 CHAPTER III	 18
METHODOLOGY	18
3.1 Research Design:	18
3.2 Subjects:.....	18
3.3 Instruments:.....	19
3.4 Procedures:.....	19
3.5 Analysis of Data:.....	20
 CHAPTER IV	 21
RESULTS	21
 CHAPTER V	 33
DISCUSSION	33
5.1 Introduction.....	33

CHAPTER VI.....	37
CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS.....	37
6.1 Conclusion	37
6.2 Limitations	37
6.3 Recommendations:.....	38
REFERENCES	40
APPENDIX.....	42

Table of Tables

Table 1.....	22
Table 2.....	23
Table 3.....	26
Table 4.....	31

Table of Figures

Figure 1.....	24
Figure 2.....	24
Figure 3.....	28
Figure 4.....	29
Figure 5.....	32

ABSTRACT

Background: Physical performance is diminished by impaired physiological responses due to dehydration as an effect of exercise. Weight losses of $\geq 2\%$ of body mass after exercise presents itself a risk factor for dehydration. Athletes should supplement fluid intake to compensate for sweat losses during physical activity. The effects of exercise on hydration status in athletes in Trinidad and Tobago have not been studied. There exist general guidelines for fluid intake for athletes in international associations that should be highlighted and promoted in Trinidad and Tobago.

Purpose: To investigate the effect of exercise on hydration status of student athletes from the UWI St. Augustine campus using urine colour change and weight loss.

Methodology: A survey design with the use of a questionnaire and urine colour scale was used. The athletes were all registered with the UWI, both as students and as athletes on the competing teams. Athletes from $n=8$ sporting disciplines were studied. The data was taken in the setting in which the athletes practiced, it included outdoor and indoor sporting grounds. The data was collected at the time of the athletes' practice sessions.

Results: Hydration status after physical activity was significantly altered ($p < 0.001$), so to were athletes weight after physical activity ($p < 0.001$). 17.3% of the sample population had weight losses that exceeded 2%.

Conclusion: Exercise increases dehydration and causes weight loss due to fluid losses in the UWI student athletes.

CHAPTER I

INTRODUCTION

1.1 Statement of the Problem:

Despite the danger of dehydration during physical performance, many athletes do not hydrate before, during and after exercise or a sporting event. As a consequence, death may occur. The Heights online periodical, in an updated article 2013, reported that a competing Boston university athlete died while competing in a regatta, the athlete collapsed and died due to dehydration (heat stress included in the autopsy). In 2001, an American football player shared the same fate, a twenty-three year old pitcher, with complications from heat stress and possible drug nutrient interaction with intake of herbal supplements, died as well (Hoag, 2003). General statistics on athletes that die annually of heat stroke was reported in an article by The Record in 2010. The article stated that in 2005 forty football players died of heat stroke and eighteen during the period 2005 to 2009 (Roberts, 2010). According to a review on hydration status and exercise conducted by Murray 2007, the changes that occur physiologically as an athlete is dehydrated, affect changes in the central nervous system, metabolic pathways, cardiovascular system and the thermoregulatory system, and as dehydration worsens, these systems are more negatively impacted. The dehydration caused by exercise results in fatigue, increased body temperature, and possible increased reliance on carbohydrates as a fuel source (Barr, 1999). In addition, Braithwaite illustrated the problems associated with hydration status for athletes. These problems were listed as; thirst, impaired performance, headache, heat cramps, chills, nausea, clammy skin, rapid pulse, gastrointestinal problems, heat exhaustion, dizziness, dry mouth, heat stroke, no sweat or urine output, unsteady walk and swollen tongue (Braithwaite). These problems increase

with severity respective to the aforementioned list as the percentage dehydration increased (Braithwaite).

Bodily fluid loss that amounts to about 2% loss of body weight carries the consequences of impaired physiological and performance responses (Kleiner, 1999). It is important to note that these consequences are exacerbated by hot temperatures (Barr, 1999). Murray 2007 pointed out specific conditions; 31°C; 88°F and 29.3°C; 85°F, in a study that manipulated temperature conditions for stints in cycling and work tasks. The results concluded that as temperature conditions increased the time for task completion also increased (Murray, 2007). Trinidad and Tobago is an island that does have a dry season and rainy season and the average temperatures is 27°C (88 F) and humidity is usually around 75% (Lonely Planet 2013). With these typical daily conditions that match the upper limit of the temperature condition for the study mentioned by Murray 2007, athletes are at risk for diminished sport performance. With increased temperatures athletes increase heat storage due to reduction in sweat rate and reduced skin blood flow, and their ability to tolerate heat strain is compromised (Sawka & Montain, 2000). With water as the main medium for plasma in blood and thus a determinant of blood volume, cardiovascular functions of the athletes in dehydrated states causes concern (Sawka & Montain, 2000) as cardio function is markedly compromised under this condition (Gonzalez-Alonzo, Mora- Rodriguez, Below, & Coyle, 1997).

The effect of exercise on hydration status of tertiary level athletes in Trinidad and Tobago has not been investigated. In the absence of evidential knowledge, local college athletes are susceptible to the risk factors and potential negative outcomes of dehydration. In research, it is important to look at both hydration status and the actual fluid intake patterns of the athletes. For example the study done by Volpe et. al. 2009 which looked at the fluid intake of collegiate

athletes and the specific gravity readings to properly assess hydration status took both the variables of hydration status and fluid intake into consideration. No research has been done in Trinidad and Tobago where these two variables have been paired. For athletes to perform at optimal bodily function and reduce the negative effects of dehydration on the body, it is necessary to ensure that they are properly hydrated before, during and after their respective exercise sessions, especially in the island of Trinidad and Tobago.

1.2 Purpose:

The purpose of this study was to investigate the effect of exercise on hydration status of student athletes from the University of the West Indies (the UWI) St. Augustine campus using urine colour change and weight loss.

1.3 Objectives:

The objectives of this study were:

1. To report pre and post-practice hydration status of the UWI student athletes.
2. To examine the percentage loss of body weight of each athlete after their practice session.
3. To investigate the fluid intake of selected beverages by the athletes using an estimation of fluid intake on practice days.
4. To determine the fluid replacement habits of the UWI student athletes.

1.4 Hypotheses:

It was hypothesized that:

1. H_0 : There will be no significant difference between hydration status before and after the practice session.

H_1 : The hydration status of the UWI athletes will be altered after the practice session.

2. H_0 : There exists no significant portion of the population with a weight loss of $\geq 2\%$ after their practice session.

H_1 : There will be a significant portion of the population with a weight loss of $\geq 2\%$ after their practice session.

1.5 Significance of the Study:

Exercise can induce dehydration in athletes (Barr, 1999). Athletes need an adequate supply of fluid and fluid replacement before, during and after their exercise routines to prevent dehydration and also to maintain a proper hydration status (Nichols, Jonnalagadda, & Rosenbloom, 2005). The effect of exercise on the UWI athletes has only been assumed in the past, and hydration status based on urine colour change and weight loss from physical activity have never been assessed in this population. It is unknown whether the UWI athletes consume the adequate amount of hydrating fluids that correspond with their individual weight, sporting activity and duration of activity needs. Regular assessment of this athletic population is not conducted and is only done so in preparation for inter-regional or international games, which occur approximately one or maybe two times annually. These assessments exclude nutritional screening, which should include hydration status and regular fluid intake.

No research has been conducted in Trinidad and Tobago on the topic of hydration status of athletes, especially when hydration status is related to significant weight loss that has negative effects on the body ((Volpe, Poule, & Bland, 2009). Hydration affects athletic performance;

euhydration and well-hydrated statuses provide an optimal physiological environment for proper bodily function that supports necessary movement in sporting activities (Murray, 2007). On the other hand, dehydration creates a stress on the body that would hinder optimal physiological function (Barr, 1999). It is therefore necessary to know the effect strain on the athletes' physiological status based on their percentage weight loss due to exercise. This helps ensure that athletes, especially those that are competing, are being well hydrated, gaining knowledge about their individual hydration status, and consuming fluids that promote hydration on days of practice and competition. And also that the athletes are aware or knowledgeable about the negative and positive effects of hydration status.

This study seeks to add to the research of hydration status of athletes and initiate further study into hydration status of athletes across Trinidad and Tobago. It also seeks to raise consciousness among the UWI athletes about their fluid intake practices on days of scheduled sporting practice sessions and their individual hydration status and how this affects their physiological function and ultimately their performance in their respective sporting disciplines.

A generalized local recommended amount for fluid intake before, during and after exercise for these athletes is not available and has not been generated. A governing board for college athletics with recommendations for proper hydration does not exist in Trinidad and Tobago, unlike countries for example the Unites States of America that provide recommendation for collegiate athletes through the National Athletics Trainers' Association (NATA) and the American College of sports Medicine (ACSM) (Nichols, Jonnalagadda, & Rosenbloom, 2005). Thus, the need for standard recommendations for proper hydration practices, to prevent risk factors for dehydration in athletes, exists in Trinidad and Tobago.

CHAPTER II
LITERATURE REVIEW

2.1 Introduction

Hydration status is the broad term used to describe the hydration state of a body (Armstrong, Assessing Hydration Status: The Elusive Gold Standard, 2007). Its explanation includes the definition of dehydration, euhydration and hyperhydration (Institute). Dehydration can be both acute and chronic; it is acute when it is induced by exercise or it can be chronic when sufficient fluid supplementation has not been met (Barr, 1999; Kleiner, 1999). Dr. Kleiner in her review on water: an essential but overlooked nutrient, defines dehydration as a 1% or greater loss of body weight as a result of fluid loss for both acute and chronic dehydration. Symptoms of dehydration range from fatigue, altered metabolic rates, heat-related disorders that range from heat cramps to heat strokes (Kleiner 1999). Death is the severest possible outcome of dehydration.

Euhydration is most simply defined as normal body water content; it is a state of being in water balance (Sheriffs 2003) and is not a static point but is represented by a sinusoidal wave that oscillates around an average (Armstrong, 2007). Hyperhydration can be defined as being both in a positive water balance (Shirreffs, 2003) and temporary increase in total body water above the usual basal level before excretion by the kidneys (Armstrong, 2007).

There are different methods to measure or assess hydration status. These methods include the following; urine indicators: volume and colour and specific gravity/ osmolality, thirst, plasma osmolality, plasma sodium concentration, blood urea nitrogen, saliva specific gravity and

bioelectrical impedance spectroscopy (Institute). The European Hydration Institute also report in their key tips on hydration, that acute changes in hydration status over a short period of time (a few hours) can be assessed by body weight differences. In an attempt to justify the reliability of bioelectrical impedance assessment (BIA) for the purpose of determining hydration status, Shanholtzer and Patterson, were successful in giving credence to this method. The study concluded that BIA was reliable across time within participants who were chronically hyperhydrated or dehydrated (Shanholtzer & Patterson, 2003). Therefore other methods are employed for less severe changes or status in hydration (Armstrong, Assessing Hydration Status: The Elusive Gold Standard, 2007). One (1) ml of water has a mass of one (1) g and thus this assumption is possible when using body weight differences as an assessment tool (Shirreffs, 2003). The gold standard for measuring hydration status has been researched and continues to be researched with little conclusive findings as the methods vary and are suitable for different situations (Armstrong, 2007). However, urine specific gravity is the most common method used to determine hydration status in the viewed literature. It is cost effective and practical, and is carried out using different tools with the underlying principle of measuring the different particles and electrolytes that are present in urine (Niemann, 2012). Urine color has been reported as the most practical field test when compared to urine specific gravity, osmolality (plasma and urine), sodium and hematocrit (Kleiner, 1999). Although it is a subjective method, it is shown to be interchangeable with these methods when a standardized urine color scale is used, because of its subjectivity urine color is not suitable for the laboratory setting, (Kleiner, 1999).

2.2 Hydration status and physical performance

Adequate nutrition is not only the intake of sufficient macronutrients and micronutrients but the intake of adequate hydrating fluids to facilitate the body's need to maintain proper

physiological functions. Fluid intake is a part of human nutrition (Kleiner, 1999). Water in the human body is necessary for most all metabolic functions in the body (Kleiner, 1999). On the regular, humans lose an average of 2.5L of fluid, with increased sweat losses in athletes during their physical activity; this figure is significantly increased (Braithwaite). The body undergoes sensible and insensible water loss, with sensible losses accounted for by perspiration and insensible losses accounted for by water losses from the lungs and skin (Kleiner, 1999). Persons in desert climates have sweat loss values at a rate of 0.3 – 1.2 L/h when performing occupational tasks, compare to persons in protective garments, values of 1-2L/h (Sawka & Montain, 2000) and include also a comparison of >1.5L/h in regular conditions for persons engaging in physical activity (Murray, 2007). One study has shown that cold climates (2°C; 36°F) cause persons to have higher cardiac output and lower core temperature and this results in a lessened negative physiological effect (Murray, 2007). Thus, as climates and conditions change, the effect of hydration status also changes for the athlete. A recent study done by Osterberg et. al. 2009 reported sweat losses in national basketball association players that surpassed the 2L mark in only 20 minutes of a game. Murray 2007 drew a parallel between sweat loss and electrolyte balance, with the main electrolyte; sodium. Though more common in long distance sporting athletes, sodium content of sweat ranges from 25 to 75 mEq/L (Bawa, 2012). As sweat rates differ, so too do the requirements for fluid intake among individuals to compensate for fluid loss during physical activity (Murray, 2007).

Where sodium goes, fluid follows and thus there is loss of weight as fluids are expelled due to physical activity (Murray, 2007). In this study weight loss of $\geq 2\%$ of body mass as a result of fluid loss due to sweat during physical activity is a marker of significance used to describe the effect of exercise on hydration status. This specific percentage figure has been highlighted in

almost all the literature done in the field of hydration status. The rationale for its significance is highlighted by Murray 2007 as his review explained that -2% or more loss of body mass is used to describe dehydration levels in the experimental setting. Weight loss can range from as low as 1% to as high as 8% in athletes to give the outcome of dehydration (Murray, 2007; Kleiner, 1999). Murray 2007, Volpe et. al. 2009 and Armstrong et. al. 1997 all drew a parallel between weight loss and negative physiological functions. It is on this premise that weight loss is used in hydration status research and experimental designs.

Murray in his 2007 review on hydration and performance outlines the benefits of hyperhydration in physical performance as delaying dehydration and reducing the rise in core temperature. This benefit minimizes the negative effect on the body's thermoregulatory system. Cardiac output, skin blood flow, visceral blood flow and skeletal blood flow are all reduced as a result of hyperthermia that is induced by dehydration (Nybo, Jensen, Nirlsen, & Gonzalez-Alonzo, 2001). The body's thermoregulatory system is dependent on water and water also helps to eliminate waste products and toxins safely, furthermore, all bodily functions are dependent on water (Kleiner, 1999). For the athlete, the role of water in the thermoregulatory system, joint lubrication and energy production (Kleiner 1999) is important. Rehydration maintains sweating and blood flow to the skin, thus reducing thermoregulatory and cardiovascular strain (Armstrong, et al., 1997). As cardiovascular strain, more oxygen is available for energy production in athletes (Barr, 1999). Montain et. al 1998 examined the effect of dehydration on skeletal muscle performance and deduced that although muscle strength was not affected by dehydration, muscle endurance was affected. This method employed healthy individuals and thus athlete health and nutrition was taken into consideration for the effect of the results. In this study also, the nutritional intake was manipulated for the participants and they were given a meal during the

recovery period, thus nutritional intake was factored into the effect on hydration status (Montain, et al., 1998).

According to a review on water done by Dr. Susan Kleiner the following amounts of fluid should be consumed daily; twelve(12) cups for the average sedentary man and nine (9) cups for the average sedentary woman. Recommendations for fluid intake for athletes are increased and are outlined by the American National Athletic Trainers' Association (NATA) and the American College of Sports Medicine (Nichols, Jonnalagadda, & Rosenbloom, 2005)The recommendations are as follows; seventeen (17) to twenty (20) fl. oz. two to three hours before competition, seven (7) to ten (10) fl. oz. twenty to thirty minutes before an event and additional fluid intake for activities during an event that lasts more than one hour (Nichols, Jonnalagadda, & Rosenbloom, 2005), this mainly includes endurance sports.

2.3 Status and athletic performance

Fluid intake is voluntary, however there is the problem of athletes reaching the upper limit of maximal gastric emptying and thus they do not consume large amounts or sufficient amounts to compensate for sweat losses (Murray, 2007). Another problem with intake stems from the type and taste of the available fluids, as suggested by Susan Kleiner. In her report on surveys done in two health centers in Rhode Island, participants chose bottled water over regular water based on the taste (Kleiner, 1999).Set guidelines for fluid intake that support athlete performance, reduce the risks of sodium related conditions (Bawa, 2012). These include hyponatremia, hyponatremia, hypovolemic hyponatremia, euvoletic hyponatremia and redistributive hyponatremia (Bawa, 2012). As listed, hyponatremia manifests in different forms based on the internal conditions of the athlete and their exposure and consumption of fluid. In

redistributive hyponatremia, water shifts from inside to outside of the cell to maintain a sodium balance and results in unchanged total body water and sodium (Bawa, 2012). Bawa 2012 further explained hypovolemic and euvoletic hyponatremic states, in that they cause water and sodium to be lost because of ingestion of hypotonic fluids and cause normal body sodium but increased total body water respectively. This defends the need for guidelines for fluid intake, so that athletes do not consume excessive or minimal fluid, and also that the types of fluid that are being ingested are in concentration that maintain proper total water balance and sodium levels. Armstrong et. al 1997 concluded from their study that large osmotic load in fluid should be avoided during prolonged exercise- heat exposure and that guidelines for fluid supplementation should minimize osmotic load.

Studies that look at the variables hydration status and fluid intake have been conducted for example in the United States, in National Basketball Association Players during competition. This study conducted by Kristin et al done in 2009 looked at n=29 players from five different teams, although urine specific gravity was used instead of a colour scale, the results showed that approximately half of the players were in a dehydrated state at the beginning of their games. This is supported as an overall of 66% (n=174) of collegiate athletes were also found to be hypohydrated before practice when specific gravity tests were conducted by Volpe et. al. The two aforementioned studies also looked at the fluid intake as another variable in the study. The relationship of these two variables has been studied. Although fluid intake during games for the basketballers was not correlated to their hydration status, the conclusion supported that fluid intake was not sufficient to compensate for the hydration state and thus because of the lack in amount of fluid intake, the dehydrated status of the athletes was maintained.

In conclusion, exercise does have an effect on hydration status based on the literature. These effects can be positive or negative based on the fluid intake practices of athletes (Volpe, Poule, & Bland, 2009). Hydration status can be assessed using different tools that correspond to different settings (Armstrong, Assessing Hydration Status: The Elusive Gold Standard, 2007) to employ the most reliable and practical methods. As research in the field of hydration status continued, the physiologically induced effects on athletic performance were studied and gave a clear depiction of negative outcomes in dehydrated states (Murray, 2007). The physiological effects are expansive (Braithwaite) but have been shown to be manipulated in the experimental setting (Armstrong, et al., 1997).

CHAPTER III

METHODOLOGY

3.1 Research Design:

Systematic sampling was the method used to select participants. The participants were selected as they came into their usual practice session. A fraction of 15% of the population of 300 competing UWI student athletes was estimated to be part of the study. Respondent participation was dependent on their volunteering to participate. The research employed a survey design with the use of both quantitative and qualitative data. The quantitative data instrument used was a questionnaire, while the qualitative data instrument used was a color scale. The data collection was done in a field setting, that is, it was conducted at or near the places where the athletes were practicing, this included; SPEC indoor court, SPEC track, Cricket field, northern football field. The data collection process was approximately three weeks long but spanned the month of March 2013.

3.2 Subjects:

All athletes from the following teams: basketball (M & W), Netball (W), Cricket (M&W), Football (M&W), Swimming (M&W), Track (M), Field Events (M&W), and Volleyball (M&W) were invited to participate in the study. Informed consent was obtained from all participants. Females who were menstruating on the day of data collection were excluded from the study. Sixty (60) students volunteered for the study, this accounted for 20% of the population. However, those individuals (n=52) (17.3%) with all the variables of interest were included in the current study.

3.3 Instruments:

Permission to use a questionnaire from a previous study on hydration status in collegiate athletes, done by (Volpe, Poule, & Bland, 2009) was obtained to assess and estimate fluid intake while a standard color scale was used to assess and estimate hydration status. The color scale used numbers in the stead of worded color description to describe the color on the scale. For general classification the numbers 1-3 were referred to as hyperhydrated hydration state, 4 was referred to as euhydrated hydration state and 5-8 was referred to a hypohydrated hydration state. Clear polystyrene cups were used to collect the urine samples, they were labeled with both numerical and alphabetical identifiers that matched the respective number of the participant's questionnaire. A stadiometer was used to measure the height of the athletes. A bioelectrical impedance scale was used to measure the athletes' weight and BMI.

3.4 Procedures:

A list of all the competing sporting activities and their practice session times was obtained from the University of the West Indies website. The respective coaches for the following sporting activities were met with and permission for the athletes' participation before and after practice was sort.

The athlete was given a coded sample cup and the urine sample before practice. The urine sample color was matched to the closest color on the color scale and the number was recorded. The cups were held up against a white wall or white tissue paper to be assessed. After the sample was collected, the athlete was guided through the questionnaire and any questions were clarified. The athlete's height, weight and BMI was measured and recorded onto their questionnaire. The athlete then engaged in his/ her usual sporting activity practice session. After practice the athlete

was given another sample cup and the urine sample was taken. The athlete's weight was taken and recorded. The urine sample color was matched to the closest color on the color scale and the number was recorded.

To estimate fluid intake of the participants, the mean of the cup values the selected by ticking was taken as the estimated intake value. The first table in the questionnaire was deemed 'hydrating fluids' while the second table was deemed 'dehydrating fluids'. Thus a sum was taken of all the averages of the hydrating fluids and the dehydrating fluids, giving each participant an estimation of their fluid intake on a regular day of practice.

3.5 Analysis of Data:

Data were analyzed using Statistical Package for the Social Sciences (SPSS, Inc., Chicago, IL, USA) version 12 for Windows. All data were compiled using descriptive statistics. The Paired Sample t-test was utilized to determine the significance in urine colour before and after practice and also to determine the significance in weight loss before and after practice. This test gave the relationship of urine color and weight loss and its effect as a result of exercise. This analytical method gave the significance values to answer the hypotheses. The significance value for all tests was given as $p < 0.05$. Tables for demographics were drawn in Microsoft Word and Figures were generated using Excel for Microsoft Word.

CHAPTER IV
RESULTS

The general objective of this study was to investigate the effect of exercise on hydration status of the UWI student athletes. The specific objectives sought to report hydration status, examine percentage loss of body weight, investigate fluid intake of the sample population and determine fluid replacement habits.

The number of participants in this current study was n=53 and this accounted for 17.3% of the population of the UWI student athletes from various sporting activities. There were 36 male participants accounting for 69.2% of the sample population, making up the majority, and 16 female participants which accounted for 30.8% of the sample population. The distribution of sporting activities and the respective number of respondents are described and shown in the pie chart. Football was the most frequent sport, with 23.1% (n= 12) of the participants measured in this activity, 15.4% (n= 8) of the participants were active in track, volleyball, swimming and basketball, 5.8% (n= 3) were accounted for in cricket and netball and the number of participants from field events was 3.8% (n= 2). No cheerleaders were surveyed (n= 0). Table 1 presents the demographics for the sample population.

Table 1: Demographic Data from the Sample Population

Variable	Category		Mean ± Standard Deviation
Gender	Male = 36 Female= 16		
Age			22.865 ± 3.206
Height			68.659 ± 4.595
Body Mass Index (BMI) kg/m ²	< 18.5	n= 4	23.235 ± 5.557
	18.5 - 24.9	n= 35	
	>25	n= 13	
Sport	Football	23.1%	
	Field Events	3.8%	

Hydration Status

The hydration statuses of the athletes are presented in Table 2 and Figures 1 and 2.

Table 2: The Mean hydration Status Before and After Practice

Hydration Status	Mean \pm Standard Deviation
Before Practice	4.12 \pm 1.489
After Practice	5.38 \pm 1.659

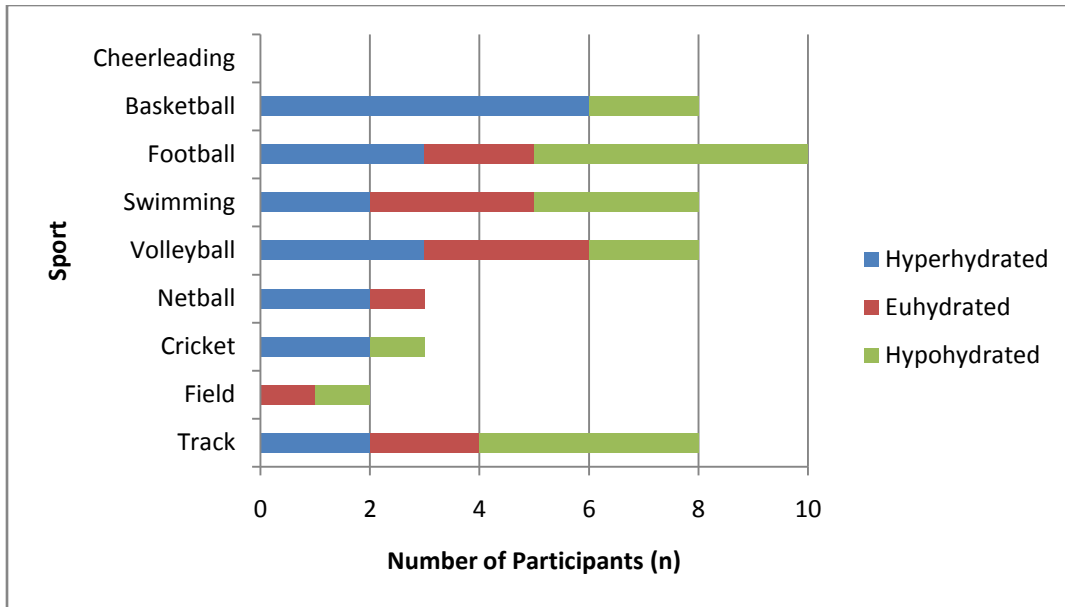


Figure 1: Hydration status of the UWI student athletes Before Practice

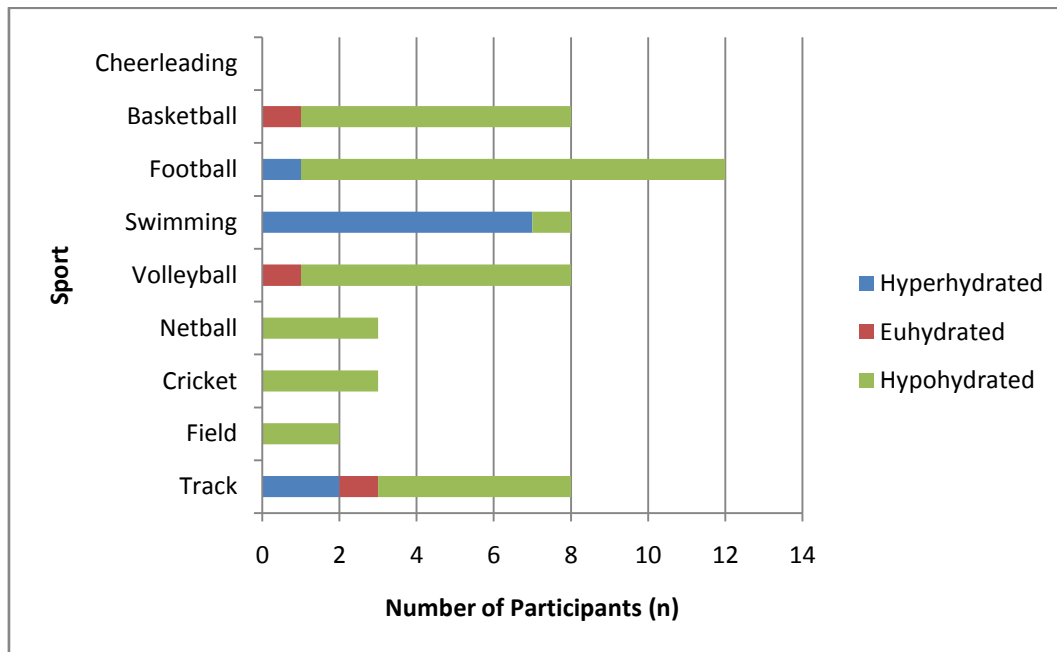


Figure 2: Hydration Status of the UWI Student athletes After Practice

Recall the first hypothesis:

H_0 : There will be no significant difference between hydration status before and after the practice session.

H_1 : The hydration status of the UWI athletes will be altered after the practice session.

Using SPSS, as mentioned in chapter III, the results from the Paired sample t-test are had a significance of 0.001 and the urine before practice mean was a lower value (4.1154 ± 1.7894) than the urine after practice mean (5.3846 ± 1.6587). This indicated that exercise increased the numerical score on the urine colour scale and this is interpreted as exercise decreasing hydration status and making the UWI student athletes more hypohydrated after practice. From the p-value (<0.001) was accept the alternative hypothesis and state that the hydration status of the UWI student athletes was altered after the practice session.

In the following table, the results from a Paired sample t-test for athlete weight before and after practice are reported. The mean for before weight was 162.0942 ± 42.1689 and for after the mean was 160.4192 ± 42.0294 . Based on this analysis it can be stated that exercise caused the participants to lose weight. The p-value of <0.001 suggested that there was significant weight loss in the sample population after the practice session.

Table 3: Showing the Results of the Paired Sample t-test: Urine Colour Before and Urine Colour After Practice and Weight Before and Weight After Practice

Variable	t- value	p- value
Pair 1:Urine Before Practice Urine After Practice	-4.116	<0.001
Pair 2: Weight Before Practice Weight After Practice	8.811	<0.001

The data revealed in this chapter, depicted a significant change in hydration status after practice from the before practice hydration state. We now focus the results on the second objective in which we look at the percentage weight loss that accompanied the change in hydration state of the athlete. The percentages weight loss of the sample population is depicted in Figure 3. For the values that are seen under the northeast plane of the graph, this indicates that the athlete had gained weight after practice and the percentage weight loss was appeared to be negative.

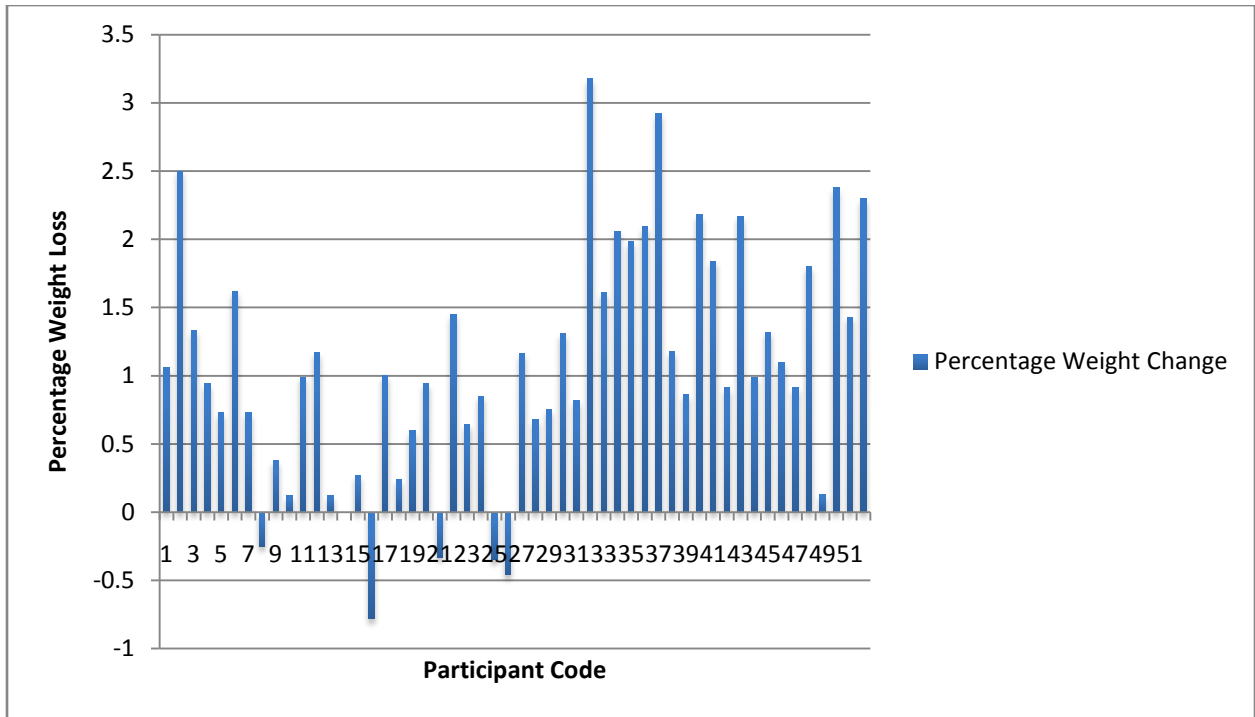


Figure 3: Percentage Weight Loss of UWI student athletes After Practice

Recall the second hypothesis:

H_0 : There exists no significant portion of the population with a weight loss of $\geq 2\%$ after their practice session.

H_1 : There will be a significant portion of the population with a weight loss of $\geq 2\%$ after their practice session.

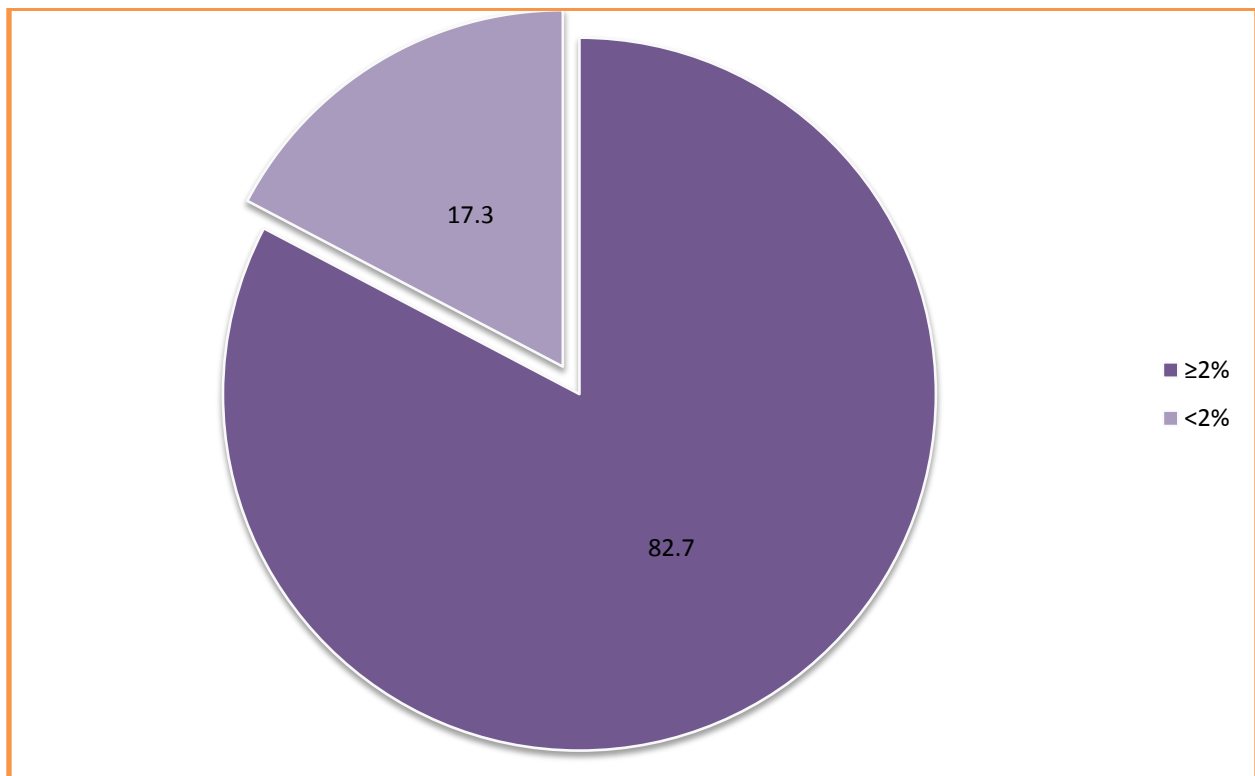


Figure 4: Percentages of Participants that lost $\geq 2\%$ and $< 2\%$ body weight as a result of exercise

From Figure 4 and the significance of weight loss after practice based on the paired sample t-test, we accept the alternate hypothesis and state, that a significant portion of the sample population had weight loss of $\geq 2\%$ after their practice session.

Fluid Intake

As mentioned in the methodology, an estimation of participant fluid intake was calculated. Table 4 gives the mean estimated fluid intake of the sample population based on the data collected from the respondents in the questionnaire.

Table 4: Means of the Estimated Fluid Intake of the Sample Population on a Regular Day of Practice

Variable	Mean \pm Standard Deviation
Total Hydrating Fluids	12.6635 \pm 2.9604
Total Dehydrating Fluids	2.4583 \pm 6.4956

Table 4 shows that the UWI student athletes consume more hydrating than dehydrating fluids.

Fluid Intake practices were listed as an objective and Figure 5 reports these practices as the UWI student athletes have responded.

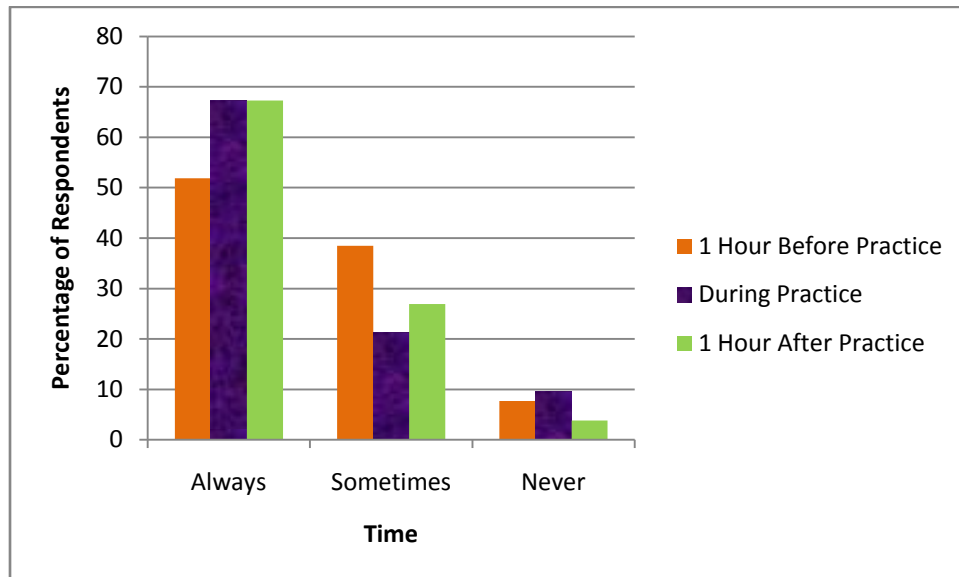


Figure 5: Frequency Percentages of Fluid Intake Practices

From Figure 5, it can be seen that most of the participants reported that they always supplemented with fluids before, during and after practice sessions.

CHAPTER V

DISCUSSION

5.1 Introduction

The purpose of this study was to investigate the effect of exercise on the hydration status of the UWI student athletes on the St. Augustine campus using urine colour and weight loss as a result of physical activity as the variable effects. The specific objectives of the study were; to report the pre and post hydration status of the athletes on a day of practice, to determine the percentage weight loss of each athlete, to estimate fluid intake of hydrating and dehydrating fluid to determine fluid replacement habits of the UWI student athletes.

The results of this study shows a significant in the before and after hydration status of the UWI athletes. The significance of this variable was $p=0.001$. The alternate hypothesis was accepted as hydration status was altered after exercise. There is also a significance in weight loss after practice, given as $p=0.001$. In the second hypothesis, the alternate was also accepted was a significant portion, 17.3%, of the population had weight loss values of $>2\%$ after exercise.

The study reported that an equal percentage 38.5% of participants were hyperhydrated and dehydrated. This could have been attributed to the value obtained from the estimated fluid intake by the athletes which was approximately twelve cups of hydrating fluids on a typical day of practice. Also, gender could be taken into consideration for this explanation as there were a larger number of male participants. Although there is the same percentage of hyper and dehydrated participants, the percentage participants for the euhydrated state lends to a positive hydration status (Murray, 2007) and thus, the athletes were mostly in a hyperhydrated state before practice. This was concluded since euhydration is a fluctuating state and there is no set

measure for a euhydrated state, there is only estimations (Shirreffs, 2003) . Recall, the average fluid intake for a sedentary persons is twelve cups (Kleiner, 1999), thus athletes are consuming below minimum required fluid intake for their activity level. It was important to note that this estimation was not true for every participant and thus, not all participants could be viewed as consuming twelve cups of hydrating fluids on practice days. Thus this also substantiates the finding of near one third of the sample population in a state of dehydration. This state of dehydration could also be attributed to the intake of dehydrating fluids, which was estimated at approximately three cups on average. Again this does not represent the entire sample population; however it does contribute to the explanation of having a significant percentage of the sample population in a dehydrated state before physical activity. A dehydrated state before physical activity can be detrimental (Heffernan, 2005) to the proper physiological functions of the athletes and may produce negative outcomes also on performance (Barr, 1999). Although knowledge about proper fluid intake was not assessed, it could be assumed that athletes are knowledgeable about proper fluid intake practices. This would account for the larger percentage of the population being in a favourable state of hydration (hyper and euhydrated). In previous research conducted with collegiate athletes; sixty six percent of the athletes were found to be dehydrated before practice (Volpe, Poule, & Bland, 2009). When compared to 38.5% in the UWI athletes, it was seen that the UWI athletes were in a better state of hydration when compared to their international counterparts. This could be attributed to the difference in Western or American diet habits compared to Caribbean dietary patterns and habits.

It is clear that the majority of the participating athletes were dehydrated after physical activity. It could be assumed that this is due to the lack of sufficient fluid supplementation during physical activity (report what the practices were). In the study by Osterberg et al. on basketball

players, they reported that although fluids supplements were made available to the athletes during a game, they did not consume sufficient fluid supplement to compensate for their hypohydrated state before a match (Osterberg, Horswill, & Baker, 2009). Also the daily fluid intake may not have been enough to supplement the athlete for the demand of the sporting activity or be enough to maintain a state of hyperhydration. A closer look at the minority, it appeared that some athletes did maintain a hyper or euhydrated state until after physical activity. This affirms the points laid out in the review done by Bob Murray, that fluid loss varies during physical activities and it is possible for some athletes to maintain a positive hydration status and reduce their risk of fatigue, cramps, heat stroke, negative physiological processes and even death.

Most of the activities lasted approximately two and a half hours. From previous research (Osterberg, Horswill, & Baker, 2009) and recommendations by the American National Athletic Trainers' Association (NATA) and the American College of Sports Medicine, physical activity lasting longer than one hour should be supplemented by fluid intake intermittently during the activity. This study is very important therefore in highlighting what can be deemed as risk factors for dehydration; which include weight loss of $\geq 1\%$ (Cite) and endurance activities lasting more than one hour.

Weight changes occur as athletes engage in physical activity (Murray, 2007). The extent of weight change could be dependent on different factors, such as, the type of physical activity, the intensity of the activity, the duration of the activity, pre-hydration status of the individual and the fluid supplementation during physical activity (Murray, 2007). Exercise induced weight loss may increase to figures $\geq 2\%$ of pre-practice weight. At weight loss percentages such as these, athletes are at risk for negative physiological functions and impaired performance (Montain, et

al., 1998). From this current study we see the significance of weight loss after physical activity and we also see a significant percentage of the population 17.3% having exercise-induced weight loss in this range. This caused concern for athletes as they were at risk for negative effects on their neurological, metabolic, cardiovascular and thermoregulatory systems (Murray, 2007).

From this study during interaction with the athletes as they completed the questionnaire, it was apparent that the athletes were not aware of how much weight they lost during their physical activity. Almost all were not knowledgeable that the weight loss was due to bodily fluid loss during their activity. Frequent assessment of athlete weight and hydration status should be conducted to improve this study. This would show a more constant pattern of weight loss and the hydration status of the individual athletes. Also a more accurate deduction of athletic risk to negative effects of dehydration could be made.

Nutritional and disease status was not assessed in this study, unlike those conducted by Montain et. al. but respondents were asked to list the additional supplements that they took for the benefit of physical performance. Mostly sports performance powders were reported, along with multivitamin supplements. Previous studies did not show any relationship between these factors and hydration status. However, with respect to nutrient intake in the form of multivitamins, this would add to the nutritional status of the athlete and have an impact on the athletes' metabolism. For future work on this study, nutritional status of the athletes using an appropriate assessment tool can be used to ensure that the athletes are at similar status or that they can be grouped into similar nutritional statuses to view the differences in hydration status induced by their physical activity. This recommendation would allow for comparison to research done, where the pre-exercise hydration status was manipulated.

CHAPTER VI

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

6.1 Conclusion

The results from previous research all show marked difference in hydration status after physical activity. Weight loss is a significant variable researched with respect to hydration status as well. Because the time of fluid intake was not factored in for the fluid supplementation practices, the study did not span to fluid intake as a variable. However, the data suggest a possible link among the three variables; urine colour, weight loss and fluid intake as markers of effect of hydration status. From this study it is clear that urine colour changed after exercise and this is indicative of hydration status alteration due to physical activity. The weight changes as an effect of exercise are significant among the UWI student athletes and thus closer attention should be paid to fluid supplementation and the individualization of fluid intake for each athlete for their respective sport.

6.2 Limitations

This study was limited to the setting of the sporting activities. Therefore the urine colour was perceived in different lighting. To reduce the difference in perception, a white sheet of paper was used below the sample cups in the best possible lighting. Some sports, for example football, were played on the outdoor field and the session finished approximately 9pm. At this time all nearby bathrooms on campus were locked and this deterred some participants. Also it deterred participants who gave pre-practice urine sample form providing post-practice urine samples. Tardiness of athletes to their respective practice session also limited the number of participants as there was little to no time for them to get the full duration of the session. The research was at

all session at least one hour prior, to invite as many participants as possible before the session. Sporting sessions held in the SPEC indoor court were also suspended for one week and delayed the data collection process. The sporting activities that did not utilize the indoor court were assessed during this week. The exclusion criteria for this study significantly reduced the number of female participants. To reduce this limitation, the same sporting activity was assessed at least twice to obtain as many participants as possible. The UWI student athletes were generally unwilling to participate in this study, due to the nature of the procedure that included a urine sample. This also had an impact of the sample population number.

6.3 Recommendations:

It is important to note that during the research of this project most of the experimental procedures mandated that the athletes pre-exercise hydration status be manipulated to achieved a desired hydration status and from this there was a clearer depiction of the outcome of exercise. Thus to improve this study, the pre-practice hydration status should be manipulated and then the effects analyzed. A simple specific gravity instrument such as a dip stick can be used to give a less subjective measure of hydration status. There should be a question in the questionnaire for athletes to choose the usual color of their urine before and after practice, this can generate a comparison to what the athlete perceives their and what is the actual color of their urine before and after a practice session. Participants should be given urine sample cups with covers to reduce the chance of spillage and increase sanitation. Athletes should be given guidance via nutrition lectures as to the importance of hydration status and they can be shown the color scale so that they may gage themselves with respect to their hydration status. The temperature of the

atmosphere in which the athletes are practicing in should be checked and recorded to assess for impact on fluid loss.

REFERENCES

- Armstrong, L. E. (2007). Assessing Hydration Status: The Elusive Gold Standard. *Journal of the American College of Nutrition*, 575S-584S.
- Armstrong, L. E., Maresh, C. M., Gabaree, C. V., Hoffman, J. R., Kavouras, S. A., Kenefick, R. W., . . . Ahlquist, L. E. (1997). Thermal and Circulatory responses during exercise: effects of hypohydration, dehydration, and water intake. *Journal of Applied Physiology*, 2028-2035.
- Barr, S. I. (1999). Effects of Dehydration on Exercise Performance. *Canadian Journal of Applied Physiology*, 164-172.
- Bawa, S. H. (2012). Vitamin and Mineral Requirements of the Physically Active. St. Augustine, Trinidad and Tobago.
- Braithwaite, K. (n.d.). Hydration Status Crucial for Athletes- Are your Athletes Drinking Enough? *Sport Medicine & Science Council of Saskatchewan*.
- Gonzalez-Alonzo, J., Mora- Rodriguez, R., Below, P. R., & Coyle, E. F. (1997). Dehydration markedly impairs cardiovascular function in hyperthermic endurance athletes during exercise. *Journal of Applied Physiology*, 1229-1236.
- Heffernan, R. (2005, July 30). *Rower died of dehydration, heat stress*. Retrieved from The Heights: The Independent Student Newspaper of Boston College: <http://www.bcheights.com/2.6176/rower-died-of-dehydration-heat-stress-1.916308>
- Hoag, H. (2003, August 10). *Drained*. Retrieved from Rowing News.com: <http://books.google.tt/books?id=QEsEAAAAMBAJ&pg=PA35&lpg=PA35&dq=athletes+dying+from+dehydration&source=bl&ots=8ITeWDODRx&sig=hpy82eCyZ4ct8kSI2DI9buIUdWU&hl=en&sa=X&ei=WTNiUbObGYSi8gTut4CYBA&ved=0CCcQ6AEwAA#v=onepage&q=athletes%20dying%20from%20dehydratio>
- Institute, E. H. (n.d.). *Key Tips on Hydration: Measuring Hydration Status*. Retrieved February 2, 2013, from http://www.europeanhydrationinstitute.org/files/EHI_Key_Tips_on_Hydration_measuring_hydration_status.pdf
- Kleiner, S. A. (1999). Water: An essential but overlooked nutrient. *Journal of the American Dietetic Association*, 200-206.
- Montain, S. J., Smith, S. A., Mattot, R. P., Zientara, G. P., Jolesz, F., & Sawka, M. N. (1998). Hypohydration effects on skeletal muscle performance and metabolism: a 31P- MRS study. *Journal of Applied Physiology*, 1889-1894.

- Murray, B. (2007). Hydration and Physical Performance. *Journal of the American College of Nutrition*, 542S-548S.
- Nichols, P. E., Jonnalagadda, S. S., & Rosenbloom, C. A. (2005). Knowledge, Attitudes, and Behaviors Regarding Hydration and Fluid Replacement of Collegiate Athletes. *International Journal of Sport Nutrition and Exercise Metabolism*, 515-527.
- Niemann, A. (2012). The Effect of Instrument Type on the Measure of Hydration Status. Terre Haute.
- Nybo, L., Jensen, T., Nirlsen, B., & Gonzalez- Alonzo, J. (2001). Effects of marked hyperthermia with and without dehydration on V̇ O₂ kinetics during intense exercise. *Journal of Applied Physiology*, 1057-1064.
- Osterberg, K. L., Horswill, C. A., & Baker, L. B. (2009). Pregame Urine Specific Gravity and Fluid Intake by National Basketball Association Players During Competition. *Journal of Athletic Training*, 53-57.
- Roberts, J. (2010, August 21). *Heatstroke dangers worsen for school athletes; deaths are rising*. Retrieved from NorthJersey.com: http://www.northjersey.com/news/101212569_HEATSTROKE_DANGERS_WORSEN_FOR_SCHOOL_ATHLETES.html
- Sawka, M. N., & Montain, S. J. (2000). Fluid and electrolyte supplementation for exercise heat stress. *The American Journal of Clinical Nutrition*, 64S-72S.
- Shanholtzer, B. A., & Patterson, S. M. (2003). *Use of bioelectrical impedance in hydration status assessment: reliability of a new tool in psychophysiology research*. Retrieved from International Journal of Psychophysiology: <http://www.sciencedirect.com/science/article/pii/S0167876003001430>
- Shirreffs, S. (2003). Markers of hydration status . *European Journal of Clinical Nutrition*, S6-S9.
- Volpe, S. L., Poule, K. A., & Bland, E. G. (2009). Estimation of Prepractice Hydration Status of National Collegiate Athletic Association Division I Athletes. *Journal of Athletic Training*, 624-629.

APPENDIX

Please complete the following questions.

1. Gender

- Male
- Female

2. Age

_____ years old

3. Height

_____ ft.

4. Weight (before physical activity)

_____ kilograms

_____ pounds

5. BMI

6. What type of sport do you participate in at the University of the West Indies? Please tick one.

- Track
- Field Events
- Cricket
- Netball
- Volleyball
- Swimming
- Football
- Basketball
- Cheerleading

7. Please ticks and indicate the average amount of fluid you consume on a **typical day of practice**.

N.B. 1 cup = 8 oz. = 240 ml

BEVERAGE	0	1-4	5-8	9-12	>12 (PLEASE INDICATE SPECIFIC AMOUNT)
Water					
Soft-drink (regular)					
Soft-drink (diet)					
Milk (Circle type: skim, 1%, 2%, whole)					
100% Fruit Juice					
Fruit drink (note: a fruit drink is not 100% fruit juice)					
Sports drink (e.g. Lucozade, Gatorade)					
Energy drink (e.g. Redbull, Monster)					
Nutrition drink (e.g. Ensure, Boost)					

BEVERAGE	0	1-4	5-8	9-12	>12 (PLEASE INDICATE SPECIFIC AMOUNT)
Coffee (regular)					
Decaffeinated coffee					
Gourmet coffee (e.g. cappuccino, espresso)					
Tea					
Beer					
Wine					
Pure Alcohol (e.g. gin, vodka, mixed drinks)					

8. Approximately how many cups of fluid **OVERALL** do you drink in one day?
 _____ cups.

9. How often do you consume fluid supplements at the following times?

TIME	Always	Sometimes	Never
1 Hour before practice			
During practice			
1 Hour after practice			

10. On average what color description best represents the color of your urine? Choose one only.

- Dark yellow (bronze)
- Medium yellow (gold)
- Yellow
- Pale Yellow
- Very pale yellow

11. On average, how many times per day do you urinate? Choose one only.

- 0-2
- 3-4
- 5-6
- 7-8
- 9-10
- 11-12
- 13 or more

12. **FEMALES ONLY:**

Do you take extra fluid supplements during menstruation?

- Yes
- No

13. Do you take a vitamin or mineral supplement? Please indicate what you supplement.

- Yes
 - No
-

14. Do you take any nutrition supplements, such as creatine or protein powders? Please indicate what you supplement.

- Yes
 - No
-

15. Please add anything about your dietary habits, fluid ingestion habits, supplement habits, training habits, etc., that may add information regarding your hydration status. Remember all data will remain confidential.

END OF QUESTIONNAIRE- THANK YOU!

Circle the number to the corresponding color examined on the urine scale.

Urine color **BEFORE** physical activity

1
2
3
4
5
6
7
8

Urine color **AFTER** physical activity

1
2
3
4
5
6
7
8

Weight after physical activity: _____ pounds
_____ kilograms