

Suboptimal Hydration in Collegian Folk Dancers - A Two-Microcycle Assessment of Fluid Intake and Urine Specific Gravity: An Exploratory Study

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Abstract

Proper hydration is essential for performance and health in physically demanding activities such as folk dancing. This exploratory study aimed to evaluate the hydration practices and hydration levels of collegiate folklore ensemble dancers by measuring urine specific gravity (USG) and monitoring fluid intake. A total of 18 dancers (7 males aged 17.54 ± 1.77 years, and 11 females aged 17.22 ± 1.87 years) participated in this study. Fluid intake was self-reported daily, and USG was measured from morning urine samples on training days. In analyzing men's USG values, no significant differences were found between the first and second microcycle (1.018 vs. 1.019 g.ml⁻¹); however, a medium practical effect was observed ($p=0.469$; $r=0.45$). Two males were hypohydrated during the whole study, and five were mildly hypohydrated. In contrast, the analysis for women (1.014 v. 1.012 g.ml⁻¹) revealed significant differences in USG across microcycles, indicating a large practical effect ($p=0.001$; $r=0.87$). One female was hypohydrated during the whole period, and ten were constantly mildly hypohydrated. Differences in males' fluid intake between microcycles (2.08 vs 1.84 l/day) were insignificant, but with a large practical effect ($p=0.100$; $r=0.76$). Females showed no significant difference (1.92 vs 1.81 l/day), with no practical effect ($p=0.700$; $r=0.08$). When analyzing intrasexual differences, we found significant differences ($U=245.5$; $p=0.004$) in USG values, which were higher in men, indicating a higher degree of hypohydration. Differences in fluid intake between the sexes were not observed ($U=160.5$; $p=0.846$), and average consumption was below recommended guidelines. These findings underscore the need for targeted hydration education to mitigate performance and health risks in our subjects. Promoting awareness and implementing tailored hydration strategies may enhance performance, cognitive function, and injury prevention in folklore dancers.

Keywords: dancing, physical performance, microcycle, fluid intake, USG

Introduction

Dance, as a form of human movement and cultural expression, occupies a unique position at the intersection of art, physical exertion, and ritual. Among its many forms, traditional folk dance is especially rich in ethnographic significance, serving as a medium for transmitting intangible cultural heritage across generations (Zhou & Chen, 2024). Folk dancers are not merely artists but highly conditioned performers who must harmonize aesthetic precision with substantial physical output (Oreb et al., 2011). From a physiological standpoint, traditional folk dance represents a hybrid load characterized by alternating aerobic and anaerobic energy demands. The execution of technically demanding movement patterns, often in elaborate and thermally insulating costumes, increases both metabolic rate and core body temperature, intensifying the need for effective thermoregulation and hydration (Örer & Doğu, 2017).

Dehydration, particularly hypohydration induced by insufficient fluid intake or excessive fluid loss, has been linked to a decrement in neuromuscular function, thermoregulatory capacity, cardiovascular efficiency, and cognitive performance (Armstrong, 2007). These consequences are especially relevant in dance settings, where optimal motor coordination, rhythm perception, and reaction timing are crucial for performance and injury prevention.

Moreover, the thermoregulatory burden experienced during dance rehearsals and performances, especially in warm environments or under stage lighting, can significantly accelerate fluid loss through perspiration. This burden is exacerbated by traditional costumes that limit heat dissipation, increasing susceptibility to dehydration (Rivera-Brown & De Félix-Dávila, 2012). Even mild hypohydration, defined as a loss of body water under 2% of body mass, has been shown to impair endurance performance and cognitive function (Armstrong, 2007; Jéquier & Constant, 2010). Despite these risks, research consistently reports a lack of awareness among dancers regarding hydration strategies and fluid requirements (Schmidt et al., 2024).

USG is a widely accepted, non-invasive biomarker of hydration status (Chapelle et al., 2017). In field conditions such as dance training, USG offers a feasible alternative to monitor hydration longitudinally.

However, the majority of studies examining hydration behaviour and status have focused on athletes in mainstream sports, with relatively little attention devoted to dance populations, particularly traditional or folk dancers, whose training conditions and cultural settings differ markedly from those of other physically active groups (Pettersson & Berg, 2014; Volpe et al., 2009). As a result, there exists a critical gap in our understanding of hydration patterns in this unique cohort. This gap is particularly relevant in younger, pre-professional dancers exposed to cumulative training loads under real-world conditions.

The primary aim of this exploratory study was to assess the hydration status and daily fluid intake in male and female collegiate folk dancers over two consecutive training microcycles. We hypothesized that dancers would exhibit signs of hypohydration, reflected by elevated USG values and fluid

intake below recommended guidelines, and that differences would be present between sexes and across microcycles.

Methods

Study design

In our study, we conducted a repeated-measures observational study to compare fluid intake and USG among dancers across two consecutive training microcycles. A training microcycle was defined as a one-week (7-day) period reflecting the ensemble's standard training routine. Additionally, we compared these findings with established reference values. In the subsequent phase, we examined the presence of intersex differences. Fluid intake was monitored on a regular daily basis, both on training and non-training days. Training frequency, duration, and structure were consistent across both microcycles, and no intentional manipulation of training intensity or load was implemented. The dancers recorded the amount of fluid intake in litres on prepared recording sheets. USG was collected each morning upon waking on training days, approximately 10 hours before the scheduled start of training sessions. USG measures the relative density of urine compared to distilled water. This parameter is used to assess an individual's hydration status. Normally hydrated individuals have diluted urine, while those who are hypohydrated have more concentrated urine (Warren et al., 2018).

Participants

The young dancers from the College Folklore Ensemble "Mladost" participated voluntarily in our study, with written consent obtained from their legal guardians. The male participants ($n=7$) had an average age of 17.54 ± 1.77 years, weighed 64.14 ± 5.73 kg, and had an average height of 180.43 ± 7.93 cm. The female participants ($n=11$) were 17.22 ± 1.87 years old, weighed 58.00 ± 4.31 kg, and had an average height of 167.00 ± 6.02 cm. The participants were experienced dancers, with an average training experience of 10.5 ± 2.75 years. The group practiced twice a week and took part in various dance performances and folklore festivals throughout the year. All participants in the research were healthy and had no injuries to their musculoskeletal systems. Legal representatives signed informed consent forms to confirm voluntary participation in the study. The research was approved by the local ethics committee under number 1/2024. The subjects were instructed not to consume any caffeine or alcohol during the experiment.

Measurements

Before the start of the study, all participants were provided with non-sterile tubes to use for sampling and recording sheets for fluid intake. Urine collection was conducted by all participants in the morning after waking up, while fasting, on training days, for a total of 4 times. To strictly adhere to the methodological procedures, we relied on proven methodologies of previous research. Wardenaar et al. (2021) state that an optimum temperature of $20\text{ }^{\circ}\text{C}$ should be ensured for urine density measurements; however, temperature differences up to $37\text{ }^{\circ}\text{C}$ do not affect the measurement results. Our samples

were stored in a refrigerated box and cooled to 7 °C (without a water bath) after collection. The samples were analyzed after a period of 24 hours. We waited until the samples reached room temperature. Due to the resulting sedimentation of urine, all tubes were thoroughly mixed before evaluation. An ATAGO - PAL10S (Made in Japan) pocket refractometer was used to analyse the samples, which can evaluate the USG of the applied sample in g/mL-1 in a few seconds for the examiner. A USG value of less than 1.010 g.ml-1 indicates a euhydrated state, while values between 1.010 and 1.019 g.ml-1 illustrate minimal hypohydration. USG values higher than 1.020 g.ml-1 may indicate hypohydration, and values higher than 1.030 g.ml-1 indicate a state of severe hypohydration (Chapelle et al., 2017). Before taking the initial measurement, we calibrated the instrument according to the manufacturer's instructions by applying distilled water until it registered 1.000 g/ml-1. The refractometer featured an NFC connection, allowing for easy transmission of the measured data to a computer. Fluid intake was monitored daily (on training and non-training days) over two consecutive microcycles. Bottles labelled with the amount of water intake were provided to the participants. The type and amount of fluid ingested were solely the choice of the dancers and were based on their everyday habits. No hydration education, counseling, or specific drinking instructions were provided before or during the study to preserve habitual hydration behavior. Self-reported fluid intake was chosen for its practicality and minimal disruption to usual behavior in a real-world training setting. Objective verification methods such as bottle weighing or pre-post body mass assessment were not employed to avoid influencing participants' natural drinking behavior. Fluid types varied and included water, mineral water, and sugary beverages, which may affect hydration status beyond total volume. This variability is recognized as a potential source of bias.

Statistical analysis

We evaluated the normality of the data distribution using the Shapiro-Wilk test, assessing the measured data separately for men and women. We used Wilcoxon's signed-rank test to compare the first and second microcycles. Additionally, we applied Wilcoxon's signed-rank test to evaluate the measured USG values against the reference values. The Mann-Whitney U-test was conducted to analyze differences between the sexes. A p-value of ≤ 0.05 was considered statistically significant. Cohen's r was used to determine the effect sizes. All data analyses were performed using IBM SPSS software (Version 23 for Windows; IBM, Armonk, NY, USA). Data are presented as median values with interquartile range.

Results

In the first and second microcycles, we recorded median USG values of 1.018 (IQR=0.010) g.ml-1 and 1.019 (IQR=0.004) g.ml-1 in male dancers (Table 1). This represents a +0.10% change in USG across microcycles. The differences were not found to be significant ($p=0.469$), with a medium effect size ($r=0.45$) (Figure 1). Fluid intake in male participants (Figure 2) was 2.08 l/day in the first and even lower in the second microcycle, with 1.84 l/day. This indicates a decrease of 11.5% in daily fluid intake between microcycles. Despite the lack of statistical significance, the large effect size suggests a practically meaningful reduction in fluid intake. In females (Figure 3), the USG values were higher in the first (1.014; IQR=0.005 g.ml-1) compared to the second microcycle (1.012; IQR=0.006 g.ml-1), with significant differences and a large practical effect ($p=0.001$; $r=0.87$). This indicates a positive change of 0.20% in USG values across microcycles. In the first microcycle, the female subject had a daily fluid intake (Figure 4) of 1.92 liters, which decreased to 1.81 liters in the second microcycle. There were no significant differences noted between the two microcycles, and the effect size was negligible ($p=0.700$; $r=0.08$). This reflects a 5.7% reduction in daily fluid intake.

In comparing the measured values of USG with the reference value of 1.010 g.ml-1, we observed mild hypohydration in both sexes. For males, the USG was 1.018 g.ml-1 in the first microcycle ($p=0.016$) and 1.019 g.ml-1 in the second microcycle ($p=0.016$). Based on USG thresholds, 5 of 7 male dancers met the criteria for mild hypohydration ($USG \geq 1.010$ g.ml⁻¹) in both microcycles; two were hypohydrated, while none reached values indicative of severe hypohydration. For females, the USG readings were 1.014 g/ml-1 in the first microcycle ($p=0.001$) and 1.012 g.ml-1 in the second microcycle ($p=0.001$). Among female dancers, 10 of 11 met the criteria for mild hypohydration in both microcycles; one was hypohydrated, and no cases of severe hypohydration were observed. The consistent elevation of USG values above the normative threshold of 1.010 g.ml⁻¹ highlights a persistent pattern of suboptimal hydration.

When comparing both sexes (Figure 5), significant differences were found in USG values ($U=245.5$; $p=0.004$), which were higher in male men, indicating a greater degree of hypohydration compared to women. This finding indicates that male dancers probably entered training sessions in a less favorable hydration state. Differences in fluid intake (Figure 6) between the sexes were not confirmed ($U=160.5$; $p=0.846$). Daily fluid intake in both sexes remained below the European Food Safety Authority (EFSA) and the Institute of Medicine recommendations throughout both microcycles.

Table 1. Median values and interquartile range of USG and Fluid intake for male and female dancers in the 1st and 2nd microcycle

	USG g.ml ⁻¹				Fluid Intake (l)			
	1 st microcycle	IQR	2 nd microcycle	IQR	1 st microcycle	IQR	2 nd microcycle	IQR
Male	1.018	0.010	1.019	0.004	2.08	0.670	1.84	0.900
Female	1.014	0.005	1.012	0.006	1.92	0.600	1.81	0.210

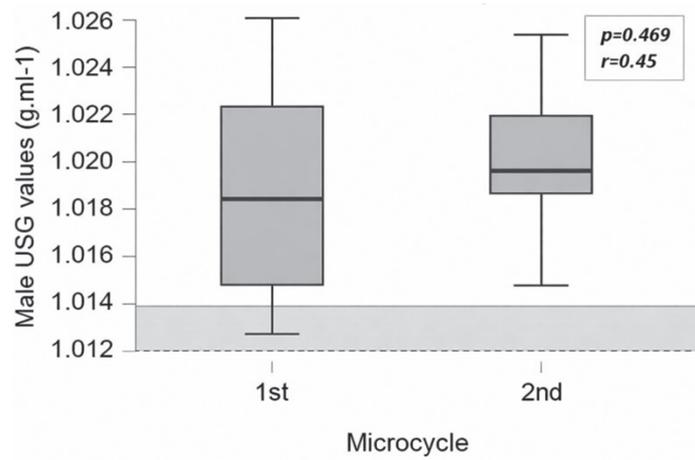


Figure 1. USG values in male dancers across two training microcycles
 Note. *p* – statistical significance, *r* – effect size. The shaded area represents the normative threshold for euhydration ($USG \leq 1.010 \text{ g}\cdot\text{ml}^{-1}$)

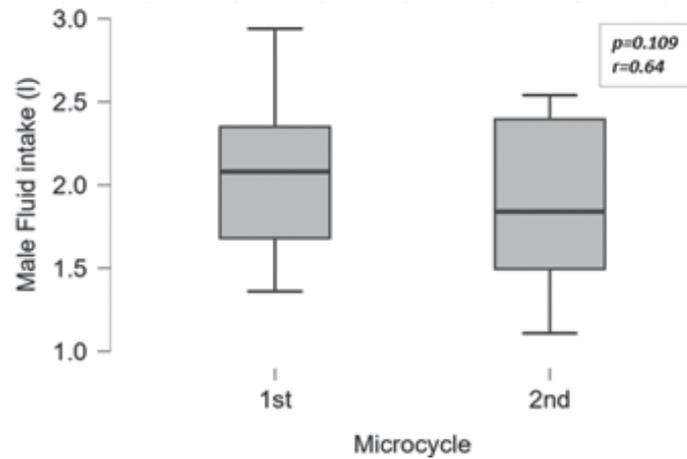


Figure 2. Daily fluid intake in male dancers across two training microcycles
 Note. *p* – statistical significance, *r* – effect size

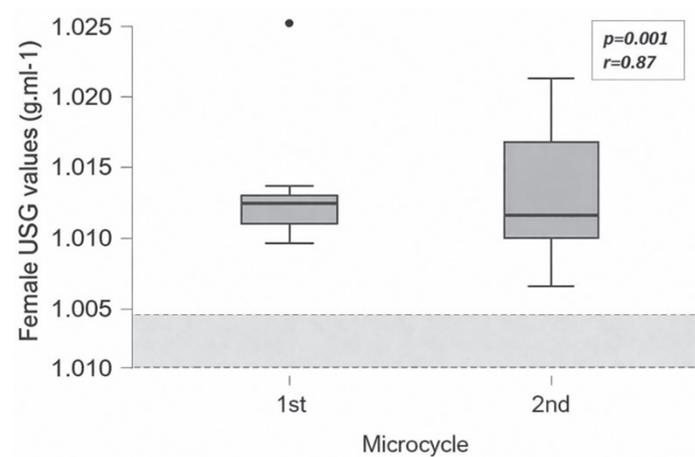


Figure 3. USG values in female dancers across two training microcycles
 Note. *p* – statistical significance, *r* – effect size. The shaded area represents the normative threshold for euhydration ($USG \leq 1.010 \text{ g}\cdot\text{ml}^{-1}$)

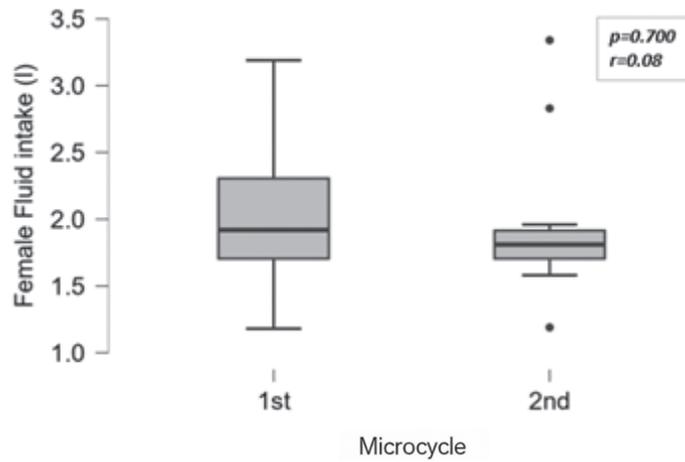


Figure 4. Daily fluid intake in dancers across two training microcycles
 Note. *p* – statistical significance, *r* – effect size

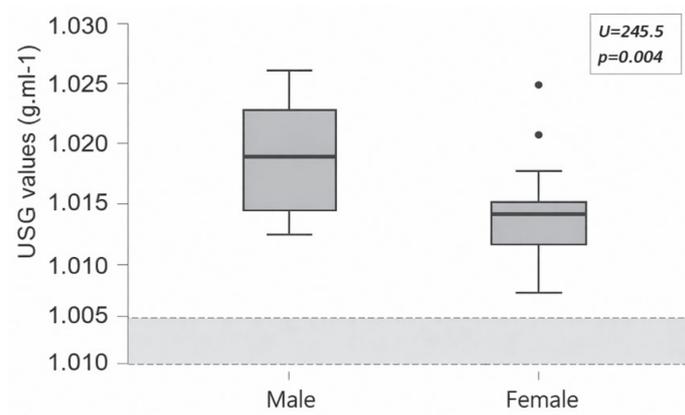


Figure 5. Comparison of USG values between male and female dancers
 Note. *U* – Mann-Whitney U-test, *p* – statistical significance. The shaded area represents the normative euhydration threshold ($USG \leq 1.010 \text{ g}\cdot\text{ml}^{-1}$)

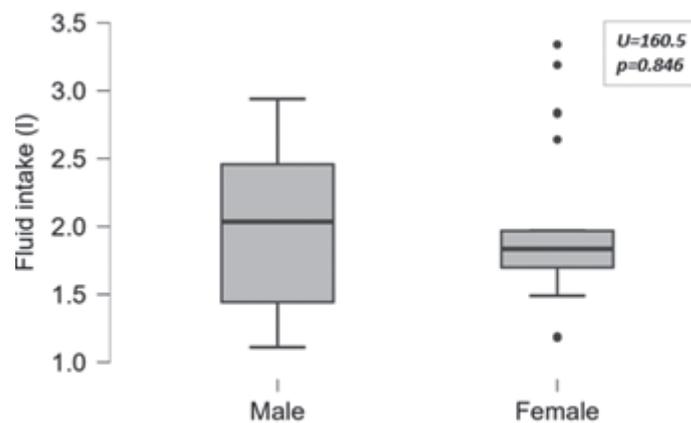


Figure 6. Comparison of daily fluid intake between male and female dancers
 Note. *U* – Mann-Whitney U-test, *p* – statistical significance

Discussion

Hydration changes across training microcycles

The present study examined hydration status and fluid intake across two consecutive training microcycles in collegiate folk dancers.

Male USG values did not show significant changes over two consecutive training microcycles. However, fluid intake decreased in the second microcycle by an average of 0.24 liters per day. While this difference was not statistically significant, the observed large effect size indicates a practically relevant decline in fluid intake. In our study, the median USG values for males were on the borderline between mild hypohydration and hypohydration. This indicates an increased risk that dancers may not begin their training fully hydrated. Insufficient hydration can negatively impact their cardiovascular and thermoregulatory responses, lead to heightened feelings of exertion, and hinder recovery, especially when training load is cumulative (Phillips et al., 2014). In terms of performance, even a slight change (as little as 1–2% of body weight, often accompanied by an increase in USG) can impair thermoregulation, perceived exertion, and cognitive function. This impairment can compromise training or competition, especially during repeated microcycles (Armstrong et al., 2025). Although the decrease in fluid intake of 0.24 liters per day was not statistically significant, it may indicate a practically relevant shift towards hypohydration, given the borderline values of USG. This highlights the importance of monitoring and educating folk dancers about hydration (Wardenaar et al., 2021).

In female dancers, a significant decrease in USG values was observed between microcycles, indicating an improvement in hydration status. Despite that, their USG values remained below the optimal hydration level, which, according to the classification by Chapelle et al. (2017, 2020), indicates mild hypohydration. Fluid intake for the women was nearly unchanged across both microcycles, with a slight decrease of only -0.11 liters per day during the second microcycle. The improvement in USG and consistent daily fluid intake indicate that factors beyond total fluid volume may have influenced the enhanced hydration status (Guelinckx et al., 2016). Approximately 20–30% of daily water intake comes from food, and with a higher proportion of foods with high water content (soups, fruits, vegetables), hydration can improve even without changing the declared drinking regime. In contrast, male dancers demonstrated stable USG values across microcycles, accompanied by a reduction in daily fluid intake.

Overall, our results suggest a tendency toward sub-optimal hydration, with USG values consistently above the recommended threshold of 1.010 g.ml⁻¹, yet still within the range classified as minimal hypohydration (Chapelle et al., 2017; Gibson et al., 2012). These findings are consistent with earlier reports in athletes and dancers, which show that mild hypohydration is common and often overlooked in training environments (Gibson et al., 2012; Tanabe et al., 2021).

Sex-specific differences in hydration status

Male dancers consistently exhibited higher USG compared to females, indicating a greater degree of hypohydra-

tion. While statistical significance supports this difference, its practical relevance is underscored by the consistent elevation of USG above normative thresholds across both microcycles. Males entered training sessions probably in a worse state of hydration than females. Several studies also report that male athletes tend to have higher USG levels and a greater proportion of hypohydrated individuals before training compared to their female counterparts (Volpe et al., 2009). There were no significant differences in fluid intake between the sexes in our study. Both groups demonstrated a reduction in fluid consumption across microcycles, which may indicate a gradual neglect of hydration habits during the training process. Self-reported values should be interpreted with caution, but this downward trend is noteworthy, as inadequate fluid replacement may accumulate and contribute to chronic mild hypohydration (Tanabe et al., 2021). Civil et al. (2019) found that the average 7-day fluid intake of professional ballet dancers was 1.65 ± 0.48 l/day, which is slightly lower than the values found in our study. Given the mounting evidence of both short and long-term detrimental effects of hypohydration on health and well-being (Jéquier & Constant, 2010), guidelines have been established to determine how much water humans require to avoid dehydration and to optimize physical and psychological function. Such daily reference values or adequate intakes range from 2 l/day for women and 2.5 l/day for men from the EFSA, up to 2.7 l/day for women and 3.7 l/day for men from the Institute of Medicine (Gibson et al., 2012).

Relevance of hypohydration for dance performance and injury risk

Even mild hypohydration may have important consequences for dancers, given the high demands on coordination, balance, timing, and neuromuscular control. Studies reveal that mild hypohydration can lead to impaired proprioception and delayed neuromuscular responses, which heighten the risk of acute injuries among dancers, particularly during repetitive or high-impact movements. For example, Long et al. emphasize that neuromuscular conditioning plays a vital role in reducing injury risk and improving functional outcomes in dancers, suggesting that any impairment due to hypohydration could exacerbate injury risks during performances (Long et al., 2021). Hypohydration can disrupt the balance and coordination that dancers rely upon. Clarke et al. (2018) discuss how significant balance capabilities are fundamental to professional dancers, indicating that when hydration is compromised, these capabilities may falter. Given that folk dance involves extensive dynamic movements—such as spins and jumps—optimal hydration is necessary to preserve the intricate balance and coordination essential for these styles. Additionally, proprioception, which is critical for maintaining posture during dynamic movements, may diminish with hypohydration (Hutt & Redding, 2014). This decline could lead to errors in movement execution, as dancers often rely heavily on proprioceptive feedback for positioning and spatial awareness. The reliance on visual inputs can exacerbate the challenges posed by inadequate hydration, potentially leading to performative discrepancies and elevated injury risk, as described by Hutt and Redding, who note how dynamic balance

performance can be affected by variable visual conditions (Hutt & Redding, 2014). Hydration decisions during exercise should account for individual variations in sweat rates, which can be influenced by environmental factors and exercise intensity (Eijsvogels et al., 2013). For instance, studies show that a minimum fluid consumption of 5-7 mL/kg of body mass should be initiated at least four hours before exercise (Li et al., 2024), while fluid consumption rates during exercise should range between 0.15 to 0.34 mL/kg for optimal performance (Holland et al., 2017). This means that a 55 kg female dancer should consume approximately 275-385 ml of fluids \geq 4 hours before training and 0.5-1.12 l/h during 60 minutes of intense exercise. This is critical, since athletes can lose 2-7% of their body weight through sweat, leading to diminished performance levels (Birkemose et al., 2013). The reduction in fluid intake over time may indicate a trend where dancers fail to adjust their hydration habits in response to training loads (Brown et al., 2016). Limited information is available regarding the effects of hypohydration on cognitive function, which is also important for a dancer's performance. In the study by Armstrong et al. (2012), mild hypohydration was produced by intermittent moderate exercise without hyperthermia, and its effects on the cognitive function of women were investigated. A degraded mood, increased perception of task difficulty, lower concentration, and headache symptoms resulted from 1.36% dehydration in females. Although our study did not directly assess cognitive or performance outcomes, the observed hydration patterns may place dancers at risk of reduced precision and increased injury susceptibility.

A drop in fluid intake can lead to behavioral fatigue and decreased adherence to recommendations, which may exacerbate health concerns. Understanding the factors contributing to inadequate hydration and implementing effective strategies to counteract these challenges is essential.

Practical applications and preventive strategies

To address hydration deficits, implementing simple yet effective preventive measures is essential. Scheduled drinking breaks during training can ensure that dancers remain adequately hydrated throughout their routines. Such interventions have been proven effective in promoting positive hydration practices among athletes, thereby enhancing overall performance (Scanlon & Norton, 2024)

There is an urgent need for coaches to understand the importance of hydration. They should be educated about effective hydration strategies and encouraged to create environments that prioritize fluid intake during training. By emphasizing the necessity of staying hydrated, coaches can help their dancers develop healthier hydration habits (Scanlon & Norton, 2024).

Integrating fundamental hydration education into regular training sessions can provide dancers with the knowledge required to make informed decisions about their fluid intake. Educational interventions have been shown to empower athletes to take charge of their hydration needs (Jafari et al., 2019)

These low-cost interventions may be particularly effective in dance settings, where formal sports nutrition support is often limited.

This study has several limitations that should be considered when interpreting the results. First, the relatively small sample size limits the generalizability of the findings. As a result, the findings should be interpreted primarily as exploratory and descriptive, reflecting hydration patterns within a specific collegiate folk-dance ensemble rather than the broader dance population. Second, daily fluid intake was assessed using self-reported fluid intake diaries. Self-reported data are inherently subject to recall bias and social desirability bias, which may have influenced the accuracy of reported fluid intake. Given the context of health-related monitoring, over-reporting of fluid intake appears more likely than under-reporting, as participants may have wished to present their behaviour as compliant with perceived hydration norms. Third, the type of fluids consumed was not standardized across participants. Different beverage types (e.g., plain water, mineral water, or sugar-containing drinks) may influence urine concentration and renal fluid handling differently, potentially affecting USG independently of total fluid volume (Wong et al., 2024). Consequently, variations in fluid composition could partially explain interindividual differences in USG values and limit direct comparison between participants. Fourth, hydration status was assessed using a single biomarker. Although USG is a validated and practical field-based marker, reliance on a single hydration indicator may not fully capture short-term fluctuations in body water balance. In future studies, using methods such as weighing water bottles, weighing athletes before and after exercise, reviewing training diaries, and incorporating bioimpedance measurements could help yield more objective results. Finally, the observational design of our study precludes causal inference.

Conclusions

The present study examined hydration status and daily fluid intake in collegiate folk dancers across two consecutive training microcycles. The results suggest that a significant proportion of dancers may have started training in a state of mild hypohydration. These findings demonstrate that mild hypohydration was prevalent across both sexes and microcycles. Even mild hypohydration may negatively affect physical performance, coordination, attention, and cognitive function, all of which are critical for complex dance movements. Although no cases of severe hypohydration were observed in the present sample. However, the persistent presence of mild hypohydration should not be considered harmless or negligible. Persistent mild hypohydration may accumulate across training days and compromise performance quality, recovery, and injury resilience. The findings highlight the need for greater awareness of hydration practices in dance training environments. Dance coaches and school-based training programs are encouraged to implement basic hydration strategies, such as setting minimum daily fluid intake targets, scheduling regular drinking breaks, and introducing simple hydration monitoring (e.g., urine color charts). These low-cost and easily implementable measures may help reduce the prevalence of hypohydration in dance populations. Future research should explore hydration interventions tailored to the specific demands of dance training.

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Conflicts of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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