Indian Journal of Health Sciences and Biomedical Research KLEU

Manuscript 1732

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ORIGINAL STUDY

Clinical Profile of Hyponatremia and Its Impact on Activities of Daily Living Among Older People *(A Prospective Observational Study)*

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ABSTRACT

Introduction: Hyponatremia is a common, serious problem among older people. The aetiology is multifactorial and has a significant association with different comorbidities, which makes it pertinent to identify the underlying causes, and it has a negative impact on activities of daily living (ADL).

In this study, we tried to correlate the impact of hyponatremia on activities of daily living.

Methodology: A prospective observational study was conducted in the intensive care unit of Shri B M Patil Medical College and Hospital, Vijayapura, on one hundred consecutive elderly patients admitted with true hyponatremia for twelve months. Detailed medical history, clinical examination, laboratory investigations, diagnosis and outcome were recorded.

Results: The mean age of older patients was 70.62 ± 9 years. The male/female ratio was 57% to 43%. The atypical symptoms were present in 71 patients, while typical symptoms like vomiting (n = 36), nausea (n = 33) and altered mental status (n = 24) were seen. Most patients were Euvolemic (50%). The common aetiologies were SIADH (30%), Gastrointestinal losses (19%) and Drug-induced (16%). Activities of daily living were poor at the time of admission in 82% patients, while significant improvement was observed after the correction of sodium levels with a significant p-value.

Conclusion: Even though older individuals are prone to hyponatremia, it is often under-investigated and sub-optimally managed. Hyponatremia affects the activity of daily living rapidly; therefore, prompt recognition and correction of sodium levels can lead to considerable improvements in function. This underscores the importance of proactive screening and early intervention for hyponatremia to maintain independence and minimize morbidity among elderly patients.

Keywords: Hyponatremia, Activities of daily living (ADL), Older person

1. Introduction

Hyponatremia is defined as serum sodium of less than 135mEq/L.[1] It is one of the most common electrolyte abnormalities, with a global prevalence of approximately 220 per 1000 (22%) in the general geriatric population and 160 to 300 per 1000 among hospitalized older adults (In accordance with the Census of India 2011, 'old age' or 'elderly' in this study is defined as individuals aged 60 years and above).[2] In the Indian context, the burden is notably high; studies indicate a prevalence of up to 463 per 1000 among elderly hospitalized patients.[3]

Age-related physiological changes, including diminished renal function[4] and altered water

Received 12 December 2025; revised 3 March 2026; accepted 24 April 2026.
Available online 30 April 2026

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https://doi.org/10.71355/2542-6222.1732

regulation, along with polypharmacy and chronic comorbidities, predispose older adults to hyponatremia.[5]

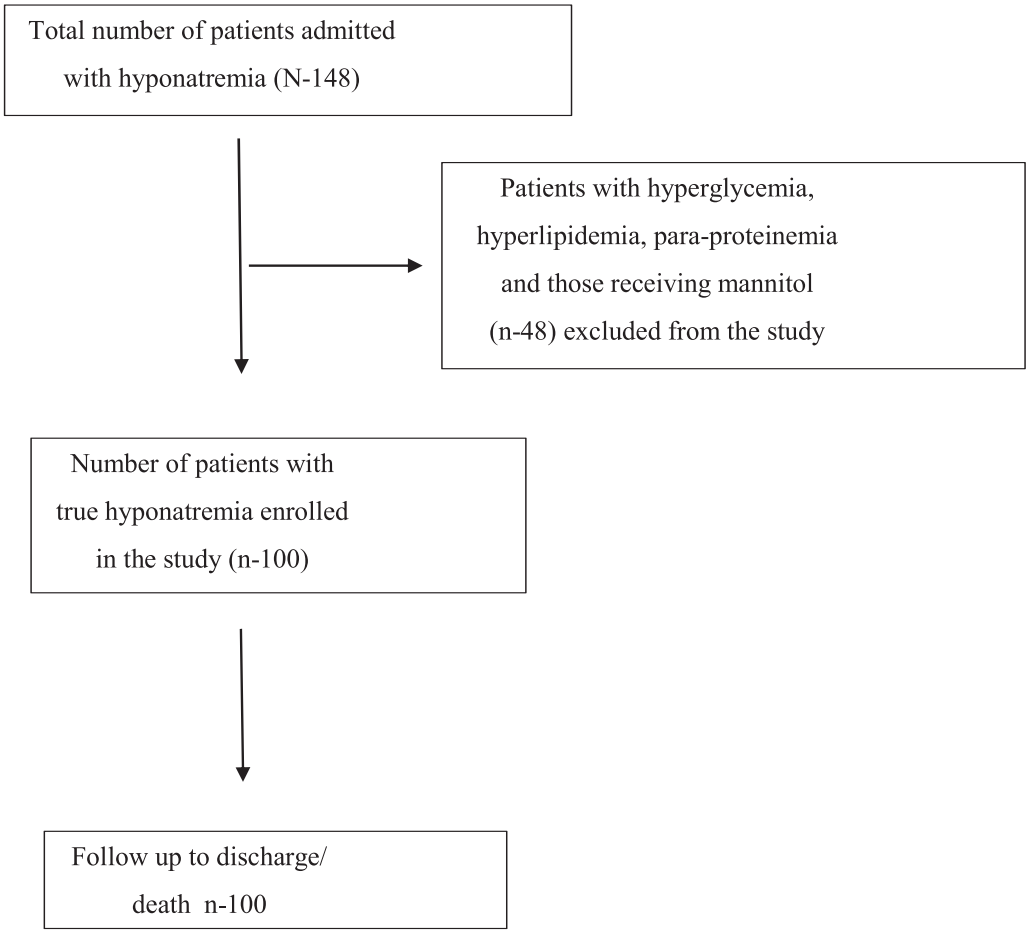
Although often perceived as a biochemical abnormality, even mild hyponatremia has been associated with clinically significant outcomes such as gait instability, cognitive impairment, falls, and functional decline. These atypical presentations are particularly relevant in geriatric patients and may contribute to increased frailty and loss of independence if not promptly recognized and corrected.[6]

Previous studies have demonstrated an association between hyponatremia and functional decline, including impairment in Activities of Daily Living (ADL) and increased frailty.[7] However, although the biochemical and etiological aspects of hyponatremia have been well studied, limited data are available on its direct impact on functional outcomes such as ADL in the Indian elderly population.

The study aimed to evaluate the clinical profile of elderly patients with hyponatremia, analyze its etiological spectrum, and assess its impact on functional status using the Katz Index of Activities of Daily Living (ADL) at the time of admission and after correction of hyponatremia.

2. Materials and methods

A total of 148 older patients >60years with hyponatremia were admitted to the Intensive Care Unit of Shri B M Patil Medical College Hospital and Research Centre, Vijayapura, over twelve months. One hundred patients of true hyponatremia were included in the study, while 48 were excluded as per the exclusion criteria (The sample size of 100 was achieved through consecutive sampling of all eligible patients). A prospective observational study was carried out for 12 months from January 2023 to December 2023 following Institutional Ethical Clearance (Approval number: BLDE (DU)/IEC/842/2022-23) on 15th December 2022. Informed consent was obtained from the study participants. A medical history including demographic details like age, sex, presenting symptoms, drug history, comorbidities, clinical examination, lab investigations, volume status and outcomes was recorded from all the patients.



2.1. Inclusion criteria

1. Age ≥ 60 years.
2. Diagnosed with true hyponatremia, defined as serum sodium < 135 mEq/L.

2.2. Exclusion criteria

1. Pseudohyponatremia due to:
   - Hyperglycemia (RBS >300mg/dl)
   - Hyperlipidemia (Serum Triglycerides >1500mg/dl)
   - Paraproteinemia (Serum Total Protein > 10gm/dl)
2. Osmotic diuresis or drug-induced dilutional hyponatremia (e.g., use of mannitol).
3. Pre-existing severe cognitive impairment or neurological deficit impairing reliable ADL assessment.
4. Terminal illness or end-of-life care where functional recovery was not a treatment goal.
5. Incomplete clinical data or those discharged against medical advice before ADL reassessment.

All patients underwent a standardized initial evaluation that included basic laboratory tests such as complete hemogram, random blood sugar, renal function tests, lipid profile, and serum protein levels. To confirm the diagnosis and classify true hyponatremia, specific biochemical investigations, including serum osmolality, urine osmolality, and spot urinary sodium, were performed in all cases. All biochemical investigations, including serum electrolytes, were analyzed at the Central Laboratory of Shri B M Patil Medical College Hospital and Research Centre, which is an NABH-accredited institution.

Where clinically indicated, endocrine evaluations such as thyroid function tests and morning serum cortisol levels were obtained to exclude hypothyroidism and adrenal insufficiency as potential secondary causes of hyponatremia. Additional assessments, such as electrocardiogram and imaging studies, were performed selectively based on individual clinical presentation.

Patients were classified according to their volume status and laboratory investigations as hypovolemic, euvolemic and hypervolemic. Hyponatremia was classified as mild(130- 135mEq/L), moderate (125-129mEq/L) and severe (<125mEq/L) based on recent clinical practice guidelines.[8]

The Syndrome of Inappropriate Antidiuretic Hormone was diagnosed using Bartter and Schwartz criteria,[9] which include:

1. Hypotonic hyponatremia with serum osmolality <275 mOsm/kg,
2. Inappropriately concentrated urine (urine osmolality >100 mOsm/kg),
3. Urinary sodium >40 mEq/L despite normal dietary salt intake,
4. Clinical euvolemia,
5. Normal adrenal, thyroid, and renal function,
6. Absence of diuretic use.

Following this categorization, aetiology was determined, and the cause was ascertained. ADL at the time of admission and at the time of discharge were calculated and correlated with the serum sodium levels.

Activities of daily living (ADL) assessment was done using the Katz ADL within 24h of admission, and at the time of discharge by the primary investigator.[10] As the Katz Index of ADL is a universally standardized and globally validated tool, no separate pilot testing or revision of the questionnaire was required. It was administered uniformly by a trained primary investigator.

The Katz ADL is an effective method of evaluating functional status since it evaluates a patient's capacity to carry out daily tasks independently.[10] The Index measures how efficiently patients accomplish the six functions of dressing, toileting, feeding, transferring, bathing, and continence. For each of the six functions,

Patients receive a yes/no score for independence.

Full function is indicated by a score of 6, moderate impairment is indicated by a score of 4, and severe functional impairment is indicated by a score of 2 or below.

The Katz index has shown good reliability with a Cronbach's alpha of 0.838.[11] Brorsson and Asberg reported a satisfactory Coefficient of Scalability for Katz's Activities of Daily Living, which is a measure of construct validity from 0.74 to 0.88.[12]

Patients presenting with severe or highly symptomatic hyponatremia were managed in the intensive care unit with appropriate corrective interventions. Upon discharge, patients and their caregivers were provided with targeted health education regarding appropriate fluid management, medication adherence, and recognizing early warning signs of hyponatremia.

2.3. Statistical analysis

Statistical analysis was conducted utilizing SPSS software, version 20. Continuous variables were represented by mean ± standard deviation (SD) or median with interquartile range (IQR), depending

on their distribution. Categorical variables were depicted as frequencies and percentages.

The primary outcome measured was the change in functional status, assessed by the Katz Activities of Daily Living (ADL) score from the time of admission to discharge. The secondary outcomes included the causes of hyponatremia, length of hospital stay, and in-hospital mortality rates.

The differences in Katz ADL scores from admission to discharge were evaluated using the Wilcoxon signed-rank test. The relationship between the severity of hyponatremia (mild, moderate, severe) and Katz ADL scores was assessed utilizing the Kruskal-Wallis test. For categorical variables (e.g., volume status, symptom types), comparisons were made using the Chi-square test.

A p-value of <0.05 was deemed statistically significant. All statistical tests were conducted as two-tailed.

3. Results

3.1. Socio-demographic profile

In our study of 100 older patients with hyponatremia, the mean age of patients was 70.62 ± 9 years, with 57 males (57%) and 43 females (43%). The majority of patients, 74%, belonged to the young old category, followed by the old old category (16%), and the very old category (10 %). (Table 1)

Table 1. Age and sex distribution.

Age (Years)	Male	Female	Total (%)
60–74	39	35	74 %
75–84	10	6	16 %
>85	8	2	10 %
Total	57	43	100 %

3.2. Clinical features

As regards to symptomatology, asymptomatic or atypical symptoms (falls, cognitive dysfunction, giddiness) were found to be the most common presenting symptoms in 71%. Typical symptoms include vomiting (36%), nausea (33%), altered mental status (24%), headache (14%), seizures (12%) and hiccups (5%)(Fig. 1).

3.3. Causes

The most common primary cause for hyponatremia in our study was SIADH (30%), followed by gastrointestinal losses (19%), drug-induced (16%), renal failure (12%), hypothyroidism (8%) and heart failure (7%). Other uncommon causes include adrenal insufficiency (2%), liver failure (2%) and head trauma (2%). Acute urinary retention (2%), although rarely reported in the literature, which was identified as a reversible trigger in two patients. The most common causes of SIADH were cerebrovascular accident (n = 8) and pulmonary tuberculosis (n = 8), meningitis (n = 3), idiopathic (n = 3), lung abscess (n = 2), pneumonia (n = 2), retroviral disease (n = 2), amyotrophic lateral sclerosis (n = 1), and bladder carcinoma (n = 1). (Table 2)

Table 2. Primary causes of Hyponatremia.

Aetiology	Frequency (No. of Patients/Percentage)
SIADH	30
Gastrointestinal Losses	19
Drug-Induced	16
Renal Failure	12
Hypothyroidism	8
Heart Failure	7
Trauma	2
Liver Failure	2
Adrenal Insufficiency	2
Acute Urinary Retention	2

The common culprit drugs causing hyponatremia were Thiazides (n = 24), Loop diuretics (n = 18), NSAIDs (n = 15), Antidepressants(n = 11), Anti-psychotics(n = 4), Anti-epileptics (n = 3) and Anti-Retroviral Drugs (n = 2). Polypharmacy – especially frequent use of diuretics and NSAIDs likely played a significant role in precipitating hyponatremia in the elderly. In one patient, hyponatremia was induced during the initiation phase of starting Levetiracetam, which eventually resolved in the maintenance phase without correction was also found in our study.

Table 3. Types of Hyponatremia.

Types of Hyponatremia	Percentage
Euvolumic	50%
Hypovolemic	29%
Hypervolemic	21%

3.4. Comorbidity

The most common comorbidity found in our study was systemic hypertension (50%), followed by Type II diabetes mellitus (26%), respiratory illnesses (18%), and renal comorbidities (12%). Other significant comorbidities included neurological disorders (12%), cardiovascular diseases (10%, encompassing Ischemic Heart Disease and heart failure), hypothyroidism (8%), and adrenal insufficiency (2%).

3.5. Types and severity of hyponatremia

Among the 100 elderly patients studied, hyponatremia was most commonly euvolemic in nature (50%), followed by hypovolemic (29%) and hypervolemic (21%) types. When categorized based

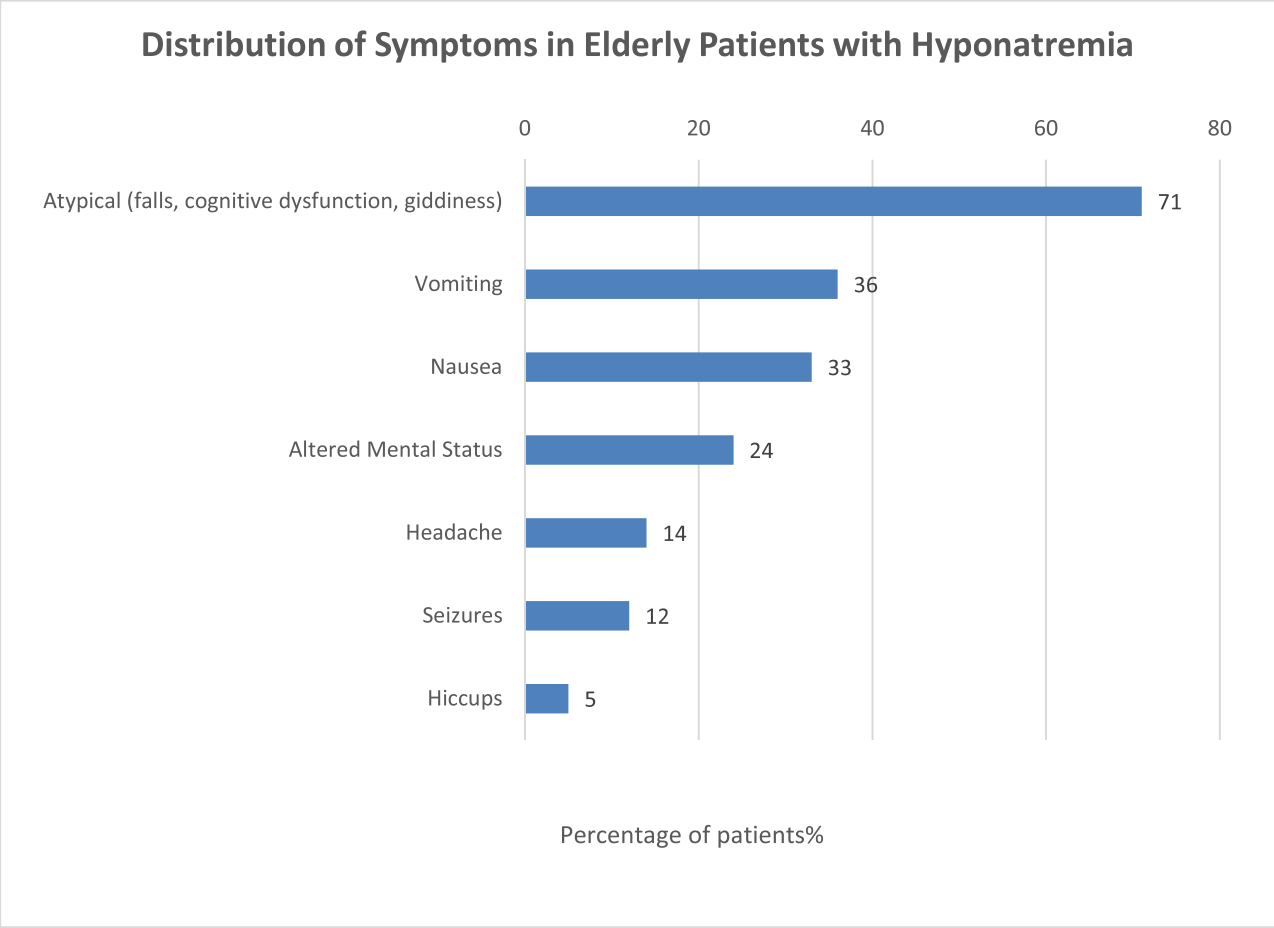


Fig. 1. Distribution of symptoms in elderly patients with Hyponatremia.

Table 4. Baseline parameters and distribution of serum sodium, urine spot sodium, serum osmolarity and urine osmolality.

	S.Sodium (mEq/L)	Urine Spot Sodium (mEq/L)	Serum Osmolality (mOsm/kg)	Urine Osmolality (mOsm/kg)
Mean	123.43	48.10	260.61	232.36
Std. Deviation	8.432	33.929	11.361	87.018
Minimum	98	5	220	66

on severity, severe hyponatremia (<125 mEq/L) was observed in 42% of patients, moderate hyponatremia (125–129 mEq/L) in 30%, and mild hyponatremia (130–135 mEq/L) in 28%. This distribution highlights the predominance of euvolemic and severe hyponatremia in the study population.

3.6. Biochemical parameters

Sodium levels were assessed, along with serum osmolality and urine spot sodium. The mean plasma sodium concentration was 123.43 ± 8.4 mEq/L, urine spot sodium 48 ± 34 mEq/L and serum osmolality 260 ± 11 mOsm/kg. The mean length of stay in hospital was 10.68 ± 5.1 days, reflecting the substantial healthcare burden and prolonged recovery period associated with hyponatremia in older adults, particularly in those with severe or symptomatic presentations. (Table 4)

3.7. Functional outcomes

Mean Katz ADL score improved significantly from 2.91 ± 1.89 at admission to 4.74 ± 1.76 at discharge ($p < 0.001$), highlighting a clear functional recovery following correction of hyponatremia. Improvement in ADL was observed across all severity groups, with the greatest improvement in patients

Table 5. ADL parameters in study participants in association with severity of Hyponatremia.

Severity	Number	ADL (at admission) ± SD	ADL (at discharge) ± SD	P value
Mild	28	4.39 ± 1.90	5.21 ± 1.77	
Moderate	30	3.50 ± 1.85	5.16 ± 1.66	
Severe	42	1.50 ± 1.88	4.11 ± 1.76	
Overall	100	2.91 ± 1.89	4.74 ± 1.76	<0.001

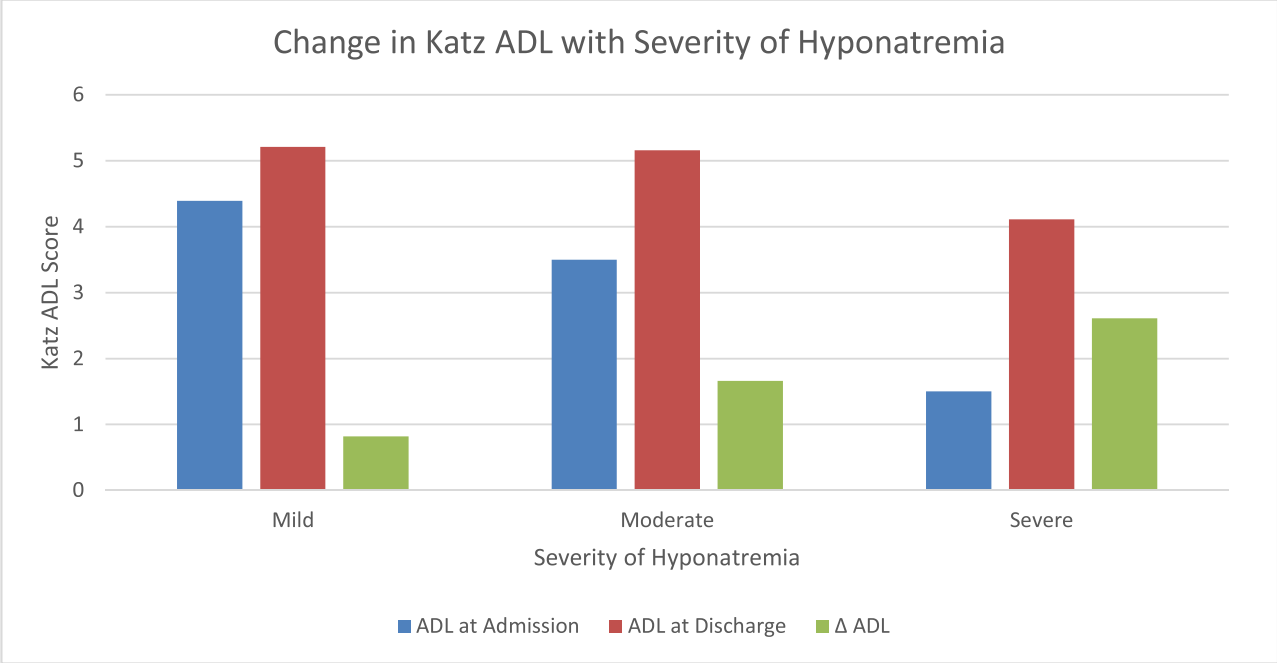


Fig. 2. Change of KATZ ADL score with severity of Hyponatremia.

with severe hyponatremia (ΔADL = 2.61), compared to moderate (ΔADL = 1.66) and mild (ΔADL = 0.82) hyponatremia. These findings underscore the clinical relevance of early identification and correction of hyponatremia in preserving and restoring functional independence in older adults. (Table 5 and Fig. 2)

3.8. Mortality

During the study, four (4%) patients died while undergoing treatment. All four had severe hyponatremia (serum sodium <125 mEq/L) at presentation and were admitted with multiple comorbid conditions, including advanced heart failure and chronic kidney disease. While hyponatremia likely contributed to clinical deterioration, the primary cause of death was attributed to underlying comorbidities compounded by electrolyte imbalance.

4. Discussion

In this prospective study of 100 elderly patients with hyponatremia, Syndrome of Inappropriate Antidiuretic Hormone Secretion (SIADH) emerged as the most common etiology (30%), while hypertension was the most frequent comorbidity (50%). The study found that Activities of Daily Living (ADL) scores, measured using the Katz Index, improved significantly following sodium correction ($p < 0.001$), underscoring the functional impact of timely intervention.

4.1. Prevalence & demographics

Our cohort had a male predominance (57%) and a mean age of 70.6 years, with the majority belonging to the "young old" (60–74 years). These findings echo the demographic distribution reported by Chatterjee et al (2012, n = 201)[13] and Chandregowda et al (2021, n = 150).[14] The higher representation of males may reflect demographic hospitalization patterns or gender-based differences in comorbidity burden.

4.2. Clinical presentations

Atypical symptoms—such as falls, cognitive dysfunction, and giddiness—were seen in 71% of

patients, outpacing typical presentations like nausea and vomiting. Whereas in a study by Chandregowda et al.(2021, n = 150),[14] had common symptoms that include Vomiting and Nausea (39%), lethargy (24%), confusion(16%), giddiness (8%), irritability (6%), seizures (5%) and coma (2%). It highlights how hyponatremia often manifests subtly in geriatric populations. These atypical features may be linked to neurocognitive effects, including gait instability, attention deficits, and, in severe cases, cerebral edema, all of which compromise mobility and independence. This explains the pronounced decline in ADL scores seen at admission.

Our findings on volume status align with Chandregowda et al.(2021, n = 150),[14] who also reported euvolemia as the most common type (50%). However, our study had a higher proportion of hypovolemic hyponatremia (29% vs. 17%).

A study by Bajaj G. et al (2021, n = 241)[15] showed 34% of patients with hypertension, 32% with Diabetes Mellitus and 7% with Chronic Kidney Disease as the most commonly associated comorbidities. Our study showed hypertension (50%) followed by diabetes mellitus (26%) as a common comorbidity. Hypertensive patients were often advised to have a low salt diet, along with the inherent mechanism of hyponatremia in hypertensive patients, and the usage of diuretics may have contributed to the cause, which has led to a high number of hypertensive patients with hyponatremia in our study.

A study by SM Yousuf (2022, n = 100)[16] mentioned the mean duration of stay in their study as 7.04, while it was 10.68 ± 5.15 in our study, which may be because we had more patients with severe hyponatremia compared to their study.

4.3. Etiologies

Chandregowda MK (2021, n = 150)[14] showed SIADH (30%), followed by Gastrointestinal losses (21%) and Sepsis (10%) as the most common causes of their study, which is comparable to our study. However, Drug-induced hyponatremia was the 3rd most common cause rather than sepsis.

A study by Babaliche P et al. (2017, n = 100)[17] showed pulmonary tuberculosis (57.7%) as the most common cause of SIADH, followed by meningitis. Our study also showed pulmonary tuberculosis as an important cause of SIADH, but also had an equally high number of patients with cerebrovascular accidents with hyponatremia.

A study by Jain AK (2019, n = 100)[18] showed diuretics (18%) as the most common cause of drug-induced hyponatremia. In our study, patients were on multiple drugs causing hyponatremia, making the cause multifactorial. A case report by Smiti Y[19] showed an uncommon case of hyponatremia after starting Levetiracetam, which was resolved after discontinuation of treatment, which was also found in our study.

4.4. ADL/Functional outcomes

The core insight of this study is the significant improvement in ADL scores following correction of serum sodium. Although most previous studies have tried to correlate hyponatremia with the Barthel's Index, we have used the Katz index for our study. A study by Luthra et al. (2016, n = 485)[20] showed that Katz's ADL is better suited to the Indian scenario than Barthel's Index.

A study by Gosch M (2012, n = 2880)[21] et al. assessed the association of hyponatremia with activities of daily living and found that hyponatremia patients scored significantly worse at admission. The mean Barthel's ADL score of the hyponatremic group was 69.26 ± 20.52 points compared to 87.56 ± 13.08 in the control group ($p < 0.001$), which is comparable to our study.

A study by Brinkkoetter PT et al. (2019, n = 150)[22] showed that correction of hyponatremia was advantageous for functional status improvement, which correlated with our results in the improvement of Activities of daily living post-correction of hyponatremia. The improvements in Barthel's ADL were markedly more pronounced in the hyponatremic group as compared to their matched reference group, with a mean ΔADL of 14.31 ± 17.12 vs 9.84 ± 14.67 ($p = 0.002$), respectively, which is similar to the findings of our study. A study by Kapoor M et al (2023, n = 200)[2] concluded that an improvement in serum sodium levels was associated with an improvement in Barthel's ADL in their comprehensive geriatric assessment parameters. ΔADL was found to be 8.8 ± 10.1, which is similar to our study. Our findings support that timely recognition and correction of hyponatremia can rapidly restore functional independence, which is critical in preventing frailty progression and prolonged hospital stays.

4.5. Mortality

Four patients (4%) died during hospitalization. This mortality rate is consistent with Dash et al. (2019, n = 950)[3] (4.5%). Severe hyponatremia was observed in 42% of cases—a higher proportion than in some published data, likely due to our ICU-based recruitment and delayed presentations. Patients admitted to critical care units tend to present later and with

more profound biochemical imbalances, which may account for the severity distribution.

4.6. Limitations

This study has several limitations. It was conducted in a single tertiary care centre, potentially limiting generalizability to broader populations. Only short-term outcomes were assessed, with no follow-up data on ADL status post-discharge. Furthermore, while the Katz ADL Index is appropriate for evaluating basic functional tasks, it may not capture subtle neurocognitive or instrumental activities relevant to elderly independence. Other potential limitations include recall bias, which may have affected the accuracy of baseline medication and functional histories. Additionally, unmeasured confounders inherent to acute care—such as illness severity, frailty, and polypharmacy—could independently influence Katz ADL scores. Larger multicentre studies with long-term functional follow-up are warranted to validate these findings.

5. Conclusion

Older individuals are prone to hyponatremia, often due to multiple factors, and present with atypical features, which can lead to delays in diagnosis. The presence of comorbid conditions, especially hypertension and diuretics, makes them prone to hyponatremia. This affects the activities of daily living and functional capacity. SIADH due to infections, vascular events and metabolic conditions contributed to hyponatremia in older people. Hyponatremia affects Activities of daily living (ADL) and is rapidly progressive; hence, identifying and correcting sodium levels leads to rapid recovery.

6. Recommendations

Given the significant impact of hyponatremia on functional independence, we recommend routine screening of serum sodium levels alongside baseline functional assessments (such as the Katz ADL index) for all geriatric hospital admissions. Early identification and targeted management of hyponatremia are crucial to preventing further functional decline.

Author contributions

Kushal Bhangale: Conceptualization, Methodology, Investigation (Primary patient assessment and data collection), Formal analysis, and Writing – Original Draft Preparation.
Aniruddha Umarji: Data curation, Formal analysis, and Writing – Review & Editing.
Anand Ambali: Investigation, Project administration, and Writing – Review & Editing.
Muddasir Indikar: Methodology, Validation, Resources, Supervision, and Writing – Review & Editing.

Conflict of interest

Nil.

Source of funding

No funding was received for this study. All research expenses were borne by the authors.

Acknowledgments

The authors would like to express their sincere gratitude to the nursing staff and administration of BLDE (Deemed to be University) for their support during the data collection process. We are also deeply thankful to the patients and their families for their participation and cooperation in this study.

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