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URINE MARKERS FOR HYDRATION MONITORING: PRACTICAL ASSESSMENT AND INTERPRETATION

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KEY POINTS

- Urine markers reflect renal responses to water balance and osmotic load, so they are best treated as screening and trend indicators rather than precise measures of hydration status.
- The first void after waking is the most practical standardized urine sample for routine field monitoring. Arbitrary later spot samples should not be interpreted using the same thresholds developed from first-morning urine.
- Urine osmolality is the most direct laboratory measure of urine concentration, urine specific gravity is the most practical quantitative field marker, urine color is the simplest self-assessment tool, and urine volume and void frequency add behavioral context.
- Hydration thresholds must match the assessment question. For euhydration screening, commonly cited first-morning urine values include urine specific gravity < 1.020, urine osmolality < 700 mOsm/kg, and urine color scale < 4/8, whereas adequate daily water intake targets generally reflect lower urine specific gravity < 1.013 and urine osmolality ≤ 500 mOsm/kg.
- Urine volume and concentration can be influenced by the type and cause of fluid loss, sample timing, acute fluid intake, diet, physical activity, environmental exposure, body size and composition, aging, medications, and illness.
- Combining simple indicators such as morning body mass, urine concentration or color, thirst, void frequency, and fluid intake can improve the accuracy of practical hydration monitoring.

INTRODUCTION

Hydration status is relevant across sport, occupational, and everyday settings because body water deficits can increase cardiovascular and thermoregulatory strain and, when sufficiently large, can impair physical function and performance. The magnitude and consequences of a deficit depend on a combination of factors, including physical attributes of the individual, environmental conditions, and the demands of the task at hand. In athletes, dehydration-induced body mass losses of 3-4% have been associated with significant reductions in muscular strength (~2%), muscular power (~3%) and high-intensity endurance performance (~10%) (Armstrong et al., 2025). However, challenges to fluid balance extend well beyond organized sport. Physically demanding work, passive heat exposure, altitude, gastrointestinal illness, diuretic use, and prolonged work or travel periods that limit routine drinking can alter water balance or renal water handling (Cheuvront & Kenefick, 2014). Even in the absence of any structured physical activity, healthy young adults may still lose ~2% of their body mass over a single day if no fluids are consumed, simply through normal daily physiological processes (Armstrong et al., 2021).

For individuals and practitioners, the challenge is determining how to monitor fluid balance in a way that is practical and meaningful outside the laboratory. Urine-based markers are attractive because they are non-invasive, accessible, and inexpensive. Markers such as urine specific gravity (USG), urine osmolality (Uosm), urine volume, void frequency, and urine color can provide useful information about renal water conservation and urine concentration, particularly when collected under standardized conditions. However, it is important to emphasize that urine is not a direct measure of body water deficit or hydration status. Rather, it reflects the kidney's response to water balance and solute load, with heavy influence of physiological, behavioral, and environmental conditions (Cheuvront et al., 2015). Therefore, the purpose of this SSE article is to describe how urine markers are measured, how sampling conditions and physiological context affect their interpretation, and how they can be incorporated into a broader, evidence-based hydration monitoring strategy.

THE ROLE OF URINE IN FLUID BALANCE

Urine is best understood as the end product of renal regulation. Under normal conditions, plasma osmolality is maintained within a narrow range (~275-295 mOsm/kg), whereas the kidneys can vary Uosm across a much wider range (~50-1200 mOsm/kg) by adjusting water excretion in order to preserve fluid and osmotic balance (Antunes-Rodrigues et al., 2014). When water loss exceeds solute loss, as with fluid restriction or hypotonic sweat loss, the resulting increase in plasma osmolality stimulates thirst and arginine vasopressin (AVP; also known as antidiuretic hormone, ADH) mediated renal water conservation (Antunes-Rodrigues et al., 2014). Urine volume therefore falls and urine becomes more concentrated. This hyperosmotic hypovolemia is often termed "intracellular dehydration" because water shifts from the intracellular to the extracellular compartment as osmotic equilibrium is restored (Cheuvront & Kenefick, 2014). When fluid intake exceeds

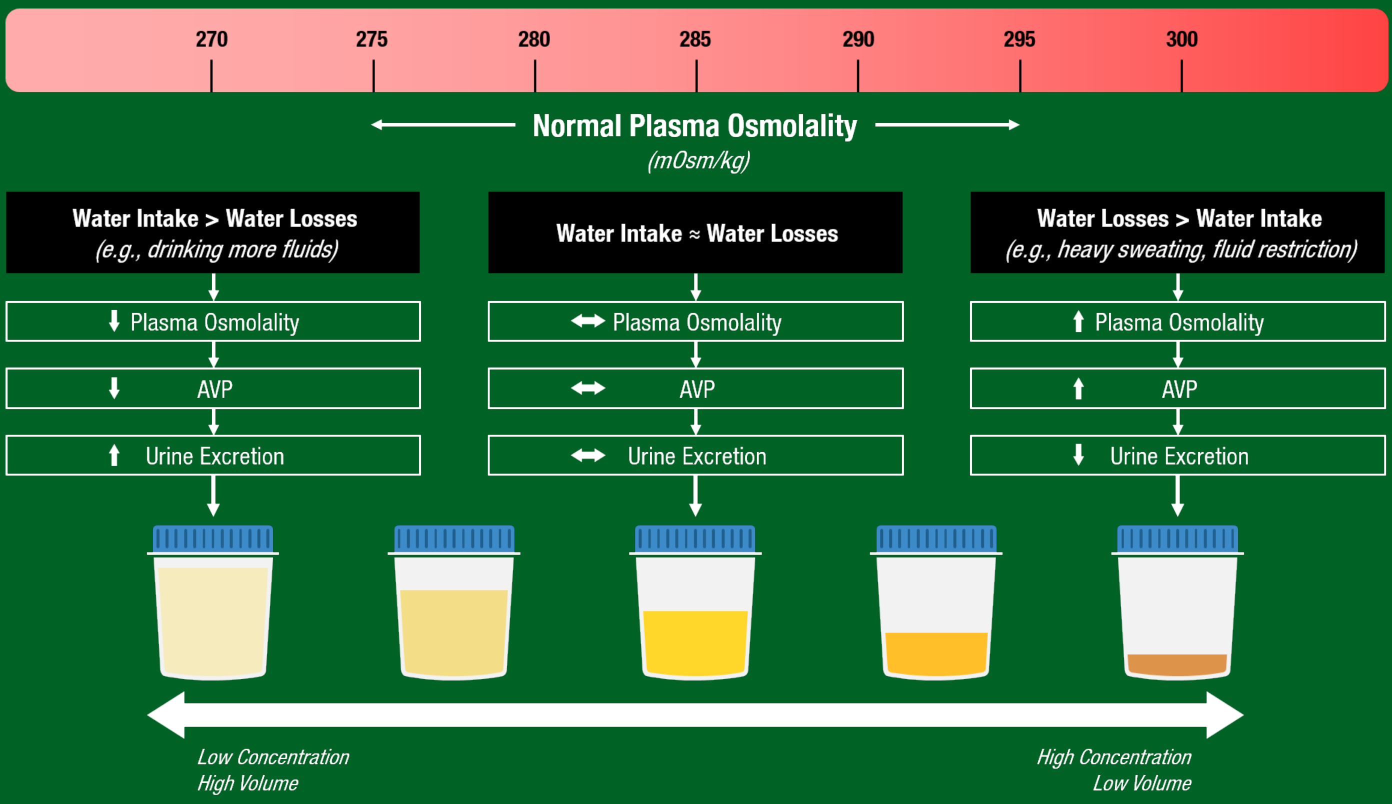

Figure 1. The reciprocal relationship between fluid balance, renal water handling, urine volume, and urine concentration. AVP, arginine vasopressin.

losses, AVP secretion is suppressed, water excretion increases, and urine becomes more diluted. Daily urine output is generally ~1-2 L/day but can increase ~10-fold when large volumes of fluid are consumed (Sawka et al., 2005). The reciprocal relationship between fluid balance, renal water handling, urine volume, and urine concentration is summarized in Figure 1.

In contrast to intracellular dehydration, iso-osmotic loss of water and electrolytes produces a proportionally greater contraction of extracellular and plasma volume without the same initial increase in plasma osmolality. This pattern, commonly termed extracellular dehydration, may occur with secretory diarrhea or loop-diuretic use (Cheuvront & Kenefick, 2014). Importantly, loop diuretics can continue to promote urinary sodium and water loss despite a developing body water deficit. As volume loss becomes sufficient, the circulatory defense mechanisms increasingly involve baroreceptor-mediated sympathetic vasoconstriction, activation of the renin-angiotensin-aldosterone system, and non-osmotic AVP release. Mixed patterns may also occur during altitude exposure, cold exposure, or gastrointestinal illness, when water and electrolyte losses arise through several pathways simultaneously (Cheuvront & Kenefick, 2014).

URINE SAMPLING

One of the primary challenges with urine-based hydration assessment is that urine concentration is highly sensitive to the conditions preceding collection. An arbitrary spot sample can be affected by recent food and fluid intake, physical activity, sweat loss, time since the previous void, environmental exposure (e.g., heat, cold, altitude, water immersion), posture, psychological stress, medication use, and age-related changes in renal water handling (Cheuvront & Kenefick, 2014; Cheuvront et al., 2015; McDermott et al., 2017). Because many urine concentration thresholds were established using standardized first-morning samples, applying those cutoffs to later, non-fasted spot samples can produce false-positive or false-negative classifications (Cheuvront et al., 2015).

For routine day-to-day monitoring, the most practical standardized urine sample is the first void after waking, collected prior to any food/fluid intake or physical activity. The use of first-morning urine void after an overnight fast minimizes key confounding influences, which in turn reduces variability and improves measurement reliability/validity of day-to-day comparisons. Muñoz and Bergeron (2023) evaluated first-morning urine in 67 healthy, recreationally active adults and found that Uosm and USG were associated with 24-h and multi-day urinary concentration measures and copeptin (estimate of AVP levels), supporting its use as a practical day-to-day screening sample. Nevertheless, first-morning urine remains a surrogate of overnight and day-to-day water balance rather than a definitive measure of hydration status or acute change later in the day. When acute hour-to-hour changes are the primary question, carefully standardized body mass is more appropriate and when the objective is to approximate 24-h urinary concentration, alternative collection windows may be considered. For example, afternoon spot samples collected between 14:00 and 20:00 h may more closely approximate 24-h urinary hydration biomarkers in some free-living adult populations (Bottin et al., 2016).

URINE HYDRATION MARKERS

Once urine sampling is standardized, the next question is which urinary marker should be used. Uosm, USG, and urine color all provide information about urine concentration, but they differ in precision, cost, accessibility, and ease of interpretation. Uosm and USG are the most widely used markers for hydration, but urine color has also been used with reasonable accuracy when laboratory analysis is not available or when a quick estimate of hydration is necessary (Kavouras, 2002). Additionally, urine frequency and urine volume are not concentration markers in the same analytical sense as these three markers, but they can provide useful behavioral context.

Urine Osmolality

Uosm is the most direct urinary measure of solute concentration. It quantifies the number of osmotically active particles per kilogram of water, providing a precise laboratory measure of urine concentration reported as mOsm/kg (Echeverry et al., 2010). Because it reflects particle number rather than particle mass, Uosm is closely aligned with the kidney's role in concentrating or diluting urine in response to water availability and solute excretion (Kamel et al., 1990). The primary limitation of Uosm in applied settings is its lack of practicality. Accurate measurement requires relatively large, specialized equipment (i.e., a freezing point osmometer) and trained personnel, limiting its feasibility for routine field monitoring. In most applied settings, it is therefore more appropriately regarded as a laboratory or research reference standard against which simpler, field-expedient measures are compared (Kavouras, 2002).

Urine Specific Gravity

USG expresses the density of urine relative to that of pure water. Distilled water has a specific gravity of 1.0000, and urine assumes progressively higher values as the concentration of dissolved substances (e.g., electrolytes, urea, and other solutes) increases (Echeverry et al., 2010). In most physiological conditions, USG and Uosm change in parallel, as both increase with greater urine concentration (Armstrong et al., 1994). However, these measures are not interchangeable. As mentioned previously, Uosm represents the number of dissolved particles per unit of water, whereas USG reflects the total density contribution of those particles, which is influenced not only by particle number, but also by their molecular size and mass (Echeverry et al., 2010). Consequently, substances such as glucose or protein can disproportionately elevate USG relative to Uosm, leading to divergence between the two measures under certain clinical conditions (Voinescu et al., 2002).

USG can be assessed using several methods, including refractometry, hydrometry, and reagent strips. In applied sport and field settings, refractometry is widely regarded as the criterion measure for USG (Stuempfle & Drury, 2003). Both manual optical and digital refractometers require only a small urine volume (2-3 drops) and provide immediate quantitative results. In contrast, hydrometers require larger sample volumes (10-20 mL) and are more susceptible to reading error, while reagent strips provide only semi-quantitative estimates and lack the precision required when small differences in USG are meaningful (Stuempfle & Drury, 2003). Wardenaar et al. (2021a) reported strong agreement between manual and digital refractometers, whereas hydrometer measurements demonstrated greater variability. Additionally, sample temperature can influence accuracy, with deviations from standard conditions introducing small but potentially meaningful errors, particularly at higher USG values. Consequently, USG measurements are preferably conducted at 20°C. Given that USG values are typically interpreted to the third or fourth decimal place, these small methodological differences may significantly influence classification of hydration status in applied contexts that have strict threshold cutoffs.

Urine Color

Urine color is the simplest urine concentration marker. The scientific basis is straightforward; as urine becomes more concentrated, the visual intensity of urinary pigments generally increases. It is typically assessed using a standardized color chart, most commonly a 7- or 8-point scale, in which lower values (e.g., 1; pale yellow) indicate dilute urine and higher values (e.g., 8; dark brown) indicate increasingly concentrated urine. Because it requires no specialized equipment and provides immediate visual feedback, urine color represents a practical and accessible tool for hydration education and routine self-monitoring (Armstrong et al., 1994; Kostelnik et al., 2021). However, measurement of urine color is subject to multiple sources of variability, including lighting conditions, container characteristics, urine volume/depth, chart design, and observer interpretation and therefore, these factors must be carefully controlled.

Collectively, the literature supports urine color as a practical field-based estimate of urine concentration, while recognizing that it lacks the precision and specificity of laboratory-derived measures such as Uosm and USG. A systematic review concluded that urine color is generally associated with USG ($r \approx 0.92$) and Uosm ($r \approx 0.74$) in adults and athletes, while also noting variability across populations (e.g., lower associations in adults > 60 yrs old) and study designs (Kostelnik et al., 2021). In athletes, Wardenaar et al. (2021b) showed that self-assessment accuracy depends partly on the urine color chart used. More objective approaches, such as CIE Lab color-space analysis, can quantify urine lightness and chromaticity, but these methods remain research tools rather than common field practice (Belasco et al., 2020).

Urine Volume and Void Frequency

Although not direct measures of urine concentration, urine volume and void frequency add additional context to the hydration story, helping to describe how much urine is being produced and how often. However, neither measure should be interpreted as a standalone indicator of hydration status, as both are heavily influenced by fluid intake/losses and the sample collection period. Consequently, 24-h urine volume is generally more informative than a single void because it captures urinary output over an entire day. In free-living adults, Perrier et al. (2013) found that 24-h urine volume, Uosm, USG and color were related to daily fluid intake, although prediction errors were too large to permit accurate estimation of fluid intake from any urinary markers alone. Void frequency provides an even simpler measure, requiring only the recording of urination events over a defined period. While less informative than urine volume or concentration measures, it may offer practical value when sample collection is not feasible, or when interpreted alongside markers of urine concentration such as urine color or USG (Adams et al., 2021).

Other Urinary Measures

Routine clinical urinalysis encompasses a broad range of variables beyond hydration assessment, including chemical parameters such as pH, glucose, protein, ketones, blood, nitrites, and leukocyte esterase, as well as microscopic examination of urine sediment (e.g., cells, bacteria, and casts) (Fogazzi et al., 2008). These measures are valuable in medical evaluation, but most are not primary hydration markers. Urine sodium, potassium, and chloride can help clinicians interpret fluid/electrolyte and acid-base disorders, but Kamel et al. (1990) emphasized that there are no universal “normal” values for urine electrolytes, therefore the interpretation depends on the clinical situation. For hydration monitoring, these markers should be reserved for specific medical or research questions.

RECOMMENDED CUTOFFS & THRESHOLDS

Although urine concentration is inherently continuous, hydration assessments frequently rely on categorical thresholds to guide decision-making. The utility of such thresholds depends on the context in which they are applied, including the timeframe and purpose of the assessment. Cutoff values developed to identify acute hypohydration may not be appropriate for evaluating habitual fluid intake or longer-term hydration patterns because these represent distinct physiological constructs. An individual may maintain euhydration across a wide range of fluid intakes due to substantial variation in water losses, dietary solute load, and renal handling of water and solutes, both within and between individuals (Cheuvront & Kenefick, 2016). Consequently, no single urine cutoff should be regarded as a universal definition of dehydration or adequate fluid intake. Commonly used screening criteria and values include USG < 1.020, Uosm < 700 mOsm/kg, and urine color < 4, that are generally interpreted as reflecting euhydration (Cheuvront & Sawka, 2005; Kavouras et al., 2016; Sawka et al., 2007). These values were proposed alongside other acceptable euhydration criteria, including plasma osmolality < 290 mOsm/kg, total body water change < 2% and body mass change < 1% (Cheuvront & Sawka, 2005).

The most common urine-based threshold in sport is a USG of 1.020. Values below this cutoff are generally considered consistent with euhydration, whereas values ≥ 1.020 are often interpreted as indicating hypohydration. However, a USG ≥ 1.020 should not automatically be described as dehydration unless the sample timing and broader hydration context support that conclusion. Sommerfield et al. (2016) illustrated this limitation in NCAA male wrestlers and female soccer players by comparing USG with plasma osmolality. Although USG demonstrated relatively high sensitivity for identifying dehydration (92% in males and 80% in females), specificity was poor, ranging from 6-10% in males and 29-40% in females. As a result, reliance on a USG threshold of 1.020 may lead to substantial overclassification of hypohydration, particularly given that some position statements have accepted a more permissive threshold of 1.025 to account for individual variability (Thomas et al., 2016; McDermott et al., 2017). This uncertainty becomes even more apparent when different urine-based definitions of dehydration status are compared directly. Hew-Butler et al. (2018) evaluated 318 hydration assessments in collegiate athletes and found that the proportion classified as “dehydrated” varied substantially depending on the marker and threshold applied. A criterion of Uosm ≥ 700 mOsm/kg classified 55% of athletes as dehydrated, whereas a USG criterion of ≥ 1.020 classified 27% as dehydrated. In contrast, no athlete met the clinical definition of dehydration based on a serum sodium concentration > 145 mmol/L. Collectively, these findings underscore an unresolved issue within the hydration literature, where there is no universally accepted urinary cutoff for defining dehydration. Reported Uosm thresholds have ranged from 700 to 900 mOsm/kg, and their applicability may vary across populations and dietary contexts (Baron et al., 2015).

The screening values described above are generally intended for the practical classification of euhydration versus likely hypohydration, particularly when first-morning urine samples are used. In contrast, Perrier et al. (2015) proposed a 24-h Uosm target of ≤ 500 mOsm/kg as a desirable indicator of adequate daily water intake from a health-oriented perspective. In a subsequent analysis of 817 urine samples, Perrier et al. (2017) reported that a USG threshold of 1.013 identified Uosm values > 500 mOsm/kg with very high accuracy (area under the curve (AUC) = 0.984), whereas self-assessed urine color ≥ 4 demonstrated high sensitivity and moderate specificity (AUC = 0.831). From a practical standpoint, a USG value < 1.013 may therefore be appropriate when the objective is to identify urine concentrations consistent with adequate daily water intake, whereas USG < 1.020 remains the more commonly applied threshold for hydration screening.

Urine color thresholds require similar contextual interpretation. Although a urine color score ≥ 4 is commonly used to indicate more concentrated urine, its practical value lies in providing individuals with a readily observable feedback tool without any instrumentation. Perrier et al. (2016) reported that a two-shade decrease on the 8-point urine color scale corresponded to an increase in daily fluid intake (~1110 mL), urine volume (~1011 mL), and a reduction in USG (~0.008 units), with similar but opposite changes observed when urine color darkened by two shades. Moreover, urine color becomes stronger when it is paired with another simple marker. For example, Adams et al. (2021) evaluated urine color in conjunction with void frequency in 101 adults and 210 children using elevated Uosm ≥ 800 mOsm/kg as the criterion for underhydration. In adults, urine color score ≥ 4 combined with < 7 voids/day identified underhydration with 97% overall diagnostic ability, 100% sensitivity, and 88% specificity. In children, urine color score ≥ 4 combined with < 5 voids/day identified underhydration with 89% diagnostic ability, 100% sensitivity, and 62% specificity.

Regardless of the tool or cutoff employed, individualization is critical for accurate interpretation of hydration markers. Armstrong et al. (2025) emphasizes the importance of developing personal reference values for metrics such as body mass, USG, and perceived thirst, as hydration responses vary substantially across individuals due to differences in physiology, physical activity demands, environmental conditions, and habitual behaviors. For example, a typical euhydrated USG baseline may fall between ~1.015 and ~1.025 in some individuals, meaning that the commonly applied threshold of 1.020 may misrepresent hydration status if interpreted in isolation. Establishing these individualized baselines therefore allows for more meaningful comparisons over time and improves the sensitivity and specificity of hydration assessment in applied settings.

FACTORS THAT CAN SHIFT URINE MARKERS

As emphasized throughout this SSE article, urine markers are very sensitive to hydration behavior. However, they are also sensitive to numerous physiological, behavioral, and environmental conditions. As alluded to in the section “Urine Sampling”, time of day is one of the strongest practical influences. First-morning urine is often more concentrated than urine collected later in the day because it reflects overnight water conservation. Armstrong et al. (2025) note first-morning USG and thirst tend to be greater than midday or afternoon values. Wilson et al. (2025) reported similar findings, where median fasted first-morning USG was higher than non-fasted spot USG (1.018 vs. 1.011), and the proportion of participants with USG ≥ 1.020 was nearly twice as high in first-morning samples compared with later spot samples (41.8% vs. 21.6%). A large reason for this disparity is because acute drinking behavior shifts urine markers rapidly, even when it does not fully replace a prior body water deficit. Rapid consumption of a large volume of water or diluted beverage, such as ~1.4 L in 30 min, can reduce USG to < 1.010 in both well-hydrated and dehydrated individuals as the kidney defends against fluid overload (Armstrong et al., 2025). In contrast, consuming the same volume gradually produces smaller changes in USG. Therefore, a low USG after rapid drinking should not be interpreted as proof that an individual has fully restored body water.

Dietary solute load is another important modifier. Because USG reflects urine density, it is influenced not only by water availability but also by the amount and type of solute being excreted. Higher protein intake can increase urea production, which may increase urine concentration independent of fluid deficit (Wilson et al., 2025). Additionally, high sodium intake, creatine supplementation, and other nutrition practices may increase urinary solute concentrations independent of hydration status, potentially through elevated concentrations of protein and muscle metabolites such as creatinine, urea, and uric acid (Wilson et al., 2025). Urine concentration can also be influenced by body size and body composition. Analysis of NHANES data from 3,634 adults found that higher body mass index (BMI) and estimated lean body mass were associated with greater odds of exceeding common USG thresholds, raising concerns about the specificity of fixed cutoffs in larger or more muscular individuals (Wilson, 2021). Consistent with these findings, overweight and obese adults have been reported to exhibit higher Uosm than normal-weight individuals despite similar thirst perceptions, suggesting that more concentrated urine in larger individuals does not necessarily reflect greater subjective hydration stress (Adams et al., 2022). Wilson and Winter (2024) extended these findings by reporting a positive association between fat-free mass and USG in athletes and

Use case	Marker(s)	Sample/window	Cutoff value	Best interpretation
Euhydration screening	USG	First-morning urine preferred	< 1.020	Urine concentration consistent with euhydration screening
Euhydration screening	Uosm	First-morning urine preferred	< 700 mOsm/kg	Urine concentration consistent with euhydration screening
Euhydration screening	Urine color	First-morning urine preferred	< 4	Visual estimate consistent with less concentrated urine
Adequate daily water intake	24-h Uosm	24-h urine collection	≤ 500 mOsm/kg	Health-oriented target for lower urine concentration across the day
Adequate daily water intake surrogate	USG	Individual void sample	< 1.013	Field surrogate consistent with 24-h Uosm ≤ 500 mOsm/kg
Adequate daily water intake surrogate	Urine color	Individual void sample	< 4	Practical visual surrogate consistent with 24-h Uosm ≤ 500 mOsm/kg
Daily behavior feedback	Change in urine color	Repeated self-assessment using spot urine collection	2-shade change	Approximate change of ~1.1 L/day in fluid intake and ~0.008 units in USG
Combined self-screening	Urine color + void frequency	24-h recall or daily tracking	Adults: urine color ≥ 4 + < 7 voids/day; children: urine color ≥ 4 + < 5 voids/day	Combined marker for elevated Uosm/ underhydration screening
Multi-item self-assessment	Fluid intake + void frequency + void volume + urine color	Combined 24-h recall and spot urine assessment (morning or afternoon)	Score of < 2	Scores of 0-1 suggest low urine concentration (24-h USG < 1.013); scores of 2-4 suggest higher urine concentration (24-h USG ≥ 1.020)

Table 1. Common urine-based hydration thresholds and how they should be interpreted.
Note. Urine color values assume use of a standardized 8-point color scale. Some guidance allows first-morning urine specific gravity (USG) value up to < 1.025 to account for individual variability; USG < 1.025 is also used in certain weight class and body composition assessment protocols. Some guidance identifies urine osmolality (Uosm) > 900 mOsm/kg as consistent with hypohydration, leaving values between 700 and 900 mOsm/kg without a single categorical interpretation.

physically active adults. More recently, Wilson et al. (2025) observed that fat-free mass, skeletal muscle mass, and total body water were associated with non-fasted spot USG, but not fasted first-morning USG, suggesting that sampling conditions may influence the extent to which body composition affects urine concentration.

Recent physical activity can further complicate interpretation by increasing urine concentration through sweat loss, reduced renal blood flow, sympathetic activation, and hormonal responses that conserve water. However, the magnitude and direction of urine changes depend on a multitude of factors, including exercise duration, intensity, environmental heat stress, fluid intake during exercise, and the time between exercise and urine collection (Cheuvront et al., 2015). Consequently, spot urine samples collected shortly after physical activity may not accurately reflect an individual's habitual hydration status and can increase the risk of hydration misclassification. Importantly, non-exercise factors can also shift urine volume and concentration in different directions. Cold exposure and water immersion may provoke diuresis through peripheral vasoconstriction and central fluid shifts, whereas moderate-to-high altitude can induce diuresis and plasma volume contraction (Cheuvront & Kenefick, 2014; McDermott et al., 2017). Psychological stress may instead promote antidiuresis through sympathetic and hormonal pathways (Cheuvront et al., 2015). Aging adds further variability, as thirst sensitivity and renal urine-concentrating ability tend to decline beyond age 50 (McDermott et al., 2017). Therefore, an atypical urine value may reflect environmental exposure or altered renal regulation rather than recent fluid intake or body water deficit alone.

Urine color has additional limitations because it is a visual measure that can be influenced by factors other than hydration. Foods, supplements, and medications may alter urine appearance; for example, riboflavin and other B vitamins can produce bright yellow urine, whereas beetroot and other red-pigmented foods may cause red or pink discoloration (Skrajnowska & Bobrowska-Korczak, 2024). However, Yates et al. (2020) found that supplementation with beetroot, riboflavin, or vitamin C had minimal effects on the clinical diagnostic utility of USG, urine volume, urine color, and Uosm following exercise-induced dehydration. Therefore, although some supplements and foods may alter urine appearance, they do not necessarily compromise urine-based hydration assessment.

SUMMARY & PRACTICAL APPLICATIONS

In summary, urine-based markers are most useful when they are collected consistently, interpreted in context, and combined with other simple field measures. Table 1 provides practical thresholds and decision rules for interpreting urine-based hydration monitoring, with emphasis on matching the cutoff to the proper assessment question (Adams et al., 2021; Armstrong et al., 1994; Baron et al., 2015; Cheuvront & Sawka, 2005; McDermott et al., 2017; Perrier et al., 2016, 2017; Sawka et al., 2007; Thomas et al., 2016; Wardenaar et al., 2026). In most applied settings, a simple approach for self-monitoring changes in hydration is the weight – urine – thirst (WUT) approach, which combines three readily accessible, simple, inexpensive markers: body weight, urine color, and thirst (Cheuvront & Kenefick, 2016). Although no single marker is sufficient to diagnose dehydration, confidence in the assessment increases when multiple markers point in the same direction (Sekiguchi et al., 2020). If two markers indicate hypohydration, dehydration becomes more likely and if all three are present, the likelihood is even greater. The same principle applies to other practical monitoring strategies mentioned in this SSE article. For example, urine color and void frequency can be used when USG or Uosm measurements are unavailable. A single dark urine sample may be difficult to interpret, but dark urine combined with infrequent voiding provides stronger evidence of underhydration. Similarly, multi-item models that incorporate fluid intake, urine frequency, urine volume, and urine color may further improve self-assessment. While these approaches do not replace laboratory measures, they offer practical tools for tracking hydration status in everyday life.

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