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A Cross-Sectional Study of the Relationship Between Dehydration and Fever in an Indian OPD

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Abstract

Background and aim: Dehydration poses a substantial public health challenge, particularly non-diarrheal dehydration, which contributes to heat exhaustion, fatigue, and weakness. Among non-diarrheal causes, fever is one of the most clinically significant yet underappreciated drivers of dehydration. The primary objective of the present study was to determine the prevalence of dehydration among patients presenting with non-diarrheal fever using salivary osmolality, an objective biomarker of hydration status. The secondary objectives were to assess the severity of dehydration and its associations with body temperature, duration of fever, fluid and electrolyte intake, demographic and clinical characteristics, and dehydration-related signs and symptoms.

Methods: This prospective, observational, multicenter, cross-sectional study enrolled 409 patients (pediatric: 119; adult: 191; elderly: 99) aged ⩾2 years presenting with non-diarrheal fever (axillary temperature: ⩾37.5°C) across five centers in four Indian states. Hydration status was objectively assessed using salivary osmolality and measured with the MX3 Hydration Testing System Pro (Austin, TX: MX3 Diagnostics Inc.). Dehydration thresholds were age-specific: adults ⩾66 mOsm, elderly >94 mOsm, and pediatric >70 mOsm. Spearman's rank correlation was used to assess associations between salivary osmolality and clinical variables. Fatigue severity was evaluated in adults and elderly patients using a visual analog scale (VAS).

Results: Overall, 65.8% (269/409) of patients were dehydrated, with the highest prevalence in pediatric patients (73.1%, 87/119) and adult patients (68.6%, 131/191), and a comparatively lower prevalence in the elderly (51.5%, 51/99). Among adults, 51.3% (98/191) had mild, 15.2% (29/191) moderate, and 2.1% (4/191) severe dehydration. Salivary osmolality correlated positively with body temperature (ρ=0.295; p<0.001) and fever duration (ρ=0.210; p<0.001) and negatively with fluid and electrolyte intake (ρ = -0.417; p<0.001). No significant correlation was observed with age or gender. Dryness of oral mucosa (43.8%, 179/409) and myalgia (41.8%, 171/409) were the most prevalent clinical symptoms; however, clinical signs showed negligible to weak correlation with salivary osmolality. Fatigue was reported by 88% (168/191) of adults and 100% (99/99) of elderly patients.

Conclusions: The study demonstrated a high prevalence of dehydration affecting two-thirds of patients with fever. These findings highlight the importance of assessing hydration status early in the clinical course. Adequate oral fluid intake, including electrolyte-containing fluids, may be considered as part of supportive fever management across age groups.

Categories: Public Health, Epidemiology/Public Health
Keywords: dehydration, fatigue, fever, muscle cramps, salivary osmolality

Introduction

Dehydration represents a disturbance in the body's fluid and electrolyte balance resulting from a deficit in total body water, occurring when fluid losses exceed intake [1]. It poses an important public health challenge and can occur in non-diarrheal illnesses; inadequate hydration can contribute to fatigue and increase susceptibility to heat-related illness, including heat exhaustion [1-4]. While diarrhea is classically recognized as the primary driver of dehydration, other important non-diarrheal causes include vomiting, excessive sweating, burns, kidney failure, and the use of diuretics [1,5]. Among all non-diarrheal contributors, fever stands out as one of the most clinically significant and yet underappreciated causes of dehydration [6].

Fever is associated with an increase in insensible fluid losses, dehydration, metabolic demands, and thermoregulatory dysregulation [7]. Clinical guidelines recommend maintaining adequate fluid intake as a key component of supportive care to prevent dehydration and its associated complications [8-10]. Early recognition and correction of hydration deficits are particularly important in patients with fever, as dehydration may exacerbate symptom severity, impair recovery, and increase the risk of adverse clinical outcomes [5,11,12]. Despite this clinical relevance, a recent real-world electronic medical health record study conducted in 1,84,89,088 patients with non-diarrheal illnesses demonstrated dehydration in only 0.026% of patients, indicating that dehydration is often underreported in this population [6]. This prevalence of underreporting highlights a critical gap in recognizing the true prevalence and magnitude of dehydration in patients with fever. The lack of objective data warrants studies that directly assess dehydration in this population.

Materials And Methods

Study design and ethical considerations

This observational, multicenter, cross-sectional study was conducted in compliance with the International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH), Good Clinical Practice (GCP), and other local regulatory guidelines. The detailed inclusion and exclusion criteria for participation in the study are presented in Table *1*. The study protocol was reviewed and approved by the institutional review board and/or independent ethics committee. Written informed consent was obtained from all patients or their legally authorized representatives prior to enrollment, following a full explanation of the informed consent document. This study is registered with the Clinical Trials Registry of India (#CTRI/2024/10/07468) on October 3, 2024.

Inclusion criteria	Exclusion criteria
1. Male and female patients aged ≥2 years	1. Patients exhibited signs indicating immediate hospitalization
2. Patients presented to outpatient departments with non-diarrheal fever (body temperature: ≥37.5°C {99.5°F})	2. Patients presented with gastrointestinal symptoms such as nausea, vomiting, or diarrhea
3. Women of reproductive age confirmed to be non-pregnant prior to study enrollment	3. Individuals with underlying medical conditions affecting salivary flow (e.g., xerostomia or sialorrhea)
-	4. Inability to provide saliva samples
-	5. Patients who were receiving medications known to alter salivary secretion (e.g., anticholinergics)
-	6. Individuals unlikely to comply with study procedures or requirements

TABLE 1: Inclusion and exclusion criteria.

Study population

The study enrolled both male and female patients aged ⩾2 years presenting to outpatient departments with non-diarrheal fever (body temperature: ⩾37.5°C {99.5°F}). Women of reproductive age were confirmed to be non-pregnant prior to enrollment in the study. Eligible patients presenting during the study period were recruited consecutively.

Patients were excluded if they had signs indicating immediate hospitalization or presented with gastrointestinal symptoms such as nausea, vomiting, or diarrhea, or had underlying medical conditions affecting salivary flow (e.g., xerostomia or sialorrhea). Patients who were unable to provide saliva samples or were receiving medications known to alter salivary secretion (eg, anticholinergics) were also excluded from the study. Additionally, patients were excluded at the investigator's discretion if they were unlikely to comply with study procedures or requirements.

Study assessments

All patients were categorized into the following three groups: pediatric patients (⩾2 to <18 years old), adult patients (⩾18 to 60 years old), and elderly patients (⩾60 years old). Body temperature of all patients was measured in the axilla using a Romsons digital thermometer (Agra, India: Romsons Group Private Limited), and blood pressure was recorded after 5 min of seated rest. A comprehensive physical examination was performed by qualified physicians. Hydration status was assessed in all patients by measuring point-of-care salivary osmolality [13]. Recent intake of food or fluids was considered a potential confounder of salivary

osmolality measurements. To minimize its influence, patients were instructed to avoid eating or drinking for at least 5 min before saliva collection. Patients were then instructed to swallow any saliva present in the mouth, generate fresh saliva, and collect it in a sampling tray. If food debris was observed, the sample was discarded; the patient rinsed the mouth with 50 mL of water, waited for 5 min, and provided a new sample. Saliva samples were analyzed immediately using the MX3 Hydration Testing System Pro (Austin, TX: MX3 Diagnostics Inc.), in accordance with the manufacturer's instructions [14,15]. Calibration of the system against a laboratory osmometer had been performed by the manufacturer, with good agreement reported between the two measurement methods.

Hydration status was also determined based on clinical signs, including the presence or absence of myalgia, cramps, skin turgor, dryness of oral mucosa, capillary refill time, and cracked, dry lips. In adult and elderly patients, self-reported fatigue was evaluated and documented using a visual analog scale (VAS score 0 for no fatigue, 1-3 for mild, 4-6 for moderate, 7-9 for severe, and 10 for very severe fatigue) [16,17]. Patients and guardians of pediatric patients were asked to record fluid intake during the previous 24 h and to indicate whether hydration had been adequately maintained since symptom onset. To standardize reporting, we defined one glass as 200 mL and estimated intake by the number of glasses consumed. Fluids included water, electrolyte-containing beverages (such as oral rehydration solutions or commercial electrolyte drinks), and other drinks such as tea, coffee, milk, and fruit juice.

Study endpoints

The primary endpoint of the study was to assess the proportion of patients with fever who were dehydrated. Secondary endpoints included (1) assessment of the proportion of adult patients with different levels of dehydration severity (mild, moderate, or severe) based on salivary osmolality. Age-specific salivary osmolality thresholds were applied based on previously published literature, taking into account differences in physiological characteristics and reference ranges across age groups. For adults, we defined thresholds as no dehydration or adequately hydrated (<66 mOsm); mildly dehydrated (66-100 mOsm); moderately dehydrated (101-150 mOsm); and severely dehydrated (>150 mOsm) [18]. The elderly were classified as hydrated (⩽94 mOsm) or dehydrated (>94 mOsm), while pediatric patients were classified as hydrated (⩽70 mOsm) or dehydrated (>70 mOsm); (2) assessment of the correlation between salivary osmolality and body temperature in all patients; (3) assessment of the correlations between salivary osmolality and demographic and clinical variables (age, gender, and fever duration), as well as patients' fluid and electrolyte intake during illness; (4) assessment of the presence of myalgia or muscle cramps in patients; (5) assessment of the proportion and severity of fatigue among adult patients; and (6) assessment of the presence of dehydration-related clinical signs and symptoms in all patients [19,20].

Sample size determination

We considered a sample size of 369 patients adequate, assuming that approximately 40% of patients with fever would exhibit dehydration (as determined by salivary osmolality), with a 5% margin of error at a 95% CI. To account for potential dropouts and incomplete data, 410 patients were screened.

Statistical analysis

We calculated point estimates and 95% CIs for the proportion of patients with fever showing dehydration (primary endpoint), degree of dehydration, presence of myalgia or muscle cramps, dehydration-related clinical symptoms and signs, and fatigue severity in adult patients with fever. Correlations of salivary osmolality with body temperature, age, gender, duration of fever, and patients' fluid/electrolyte drink intake during the illness were all evaluated using Spearman's rank correlation coefficient (ρ), with corresponding 95% CIs for the population correlation derived by Spearman's rank correlation method. The statistical analysis for the categorical variables was performed using the adjusted chi-square test or Fisher's exact test, as appropriate. P-value <0.05 was considered statistically significant. There were no missing data for the variables included in the analyses; therefore, no imputation or other methods for handling missing data were required. All statistical analyses were conducted on the full analysis set (defined as all patients enrolled in the study), using SAS version 9.4 (Cary, NC: SAS Institute Inc.).

Results

The study was conducted at five centers across four Indian states (Tamil Nadu {site 1}, Delhi {site 2}, West Bengal {site 3}, and Gujarat {sites 4 and 5}) between October 4, 2024, and December 11, 2024. We screened 410 patients; of these, 409 were included in the study (pediatric: 119; adults: 191; elderly: 99), and we excluded one patient because they could not provide a saliva sample at site 3 (Figure *1*). Site-specific enrollment was as follows: 79 patients at site 1, 52 at site 2, 72 at site 3, 125 at site 4, and 81 at site 5.

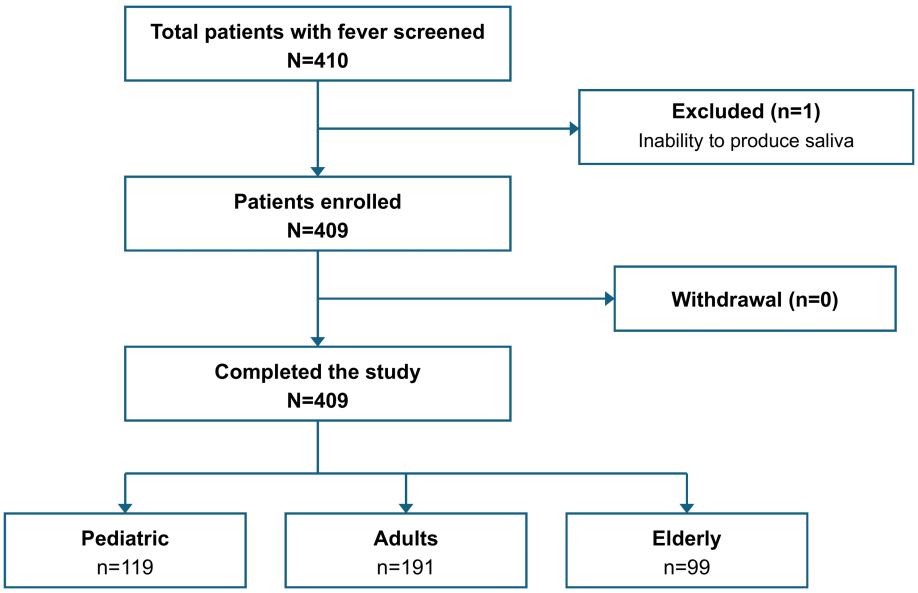


FIGURE 1: Patient disposition showing the flow of participants through the study, including enrollment and analysis.

Demographics and baseline characteristics

All enrolled patients completed the study with no discontinuations reported. Median age of all patients was 32 years (range: 2-82 years); 52.6% (215/409) were men. Mean (SD) fever duration at baseline was 45.6 (52.9) h and mean (SD) body temperature was 101.0°F (1.1°F) (Table *2*).

Parameters	Values
Age (years), median (range)	
All patients (N=409)	32 (2-82)
Pediatric patients (n=119)[a]	7 (2-17)
Adult patients (n=191)[a]	33 (18-59)
Elderly patients (n=99)[a]	67 (60-82)
Gender, n (%)	
Male patients	215 (52.6)
Female patients	194 (47.4)
Race, n (%)	
Indian	409 (100)
Others, mean (SD)	
Duration of fever (h)[b]	45.6 (52.9)
Body temperature (°F)	101.0 (1.12)
Systolic blood pressure (mmHg)	116.0 (13.67)
Diastolic blood pressure (mmHg)	73.4 (8.88)
Pulse rate (beats/min)	100.9 (20.75)
Respiratory rate (breaths/min)	19.1 (4.55)

TABLE 2: Demographics and baseline characteristics.

[a]Pediatric: ≥2 to <18 years, adult: ≥18 to <60 years, and elderly: ≥60 years.

[b]Duration of fever (h) was calculated as: (date and time of salivary osmolality measurement - date and time of fever onset) divided by 3,600.

Prevalence of dehydration in patients with fever

Overall, 65.8% (269/409) of patients had dehydration. Dehydration was more common in pediatric (73.1%; n=87; 95% CI: 64.51-80.26) and adult patients (68.6%; n=131; 95% CI: 61.69-74.75) than in the elderly (51.5%; n=51; 95% CI: 41.80-61.12) (Figure *2*). The proportion of patients (all age groups) with dehydration was significantly higher than that of patients who were hydrated, irrespective of fever grade (Table *3*). Among the three age groups, the proportion of elderly patients with dehydration was significantly lower than that of those who were adequately hydrated, irrespective of fever grade (Table *3*). The mean (SD) salivary osmolality observed in elderly, pediatric, and adult patients was as follows: 103.2 (46.1) mOsm, 92.6 (33.7) mOsm, and 79.6 (27.7) mOsm, respectively.

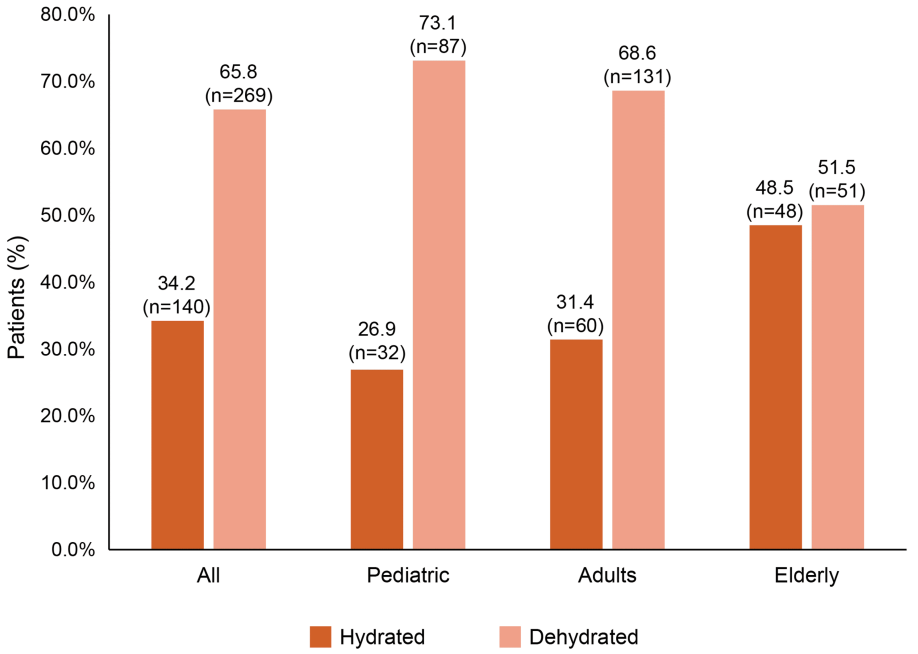


FIGURE 2: Hydration status among patients with fever.

Data are represented as percentages and numbers of patients.

Degree of fever[a]	Hydrated, n (%)	Dehydrated, n (%)	p-Value
All patients			
Low-grade	79 (44.9)	97 (55.1)	<0.001
Moderate-grade	49 (28.5)	123 (71.5)	
High-grade	12 (20)	48 (80)	
Hyperthermia	0 (0)	1 (100)	
Pediatric patients			
Low-grade	15 (38.5)	24 (61.5)	0.067
Moderate-grade	15 (24.6)	46 (75.4)	
High-grade	2 (10.5)	17 (89.5)	
Adult patients			
Low-grade	35 (36.1)	62 (63.9)	0.230
Moderate-grade	21 (29.2)	51 (70.8)	
High-grade	4 (18.2)	18 (81.8)	
Elderly patients			
Low-grade	29 (72.5)	11 (27.5)	<0.001
Moderate-grade	13 (33.3)	26 (66.7)	
High-grade	6 (31.6)	13 (68.4)	
Hyperthermia	0 (0)	1 (100)	

TABLE 3: Hydration profiles in patients with respect to fever grades.

[a]Fever is classified as - low-grade: 99.5-100.5°F, moderate-grade: 100.6-102.3°F, high-grade: 102.4-105.8°F, and hyperthermia: >105.8°F.

Statistical analysis was performed using Fisher's exact test; p<0.05 was statistically significant.

Severity of dehydration

Approximately half of adult patients (51.3%; 98/191) had mild dehydration (66-100 mOsm). About 15.2% (29/191) of adult patients had moderate dehydration (101-150 mOsm) and only 2.1% (4/191) of adult patients had severe dehydration (>150 mOsm).

Correlations between salivary osmolality and clinical variables

All patients exhibited a positive correlation between salivary osmolality and body temperature (ρ=0.295; p<0.001) and duration of fever (ρ=0.210; p<0.001) (Table *4*, Figure *3*). Consistently, there was a significant negative correlation between salivary osmolality and fluid/electrolyte intake (ρ = -0.417; p<0.001). Significant correlations were also observed between salivary osmolality and body temperature across different age groups and between salivary osmolality and fluid/electrolyte intake across different age groups (Table *4*). On the other hand, there was no correlation observed between salivary osmolality and age (ρ=0.066; p=0.186) or gender (ρ=0.076, p=0.123) (Table *4*).

Parameters/symptoms	Overall (N=409)		Pediatric (n=119)		Adults (n=191)		Elderly (n=99)	
Salivary osmolality[a]	ρ	p-Value	ρ	p-Value	ρ	p-Value	ρ	p-Value
Body temperature (°F)	0.295	<0.001	0.221	0.016	0.226	0.002	0.414	<0.001
Duration of fever (h)	0.210	<0.001	0.277	0.002	0.124	0.087	0.154	0.129
Fluid/electrolyte intake (glasses)[b]	-0.417	<0.001	-0.332	<0.001	-0.266	<0.001	-0.617	<0.001
Age (years)	0.066	0.186	-	-	-	-	-	-
Gender	0.076	0.123	-	-	-	-	-	-
Hydration status[c]								
Dryness of oral mucosa	0.211	<0.001	0.320	<0.001	0.124	0.087	0.496	<0.001
Myalgia	0.037	0.455	0.017	0.852	0.072	0.322	0.170	0.090
Skin turgor	-0.041	0.699[d]	0.056	>0.999[e]	NA	NA	-0.053	0.945[d]
Muscle cramps	0.065	0.186	0.104	0.417[d]	0.079	0.274	0.292	0.004
Delayed capillary refill	-0.059	0.563[d]	NA	NA	NA	NA	-0.064	0.957[d]
Cracked lips	0.033	0.511	0.239	0.021[d]	-0.074	0.308	0.038	0.705

TABLE 4: Correlations between salivary osmolality/hydration status and fever-related clinical parameters and symptoms.

[a]Spearman's rank correlation method.

[b]Fluid/electrolyte intake is the total amount of water, other fluids, and electrolytes consumed in the past 24 h; each glass has a capacity of 200 mL.

[c]Chi-square test.

[d]Adjusted chi-square test.

[e]Fisher's exact test.

P<0.05 was statistically significant.

Degrees of freedom: overall (df=407), pediatric (df=117), adults (df=189), and elderly (df=97).

n: number of patients; N: total number of patients; NA: not applicable; ρ: correlation coefficient; df: degrees of freedom

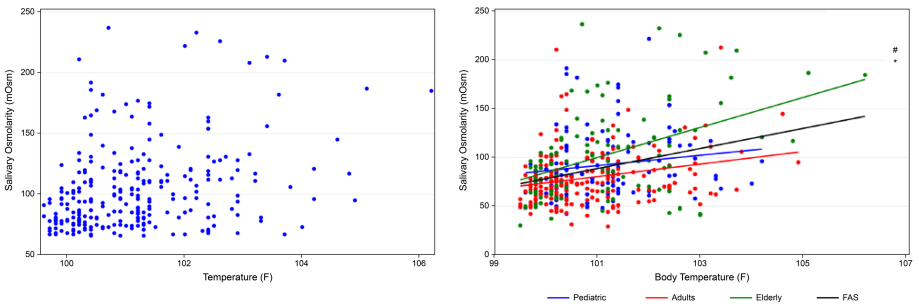


FIGURE 3: Correlation between dehydration and fever (different grades) in different age groups.

The correlations are represented by Spearman's rank correlation coefficient (ρ).

FAS: full set analysis

Fatigue scores among adult and elderly patients with fever

Overall, 92.1% (267/290) of patients experienced fatigue. Most adult patients (88%; 168/191) and all elderly patients (100%; 99/99) experienced fatigue during fever. Most adult patients reported mild fatigue (VAS score: 1-3, 63.4%; 121/191), while almost half of the elderly patients (49.5%; 49/99) reported moderate fatigue (VAS score: 4-6) (Table 5).

Fatigue	n (%)
Overall (n=290)	
No fatigue	23 (7.9)
Fatigue	267 (92.1)
Mild fatigue	158 (54.5)
Moderate fatigue	95 (32.8)
Severe fatigue	14 (4.8)
Adults (n=191)	
No fatigue	23 (12)
Fatigue	168 (88)
Mild fatigue	121 (63.4)
Moderate fatigue	46 (24.1)
Severe fatigue	1 (0.5)
Elderly (n=99)	
No fatigue	0 (0)
Fatigue	99 (100)
Mild fatigue	37 (37.4)
Moderate fatigue	49 (49.5)
Severe fatigue	13 (13.1)

TABLE 5: Fatigue score of patients with fever.

Fatigue was assessed using a visual analog scale (VAS) and classified as none (0), mild (1-3), moderate (4-6), or severe (7-9).

Dehydration-related clinical symptoms and signs in patients with fever

The prevalence of dehydration-related clinical symptoms and signs varied considerably among patients across the three age groups. Most common symptom of dehydration observed in all patients included dryness of oral mucosa (overall: 43.8% {179/409}, pediatric: 34.5% {41/119}, adult: 37.2% {71/191}, and elderly: 67.7% {67/99}) and myalgia (overall: 41.8% {171/409}, pediatric: 42% {50/119}, adults: 29.8% {57/191}, and elderly: 64.6% {64/99}) (Figures *4A*-*4D*). The other common clinical symptoms of dehydration observed in these patients included muscle cramps and cracked lips (Figures *4A*-*4D*). A significant but weak positive correlation was observed between dryness of oral mucosa and hydration status in all patients (ρ=0.211, p<0.001) (Table *4*).

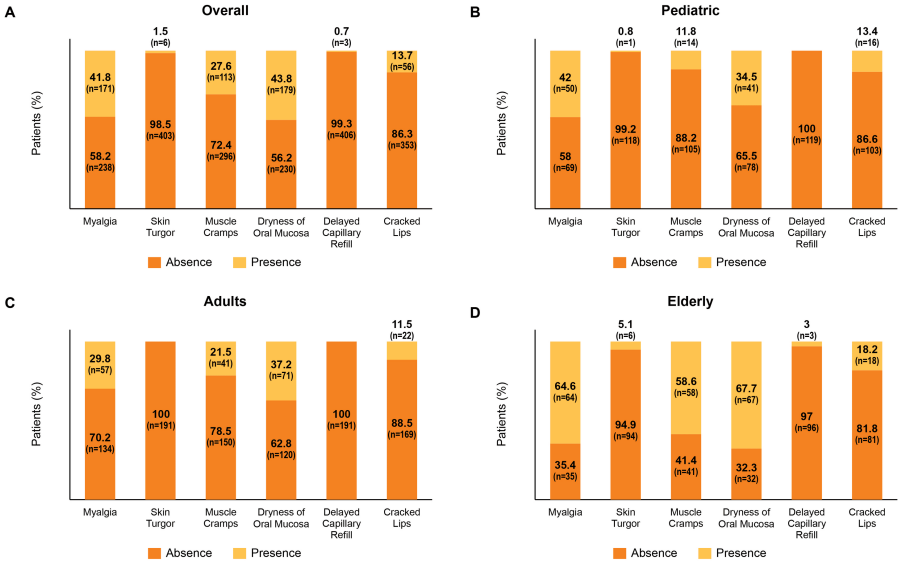


FIGURE 4: Percentage and number of the patients with fever showing absence or presence of vital signs of dehydration among overall (A), pediatric (B), adults (C), and elderly (D) population.

Discussion

This multicenter, cross-sectional study objectively quantified and demonstrated a high overall prevalence of dehydration among outpatients with fever in India across all age groups. Nearly two-thirds (65.8%, 269/409) of patients presenting with non-diarrheal fever were dehydrated. This contrasts significantly with the earlier study where dehydration was documented in only 0.026% of patients (4,917/1,84,89,088) with non-diarrheal illnesses [6]. The current study demonstrates a high prevalence of dehydration among outpatients with fever and underscores the importance of considering hydration status even in patients with fever without diarrhea.

The comparatively lower dehydration prevalence among elderly patients (51.5%, 51/99), despite this group having the highest salivary osmolality values across age groups, should be interpreted in light of the age-specific dehydration threshold (>94 mOsm) applied in this study. For elderly patients, dehydration was defined using a higher salivary osmolality cutoff, which may partly explain why fewer elderly patients were classified as dehydrated despite greater osmolar concentration. Importantly, this does not indicate lower physiological vulnerability. Aging is associated with diminished thirst responses to hypovolemia, hypertonicity, and dehydration, as well as alterations in endocrine mechanisms regulating fluid and electrolyte balance, making older adults more susceptible to dehydration during heat exposure due to impaired central thirst regulation [21]. Despite similar sweat loss, older individuals develop higher plasma osmolality, feel less thirsty, and do not perceive themselves as hotter than younger individuals, and their physiological markers take longer to normalize even after drinking fluids [22]. Therefore, the lower prevalence of dehydration observed among elderly patients should be interpreted cautiously and in the context of the age-specific salivary osmolality threshold used for dehydration classification.

Although dryness of oral mucosa (43.8%, 179/409) and myalgia (41.8%, 171/409) were the most frequently reported clinical symptoms, classical signs and symptoms appeared to be relatively unreliable markers for identifying dehydration. Dryness of oral mucosa showed only a weak positive correlation with salivary osmolality (ρ=0.211; p<0.001), and other physical signs, including skin turgor, cracked lips, muscle cramps, and capillary refill time, showed no significant association with salivary osmolality. These findings indicate

that the correlation between clinical symptoms and hydration status was negligible to weak, suggesting that relying on physical signs alone may be insufficient to identify dehydration.

This finding is consistent with previous evidence indicating that clinical signs are often insufficiently reliable for dehydration assessment. A review of potential signs and markers of dehydration in older adults found no clinical signs to be consistently diagnostically accurate across studies, with only bioelectrical impedance, expressions of fatigue, and observed reduced oral fluid intake correlating with dehydration to some degree [1]. Similarly, an earlier study examining clinical signs in patients with acute fever found that dehydration as a physical sign demonstrated only borderline interobserver reliability, with a kappa CI spanning values classified as regular [23]. Our findings are consistent with this conclusion across a broader population with fever and suggest that objective hydration assessment may help identify dehydration that is not apparent on routine clinical examination. Notably, dehydration prevalence remained high despite the limited association between symptoms and salivary osmolality. These findings suggest that dehydration may be present despite the absence of obvious clinical signs. Therefore, the absence of obvious clinical signs should not be interpreted as the absence of dehydration, particularly in outpatients with fever, where insensible fluid losses and reduced oral intake may coexist.

One of the most important findings of this study was the positive correlation between salivary osmolality and body temperature (ρ=0.295; p<0.001), indicating that higher body temperature was associated with higher salivary osmolality. Established physiological responses to fever reported in previous literature show that each 1°C rise in body temperature increases basal metabolic rate by approximately 10-12%, leading to greater oxygen consumption, carbon dioxide production, and fluid and caloric requirements. Fluid needs are estimated to increase by about 100 mL/m^2/day for every 1°C increase above 37.8°C [24]. A positive, albeit weak, correlation was also observed between degree of fever and hydration classification in adults (ρ=0.146; 95% CI: 0.004-0.282), indicating an association between these variables.

The positive correlation between salivary osmolality and fever duration (ρ=0.210; p<0.001) is indicative of an association between fever duration and salivary osmolality. Earlier work in nursing home residents also demonstrated that many elderly patients with fever have laboratory evidence of dehydration, with elevated serum sodium and blood urea nitrogen (BUN)/creatinine ratios being significantly associated with episodes of fever compared with the control population without fever [25,26]. Previous literature also emphasizes adequate hydration as an important component of supportive care during febrile illness and has reported dehydration in association with fever, particularly in young infants [27,28].

The study found a negative correlation between salivary osmolality and fluid and electrolyte intake (ρ = -0.417; p<0.001). Salivary osmolality has been reported to increase with dehydration and body fluid loss, supporting its sensitivity to changes in hydration status [29]. Previous literature reports that elevated body temperature increases evaporative and insensible water losses, thereby increasing fluid requirements. When these losses are not adequately replaced by oral intake, dehydration may worsen and, in more pronounced cases, contribute to hypovolemia [30]. Hence, consumption of water and appropriate electrolyte-containing beverages may help correct mild-to-moderate dehydration in outpatient settings. This is concordant with the Indian Council of Medical Research (ICMR) and National Institute for Health and Care Excellence (NICE) guidelines, which advise that patients with fever, including children, should be encouraged to increase fluid intake regularly to reduce the risk of dehydration [8,10].

The absence of significant correlation with age (ρ=0.066; p=0.186) or gender (ρ=0.076; p=0.123) further suggests that the observed dehydration was not significantly associated with these demographic characteristics in the study population. Fatigue was reported by most adults and elderly patients during fever. Among adults, 88% reported fatigue, predominantly of mild intensity, whereas all elderly patients experienced fatigue, most commonly of moderate intensity. Older adults are known to have greater physiological vulnerability to dehydration due to age-related physiological changes and a higher burden of comorbidities [31]. However, because fatigue is non-specific, it has limited utility as a standalone diagnostic marker of dehydration. A recent study found that fatigue was significantly higher during dehydration than during hydration, and mild dehydration was associated with increased sleep duration and reduced ease of falling asleep [32]. These observations suggest that even mild dehydration may contribute to clinically relevant symptoms such as fatigue and weakness.

The findings highlight distinct age-related patterns in dehydration symptoms. Subjective symptoms (dryness of oral mucosa, myalgia, cramps) were reported more frequently than objective clinical signs across all groups, suggesting traditional indicators such as reduced skin turgor or delayed capillary refill may be unreliable, particularly in younger patients. In contrast, elderly patients presented both a higher symptom burden and more detectable clinical signs. Among clinical symptoms, only dryness of oral mucosa was significantly linked to dehydration. Muscle cramps, myalgia, and cracked lips showed no significant associations. The Dehydration Recognition in the Elderly (DRIE) cohort study found non-urinary signs and symptoms lacked diagnostic accuracy in older adults, supporting discontinuation of such markers as routine screening tools [33].

If dehydration remains unrecognized and untreated, it may lead to clinically significant complications [34].

Volume depletion can reduce renal perfusion and lower glomerular filtration rate, thereby increasing the risk of prerenal acute kidney injury; additionally, inadequate fluid intake and reduced urinary flow may increase susceptibility to urinary tract infection [35,36]. Bacterial eradication from the urinary tract depends in part on urine flow and voiding frequency, and dehydration may reduce both, creating conditions that facilitate bacterial adherence and ascending infection [37]. Therefore, early recognition and proactive hydration counseling may be considered for outpatient fever management.

Strength and limitations

This multicenter, clinical study aimed to objectively quantify the prevalence and severity of dehydration across all age groups in patients presenting with non-diarrheal fever in India. This represents a meaningful contribution to a field where data have been conspicuously absent, as dehydration in patients with fever has been underreported or not investigated. The multicenter design, adequate sample size, inclusion of a broad age range, and use of an objective point-of-care measure of hydration rather than reliance solely on clinical signs and symptoms are some of the strengths of the present study.

However, the cross-sectional nature of the study and absence of a non-febrile control group preclude determining whether fever itself contributed to dehydration or establishing a causal relationship. Hence, the observed prevalence of dehydration among febrile patients cannot be directly compared with the prevalence among individuals without fever. Hydration status is dynamic, and a single time-point measurement cannot capture the trajectory of dehydration over the course of fever. Potential confounding factors, including timing of fluid intake, antipyretic and other medication use, fever phase, underlying medical conditions, comorbidities, and etiology, were not fully controlled and may have influenced hydration status and salivary osmolality, thereby introducing potential variability in the observed dehydration estimates. Recruitment from outpatient departments may also limit the generalizability of the findings to hospitalized patients or other clinical settings. Furthermore, fluid intake during illness was self-reported and may therefore be subject to recall bias. Age-specific salivary osmolality thresholds, based on published literature and physiological differences across age groups, enhanced the clinical relevance of dehydration assessment; however, their use limits direct comparison of dehydration prevalence across pediatric, adult, and elderly groups. In addition, no independent objective reference measure of hydration status, such as measured serum/plasma osmolality or change in body weight, was used to validate dehydration classification based on salivary osmolality.

Conclusions

Globally, this is one of the first clinical studies to demonstrate an association between dehydration and fever. In this study, nearly two-thirds of patients with fever also experienced dehydration, regardless of fever severity. The findings also revealed that clinical signs alone are insufficient to determine dehydration status. These results highlight the importance of assessing hydration status in patients presenting with fever. Maintaining adequate fluid intake, including electrolyte-containing fluids when appropriate, may be considered as part of supportive care during fever.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Review Board (IRB) Ethics Committee of Kanchi Kamakoti CHILDS

Trust Hospital and The CHILDS Trust Medical Research Foundation issued approval #EC/NEW/INST/2022/3028(DHR). **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** Dr. Janani Shankar served as the principal investigator and a member of the steering committee for this study. Dr. Nagpal, Dr. Dabhi, and Dr. Chetan served as steering committee members. All steering committee members received honoraria for their professional services. No other conflicts of interest are declared.

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