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The Role of Hypotonic and Isotonic Drinks in Supporting Hydration and Recovery in Team Sport Athletes – A Literature Review

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ABSTRACT

Introduction: Correct hydration is essential for athletes engaged in high-intensity activities that involve frequent changes in pace and limited opportunities to drink. Hypotonic and isotonic sports drinks play a huge role in maintaining water balance among athletes. Fluid loss during physical activity varies between individuals and depends on the environment, type of activity, and individual physiology. Mild dehydration has adverse effects on cardiovascular function, cognitive performance, including decision-making, and overall performance. Methods: We conducted a comprehensive review of the available literature from electronic databases, including PubMed and ResearchGate. Conclusions: Both hypotonic and isotonic drinks are effective in sports hydration. Hypotonic drinks get absorbed faster and are easier on the stomach during short workouts or hot weather, while isotonic drinks help replace both fluids and energy during longer training sessions. Every athlete needs a proper hydration plan adjusted to their needs.

Keywords: hypotonic drinks, isotonic drinks, hydration, osmolality

1. INTRODUCTION

Team sports are usually characterized by repeated high-intensity efforts, and the recovery time is often short during the game. Optimal fluid balance is very important for supporting their cognitive function and decision-making (Jyoti et al., 2023). Physical activity is typically associated with water loss due to thermoregulation. When fluid intake is insufficient, dehydration can develop rapidly. The amount of water loss depends mainly on the intensity and duration of the exercise (Smith et al., 2021). Dehydration over 2% of body mass, along with electrolyte loss and reduced energy substrate availability, may lower cardiac output and increase perceived exertion. It can also impair thermoregulatory function, reduce muscle blood flow, and decrease sports performance, depending on environmental and exercise conditions (Gonzalez-Alonso et al., 1995; Sawka & Noakes, 2007; Watanabe et al., 2020). Sweat loss during team sports is influenced by the varying intensities of exertion and exhibits significant variability, both among players and within a player across different phases of activity (Burke, 1997). Maintaining proper fluid intake is crucial during physical activity and becomes even more critical during extended training sessions or competitive events. Sports drinks, especially hypotonic and isotonic types, are often used to face these challenges. This paper evaluates recent studies concerning the use of hypotonic and isotonic sports drinks in the context of team sports, with a focus on hydration efficacy and performance implications.

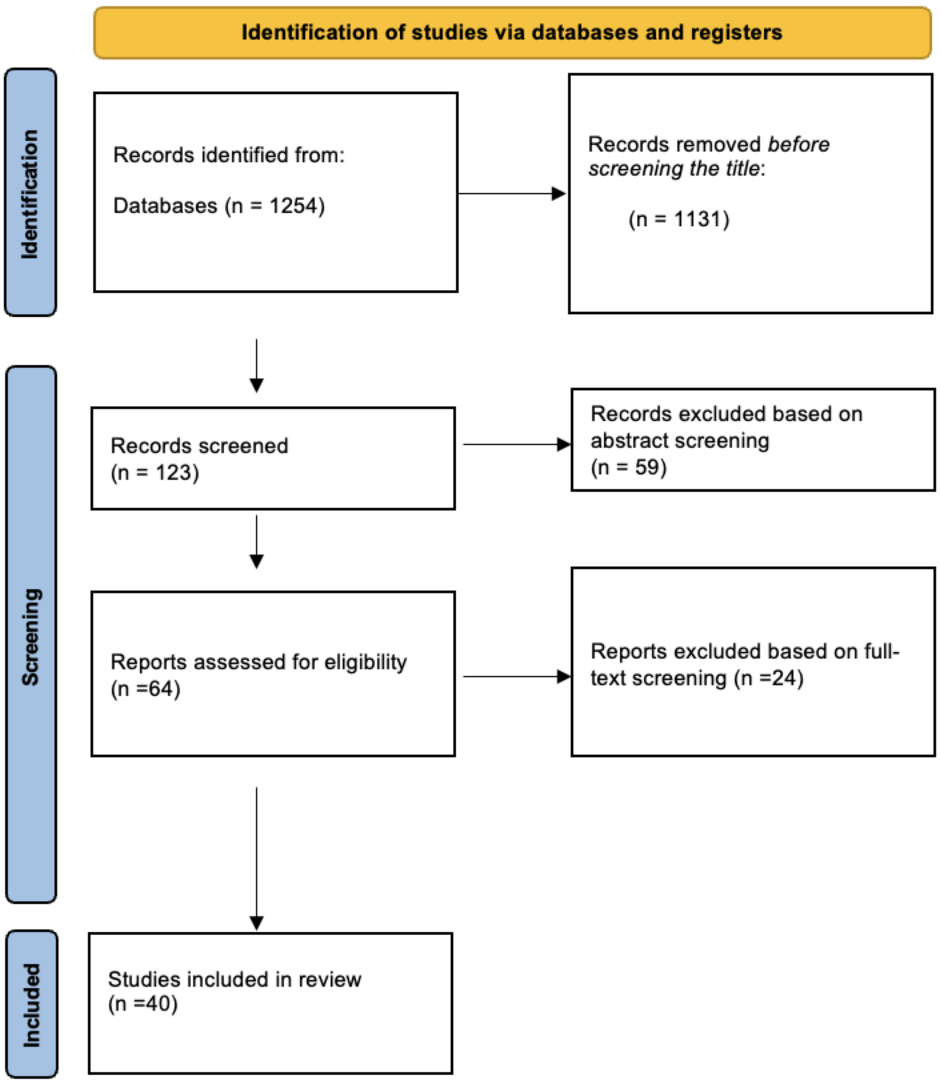

Figure 1. PRISMA flow diagram

2. REVIEW METHOD

The authors conducted this literature review with the use of databases such as PubMed and ResearchGate, using the following keywords: 'hypotonic drinks,' 'isotonic drinks,' 'hydration,' 'team sports,' and 'osmolality.' Boolean terms like "AND" and "OR" were applied to filter the search and focus on studies related to hydration and recovery in team sports. We include articles from November 1989 to February 2025. Preference was given to research published after 2010 to ensure that the review reflects current knowledge and recent findings in the field.

Inclusion criteria: This review focuses on peer-reviewed clinical studies, randomized controlled trials, and meta-analyses published in English that evaluate the role of hypotonic and isotonic drinks in hydration and post-exercise recovery in team sports contexts.

Exclusion criteria: Articles with poor methodological quality, non-peer-reviewed articles, or those published in languages other than English.

We initially filtered the search results by looking at titles and abstracts. For those studies that fit our inclusion criteria, we obtained the full texts. Ultimately, 40 studies were selected for thorough review and detailed analysis, as outlined in the PRISMA flow diagram (Figure 1).

3. RESULTS AND DISCUSSION

Hydration Demands in Team Sports

In many continuous forms of physical activity, athletes must replace fluids while still engaged in exercise, which can limit intake due to the time lost when slowing down or pausing to drink. Several situational factors shape fluid consumption in team sports. Athletes can drink during breaks, such as quarter-time or half-time intervals, during player substitutions, or in unplanned pauses in play, such as those following rule infractions or injury stoppages. The frequency and duration of these opportunities vary across sports. Usually, depending on the specific rules and the nature of gameplay (Burke, 1997). A wide range of dehydration-related factors influences fluid requirements during physical exertion. These include individual characteristics such as body mass, genetic predispositions, and level of heat acclimatization, as well as environmental conditions like high ambient temperature, elevated humidity, and the use of protective equipment (Barr and Costill, 1989; Gagnon et al., 2013). The type of physical activity performed also influences sweat loss.

Research indicates that variations in sweat rate among football players are influenced by their playing position, style of play, and the amount of time they spend on the field. Reported perspiration rates range from 0.3 to 2.5 liters per hour. In particular, higher values were observed in players competing in hot environmental conditions (Kurdak et al., 2010; Owen et al., 2013). Researchers have also noted increased sweat rates among basketball players, recording losses varying from 1.0 to 4.6 liters. However, compared to football, basketball offers more frequent chances for fluid intake due to easier access to beverages and a higher number of breaks in play (Osterberg et al., 2009). Athletes don’t all sweat the same way or need the same amount of fluids, which makes it clear that hydration plans should be tailored to the individual. If you don’t keep up with your body’s fluid needs, dehydration can sneak up on you, especially during long training sessions or full-day tournaments. Even relatively minimal fluid deficits, such as those exceeding 2% of body mass, will hamper thermoregulation. Impaired thermoregulation can affect the cardiovascular system and, as a result, compromise both cognitive function and physical performance. They are essential in fast-paced sports that require quick thinking and coordination (Shirreffs, 2009). In team sports, despite the hydration during gameplay, it is vital to recover between training sessions and matches. It is especially challenging in high-frequency competition schedules.

Recovery encompasses not only energy replenishment and muscle regeneration but also the replenishment of fluids and electrolytes. Rehydration after exercise must be rapid to re-establish plasma volume and electrolyte balance (Broad et al., 1996). Insufficient rehydration may compromise performance. It is essential to plan rest effectively to make the most of the time between matches. Proper hydration plays a crucial role between tournaments and during packed match schedules (Calleja-González et al., 2018). To meet these challenges, athletes reach for different types of sports drinks. Many specifically formulated drinks are common among athletes, such as hypotonic and isotonic beverages. Their use depends on the intensity of exercise and the time of ingestion. Water, however, is generally inadequate because it contains a relatively low amount of electrolytes and shows low retention properties (Boyd-Shiwarski et al., 2025). In the context of recovery, hypotonic and isotonic drinks offer several noticeable benefits. Hypotonic beverages enable rapid rehydration and help reduce the risk of gastrointestinal distress. Isotonic beverages supply hydration and provide carbohydrate energy, which is essential during longer performances (Pérez-Castillo et al., 2023). The amount of fluids consumed during physical activity is influenced mainly by the taste and concentration of the drink (Minehan et al., 2002). This results in changes in plasma volume and serum osmolarity.

Composition and Absorption Characteristics

Osmosis is a natural physical phenomenon that occurs when a semipermeable membrane divides two solutions with unequal concentrations. It is based on the movement of solvent molecules through the semipermeable membrane along the concentration gradient until the concentrations on both sides equalize (Raghunathan and Aluru, 2006). Osmotic pressure is the pressure that must be achieved to prevent solvent molecules from passing through a semipermeable membrane, resulting in the stopping of the osmosis process.

Hypotonic Drinks

An osmolality below approximately 275 mOsm/kg defines hypotonic drinks. They contain lower levels of carbohydrates, usually 3 g/100 mL, and variable amounts of electrolytes (Chatterjee and Abraham, 2019). Their composition, due to the low amount of carbohydrates, promotes faster gastric emptying and intestinal absorption of fluid. Several studies have reported that the jejunum exhibits higher rates of water absorption when exposed to hypotonic solutions rather than isotonic solutions (Ferreira et al., 1992; Wapnir and Lifshitz, 1985). This kind of beverage works well during short recovery periods or in cases where athletes are sensitive to how much fluid they can comfortably consume. It's most effective when the priority is fluid replacement, more than delivering extra energy. The primary uses include short training sessions and activities where carbohydrate levels are well-controlled (Chatterjee and Abraham, 2019; Skarlovnik et al., 2024). Furthermore, athletes who experience gastrointestinal complaints from carbohydrate-rich beverages tend to tolerate hypotonic solutions better. They are beneficial in hot conditions or in team sports that require rapid recovery between training periods (Leiper et al., 2001).

Suzuki et al., (2013) investigated the effect of the osmolality of sports drinks on the immunoendocrine response in cyclists training in high-temperature conditions. They compared three types of fluids: a hypotonic drink composed of 0.5% maltodextrin, 1.2% fructose, and 2.4% sucrose; an isotonic drink made up of 2% sucrose and 4% glucose; and plain water.

Isotonic Drinks

Isotonic drinks have an osmolality similar to blood plasma, ranging from 275 to 300 mOsmol/kg (Rowlands et al., 2022). The carbohydrate and electrolyte content varies, but together they result in an osmotic pressure similar to that of blood. Currently, no internationally accepted definition specifies the exact composition of carbohydrates and electrolytes in solutions (Ruiz Díaz and García Pérez, 2022). The composition of isotonic drinks provides a balance between fluid replacement and energy replenishment. This makes them appropriate for long-duration activities and extended training sessions, especially in team sports, where both rehydration and carbohydrate supply are essential (Shirreffs, 2009). The meta-analysis conducted by Rowlands et al. examined the effects of hypotonic, isotonic, hypertonic drinks, and water on delta percent plasma volume (dPV) during exercise. The studies found that the most significant reduction in dPV during exercise occurred after the consumption of isotonic drinks (overall mean dPV − 8.7%).

In comparison, researchers observed the smallest reduction during the intake of hypotonic drinks (− 6.3%) and water (- 7,5%) (Rowlands et al., 2022). Such results make a suggestion that that isotonic drinks may be less effective in the hydration of team sports athletes. The rate and extent of gastric emptying and intestinal absorption depend on multiple factors, including fluid volume, exercise intensity, stress, and osmolality (Brouns and Kovacs, 1997; Maughan and Leiper, 1999). In the case of isotonic drinks, the situation varies depending on the level of osmolality—values above 290 mmol/kg lead to an initial secretion of water into the intestinal lumen, which can exacerbate dehydration. However, even beverages with osmolality between 280 and 190 mmol/kg are not absorbed the fastest (Samuel et al., 2006). Higher carbohydrate concentrations in isotonic drinks delay gastric emptying compared to hypotonic beverages (Maughan, 1998). The findings indicate that while isotonic drinks can be efficient in rehydrating and providing energy, their effectiveness depends on specific osmolality and carbohydrate content. The study conducted by Shi et al. examined how sports drinks with 6% and 8% carbohydrates affect the stomach during intense, stop-and-go exercise. Thirty athletes completed four rounds of 12-minute drills, which included sprints, jumps, and shuttle runs. The 8% drink led to more stomach pain and cramping, especially in the later rounds. Studies show that solutions with higher carbohydrate levels and greater osmolality, as in isotonic drinks, can promote gut issues in intensive training (Shi et al., 2004).

Electrolyte Content in Hypotonic and Isotonic Drinks

Electrolytes play a key role in sufficient body hydration. The most important are sodium and chloride. They help the body stay properly hydrated by regulating fluid balance, regulating nerve function, and facilitating muscle contraction during physical activity. Sodium stimulates sugar and water absorption in the small intestine while also helping to maintain extracellular fluid volume. Additionally, sodium increases thirst by maintaining a stable blood concentration (Maughan et al., 2007). Sweat usually contains between 40 and 60 mmol/L of sodium. This results in a loss of 20 to 90 mmol of sodium in one excretion when sweat rates range from 0.5 to 1.5 liters per hour. Wemple et al. investigated a group of six volunteers who participated in three dehydration/rehydration protocols using different fluids. The research showed that drinks with a moderate amount of sodium tend to taste better, which helps people drink more and rehydrate more effectively. On the other hand, when the sodium level is too high (over 60 mmol/L), it can discourage drinking and lower fluid intake (Wemple et al., 1997).

The American College of Sports Medicine suggests consuming drinks containing sodium chloride at a level of 20-30 mmol/L. Athletes should use them during exercises with high sweat rates and high sodium losses (Sawka et al., 2007). The research assessed urine osmolality, sweat sodium concentration, and total sodium loss through sweat during the match. The analysis revealed that there are many differences between players in sweat loss, their hydration needs, and frequency of drinking during a match in cool conditions. The evidence indicates that an individual hydration strategy is necessary (Maughan et al., 2007). Another study, undertaken by Barnes et al., collected data from 1303 athletes to demonstrate sweat levels in different types of sports. The results indicate that there is a significant difference between American football players and endurance performers. These two sports disciplines are connected with higher sweat and sodium loss rates than athletes in other team sports, such as basketball and soccer. Experts emphasize the importance of tailoring sports drinks to the specific sport discipline in terms of electrolyte content (Barnes et al., 2019).

Despite the sodium and chloride content, the presence of other electrolytes, such as potassium and magnesium, is also essential. Potassium is lost through sweat as well, but its concentrations are much lower than sodium. Approximately 2–8 mmol/L (Baker, 2017). However, the study conducted by Baker et al. indicates that exercise intensity has minimal effect on potassium loss through sweat in practical settings (Baker et al., 2019). Some believe that drinks containing potassium may help draw water into cells, which promotes intracellular hydration (Rehrer, 2001). However, when it came to rehydrating the body, drinks containing potassium chloride worked just as well as those containing sodium chloride. There was no significant difference in the amount of total body water restored (Maughan et al., 1994). Another electrolyte is magnesium, which is essential for muscle function, especially among athletes. During exercise and in hot conditions, the body usually retains magnesium quite effectively. Its part in hydration is thought to be minor, much like other naturally occurring ions or those included in beverages (Maughan, 1991).

Table 1. Summary of Hypotonic and Isotonic Drinks Usage

Aspect	**Hypotonic Drinks**	**Isotonic Drinks**
Osmolality	< 275 mOsm/kg (Chatterjee and Abraham, 2019)	275–300 mOsm/kg (Rowlands et al., 2022)
Main Components	Low carbohydrates (~3g/100 mL), variable electrolytes (Chatterjee and Abraham, 2019)	Moderate carbs (6–8%), electrolytes (Na^+, Cl^-, etc.) (Shi et al., 2004)
Absorption Rate	Rapid gastric emptying and intestinal absorption (Ferreira et al., 1992; Wapnir and Lifshitz, 1985)	Slower absorption, especially with higher carb concentrations (Maughan, 1998)
Use Case	Short workouts, hot environments, sensitive stomachs (Leiper et al., 2001)	Long-duration exercise requiring energy and carbohydrates replacement (Shirreffs, 2009)
Plasma Volume Retention	Better retention of plasma volume (dPV -6,3%) (Rowlands et al., 2022)	Greater reduction in dPV (−8.7%) compared to hypotonic drinks (Rowlands et al., 2022)
Inflammatory Response	May reduce IL-6 levels post-exercise (Suzuki et al., 2013)	Less effective than hypotonic drinks in reducing immune response (Suzuki et al., 2013)
Side Effects	Low risk of gastrointestinal distress (Leiper et al., 2001)	Higher chance of gastrointestinal issues with higher carbohydrates concentration (Shi et al., 2004)

4. CONCLUSION

Adequate hydration for team sports players is essential to sustain optimal performance and recovery. This review underlines the crucial role of sports drinks in fluid and electrolyte balance. The electrolyte content, especially the level of sodium, affects water retention and thirst. Because athletes lose sweat at different rates and have unique electrolyte needs, hydration plans should be tailored to each individual. Research shows that using both kinds of drinks can be effective, depending on individual needs. Although more research is needed to develop precise hydration recommendations for team sports athletes.

Author's Contributions

Conceptualization, A.G. and M.W.; Methodology, A.G. and A.K.; Software, N.G. and M.W.; Validation: F.C. and M.W.; Formal analysis: A.S. and A.R.; Investigation: P.L. and A.Z.; Resources: A.Z. and A.R.; Data curation: P.L. and M.W.; Writing- Original- draft preparation: A.S. and A.Z.; Writing-review and editing: A.K. and N.G.; Supervision: A.G. and P.L.; Project administration: A.G., N.G., A.K., A.S., P.L., A.R., A.Z., F.C., M.W.

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Informed consent

Not applicable.

Ethical approval

Not applicable.

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Conflict of interest

The authors declare that there is no conflict of interest.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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