

**ATHLETE PERCEPTIONS OF HYDRATION WHEN COMPETING ON
NATURAL GRASS VERSUS ARTIFICIAL TURF IN EXTREME HEAT
CONDITIONS**

An Undergraduate Research Scholars Thesis

by

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This project required approval from the Texas A&M University Research Compliance & Biosafety office. TAMU IRB #: 2022-0310M Approval Date: 03/09/2022

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ABSTRACT

Athlete Perceptions of Hydration When Competing on Natural Grass Versus Artificial Turf in Extreme Heat Conditions

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Third generation (3G) artificial turf sports fields have been utilized since the 1990s. Research has shown the surface temperature of these turf fields can reach up to 170°F. This temperature is significantly higher than natural grass fields and raises concerns for athletes. No known literature currently has examined the hydration status and performance of athletes on artificial turf versus natural grass fields. We made comparisons of artificial turf and natural grass, focused on performance, different surface temperatures, and possibly investigate further research regarding hydration on only artificial turf.

The purpose of the study was to evaluate the athletes' perception of hydration status and performance on natural grass versus artificial turf and how they prepare for each surface. We hypothesized that the participants would say they've become dehydrated more quickly playing on artificial turf in comparison to natural grass. Additionally, we hypothesized sharing results of the hydration study would alter the athletes' perspective on dehydration when competing on natural grass versus artificial turf fields.

Athletes ranging from 18-28 years old were given two surveys using RedCap. The two surveys consisted of their hydration preparation and game behavior. The participants were divided into two groups. The first group was the hydration group, where we took measurements of their weight loss, sweat production, urine samples, heart rate, active participation, distance traveled, and body temperature. The second group was the non-hydration group, where only heart rate, active participation, and distance traveled was measured. Participants had previously completed a two-day hydration study playing on both artificial turf and natural grass. The surveys were distributed six months after the hydration study in a class setting. The first survey was given before presenting the hydration study results, and the second survey was given after. We surveyed all the athletes that were part of TAMU Men's Soccer club team, however, we primarily looked at the ones that participated in the hydration study. It was found that most participants had a preference of performing on natural grass, as the athletes unanimously voted that there is a temperature difference between artificial turf and natural grass. Prior to the presentation, in the second survey it was recorded that 90% of participants stated they would change their hydration habits in the future. These findings are in support of our hypothesis, as the participants have learned of the extreme water loss that takes place on only one outdoor sports event in hot conditions and made conscious acknowledgements to properly hydrate in the future.

DEDICATION

We would like to begin by expressing with great gratitude and appreciation to our families that have supported us throughout this research project. Although they may not have been physically by our side, their words of encouragement positively impact us to give our greatest effort. We thank them for their countless support, encouragement, and guidance from the beginning of this study. In addition, we would also like to extend our appreciation to our friends that have motivated us and expressed their deepest support. Despite our academic responsibilities, they were there to remind us about our hard work and dedication to this study. Lastly, we also want to specifically thank our LAUNCH advisor, Dillon, for his immense help, advice, and encouragement throughout the beginning of our thesis paper. Dillon always expressed great interest in providing excellent resources and feedback to our group.

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Contributors

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The data collected in this study were part of a larger study entitled, "Temperature, hydration and performance differences between artificial turf and natural grass simulated soccer matches in a hot environment." The study was conducted in 2021 and 2022 in collaboration with faculty, staff, and students in Soil and Crop Sciences and Health and Kinesiology Departments at TAMU. Data from that study, and data presented in this thesis, are not currently published; however, a manuscript is in preparation.

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NOMENCLATURE

AT	Artificial turf
NT	Natural turfgrass
IRB	Institutional Review Boards
BMI	Body Mass Index
TAMU	Texas A&M University

1. INTRODUCTION

Water is an essential part of human life and performs various regulatory functions in the body. The regulation of body temperature is one aspect that is essential for everyone, especially for individuals in locations with hotter climates and performing more intense physical activities. When focusing on an athlete, consumption of water is especially important because a state of dehydration can interfere with both the physical and psychological aspects of an athlete. During summer months, this issue is at a heightened level of concern. Due to the extreme temperatures the body attempts to accommodate the body's needs and in response increases fluid output. In periods of exercise-heat stress, athletes often fail to match their fluid input with their sweat output. This imbalance can be accelerated if athletes are not properly hydrated before initiating any exercise-heat stress. If proper hydration is not reached the body can reach dangerous conditions and increase chances of heat stroke and can even increase chances of death. Previous studies have examined the effects of hydration status affecting athlete's performance.

At a summer soccer camp, adolescents' hydration status prior to playing was evaluated in addition to observation of their performance. Approximately 90% of the players were dehydrated prior to the game. The players only drank water based on thirst cues during the matches and the study found they did not reach proper hydration (Arnaoutis et al., 2013).

In order to maintain homeostasis during these exercise-stress conditions, sweat is induced by the body. In warm environments sweat plays a role in 50% of the body's reduction of heat and 100% in extremely hot environments (Casa et al., 2019). Progressive dehydration without proper rehydration can result in hypertonic hypovolemia associated with increase in heart rate and core body temperature (Francesconi et al., 1983; Brandenberger et al., 1986).

In one study, researchers developed a questionnaire that examined the level of nutrition knowledge in coaches and athletes. The level of knowledge has been found to have adverse effects on performance (Heikkilä et al., 2017). However, there is limited research regarding athlete's knowledge of hydration and performance specifically on different fields.

An athlete's environment plays a key role in the maximum level of performance that can be displayed during a practice or event. Many environments across the states differ based on the location, climate, and geographic features in the area. This ultimately plays a role in the type of field athletes are accustomed performing in. Therefore, the type of field that athletes perform in contributes to the perceptions of preparation along with their performance. Primary environmental factors that can influence a player's performance are temperature and field type. The temperature analyzed in this study was strictly hot weather conditions and the two types of fields studied were artificial turf (AT) versus natural turf grass (NT). Parameters within the environmental factors which affected performance included the surface temperature difference between AT and NT, the effects of the heat radiated on athletes, and the level of comfort associated with each AT and NT.

Artificial turf consists of layers of composite materials that are hidden under the topmost portion of plastic grass leaf blades used to simulate natural grass. Approximately half of the blades are buried in black rubber granules, and these granules can be expected to accumulate much more heat than soil due to the lack of water retention and black color.

It was found in a recent study that AT was 35.8 °C (96.4 °F) hotter than NT, this is ultimately due to NT ability to dissipate heat using ground-air by the processes of convection and conduction (Jim, 2017). The difference in surface temperature of AT and NT are vastly different during hot weather conditions and imply there can be serious complications for athletes not well

equipped to compete in extreme conditions. Yet, it is important to state that the temperatures are not localized to just the surface or even a few inches above the ground, rather the heat radiated well above the surface onto athletes' bodies.

The increased surface temperature of AT, especially around noon or early afternoon on a sunny day, was found to reflect a more significant amount of longwave radiation (Liu et al., 2021). Thus, the athletes experience a greater deposit of heat waves from the AT, raising the individual's body temperature. Another important aspect when comparing an AT and NT field is their abilities to support the movement and joint health of athletes which use them. Natural turf grass has been used for decades and has many living components which essentially have regenerative properties to maintaining ground softness. However, when comparing the man-made infill rubber granules, they are slowly degraded by water resulting in the stiffening of what is meant to be the shock absorbing layer (Ataabadi et al., 2017). Therefore, increasing the risk of an athlete's joint health to deteriorate causing them to be more prone to injury.

There has been limited scientific knowledge regarding the effect different surface temperatures on affect the hydration status of athletes. It is important to have knowledge regarding surface temperatures and the effect on athletes to ensure proper safety of their health, especially during warmer months. The purpose of this research was to survey athlete's perception of hydration and performance when competing on two different playing surfaces – natural grass versus artificial turf fields. The athletes participated in an initial survey regarding their general perception of hydration and performance. This was used as a base measure to use when comparing. Afterwards, a presentation was given where they received results from an experimental study and took a post-survey about their future game preparation. The questions in

the second survey varied slightly but continued to measure the focus of the study – their perception on hydration.

The purpose of showing the athletes their results and taking a post-survey was to see if their perspective changed about their game hydration preparation behavior. We hypothesized that the athletes would indicate they became more dehydrated when playing on artificial turf compared to natural grass. Additionally, we hypothesized that after receiving the experimental study's results, they would indicate a behavioral change in their future hydration habits for exercise-heat activity. We believed the athletes would alter their preparation to help improve their performance and to also prepare properly to prevent dangerous conditions that their body could meet. This study would help the athletes understand why being hydrated in various climates and conditions is an important aspect for performance. The results collected from this study would be beneficial in applying them when creating interventions to ensure proper athlete hydration and safety in the future. This research additionally provides information on how athletes can better prepare for physical activity during hotter weather on different surfaces.

2. METHODS

After completing a hydration study with a men's club soccer team in September 2021, we wanted to know what the individuals thought their performance was on artificial turf and natural grass after the study was conducted. We created surveys for the individuals that participated in the study. These surveys consisted of questionnaires before and after showing the participants the results from the hydration study. We wanted the participants to view the results, and this could additionally encourage them to improve their hydration and performance for future games they would play in.

We also wanted to be able to analyze what their perception were prior to showing the results and see their true thoughts on their performance and how they felt during the study. Additionally, we also wanted to analyze any change of perception and action that would be taken from showing the results. We did this by looking at the variables we measured: weight loss, sweat rate, fluid loss, sodium loss, urine color, heat rate, pulse, distance ran, acceleration, deceleration, and body temperature. There was a total of 27 participants involved in the preliminary study. Six months later they were followed up with and asked to participate in this second study.

Overall, we had two hydration participants and eight non-hydration participants involved in responding to the surveys. We stated in an informed consent form that the participants did not need to attend the presentation of the results and they were not obligated to answer the survey questions if it caused them any discomfort. We also emphasized that their answers would be anonymous. Their participation in the study was voluntary and they could decide not to participate in the study without having anything held against them with an option to leave the

study at any time. There were no direct personal identifiers that were collected. We created a QR code for the participants to scan before and after looking at the results to get access to the surveys. The surveys were combined into one link and the participants were instructed not to advance to the second portion until the results have been displayed and broken down in a presentation by Dr. Chase Straw and Dr. Steven Riechman. The results were presented on a PowerPoint with graphs and statistics about their performance and hydration status.

We surveyed athletes ranging from age 18 to 28 years old, six months after a hydration study. The surveys and results were presented and distributed at the Scotts Miracle-Gro Facility for Lawn and Garden Research. The surveys were constructed through RedCap, and we wanted to view their perspectives about their hydration preparation and their game behavior. Redcap is a web application to create online surveys and databases. From the surveys in Redcap, we derived the tables from the questions completed and compared the results. The tables compared the athlete's perception and opinions about hydration. We also took a closer look at the results from the hydration study to tell the participants if their perceptions were right or wrong.

The two surveys were created, and follow-up questions were asked regarding the individuals that participated in the hydration group. The first survey given to the participants was before they viewed the results from the study, that had previously participated in six months prior to the survey distribution. In that survey we asked about their water intake before, the day of, during, and after playing a game of soccer. Additionally, we integrated the type of preference of surface they like to play on when comparing the two different surfaces they had previously played on during the study. Next, we wanted to see what they thought about their speed on natural grass and artificial turf before we presented the results that found there was a pattern of

differentiation in their acceleration and deceleration maneuvers two different surfaces, favoring performance on artificial turf.

After we asked the participants about their performance on the different surfaces, we asked what type of fluids they consumed and their views on how important it is to consume fluids prior to and during games, as well as when they drink fluids. Similarly, we asked the participants when they're experiencing a heat induced illness during a practice or game, what they do in response to alleviate their discomfort. Once the participants completed the first survey, we presented the results from the hydration study and gave the visual representations of the data to ensure the participants were able to follow along with the study's findings.

Once the results were presented, the participants were then instructed to continue their previously opened link and complete the second portion of the survey. In the survey it was asked if they were part of the hydration group. If they answered yes, a follow-up question was asked if they were surprised by the amount of water needed to be consumed after the game to be properly rehydrated. This was asked because these were the only individuals who had their fluid intake and output measured during the study. Once this question was asked specifically for the hydration group, the rest of the survey had the same questions for all the participants.

We asked individuals if they thought they were dehydrated when looking in hindsight to their previous games and practices in hot weather conditions after viewing the results. Additionally, with this question we asked if they would prepare differently for future games after viewing the results. If the individual answered yes, then we asked them if they would change their water intake when playing on natural grass or artificial turf. Next, we asked if they felt more tired playing on natural grass or artificial turf. Lastly, we asked if they would change their water intake before, during, and after a game.

Since the surface temperature of turf is significantly higher than natural grass temperature in hot conditions. We wanted to see if individuals would have different hydration opinions performing on natural grass and artificial turf. Individuals lost equal amounts of fluids in each condition, when comparing the two field types. The individuals had different core temperature between the fields, but this was likely because they were at their maximum sweat rate. The participants had stunningly similar water loss on both natural grass and artificial turf. Additionally, from this, their hydration would not help with their sweat rate as there cannot be an increase in sweat rate even with a higher volume of body water. This is due to the limitation of the number of sweat glands rather than the amount of sweat they were excreting. The surface hardness was an important factor in performance which was correlated with the amount of strain an athlete's body endures. When this factor was measured between the surfaces there were no major differences. We took measurements of traction, which like the surface hardness, helped us assess the stress an athlete experiences, which was also not drastically different.

From the hydration group, we measured their different speed zones and average sprint speed on both natural grass and artificial turf. There was not an influence from the surface temperature. However, the data expressed a consistent pattern of difference when measuring acceleration and deceleration when performing on the two surfaces being compared. There were similar findings for the participants who were not part of the hydration group.

Even when the individuals came into the study with hydration protocols, they were not as hydrated as they needed to be to perform in hot conditions. With these surveys we wanted to take a closer look on athlete perception of their hydration along with their performance in addition to the data collected in the study. We planned to convince the participants there is a major

difference when it comes to consuming fluids on turf and natural grass. This was done by showing them the difference in surface temperatures after completing the first survey.

With the athlete's participation and completion of our surveys, we not only wanted to see their perspective, but also for them to analyze the results and to internalize the importance of taking better measures in hydrating themselves properly for their own health and wellbeing. With that being said, we are hopeful there was a moment of realization for these athletes to go forth and put what they have learned into practice. Additionally, for the participants to share their newfound knowledge with their fellow teammates for years to come.

3. RESULTS

We asked the TAMU Men’s Club Soccer team who participated in the research study in September 2021 to evaluate their perceived hydration and performance differences between artificial turf and natural grass in extreme heat conditions during a simulated soccer match. We invited the team to a presentation of the results of that study. Before the presentation of the results, we invited the team to answer questions regarding their perception of hydration. The questions revolved around perceptions of artificial turf and natural grass and hydration practices. After the presentation, we asked them to take another survey.

Table 3.1: How many ounces of fluids do you drink the day before, the day of, during, and after a game?

	16 oz	24 oz	32 oz	40 oz	48 oz	56 oz	64 oz	72 oz	80 oz
Before a game	10%	0%	0%	0%	30%	20%	30%	10%	0%
The day of a game	0%	10%	10%	10%	10%	10%	40%	0%	10%
During a game	20%	30%	30%	0%	0%	0%	0%	10%	10%
After a game	0%	20%	30%	10%	20%	0%	10%	0%	10%

To begin the first portion of the survey we asked for a quantitative measure of the amount of fluid intake before, during, and after an outdoor athletic event takes place. Throughout the data points there were variations across the board between the participants.

Hydration before the game, as in days leading up to the event, according to table 3.1, there was a concentration between 48 to 64 ounces, with the expectation of an outlier of only 16 ounces. Although there was a variation of answers, the highest percentage recorded was 30% of

participants consumed 48 ounces prior to beginning a game. Hydration that took place the day of the game was much more varied, as it ranged from 24 to 80 ounces. The highest percentage of participants selected 64 ounces (40%). During the outdoor athletic event, water intake of athletes was significantly more concentrated in the lower end, between 16 to 32 ounces. However, 20% of participants stated their water intake was from 72 to 80 ounces. Lastly, after the performance there was a vast similarity of water consumption totaling anywhere from 24 to 48 ounces. The highest percentage of water intake after a game was 32 ounces reflected by 30% of participants. Once again, there was an outlier stating the consumption of around 80 ounces of water.

Table 3.2: Do you prefer to play on artificial turf or natural grass?

Artificial Turf	Natural Grass	No preference
30%	50%	20%

When participants were asked what kind of field, they preferred to play on. The results from table 3.2 showed that 50% of participants responded that they preferred performing on natural grass. In comparison to 30% that preferred artificial turf and 20% who had no preference. We assumed half of the participants preferred to play on natural grass because the surface is better on the muscle and tendons of an athlete when they are running on the surface.

Table 3.3: When playing on artificial turf or natural grass in 90F+ degree weather, how do you feel?

	Excited	Optimistic	Neutral	Anxious	Not Excited
Artificial Turf	0%	10%	30%	0%	60%
Natural Grass	20%	40%	20%	20%	0%

We then followed by asking participants how they felt playing in 90 degrees or hotter weather. We included a question for both, artificial turf and natural grass, as the dependent factors since they were the two field types used in the study. The results from table 3.3 stated that 60% of participants were not excited when playing on artificial turf. Additionally, relating to artificial turf, 0% were excited to play on artificial turf and 30% felt neutral with the idea of performing on said field type. As opposed to natural grass, 40% of participants were optimistic and 20% of athletes felt excited to perform on natural terrain. Lastly, an additional point of interest is that 0% of the participants were not excited to play on natural grass compared to 60% that presented they were not excited to play on artificial turf.

Table 3.4: Do you feel there was a temperature difference between the turf and grass?

Yes	No
100%	0%

Continuing, we questioned participants whether they perceived a temperature difference between artificial turf and natural grass. The results stated in table 3.4 showed that 100% of the participants agreed that they felt a temperature difference between both field types.

Table 3.5: Does your consumption of fluids depend on whether you are playing on turf or grass?

Yes	No
20%	80%

Additionally, we asked if athletes believed that there was a temperature difference between fields. To gather the general perspective the athletes, have when relating their water intake to the type of field they will be playing on, we asked if there were any changes made to consumption habits when they were aware they would be playing on artificial turf or natural grass. Based on table 3.5, in the pool of participants 80% stated that they did not adjust their consumption of water based on the field type.

To gather the general perspective the athletes, have when relating their water intake to the type of field they would be playing on, we asked if there are any changes made to consumption habits when they are aware if they would be playing on artificial turf or natural grass. It was found a great majority of the participants were not influenced to change their consumption habits. However, 20% claimed that they did in fact change their hydration in preparation for the designated field type.

Table 3.6: Do you feel you run overall longer distance on natural grass or artificial turf?

Natural grass	Artificial turf	I run the same distances
20%	20%	60%

To gather the participants' thoughts about how they performed on artificial turf when compared to natural grass, they were asked if they believed there was an overall difference in distance they had to run on each surface. The results of the question in table 3.6 showed that 60%

of participants felt they ran the same distances on each. Although, the remaining athletes were equally split between running longer distances on either artificial turf or natural grass.

Table 3.7: Do you feel you run at faster speeds on natural grass or artificial turf?

Natural grass	Artificial turf	I run the same distances
0%	50%	50%

To further assess the participants perception of performance variations between the differing fields, they were asked if they had noticed any difference in the speed at which they ran respective to the field type. The responses from the participants stated that none of the athletes felt they ran faster on natural grass according to table 3.7. However, 50% of the respondents felt that there was a discrepancy between the fields and ran at faster speeds when performing on artificial turf. The remaining 50% felt there was not a noticeable difference in their speeds between artificial turf and natural grass.

Table 3.8: Do you feel you were dehydrated at any point during the study?

Yes	No	Maybe	Not sure
70%	20%	10%	0%

After the presentation of the results, a second survey was completed by the participants. At the beginning of the secondary survey, the participants were asked if they felt, at any point, they were dehydrated. In table 3.8, 70% confirmed they felt dehydrated, while only 20% did not believe they were dehydrated. The remaining 10% possibly thought they felt dehydrated.

Table 3.9: Which surface did you feel MORE dehydrated playing on, artificial turf or natural grass?

Artificial turf	Natural grass	I did not see a difference
70%	0%	30%

When asked to compare the difference between the degree of dehydration being experienced when playing on each field type, in table 3.9, there were 70% of participants stated that they felt more dehydrated on artificial turf. None of the participants stated they felt more dehydrated on natural grass, and the remaining 30% claim to not have felt a difference between the two surfaces. We assume this difference in answer could be due to the players reaching their maximum sweat rate on both artificial turf and natural grass. While most of the participants said they felt more dehydrated while playing on artificial turf, earlier in table 3.4 100% of the participants felt as if they did feel a difference in surface temperatures between the natural grass and artificial turf.

Table 3.10: Based on the results of the hydration study do you think you will change your water intake BEFORE a game when playing on artificial turf or grass?

	Yes	No
Artificial Turf	90%	10%
Natural grass	90%	10%

To gather the perception of the athletes after the presentation, it was asked if they believe their personal water intake would be changed after learning of the quantifiable loss of water experienced. In table 3.10, the results of the question showed that a vast majority of the participants stated they would change their own hydration habits with 90% responding in

correspondence to playing in artificial turf. Although, 10% of the athletes stated their hydration habits would not be altered. Similarly, the participants also responded with 90% saying that they would change their water intake when playing on natural grass. Lastly, the same results were presented for natural grass with 10% of participants indicating that they would not change their water intake.

Table 3.11: Based on the results of the hydration study do you think you will change your water intake DURING a game when playing on artificial turf or grass?

	Yes	No
Artificial Turf	80%	20%
Natural grass	80%	20%

Like the last question, the participants were asked if their own water consumption habits would be altered moving forward during an active sporting event. According to table 3.11, the agreement range decreased slightly, suggesting that 80% of participants would change their habits and 20% would continue the same as before. The results were similarly reflected for the natural grass with 80% of participants saying they would change their water intake during a game. Lastly, 20% of participants also said they would not change their water consumption during a game.

Table 3.12: Based on the results of the hydration study do you think you will change your water intake AFTER a game when playing on artificial turf or grass?

	Yes	No
Artificial Turf	80%	20%
Natural grass	80%	20%

In the final series of questions regarding the alteration of hydration habits, it was asked whether there would be a difference in water intake following an outdoor sporting event. This question resulted in the same distribution of percentages as the previous question. In table 3.12, it stated 80% of athletes would change their water intake and 20% of them would not.

In Figure 3.13 and 3.14, the Texas A&M's Men's Club Soccer team was playing on natural grass. The soccer match was not typical game. The soccer match was split up into four quarters. There were at least six players on each team. This was done to take measurements during each quarter for the hydration group. We also did this to observe the players and to act in case they were experiencing heat exhaustion. If they were experiencing heat exhaustion, we sat the players down in a shaded area to cool down and to consume fluids. All the participants played one game on artificial turf and one game on natural grass, with three groups.

According to figures 3.13 and 3.14 the players were on natural grass. They were generally slower on this surface when compared to artificial turf. This is possibly due to the natural grass being made of different material. Artificial turf had a higher energy restitution, meaning that more energy was returned to them when impacting the surface. They may have ran fast and had more accelerations because of this. They were expected to move faster on artificial turf, despite the temperature being drastically hotter than natural grass.



Figure 3.13: Texas A&M's Men's Soccer Club Team performing on Natural Turf Grass.



Figure 3.14: Texas A&M's Men's Club Soccer Team performing on Natural Turf Grass.

4. CONCLUSION

The purpose of this study was to examine athletes' perception of hydration on two different surfaces: artificial turf and natural grass. In addition to this, our focus in this study was also on their perception of performance involving the variables we measured while conducting our study. Those variables that were included were weight loss, sweat rate, fluid loss, sodium loss, urine color, heart rate, pulse, distance ran, acceleration, deceleration, and body temperature. This study plays an important role in the safety of athletes due to hydration levels when performing physical activity in hot conditions. Additionally, to the safety of their health the results can encourage athletes to better prepare for any physical activity under extreme temperatures.

A state of dehydration can influence an athlete both physically and psychologically. It is essential that athletes' perceptions of hydration and performance are interpreted to determine proper interventions that can be implemented. After analyzing the results, it is important for participants to view what occurred in comparison to what they believed happened. In all, by perceiving the results and the need of proper hydration in extreme hot temperatures. The athletes can understand how hydration can impact their performance. We hypothesized that the athletes would indicate they became more dehydrated when playing on artificial turf as well as to consider implementing behavioral change for future hydration habits.

Two different surveys were conducted for this study to best gauge the level of influence the presentation explaining the findings of water loss had on the athletes. During the first survey, participants were asked if their consumption of fluids would be influenced by the type of field they would be competing on, resulting in 80% of the participants stating there would not be a

difference in water intake between the two fields. Following the presentation during the second survey, the question was asked whether the athletes felt more dehydrated on either artificial turf or natural grass. The results of this question showed that 70% of the participants felt more dehydrated while they played on artificial turf and 30% not noticing a difference.

However, there is a discrepancy between the two data points as most participants had previously answered that they would not feel the need to hydrate differently between the field types. The athletes were expected to be more inclined to hydrate to a higher degree prior to performing on artificial turf since the majority felt more dehydrated while playing on this type of field. Therefore, the initial failure to determine if they would need to hydrate more before playing on artificial turf during the first portion of the survey is a questionable data entry found by our data collection.

Within the second survey, the participants were asked if they believed their hydration habits would change before, during and after an outdoor sporting event. It was expected that every participant would have stated they would have changed their water intake patterns after analyzing the data found by the study data which showed the severe dehydration occurring within athletes during a single outdoor soccer match in hot conditions. Although there was an outlier in the survey, 90% of participants selected they would change their habits and 10% stated they did not believe they needed to change their water intake. However, it is observed from the previous survey that there was also an outlier participant stating their water consumption was much higher than their fellow participants. This could be an explanation attributing to the reason why there was a participant who felt they did not need to alter their water intake. Further, this is likely due to their belief that they already practice exceptional hydration.

Based on the participants survey answers, their drinking pattern mainly indicates a response to their thirst cues and not necessarily a drink to replenish the water being lost as they perspire during the game. The participants were optimistic when playing on natural grass and not excited when they play on artificial turf. The participants displayed an understanding regarding the importance of hydrating during the game and the importance of opting to rest when feeling symptoms related to heat illness. The results from the first survey indicate that 100% of participants felt they exerted more energy and felt a temperature difference when playing on the artificial turf as opposed to the natural grass.

The results of the second survey indicated a gap in knowledge regarding the most accurate amount of water that should be consumed to restore the amount lost while playing. This is a very important aspect of the study and an area that should be explored further. The knowledge athletes receive as to how to properly care for themselves and rehydrate after a game is critical in their physical and psychological well-being. Educating the athletes is the main point of intervention to ensure proper knowledge and bridge the gap between knowing the importance of hydration and the act of knowing how to properly rehydrate. The hydration group specifically was surprised by the amount of water needed to properly hydrate. They stated they felt dehydrated at a point in time. Overall, the results indicated that the participants are planning on implementing changes to their hydration behaviors before, during, and after a game or practice.

The very purpose of the scientific study, from which our data was collected, was to determine if there was a large disparity between the health and wellbeing of the individuals who are pushing their bodies to the limit in extreme weather conditions. The data were collected in a series of measurements taken to determine the hydration levels of a group of soccer players, including taking their precise weight, measuring their BMI on a bioelectric impedance machine,

and taking urine samples after each quarter of an outdoor soccer match. These steps were done to determine exactly how the subjects' bodies were reacting to the heat and texture of each field. After the data was collected and analyzed by our team, the results were unexpectedly very similar when comparing the two surfaces' effects on the player's body temperature and activity levels.

In our study, the data was presented to the participants to understand the perspectives the players experienced when learning about how their own bodies were affected by playing on a very hot surface. For all the participants, there was an initial understanding of the importance of drinking water when living an active lifestyle. However, the most unexpected portion of the results to the participants was the amount of water loss that occurs within a single soccer match. Most athletes are comfortable with drinking a single water bottle after a two-hour game. This idea quickly became an incorrect assumption by the participants after learning there was about a greater than 3% percent decrease in overall body weight due to water loss. To replenish the amount of water loss, the participants would be required to drink an equivalent amount of water post soccer game. To properly prepare for an event, players are advised to hydrate days before to better prevent severe dehydration, with no difference if played on artificial turf or natural grass. It is also important to mention that athletes are often unaware of their hydration and nutrition until they experience extreme heat exhaustion. Therefore, in correlation with our expectations, the participant's perceptions of hydration habits changed in favor of increasing fluid intake before, during, and after an athletic event.

One major limitation of this study is the questionnaire's attrition rate. There was about a 50% decrease in the number of participants answering the surveys compared to those that competed in the preliminary study in September of 2021. Future research should investigate

attaining a larger sample size when performing the surveys. The cause of high attrition rate was most likely due to time conflicts and lack of incentives. Further, the time in between the preliminary study and the survey could have played a role in the higher attrition rate. The six-month period between these two events may be associated with a decrease in interest and participation. Future research should consider looking into ways of maintaining contact with participants in between phases of the study.

In figure A.1 general hydration practices and perceptions playing on different fields, we asked the participants to state their first and last name. This was to help us identify if they were in the hydration group or non-hydration group for the first survey. We did not use their personal information for this study as stated in the consent form. The study consisted of 100% males. We included more questions on the survey than we included in our results due to some data not being relevant to this specific study. We did not focus on the type of fluids the participants consumed, instead we focused on how much fluids they consumed before, during, the day of, and after a game.

Next, in figure A.2 fluid intake and preference of field types, we continued with the first survey, we mainly focused on the number of times the participant consumed fluids and we continued to look at their fluid intake during a game and after a game. We also looked at their preference for playing on different surfaces. This question was extremely important to our study because we wanted to see how their preference affected their water loss on the field they played on. The participants lost the same amount of water on both fields and reached their maximum sweat rate. We also wanted to see how the participants felt about playing on artificial turf or natural grass in 90 degree or hotter weather. The participants were leaning to not being excited about playing on artificial turf, however, their feelings changed when we asked if they enjoyed

playing on natural grass. The participants did not choose that they were not excited, instead they were shifting more towards being optimistic about it.

Moreover, in figure A.3 field observations, concluding the first survey, we asked the participants if they felt they ran longer distances on the different types of surfaces or if they felt as if they ran the same distance on both. From our research study from September 2021, it was said that the athletes ran longer distances on artificial turf. This was interesting to us because most of the athletes did not consider the difference in field types and how it could affect their endurance. Additionally, we asked the athletes if they felt they ran faster speeds on natural grass or artificial turf. According to the results from the study in September 2021, the athletes ran slightly faster speeds on artificial turf. This is due to the cutting speeds being faster on this surface and more muscles and tendons are being used on natural grass for athletes to maintain their form on an uneven surface.

In figure B.1 survey after viewing the results, regarding the second survey about the athletes related experiences from the hydration study, we asked questions after showing the athletes their results from the September 2021 study. We asked the participants if they felt they were dehydrated at any point. Most of them said they dehydrated were after viewing the results. The next questioned asked if the participants felt more dehydration playing on artificial turf or natural grass, the same participants said they felt more dehydration when they played on artificial turf. When we asked if the participants would change their water intake before, during, or after a game, about 80 to 90 percent of participants said they would change their water intake. They saw how quickly they reached their sweat rate. After viewing the results six months after playing in extreme heat conditions, the participant's overall perspective about hydration mostly changed.

We decided to not include all the questions in this research study because it did not pertain to an athlete's perception. The questions that were not used in this study was due to the results being used by Dr. Chase Straw and Dr. Steven Riechman to compare their data from September 2021 to the perceptions of the Men's Club Soccer team.

Overall, this study offers data that indicates a need for athletes to be informed about the possibilities of heat stress and the effect proper hydration plays in their comfort and performance. This study also offered the opportunity to investigate the gaps in the literature that fail to indicate the effect of the type of field they perform in. In addition to that, including extreme hot temperatures and how it affects them directly and through the environment. Moreover, not only the effect it has on the athlete, but it includes factors such as hydration and performance that were examined in our study.

Future research needs to investigate the performance of athletes using a larger sample size and the differences between artificial turf and natural grass. Another approach that should be taken is viewing the different types of fields other than artificial turf and natural grass. In addition to that, since our study consisted of the men's club soccer team exploring other sports would be an addition to sports performance and hydration status. Lastly, since the focus was also 100% males front the team a shift in looking at both males and females will help better understand the gap there is in literature.

The research conducted is a valuable addition to the knowledge gap that would assist athletes, coaches, and trainers in how to better prepare their athletes for hot playing conditions for different field surfaces.

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**APPENDIX A: ATHLETE PERCEPTIONS OF HYDRATION WHEN
COMPETING ON NATURAL GRASS VERSUS ARTIFICIAL TURF IN
EXTREME HEAT CONDITIONS HYDRATION SURVEY 1**

Page 1

Hydration Survey #1

The purpose of this survey is to gather information about your general hydration practices and perceptions of natural grass versus artificial turf fields. Please answer these questions assuming you are playing a game in 90+ degree weather.

Please provide your first and last name

How old are you?

What is your gender?

- Male
- Female

How many days in advance of a game are you hydrating?

- Same day
- 1-2 days
- 3-4 days
- 5+ days

At practice or a game, how important do you feel is it to drink fluids?

- Not that important
- Important
- Very important

Do you drink sports drinks or water?

- Sports drink
- Water
- Neither
- Both

How many ounces of fluids are you drinking THE DAY BEFORE a game

- 8 oz (1 cup)
- 16 oz (2 cups)
- 24 oz (3 cups)
- 32 oz (4 cups)
- 40 oz (5 cups)
- 48 oz (6 cups)
- 56 oz (7 cups)
- 64 oz (8 cups)
- 72 oz (9 cups)
- 80 oz (10 cups)

How many ounces of fluids are you drinking THE DAY OF a game

- 8 oz (1 cup)
- 16 oz (2 cups)
- 24 oz (3 cups)
- 32 oz (4 cups)
- 40 oz (5 cups)
- 48 oz (6 cups)
- 56 oz (7 cups)
- 64 oz (8 cups)
- 72 oz (9 cups)
- 80 oz (10 cups)

Figure A.1 General Hydration Practices and Perceptions Playing on Different Fields

How many ounces of fluids are you drinking DURING a game?	<input type="radio"/> 8 oz (1 cup) <input type="radio"/> 16 oz (2 cups) <input type="radio"/> 24 oz (3 cups) <input type="radio"/> 32 oz (4 cups) <input type="radio"/> 40 oz (5 cups) <input type="radio"/> 48 oz (6 cups) <input type="radio"/> 56 oz (7 cups) <input type="radio"/> 64 oz (8 cups) <input type="radio"/> 72 oz (9 cups) <input type="radio"/> 80 oz (10 cups)
How many ounces of water are you drinking AFTER a game?	<input type="radio"/> 8 oz (1 cup) <input type="radio"/> 16 oz (2 cups) <input type="radio"/> 24 oz (3 cups) <input type="radio"/> 32 oz (4 cups) <input type="radio"/> 40 oz (5 cups) <input type="radio"/> 48 oz (6 cups) <input type="radio"/> 56 oz (7 cups) <input type="radio"/> 64 oz (8 cups) <input type="radio"/> 72 oz (9 cups) <input type="radio"/> 80 oz (10 cups)
During a practice or game, WHEN do you drink fluids?	<input type="radio"/> When I am thirsty <input type="radio"/> When I am hot <input type="radio"/> Only during scheduled breaks <input type="radio"/> When my coach tells me to <input type="radio"/> I don't drink fluids during practices or games
Do you prefer to play on artificial turf or natural grass?	<input type="radio"/> Artificial turf <input type="radio"/> Natural grass <input type="radio"/> No preference
When playing on artificial turf in 90+ degree weather I feel	<input type="radio"/> Excited <input type="radio"/> Optimistic <input type="radio"/> Neutral <input type="radio"/> Anxious <input type="radio"/> Not Excited
When playing on natural grass in 90+ degree weather I feel	<input type="radio"/> Excited <input type="radio"/> Optimistic <input type="radio"/> Neutral <input type="radio"/> Anxious <input type="radio"/> Not Excited
Do you feel there was a temperature difference between the artificial turf and natural grass?	<input type="radio"/> Yes <input type="radio"/> No
Does your consumption of fluids depend on whether you are playing on artificial turf or natural grass?	<input type="radio"/> Yes <input type="radio"/> No
Does your consumption of fluids depend on anticipated air or surface temperature?	<input type="radio"/> Yes <input type="radio"/> No
During a game, if I feel like I am experiencing a heat illness at a practice or a game, I usually	<input type="radio"/> Tell my coach or teammate <input type="radio"/> Drink water <input type="radio"/> Drink a sports drink <input type="radio"/> Find a cool place to rest <input type="radio"/> Do nothing and finish my game

Figure A.2 Fluid Intake and Preference of Field Types

Do you feel you run overall longer distances on natural grass or artificial turf?	<input type="radio"/> Natural grass <input type="radio"/> Artificial turf <input type="radio"/> I run the same distances
Do you feel you run at faster speeds on natural grass or artificial turf?	<input type="radio"/> Natural grass <input type="radio"/> Artificial turf <input type="radio"/> I run the same speeds
Do you feel you are able to make more explosive effort (e.g., accelerations/decelerations) on natural grass or artificial turf?	<input type="radio"/> Natural grass <input type="radio"/> Artificial turf <input type="radio"/> I have the same explosive efforts

Figure A.3 Field Observations

**APPENDIX B: ATHLETE PERCEPTIONS OF HYDRATION WHEN
COMPETING ON NATURAL GRASS VERSUS ARTIFICIAL TURF IN
EXTREME HEAT CONDITIONS HYDRATION SURVEY 2**

Page 1

Hydration Survey #2

The questions asked in this survey are related to your experiences from the hydration study.

Please provide your first and last name _____

Were you in the hydration group? Yes
 No

Were you surprised by the amount of water needed to be consumed after the game to be properly rehydrated? Yes
 No

Do you feel you were dehydrated at any point during the study? Yes
 No
 Maybe
 Not sure

Which surface did you feel MORE dehydrated playing on, artificial turf or natural grass? Artificial turf
 Natural grass
 I did not see a difference

Based on the results of the hydration study do you think you will change your water intake BEFORE a game when playing on artificial turf? Yes
 No

Based on the results of the hydration study do you think you will change your water intake BEFORE a game when playing on natural grass? Yes
 No

Based on the results of the hydration study do you think you will change your water intake DURING a game when playing on artificial turf? Yes
 No

Based on the results of the hydration study do you think you will change your water intake DURING a game when playing on natural grass? Yes
 No

Based on the results of the hydration study do you think you will change your water intake AFTER a game when playing on artificial turf? Yes
 No

Based on the results of the hydration study do you think you will change your water intake AFTER a game when playing on natural grass? Yes
 No

Figure B.1 Survey After Viewing the Results