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Survey of Hydration Knowledge and Behavior in Youth Mountain Bike Teams

Natasha Brand
University of Arkansas, Fayetteville

Survey of Hydration Knowledge and Behavior in Youth Mountain Bike Teams

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Natasha Ann Brand
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____
Stavros Kavouras, PhD
Thesis Advisor

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Dean Gorman, PhD
Committee Member

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Erin Howie, PhD
Committee Member

Abstract

Many youth sports organizations recognize the importance of educating on hydration practices and awareness, although according to recent research current hydration education is not correlating to effective practices. **PURPOSE:** The purpose of this study was to assess and describe the hydration knowledge and behavior of student-athletes participating in competitive junior high and high school mountain bike teams, in order to substantiate further research. **METHODS:** A total of 133 male and female participants, ranging from 11-18 years were surveyed on their hydration knowledge and behavior. All participants were apparently healthy and were active members of a National Interscholastic Cycling Association (NICA) Mountain Bike Team. **RESULTS:** The mean score for knowledge was 9.28, *SD* 1.52. Less than 30% of participants received an adequate score (=>10.5). 65% of participants received hydration education but mean knowledge scores were still inadequate (M=9.5, SD =1.51). Significant differences ($p < 0.05$) in knowledge scores were seen between genders, year in school, receiving education, and drinking behaviors. **CONCLUSION**: Despite understanding the importance of keeping hydrated, mean knowledge scores indicated inadequate knowledge, while behavior responses indicated inconsistency in translation of knowledge.

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1. Introduction

Hydration is considered one of the most important priorities for youth athletes (Bergeron, 2015), yet there is a distinct lack of hydration studies conducted with this age group in the heat, in sport specific situations. (Arnaoutis et al., 2013; Garth & Burke, 2013; S. A. Kavouras et al., 2012; Rowland, 2011). Lack of age and sport specific studies in free-living conditions, lead to difficulties in developing and disseminating effective hydration education to parents, coaches, and athletes. While many youth sports organizations recognize the importance of educating on hydration practices and awareness - according to current research - hydration education is not correlating to effective practices (Decher et al., 2008; Stavros A. Kavouras & Arnaoutis, 2012). In addition, in a recent survey of 7 – 9 year olds, by the Natural Hydration Council, data revealed that more than 40% of those surveyed do not drink water while playing sports or exercising, and 35% do not drink water when thirsty; the survey also identified significant gaps in knowledge (Natural Hydration Council, 2014).

2. Review of Literature

Many current guidelines on hydration are based upon early research, which reported that thermoregulatory responses differ between adult and youth athletes. Early studies highlighted differences in several major areas – greater heat gain (Astrand, 1952; MacDougall, Roche, Bar-Or, & Moroz, 1983), lower age related sweat rates (until early puberty) (Bar-Or, 1980; Falk, Bar-Or, & MacDougall, 1992; Falk, Bar-Or, MacDougall, Goldsmith, & McGillis, 1992; Meyer, Bar-Or, MacDougall, & Heigenhauser, 1992), differences in sex related performance (post-puberty) (Astrand, 1952), differences in core body temperature (Bar-Or, 1980), and differences in heat acclimatization (Bar-Or, 1980, 1989; O. Inbar, 1980).

Since many of the early studies were conducted in climate controlled laboratory conditions (Falk, Bar-Or, & MacDougall, 1992 a; Falk, Bar-Or, MacDougall, et al., 1992 b; O. Inbar, 1980; MacDougall et al., 1983); in male only studies (Falk, Bar-Or, & MacDougall, 1992 a; Falk, Bar-Or, MacDougall, et al., 1992 b ; O. Inbar, 1980); in non-acclimatized or artificially-acclimatized children (O. Inbar, 1980), and with little mention of fluid intake - this has led to more recent research focusing on hydration and exertion levels in different age groups, and in free-living conditions (Omri, Inbar, Morris, Epstein, & Gass, 2004; Rivera-Brown AM, Rowland TW, Ramírez-Marrero FA, Santacana G, & Vann A, 2006; Rowland, 2008, 2011; Rowland T, Garrison A, & Pober D, 2007).

Rowland (2008, 2011) and Inbar (2004) revisit their earlier research and the early research of Bar-or et.al to conclude that thermoregulatory adjustment can be achieved in children and adolescents when dehydration is prevented. In fact in a review as early as 1994 Meyer and Bar-Or concluded "when correcting for body mass, children are generally similar to adults with regard to their water losses during exercise" (p. 777). Therefore adequate hydration practices are an important factor (Bergeron, 2015) regardless of age, sex, sweat rates, or body mass. In addition appropriate acclimatization is a contributing factor since studies show that children can take up to twice as long to acclimatize to a hot environment (O. Inbar, 1980).

In 2011, due to these new findings, the American Academy of Pediatrics (AAP) updated its policy statement regarding climatic stress and exercise in children and adolescents (Bergeron, Devore, & Rice, 2011) and is currently the only professional policy statement that specifically addresses children and adolescents with regards to exercise. Certain youth sports organizations such as the U.S. Soccer Federation have youth specific guidelines (Casa, 2006), which although based upon the AAP guidelines, still refer to earlier research. The AAP in their revised policy statement state:

> These newer findings indicate that children and adults have similar rectal and skin temperatures, cardiovascular responses, and exercise-tolerance time during exercise in the heat. Accordingly, modifiable evidence-based determinants of exertional heat-illness risk in youth should be the focus of prevention measures (p. e741).

Some of these modifiable evidence-based determinants include excessive physical exertion, insufficient recovery time or closely scheduled practices or races, practices in excessive heat, poor preparation, not heat-acclimatized, and inappropriate clothing (Bergeron et al., 2011). Modifying these risk factors and increasing the frequency of breaks can help prevent heat related illness (Bergeron, 2013; Armstrong et al., 2007). In addition, recent field studies have suggested that when breaks are provided for fluid intake, *and* fluid is offered, that initial levels of hydration can be maintained (Rivera-Brown et al., 2006; Rivera-Brown AM et al., 2006).

In addition to modifying risk factors, adequate hydration before and during exercise is necessary in order to maintain performance and prevent heat illness (Bergeron, 2014; Sawka, Burke, & Eichner, E R, 2007); losses as small as 2% of body weight have been shown to have a negative impact on thermoregulation and performance. (Casa et al., 2000; Rowland, 2011) Heat –induced illness is one of the most preventable sports injuries if appropriate guidelines are followed (Casa, 2006). According to the AAP a child should be well hydrated before beginning any type of physical activity, and that periodic drinking should be enforced even if the child does not feel thirsty (Bergeron et al., 2011). This finding is supported in a review by Rowland (2011), which concludes, “coaches and parents need to take responsibility for enforcing fluid intake guidelines in young athletes” (p. 287).

It can be seen from the aforementioned studies, when working with youth athletes a combination of approaches are needed in order to avoid heat illness, and safely achieve optimum performance while exercising in the heat. Drinking according to thirst (Arnaoutis et al., 2013), regular breaks, nor hydration education alone (Decher et al., 2008; Kavouras et al., 2012) have been found to be effective measures to combat risk and reduce thermal strain. A more holistic approach is needed including more sport specific hydration education programs aimed at athletes, coaches and parents. Athletes and parents need to have the knowledge and provision for the student-athlete to begin exercise euhydtrated, while coaches need to plan for ad libitum fluid intake, schedule breaks for recovery and fluid intake, and offer fluids during breaks. Therefore it is essential to conduct more sport specific studies of youth athletes with regards to hydration status, knowledge and practices in order to educate all involved – athlete, coach, and parents, as well as impact whole-school and team practices.

3. Purpose of the Study

To assess and describe the hydration knowledge and behavior of student athletes participating in competitive junior high and high school mountain bike teams, within the National Interscholastic Cycling Association (NICA) in order to substantiate further research

3.1 Hypotheses

- Current hydration awareness education does not translate to effective hydration behavior in student athletes.
- Youth Mountain Bike Teams are not receiving adequate hydration education.

4. Methods

4.1 Participants

The study included 133 student-athletes (98 males, 35 females) between the ages of 11-18. These participants were from junior high and high school mountain bike teams, in eighteen states. The subject inclusion criteria included that all participants were required to be physically healthy with no pre-existing medical conditions, and have obtained a medical release from a physician, through their corresponding NICA teams.

4.2 Research Design

This study consisted of a survey design, which collected information on hydration knowledge and behavior of student-athletes participating in competitive youth mountain bike teams.

Questionnaire Description: Participants were asked to complete questionnaires regarding their hydration knowledge and behavior. The survey was completed online, using the Qualitrics survey platform, from a link accessed through the parents NICA League email.

- Demographics section – 5 questions (*Appendix A*)
- Hydration Knowledge Questionnaire - cycling (HKQ-c) – 15 questions including True/false, multiple-choice options (*Appendix B*)
- Hydration Behavior Questionnaire - cycling (HBQ-c) – 10 questions including True/false, multiple-choice options (*Appendix C*)

Questionnaire Development: Both the HKQ-c and HBQ-c were developed using questionnaires provided by the University of Connecticut's Department of Kinesiology. Permission was granted for use. Questionnaires and questions were modified with input from Dr. Stavros Kavouras – Professor and Director of the Hydration Science Laboratory, University of Arkansas, to address the sport specific nature of this study.

Prior to the study, the questionnaires were pilot tested on ten students from various teams in the Arkansas NICA League. The student-athletes were asked to provide feedback on any questions they did not understand; questionnaires were updated after assessing the feedback. The University of Arkansas Institutional Review Board has approved this study. (*Appendix E*)

4.3 Procedures

One week prior to the survey being emailed, NICA sent out an informational email regarding the study in their National newsletter, including instructions on how to complete the survey. Seven days later a link to the survey was emailed from NICA in their coaches newsletter with instructions on how to distribute the link to parents. The extended process of getting the survey to the parents was due to NICA 3rd party mailing list restrictions. The survey was administered using the Qualtrics online platform. Consent was obtained from parents via digital acknowledgment prior to the collection of any data; assent was obtained from the child in the same way, before beginning the survey.

4.4 Statistical Analysis

Data from the HKQ-c was analyzed to provide mean, minimum and maximum scores. The questionnaire was scored out of a 15-point maximum. A score for adequate knowledge was determined from the upper 25th quartile scores, (Fig.1), and determined as =>10.5, or 70%.

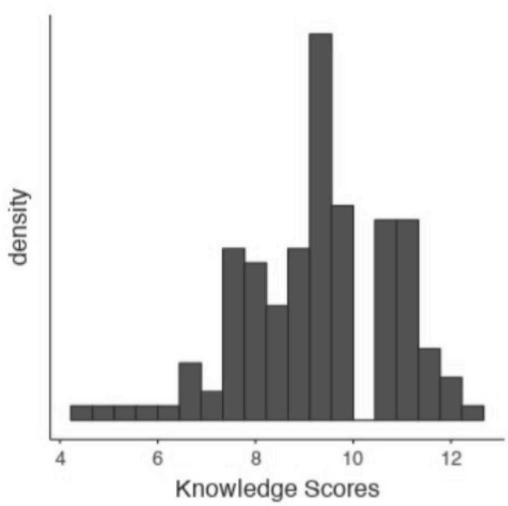

Figure 1. Knowledge Scores

Knowledge scores were then analyzed by demographics, and hydration education received using independent samples t-tests, analysis of variance (ANOVA), and chi-square test of association. Behavior responses were analyzed by demographics using chi-square test of independence (X^2). Results from the HBQ-c were also used to describe behaviors. An alpha level of .05 defined significance for all tests.

5. Results

5.1 Hydration Knowledge

Individual demographic and knowledge questions and results can be seen in *Appendices A - C*. Mean knowledge score for all participants (*N*=133), was (*M* =9.28, *SD* = 1.52) with a minimum score of 4.5 and a maximum score of 12.5 on a 15-point scale. 27.82% of participants (*N*=37) had adequate scores (=>10.5) as defined in section 4.4. The adequate knowledge group had significantly higher knowledge scores (*M* =11, *SD* = 0.53), than the sample as a whole (*M* =9.28, *SD* = 1.52), *t*(36) =19.9, *p*<0.001. Knowledge score tables can be seen in *Appendix D.*

Demographics

Knowledge scores were analyzed by gender, state, year in school, and ethnic group, using independent samples t-tests and analysis of variance. An independent samples t-test showed no difference in knowledge scores (95% *CI:* -0.4,0.8, *p*=0.559) between males (*M* 9.23, *SD* 1.43) and females (*M* 9.41, *SD* 1.78). Analysis of variance showed no difference by state, *F* (17,115) = 1.17, *p* = 0.303.

Table 1.1
Independent T-Test Knowledge Scores by Gender

					95% Confidence Interval	
		statistic	df	p	Lower	Upper
Knowledge Scores	Student's t	0.609	130	0.543	−0.414	0.782

Table 1.2
Analysis of Variance Knowledge Scores by State

	Sum of Squares	df	Mean Square	F	p
State of League	45.1	17	2.65	1.17	0.303
Residuals	261.5	115	2.27		

Analysis of variance showed a significant difference in Knowledge Scores by Year in School, *F* (4, 128) =3.59, *p*=0.008. Analysis of variance also showed a significant difference in knowledge scores by ethnic group, *F* (6,126) = 2.34, *p* =0.036. A point to note about significance by ethnic group is that 88.72% of participants identified as White (Non-Latino).

Table 1.3
Analysis of Variance Knowledge Scores by Year in School

	Sum of Squares	df	Mean Square	F	p
Year in School	31.0	4	7.74	3.59	0.008
Residuals	275.7	128	2.15		

Descriptives

Year in School	N	Mean	SD
Freshman	28	8.91	1.83
Junior	19	9.97	1.34
Junior High	40	8.79	1.39
Senior	15	9.93	1.13
Sophomore	31	9.53	1.42

Table 1.4
Analysis of Variance Knowledge Scores by Ethnic Group

	Sum of Squares	df	Mean Square	F	p
Ethnic Group	30.7	6	5.12	2.34	0.036
Residuals	275.9	126	2.19		

Descriptives

Ethnic Group	N	Mean	SD
African American	1	8.00	NaN
Asian & Pacific Islander	2	10.75	0.354
Latino	3	9.00	2.179
Mixed Race	6	9.75	1.636
Native American	1	12.50	NaN
Other	2	6.75	0.354
White (non-Latino)	118	9.27	1.470

Education

An independent samples t-test showed knowledge scores to be significantly higher, (*CI* 95%: -1.14, -0.07, p=0.028) in participants who had received hydration education (M = 9.5, SD = 1.51) than those who did not (M = 8.89, SD = 1.49). 65% of participants reported receiving hydration education.

Table 2.1
Independent Samples T-Test Knowledge Scores by Hydration Education Received

					95% Confidence Interval	
		statistic	df	p	Lower	Upper
Knowledge Scores	Student's t	−2.22	131	0.028	−1.14	−0.0654

Analysis of variance showed mean knowledge scores to be significantly different by urine color choice, $F(3,129) = 10.7$, p=<0.01. Post-hoc comparisons using the Tukey HSD test indicated that the mean score for selecting correct urine color (M = 9.67, SD = 1.29) was significantly higher. In addition the chi-square test of association showed a significant relationship between urine color choice and adequate/inadequate knowledge scores, X^2 (3, N = 133) = 11.3, p = 0.010, V= 0.29). Only 5.4% of those with adequate knowledge scores identified urine color incorrectly compared to 32.3% with inadequate knowledge scores.

Table 2.2
Analysis of Variance Urine Color by Knowledge Scores

	Sum of Squares	df	Mean Square	F	p
K9 What color is your urine when you are hydtrated	61.0	3	20.34	10.7	<.001
Residuals	245.6	129	1.90		

Descriptives

K9 What color is your urine when you are hydtrated	N	Mean	SD
Bright Yellow (similar to Mountain Dew	18	8.19	1.28
Brown Yellow (similar to mustard)	2	7.25	3.89
Dark yellow (similar to apple juice)	13	8.15	1.80
Pale yellow (similar to lemonade)	100	9.67	1.29

Table 2.3

Chi-Square Test of Association Urine Color by Adequate/Inadequate Knowledge Scores

K9 What color is your urine when you are hydtrated		Knowledge Adequate/Inadequate 0	1	Total
Bright Yellow (similar to Mountain Dew	Observed	18	0	18
	% within column	18.8%	0.0%	
Brown Yellow (similar to mustard)	Observed	2	0	2
	% within column	2.1%	0.0%	
Dark yellow (similar to apple juice)	Observed	11	2	13
	% within column	11.5%	5.4%	
Pale yellow (similar to lemonade)	Observed	65	35	100
	% within column	67.7%	94.6%	
Total	Observed	96	37	133
	% within column	100.0%	100.0%	

χ^2 Tests

	Value	df	p
χ^2	11.3	3	0.010
N	133		

Sweat Loss and Dehydration

Frequency tables for knowledge questions regarding sweating and weight loss split by post exercise checks for dehydration show that 90.9% of participants reported that excessive sweating leads to weight loss, and 81.9% reported that post practice weight loss is due to sweating, yet there were no correct answers for weight being the best check for dehydration, post exercise.

Table 2.4

Frequencies Sweating and Dehydration

K10 Execessive sweating can lead to dehydration	After exercise best way to tell im dehydrated: Nausea	Thirst	Urine color	Weight
False	1	1	3	0
Not Sure	5	1	1	0
True	13	48	60	0

Table 2.3
Frequencies Weight Loss and Dehydration

	After exercise best way to tell im dehydrated			
K11 If i weigh less after a paractice/race its probably due to	Nausea	Thirst	Urine color	Weight
Carbohydrate loss	5	6	3	0
Fat loss	2	1	3	0
Protein loss	1	2	1	0
Sweat loss	11	41	57	0

5.2 Hydration Behavior

Demographic and behavior questions can be seen in *Appendices A and C*. The HBQ-c was not scored. Behavior questions were analyzed by demographics. Drinking perceptions were analyzed by knowledge scores, by adequate knowledge, and by education received.

Demographics

For all behavior questions by demographics, chi-square test of association was used. There was no relationship found by ethnic group. By gender, a significant relationship was seen in drinking perceptions, X^2 (2, N = 132) = 9.2, p = 0.01), drinking locations, X^2 (23, N = 132) = 44.6, p = 0.004), and heat stoppages, X^2 (1, N = 132) =5.36, p=0.021.

Table 3.1
Chi-Square Test of Association Perceptions of Drinking by Gender

		Gender		
B2 Do you feel like you drink enough fluids at a practice/race		Female	Male	Total
No	Observed	13	22	35
	% within column	37.1 %	22.7 %	
Not sure	Observed	9	11	20
	% within column	25.7 %	11.3 %	
Yes	Observed	13	64	77
	% within column	37.1 %	66.0 %	
Total	Observed	35	97	132
	% within column	100.0 %	100.0 %	

χ² Tests

	Value	df	p
χ²	9.20	2	0.010
N	132		

Table 3.2

Chi-Square Test of Association Drinking Locations by Gender

	Value	df	p
χ²	44.6	23	0.004
N	132		

Table 3.3

Chi-Square Test of Association Heat Stoppages by Gender

Gender		B10 Have you ever had to stop due to being too		Total
		No	Yes	
Female	Observed	19	16	35
	% within column	20.7 %	40.0 %	
Male	Observed	73	24	97
	% within column	79.3 %	60.0 %	
Total	Observed	92	40	132
	% within column	100.0 %	100.0 %	

χ² Tests

	Value	df	p
χ²	5.36	1	0.021
N	132		

By State of league a significant relationship was seen in those receiving hydration education. X^2 (17, N = 133) = 30.1, p = 0.026. By State temperature a significant relationship was seen in drink preference X^2 (2, N = 133) =7.41, p = 0.025; but not in drink choice.

Table 3.4

Chi-Square Test of Association Hydration Education by State

	Value	df	p
χ²	30.1	17	0.026
N	133		

Nominal

	Value
Phi-coefficient	NaN
Cramer's V	0.476

Table 3.5

Chi-Square Test of Association Drink Preference by State Temperature

Contingency Tables

State Temp		B4 Which type of drink do your prefer given the choice			
		Flavored water	Plain water	Sports drink	Total
0	Observed	15	50	18	83
	% within row	18.1 %	60.2 %	21.7 %	
1	Observed	6	22	22	50
	% within row	12.0 %	44.0 %	44.0 %	
Total	Observed	21	72	40	133
	% within row	15.8 %	54.1 %	30.1 %	

χ^2 Tests

	Value	df	p
χ^2	7.41	2	0.025
N	133		

V=0.236

Behavior - Drinking Perceptions

Analysis of variance showed that knowledge scores did not differ by drinking perceptions, $F(2, 130) = 0.544$, p=0.582.

Table 4.1

Analysis of Variance Knowledge Scores by drinking perceptions

	Sum of Squares	df	Mean Square	F	p
B2 Do you feel like you drink enough fluids at a practice/race	2.55	2	1.27	0.544	0.582
Residuals	304.07	130	2.34		

Descriptives

B2 Do you feel like you drink enough fluids at a practice/race	N	Mean	SD
No	35	9.50	1.60
Not sure	20	9.09	1.59
Yes	78	9.24	1.48

A chi-square test of association showed there was also no relationship between drinking perceptions and adequate knowledge scores X^{2} *(2,N=133)=1.24,* p=0.538 or by hydration education received F (2.36, 133)=2, p=0.307

Table 4.2

Chi-Square Test of Association Drinking perceptions by Adequate Knowledge

Knowledge Adequate/Inadequate	B2 Do you feel like you drink enough fluids at a practice/race			
	No	Not sure	Yes	Total
0	23	14	59	96
1	12	6	19	37
Total	35	20	78	133

χ^2 Tests

	Value	df	p
χ^2	1.24	2	0.538
N	133		

Table 4.3

Chi-Square Test of Association Drinking perceptions by Hydration Education Received

B8 Have you recieved hydration education	B2 Do you feel like you drink enough fluids at a practice/race			
	No	Not sure	Yes	Total
No	16	7	24	47
Yes	19	13	54	86
Total	35	20	78	133

χ^2 Tests

	Value	df	p
χ^2	2.36	2	0.307
N	133		

6. Discussion

The present study surveyed knowledge and behavior in youth mountain bike teams across eighteen states. Results support the current literature that hydration education is not correlating to effective practices (Decher et al., 2008; Stavros A. Kavouras & Arnaoutis, 2012). Findings also support both hypotheses that current hydration awareness education does not translate to effective hydration behavior in student athletes, and that youth mountain bike teams are not receiving adequate hydration education.

Knowledge Scores

Results of the HKQ-c determined knowledge to be of an inadequate level, with less than a third of participants meeting the required score of 70%. Receiving hydration education significantly increased knowledge scores, although those who received education still did not meet the level required for adequate knowledge.

Knowledge Demographics

No differences in knowledge scores were seen by gender or State, but significant differences were seen by year in school, which could be attributed to age-related learning. Despite an upward trend in mean scores, none of the grades met the required level for adequate knowledge.

Knowledge Understanding and Translation

With regards to understanding the importance of fluids on performance, students scored extremely well. 99.24% of participants reported that they felt keeping hydrated was very important, while 99.74% reported that they needed fluids to perform at their best in cycling, and 98.5% reported it was important for them to drink before, during and after a race or practice. Despite understanding the importance of keeping hydrated, mean knowledge scores indicated inadequate knowledge, while behavior responses indicated inconsistency in translation of knowledge.

Inconsistencies in behavior translation can be seen in the study by Decher (2008), which expected that young athletes who understood the importance of hydration would better prevent dehydration during sports camp; however, this expectation was not supported. Kavouras et al. (2012) had similar findings with 60% of subjects remaining dehydrated even after an educational intervention program, and self reporting that they were well hydrated The results of the present study are in line with these findings that knowledge is not translating to effective behaviors.

Knowledge responses in the current study revealed that 90.98% of participants understood that post exercise weight loss was due to sweating, while 81.95% understood that sweat loss can lead to dehydration, yet no one answered correctly that weight loss was the best way to check for dehydration post exercise, with responses being varied. This is another indicator of inconsistency in translation of knowledge.

Although having received hydration education did increase knowledge scores significantly, it did not translate to behavior differences. Despite higher knowledge scores in those who had received hydration education, drinking perceptions did not differ based on hydration education received, or adequate knowledge. No difference was seen in knowledge scores based on drinking perceptions, and 70% of those who felt they did drink enough, had inadequate knowledge scores. These findings indicate that future education methods need to be relatable to performance outcomes so that athletes are equipped to better understand how much they need to drink and why.

Drinking Practices and Preference

With regards to drink choice knowledge and behaviors; only 30% correctly answered the knowledge question that sports drinks should be consumed when exercising for more than an hour, and less than 40% selected Gatorade, or hydration tablets, as their drink choice in the behavior section. In addition only 30% selected sports drink as their preferred choice; which could indicate a lack of knowledge regarding proper fluid replacement with sports drinks during longer practices or races. It would be difficult to attribute the high percentage of plain water consumption to parental provision, since preferred drink choice was also plain water. When analyzing drink choice and preference by State temperature there was a significant relationship seen in drink preference, but none seen in drink choice. In plain water or flavored water drinkers, preference was significantly higher in the cooler States, while sports drink preference was higher in the warmer States. No relationship was seen in drink choice, and no correlation between preference and choice.

According to the review by Garth and Burke (2013) there are little data on drinking practices in most continuous sports, particularly in higher levels of completion and among youth athletes, and almost no information on the athletes' rationale for their drinking behaviors. Also noted was the need for further field studies during competitive events that represent the true nature of the specific sport, while concluding that a range of individualized and flexible drinking strategies and hydration practices may be needed. These findings support the aims of this study that a more holistic approach is needed toward education.

Due to a combination of lack of knowledge and inadequate education, there is inconsistency in hydration practices among athletes, which can be seen in the current study, this issue has also been highlighted in several studies during summer sports camps. McDermott et al. (2009) and Arnaoutis (2013) found that participants that arrived at camp hypohydrated remained so throughout their stay, Arnaoutis (2013) also found that those who were hypohydrated pre-exercise became more dehydrated during practice, despite fluid being readily available. Decher et al. (2008) reported differences in drinking perceptions and actual hydration state.

Gender Differences in Behavior

Certain behaviors were also seen to differ by gender, such as heat stoppages, with more boys having to stop than girls. Differences were also seen in drinking perceptions by gender; a higher amount of girls reported not knowing if they drank enough. Differences in choice of drinking location were also seen by gender. According to Garth and Burke (2013) more data are needed before a clear pattern can be established for any sport, with observations modified by caliber, age, and sex; the findings from this study indicate that observations by gender, particularly in youth cycling may need further research.

Limitations

Limitations for this study include the self-reporting on questionnaires by student athletes, individual team coaches' hydration education and experience, as well as the small number of participants due to the blind survey design, and the fact it was off-season during the survey period. Despite limitations the results identify the need for more effective hydration education, particularly with regards to youth athletes, participating in continuous sports.

7. Conclusion

It can be seen from the present study and the current literature, that hydration knowledge is both inadequate and not translating to effective hydration behaviors. A more holistic approach is needed if we are to increase knowledge and translation. In creating effective hydration interventions, strategies, and education programs it may be necessary to use an interdisciplinary approach. The fact that existing education and interventions are not working well, future research and applications should explore several critical areas; using developmentally appropriate strategies to translate knowledge to behavior, increasing coaching knowledge and understanding with regards to approaches towards hydration education, and relating drinking to performance and health. If knowledge can be successfully translated into effective behaviors then youth athlete hydration status will improve, ultimately increasing cycling performance, while reducing risk of heat related injuries.

8. References

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9. Appendix A Demographics

Answer	%	Count
Gender		
Male	73.68%	98
Female	26.32%	35
Ethnic group		
White (non-Latino)	88.72%	118
Other	1.50%	2
Native American	0.75%	1
Mixed Race	4.51%	6
Latino	2.26%	3
Asian & Pacific Islander	1.50%	2
African American	0.75%	1
Year in school		
Freshman	21.37%	28
Junior High	29.01%	38
Sophomore	23.66%	31
Junior	14.50%	19
Senior	11.45%	15
State of League		
Alabama	4.51%	6
Arkansas	19.55%	26
Colorado	2.26%	3
Georgia	3.01%	4
Idaho	6.02%	8
Minnesota	11.28%	15
Nevada	0.75%	1
New Jersey	8.27%	11
New York	10.53%	14
NorCal	5.26%	7
North Carolina	2.26%	3
Pennsylvania	1.50%	2
SoCal	3.76%	5
Tennessee	2.26%	3
Texas	1.50%	2
Utah	6.77%	9
Virginia	0.75%	1
Wisconsin	9.77%	13
Total participants		**133**

9. Appendix B Hydration Knowledge Questionnaire (HKQ-c)

Answer	%	Count
DURING exercise, the best way to tell that I am dehydrated would be		
Thirst	51.88%	69
Sweat	9.02%	12
Dizziness / Headache	27.07%	36
Muscle cramps	12.03%	16
AFTER exercise, the best way to tell that I am dehydrated would be		
Urine color	48.12%	64
Weight loss	0.00%	0
Thirst	37.59%	50
Nausea	14.29%	19
When I am thirsty it means (you may select more than one answer)		
My body is hot / body temperature is high	41.12%	64
It is not related to my hydration or my body temperature	5.26%	7
I am already dehydrated	46.61%	62
I am almost dehydrated	51.13%	68
It is important for me to drink		
Before exercise	14.29%	19
During exercise	14.29%	19
After exercise	13.53%	18
All of the above	98.5%	131
When exercising for more than an hour, what is the best choice of drink?		
Plain water	69.17%	92
Sports drink	30.08%	40
Juice	0.75%	1
Soda	0.00%	0
I need to drink fluids to perform at my best in cycling		
TRUE	97.74%	130
Not sure	2.26%	3
FALSE	0.00%	0
I need to drink fluids during cold weather practices or races		
TRUE	93.23%	124
Not sure	5.26%	7
FALSE	1.50%	2
During practices or races on average I should drink		
As much as I sweat out	29.32%	39
Less than I sweat out	2.26%	3
More than I sweat out	66.92%	89
It doesn't matter	1.50%	2
What color is your urine if you are hydrated?		
Pale yellow (similar to lemonade)	75.94%	101
Dark yellow (similar to apple juice)	9.02%	12
Brown Yellow (similar to mustard)	1.50%	2
Bright Yellow (similar to Mountain Dew	13.53%	18

Appendix B cont.

Answer	%	Count
Excessive sweating can lead to dehydration		
TRUE	90.98%	121
FALSE	3.76%	5
Not Sure	5.26%	7
If I weigh less after a practice or a race than I did at the beginning, then the weight I lost is probably due to		
Fat loss	4.51%	6
Carbohydrate loss	10.53%	14
Sweat loss	81.95%	109
Protein loss	3.01%	4
In pre-season practice, how long does it take for my body to get used to the temperature?		
1 day	16.54%	22
4 days	54.14%	72
12 days	23.31%	31
20 days	6.02%	8
If I feel like I am experiencing heat illness at a practice or a race, I should (you may select more than one answer)		
Tell my coach or teammate	90.23%	120
Drink plain water	74.44%	99
Drink a sports drink	33.83%	45
Find a cool place to rest	81.12%	108
Finish my practice or race	9.02%	12
Heat-induced illness is one of the most preventable sports injuries		
TRUE	87.97%	117
FALSE	2.26%	3
Not sure	9.77%	13
The most serious form of heat illness is		
Heat Cramps	0.75%	1
Heat Exhaustion	3.01%	4
Heat Stroke	90.23%	120
Dehydration	6.02%	8
Total participants		**133**

9.Appendix C Hydration Behavior Questionnaire (HBQ-c) responses

Answer	%	Count
At a practice or a race, how Important do you feel drinking fluids is?		
Not that important	0.76%	1
Very important	99.24%	130
Do you feel like you drink enough fluids when you are at a practice or a race?		
Yes	60.15%	80
No	26.32%	35
Not sure	13.53%	18
WHAT kind of fluids do you drink when you are at a practice or a race? (you may select more than one answer)		
Water with hydration tablet added	29.32%	39
Water	93.98%	125
None	0.00%	0
Juice	0.75%	1
Gatorade	39.85%	53
Which type of drink do you prefer, given the choice?		
Sports drink	29.77%	39
Plain water	54.20%	71
Flavored water	16.03%	21
During a practice or race HOW do you drink? (you may select more than one answer)		
Water supplied by coach	13.53%	18
Team cooler during breaks	16.54%	22
Friend/teammate	2.26%	3
Camelbak	66.17%	88
Bottle on bike	69.17%	92
During a practice or race, WHEN do you drink? (you may select more than one answer)		
When I am thirsty	95.49%	127
When I am hot	60.90%	81
Only during scheduled breaks	5.26%	7
When my coach tells me to	25.56%	34
I don't drink during practices or races	0.00%	0
During a practice or a race, WHERE do you drink? (you may select more than one answer)		
Easy sections of the trail	87.97%	117
During a descent	12.78%	17
Before start of practice or race	77.44%	103
At the top of climb	46.61%	62
At end of practice or race	72.18%	96
Have you received any hydration education?		
Yes	64.89%	85
No	35.11%	46

Appendix C cont.

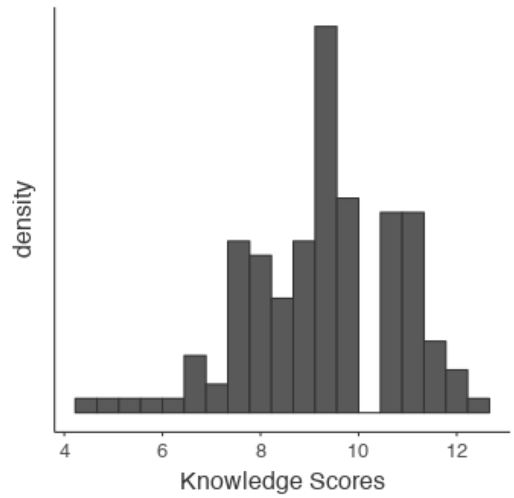
Answer	%	Count
If you answered YES to the last question, where did receive the hydration education? (you may select more than one answer)		
School	32.33%	43
Parents	33.08%	44
Other	14.29%	19
Gatorade Website	0.75%	1
Coach	52.63%	70
At a practice or a race have you ever had to stop due to being too hot?		
Yes	30.53%	40
No	69.47%	91
Does your coach talk to the team regularly about keeping hydrated?		
Yes	87.79%	115
No	12.21%	16
Total participants		**133**

Appendix D Knowledge Scores

1. Knowledge Scores Descriptives and Graph

Descriptives

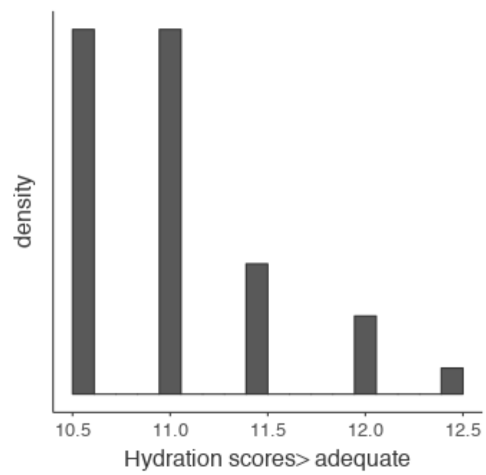
	Knowledge Scores
N	133
Mean	9.28
Standard deviation	1.52
Minimum	4.50
Maximum	12.5
25th percentile	8.00
50th percentile	9.50
75th percentile	10.5



2. Adequate Knowledge Scores Descriptives and Graph

Descriptives

	Hydration scores> adequate
N	37
Mean	11.0
Standard deviation	0.527
Minimum	10.5
Maximum	12.5



3. One-sample T-Test Adequate Scores by Mean Scores

						95% Confidence Interval	
		statistic	df	p	Mean difference	Lower	Upper
Hydration scores> adequate	Student's t	19.9	36.0	<.001	1.72	10.8	11.2

Note. H_a population mean ≠ 9.28

Descriptives

	N	Mean	Median	SD	SE
Hydration scores> adequate	37	11.0	11.0	0.527	0.0866

Appendix E Institutional Review Board Approval

UNIVERSITY OF ARKANSAS

To:	Natasha A Brand BELL 4188
From:	Douglas James Adams, Chair IRB Committee
Date:	01/16/2018
Action:	**Expedited Approval**
Action Date:	01/16/2018
Protocol #:	1711087019
Study Title:	Survey of Hydration Knowledge and Behavior in Youth Mountain Bike Teams
Expiration Date:	01/04/2019
Last Approval Date:	

The above-referenced protocol has been approved following expedited review by the IRB Committee that oversees research with human subjects.

If the research involves collaboration with another institution then the research cannot commence until the Committee receives written notification of approval from the collaborating institution's IRB.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date.

Protocols are approved for a maximum period of one year. You may not continue any research activity beyond the expiration date without Committee approval. Please submit continuation requests early enough to allow sufficient time for review. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study closure.

Adverse Events: Any serious or unexpected adverse event must be reported to the IRB Committee within 48 hours. All other adverse events should be reported within 10 working days.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, study personnel, or number of participants, please submit an amendment to the IRB. All changes must be approved by the IRB Committee before they can be initiated.

You must maintain a research file for at least 3 years after completion of the study. This file should include all correspondence with the IRB Committee, original signed consent forms, and study data.

cc: Stavros A Kavouras, Investigator