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Associations between serum electrolyte impairments and frailty status in older adults

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Abstract

Purpose Electrolyte imbalances are common, and may be associated with frailty owing to their physiological roles in homeostasis. This study assessed the association between frailty and electrolyte imbalances.

Methods This cross-sectional study included older adults who underwent a comprehensive geriatric assessment in an outpatient clinic of a university hospital. According to Fried's criteria, associations between each electrolyte abnormality (hypo/hypernatremia, hypo/hyperkalemia, hypo/hypermagnesemia, hypo/hyperphosphatemia, hypo/hypercalcemia) and frailty group (frail, prefrail, robust) were investigated.

Results Of the 1722 patients included, 71% were females, and the mean age was 84 ± 8 years. Frailty was found in 1066 (62%) patients, while 488 (28%) were prefrail, and 168 (10%) were in the robust group. Hyponatremia rates in frailty, pre-frailty, and no frailty groups were 10.6%, 5.9%, and 2.4%, respectively ($p < 0.001$). Hypomagnesemia rates were 18.1%, 11.1%, and 6.5%, respectively ($p < 0.001$). The prevalence of other electrolyte abnormalities was comparable between groups. Frailty was associated with hypomagnesemia when compared to pre-frailty, also after adjustments for age, sex, drug count, MNA score, Charlson comorbidity index, Lawton and Bartel scores (OR:1.63, 95% CI 1.03–2.57, $p = 0.037$). Compared to patients without frailty, those who had frailty were more likely to have hyponatremia after adjusting for age and sex, but the significance was lost after the inclusion comorbidities, drug counts, daily living scores and the MNA score in the model. Other comparisons between groups were not significant after adjustments. Frail patients were more likely to have multiple electrolyte abnormalities. Multiple electrolyte abnormalities were not associated with worse frailty status than single abnormality after age- and sex-adjustment.

Conclusion Hypomagnesemia and hyponatremia are common in older adults and are associated with frailty. Prevention or correction of these imbalances may improve frailty outcomes.

Keywords Electrolytes · Frailty · Frail Elderly · Hyponatremia

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Introduction

With the global increase in the older adult population, frailty has become a significant concern. A recent meta-analysis including 240 studies and approximately 1,750,000 individuals reported the pooled prevalence of frailty as 12% based on physical frailty measures, and as 24% based on frailty index, while prevalences for prefrailty based on similar methods were 46%, and 49%, respectively [1]. Another meta-analysis found a prevalence of frailty of one in five among older adults who live in rural communities [2]. One meta-analysis which involved non-frail individuals aged 60 years or older found a pooled incidence of frailty of 43.4 per 1000 person years [3]. Increased rates of frailty are associated with longer

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hospital stays and higher hospital and healthcare costs [4]. Another study among nursing home residents found an association between frailty and mortality [5]. Therefore, identifying clinical factors that may cause frailty is becoming increasingly important.

Similar to frailty, electrolyte imbalances are also very common among the elderly. A study from carried out in Turkey found the prevalence of electrolyte imbalance as 41.2%, hyponatremia (11.2%), hypomagnesemia (9.1%), and hypermagnesemia (8.8%) as the most common [6]. Liamis and colleagues reported a prevalence of 15% in participants aged 55 years and over [7]. Older adults, especially frail older adults, are prone to electrolyte imbalances due to nutritional deficiencies, chronic and acute infections, multiple medication use, loss of appetite, and muscle loss [8]. Electrolyte imbalances, on the other hand, may increase the risk of geriatric syndromes. Electrolyte imbalances may be associated with comorbidities, dependency, and lower quality of life [6]. Various types of electrolyte imbalances may be related to unique comorbidities (hyperkalemia in chronic kidney disease, hyponatremia in heart failure, etc.). Hypomagnesemia is common and is associated with muscle cramps and dynapenia [9]. Sodium complications are associated with altered mental status and decline in mobility [10]. Clinical symptoms such as weakness, fatigue, and muscle weakness caused by the electrolyte imbalances mentioned above may be a cause of frailty in older adults.

A possible relationship between frailty and electrolyte imbalance has not been investigated in detail. Therefore, the present study aims to investigate the effects of electrolyte imbalances on frailty.

Methods

This study was approved by the Institutional Review Board of Bezmialem University Hospital (IRB code: 54,022,451–050.05.04-; 25.08.2020), and adheres to the Declaration of Helsinki. Written informed consent was obtained from the patients or their relatives/caregivers. Consecutive patients who were admitted to one outpatient geriatric clinic in Istanbul, Turkey, for comprehensive geriatric assessment were evaluated. The participant exclusion criteria were having an acute health problem ($n = 53$), no frailty assessment ($n = 230$), lack of electrolyte data ($n = 535$), and being younger than 65 years of age ($n = 19$).

Electrolyte measurements

All of the measurements were performed as part of the comprehensive geriatric assessment within the same week of the first visit. Laboratory tests were carried out to assess the biochemical status of patients in the geriatric department. If the patients were in a fasting state, blood was taken on the day of the visit. Otherwise, blood was withdrawn on another day within the same week. Laboratory tests included complete blood count, C-reactive protein, kidney and liver function tests, serum electrolytes, cholesterol levels, thyroid-stimulating hormone, vitamin B_{12}, folic acid, and vitamin D levels. All biochemical tests were carried out on the Diagnostic Modular Systems autoanalyzer (Roche E170 and P800). After blood collection, the gel tubes were centrifuged within 1 h, and the sera were stored at 20 °C for serum vitamin D analysis. Sodium and calcium concentrations were corrected for blood glucose and serum albumin levels.

The following cut-off levels were used for the definition of each electrolyte imbalance [6]: Serum sodium of < 136 mmol/L, hyponatremia; Serum sodium of > 145 mmol/L, hypernatremia; Serum potassium of < 3.5 mmol/L, hypokalemia; Serum potassium of > 5.3 mmol/L, hyperkalemia; Serum calcium of < 8.5 mg/dL, hypocalcemia; Serum calcium of > 10.5 mg/dL, hypercalcemia; Serum phosphorus of < 2.5 mg/dL, hypophosphatemia; Serum phosphorus of > 4.5 mg/dL, hyperphosphatemia; Serum magnesium of < 1.6 mg/dL, hypomagnesemia; Serum magnesium of > 2.3 mg/dL, hypermagnesemia.

Comprehensive geriatric assessment

The cohort comprised ambulatory older patients who were deemed to benefit from a comprehensive geriatric assessment. This assessment included history taking (eg, recording data for age, sex, comorbidities, drug exposures, and social life), laboratory evaluation, and evaluations for geriatric syndromes. The age-adjusted Charlson comorbidity index was calculated as mentioned elsewhere [11]. For this study, we included frailty and basic and instrumental daily activity living scores data, and the Mini-Nutritional Risk Assessment Score (MNA). Basic and instrumental activities of daily living were assessed by the Barthel Index and the Lawton scale, respectively [12]. For the evaluation of nutrition, the MNA-long form was created based on the patient's measurements including weight, height, calf and upper arm circumference, and factors related to the patient's diet.[13]

Frailty assessment

Frailty was evaluated according to the Fried criteria based on a five-point scale [14]. Patients were evaluated for weight loss, exhaustion, vulnerability, slow walking speed, and low physical activity. Frailty was determined according to the criteria proposed by Fried et al. as follows: (1) Looseness: determined by the time used to pass a 4-m gait test. The cut-off point was adjusted for gender and height, and those in the lower quintile were identified as having slow gait speed. (2) Grip strength: measured using a hand dynamometer. Three measurements were made on both hands, and the highest was retained. The cutoff point was adjusted for body mass index and gender, and those in the lowest quintile were determined to have the poorest grip strength. (3) Physical activity: defined using the physical activity scale for the elderly, which is an instrument that measures the level of physical activity for older adults. (4) Exhaustion: the elderly with a negative answer to the following 2 questions were categorised as exhausted: "Do you feel full of energy?" and "Do you have enough energy for your daily life?". (5) Weight Loss: determined using the self-reporting of weight loss (5 kg) during the last 6 months. Those who meet 3 or more of the criteria were considered frail, while those who meet 1 or 2 criteria were considered prefrail.

Statistics

Normality analyses were performed by Kolmogorov–Smirnov tests. Quantitative variables were expressed as median with the interquartile range (25–75%) in the case of non-normal distribution, and mean with standard deviation if normally distributed. Qualitative variables were expressed as proportions. Groups were compared for means using the Mann–Whitney U test or the Kruskal–Wallis test, as appropriate. Chi-squared tests were used for comparisons between proportions. Post-hoc tests were used in comparisons between multiple groups. Associations between frailty status and each electrolyte abnormality were assessed using logistic regression analysis. Logistic regression analysis was performed to determine significant associations between frailty vs no frailty, frailty vs prefrailty, and prefrailty vs no frailty. The first model was adjusted for age and sex. Given the well-defined associations between polypharmacy, diabetes mellitus, chronic kidney disease, and dementia with some electrolyte impairments [15–20], the second model included these variables, and activities of daily living scores. Results were expressed as odds ratios and 95% confidence intervals for logistic regression. Possible collinearity was evaluated using correlation coefficients and variance inflation factors. Statistical analysis was performed using SPSS 22.0 version (IBM SPSS, Chicago, IL). A P value of 0.05 or lower was considered to be statistically significant.

Results

Of the 1722 patients included, females comprised 71% of the cohort (1226 patients), and the mean age was 84 ± 8 years. Frailty was found in 1066 (62%) patients, 488 (28%) were prefrail, and 168 (10%) were in the no-frailty group. The mean age increased significantly as frailty status became more severe between groups (Table 1). There were more females in the frailty group than in the prefrail and no-frailty groups. Patients with frailty were more likely to have diabetes, dementia, cerebrovascular disorders, chronic kidney disease, and exposure to a higher number of drug counts compared to patients in prefrailty and no-frailty groups. Lawton and Barthel index scores were significantly lower in the frailty group compared to other groups.

Overall, the percentage of patients with various electrolyte abnormalities was as follows: hyponatremia 8.5%, hypernatremia 1.7%, hypokalemia 3.4%, hyperkalemia 3%, hypomagnesemia 15%, hypermagnesemia 6%, hypocalcemia 3.9%, hypercalcemia %4%, hypophosphatemia 3.9%, and hyperphosphatemia 4%. Patients with frailty had significantly higher rates of hyponatremia than patients with prefrailty (10.6% vs 5.9%) and than patients within the no-frailty group (10.6% vs 2.4%, Table 2). Similarly, patients with frailty had significantly higher numbers of patients with hypomagnesemia than other groups (18.1%, 11.1%, and 6.5%, respectively, $p < 0.001$ for frailty vs prefrailty and frailty vs no frailty). Figure 1 shows a graph of prevalence data for each electrolyte abnormality across frailty status groups. There were no other significant associations between other electrolyte abnormalities and frailty groups.

Compared to patients without frailty, those who had frailty had a significant association with hyponatremia after adjusting for age and sex (OR 2.02, 95% CI 1.20–3.39, $p = 0.008$; Table 3). In the second model adjusted for age, sex, Charlson comorbidity index, the MNA score, the number of drugs used, Lawton index, and Barthel index, the significance was lost.Compared to prefrailty, frailty was associated with hyponatremia after adjusting for age and sex (OR 1.75, 95% CI 1.13–2.70, $p = 0.012$); however, the significance was lost after adjusting for other variables, including drug exposures, comorbidities, and activities of daily living. There was no significant association in multivariate models in patients with prefrailty with hyponatremia compared to the no-frailty group.

Compared to no-frailty, frailty was associated with hypomagnesemia after adjusting for age and sex (OR 1.84, 95% CI 1.30–2.61, $p < 0.001$). This significance was lost after adjustments in a second model for drug exposures, comorbidities, and activities of daily living scores. Frailty was associated with hypomagnesemia when compared to pre-frailty, even after adjustments for age, sex, age-adjusted Charlson comorbidity score, the MNA sore, the number of drugs used, Lawton index, and Barthel index (OR 1.63, 95% CI 1.03–2.57, $p = 0.037$). There was no significant association between prefrailty and hypomagnesemia compared to the no-frailty group.

The following prevalence data were found for no frailty, prefrailty, and frailty groups, respectively: lack of electrolyte abnormality, 69%, 72%, 57%; the presence of one electrolyte abnormality, 24%, 23%, 31%; the presence of

Table 1 Characteristics of the whole cohort and frailty status groups

Variables	All cohort ($N=1722$)	Frail ($n=1066$)	Prefrail ($n=488$)	No frailty (168)	P
Age	84 ± 8	86 ± 7	82 ± 7	78 ± 6	< 0.001[abc]
Female sex	71%	74%	69%	62%	< 0.001[ab]
Education, years	5 (0–8)	5 (0–6)	5 (3–8)	5 (5–11)	< 0.001[abc]
Diabetes	35%	37%	34%	27%	0.002[a]
Hypertension	70%	72%	70%	61%	0.002[bc]
Dementia	38%	46%	30%	15%	< 0.001[abc]
Cerebrovascular disease	11%	14%	8%	7%	< 0.001[ab]
Ischemic heart disease	18%	19%	16%	12%	0.009[a]
Chronic kidney disease	37%	45%	30%	15%	< 0.001[abc]
Charlson index	6.0 (4.7–7.2)	6.5 (5.4–7.6)	5.4 (4.4–6.7)	4.3 (3.3–5.2)	< 0.001[abc]
Number of drugs	6 (4–9)	7 (5–9)	6 (4–8)	4 (2–7)	< 0.001[abc]
Body-mass index	28.9 ± 5.8	28.7 ± 6.2	29.4 ± 5.5	28.6 ± 4.5	0.007[a]
Blood pressure, mm Hg					
Systolic	141 ± 25	139 ± 26	144 ± 23	143 ± 22	< 0.001[ab]
Diastolic	77 ± 20	76 ± 14	80 ± 29	78 ± 13	< 0.001[a]
Hemoglobin	1.4 ± 1.7	12 ± 1.7	12.8 ± 1.4	13.3 ± 1.6	< 0.001[abc]
Serum albumin	4.2 ± 0.4	4.1 ± 0.5	4.3 ± 0.4	4.4 ± 0.3	< 0.001[ab]
eGFR	60 ± 19	56 ± 19	64 ± 18	73 ± 16	< 0.001[abc]
Serum sodium	139 ± 3	139 ± 4	140 ± 3	140 ± 3	< 0.001[ab]
Serum K +	4.4 ± 0.5	4.4 ± 0.6	4.4 ± 0.5	4.5 ± 0.4	0.131
Serum Mg + +	1.9 ± 0.3	1.9 ± 0.3	1.9 ± 0.3	2.0 ± 0.3	< 0.001[b]
Serum Ca + +	9.4 ± 0.6	9.4 ± 0.6	9.5 ± 0.6	9.5 ± 0.6	0.016[NS]
Serum PO4	3.5 ± 0.6	3.5 ± 0.5	3.5 ± 0.7	3.4 ± 0.6	0.137
Vitamin D, ng/ml	23 (15–32)	23 (14–33)	23 (15–32)	24 (16–34)	0.385
Vitamin B12, pg/ml	387 (277–587)	397 (282–608)	368 (265–558)	364 (272–553)	0.016[b]
Folate, ng/ml	7 (5.1–9.7)	6.9 (4.8–9.7)	6.9 (5.2–9.7)	7.5 (5.7–10.2)	0.038[NS]
CRP, mg/L	2.5 (0.5–10.1)	3 (0.9–15)	2 (0.3–7)	0.1 (0.2–3)	< 0.001[ab]
Barthel index	85 (67–95)	75 (50–89)	95 (88–100)	100 (95–100)	< 0.001[abc]
Lawton index	12 (4–19)	6 (2–13)	18 (12–22)	22 (19–23)	< 0.001[abc]
MNA score	21.1 ± 5.3	18.7 ± 5.2	24.5 ± 3.2	26.5 ± 2.1	< 0.001[abc]

NS, not significant; eGFR, Estimated glomerular filtration rate

Continuous variables are presented as mean ± standard deviation or median with the interquartile range (25%-75%). Comparisons for post-hoc tests were as follows: [a]Frail vs Prefrail,[b]Frail vs Normal, and [c]Prefrail vs Normal

two or more electrolyte abnormalities, 7%, 5%, and 12% ($p < 0.001$). None of the patients in the no-frailty group had three or more electrolyte abnormalities. This rate was 1%, and 3% for prefrailty and frailty groups, respectively (Fig. 2). Compared to no electrolyte abnormality, multiple (≥ 2) electrolyte abnormalities were associated with a higher risk of frailty after adjustments for age and sex, however, the significance of this association was lost after adjustments for the Charlson index, the MNA score, the number of drugs exposed, and activities of daily living scores (Table 4). The presence of a single electrolyte abnormality was also associated with a higher risk of frailty versus prefrailty after multiple adjustments. Compared to patients with single electrolyte abnormality, multiple electrolyte abnormalities were not associated with a higher risk of frailty or prefraily after adjustments.

Discussion

The current study's results demonstrate significant associations between frailty and common electrolyte imbalances, including hypomagnesemia and hyponatremia, but not other types of electrolyte impairments. Frail patients were more likely to have hyponatremia than patients without frailty, while there was no significant association between hyponatremia and frailty versus pre-frailty or pre-frailty versus no-frailty groups. There was a significant association between

Table 2 Prevalence of each electrolyte impairment across frailty status groups

All cohort	All cohort	Frail	Prefrail	No frailty	P
Hyponatremia	8.5%	10.6%	5.9%	2.4%	< 0.001[ab]
Hypernatremia	1.7%	1.9%	1.4%	1.2%	0.720
Hypokalemia	3.4%	4.1%	2.3%	2.4%	0.124
Hyperkalemia	3%	3.7%	1.8%	1.2%	0.043[NS]
Hypomagnesemia	15%	18.1%	11.1%	6.5%	< 0.001[ab]
Hypermagnesemia	6%	5.9%	6.3%	6.5%	0.923
Hypocalcemia	3.9%	4.6%	3%	1.8%	0.129
Hypercalcemia	4%	4.4%	3.2%	3.7%	0.568
Hypophosphatemia	3.9%	3.8%	3.2%	6.7%	0.201
Hyperphosphatemia	4%	3.9%	4.7%	3%	0.680

NS, not significant

[a]Frail vs Prefrail

[b]Frail vs Normal

[c]Prefrail vs Normal

hypomagnesemia and frailty (versus prefrailty). Although this was the case for frailty versus no frailty, the significance was lost after adjustments. However, frail patients appeared to have a higher risk of hyponatremia and hypomagnesemia than their non-frail counterparts. These associations remained significant even after adjustments for age, sex, and comorbidities that may have a crucial impact on electrolytes, drug exposures, and daily living scores.

One similar study by Fujisawa and colleagues classified their cohort of older adults based on Rockwood's frailty index (no frailty, mild frailty, moderate frailty, severe frailty) [10]. The index was calculated based on health-related deficits/variables. Similar to ours, their severely frail patients were more likely to have hyponatremia than their non-frail counterparts. However, they also observed differences between frailty groups in terms of other electrolyte impairments, including hypernatremia, hypophosphatemia, and hypokalemia. Indeed, hypophosphatemia has also been found to be related to frailty in a systematic review [21]. Different classification of frailty in our study and different characteristics of our patients, including but not limited to older age and different geography, may in part explain such differences. Also, our definitions for electrolyte impairments were slightly different in terms of reference values. Fujisawa and colleagues did an extensive evaluation on relationship between frailty and electrolyte impairments, but did not evaluate associations between frailty and magnesium disorders. The possible impact of these electrolyte problems on frailty development is not known and should be tested in a longitudinal follow-up. Our results also demonstrate that frail older adults are more likely to have multiple electrolyte abnormalities.

Based on associations between hyponatremia and falls, sarcopenia, decline in mobility and cognition, and diuretic use [22], an association with frailty and hyponatremia is not

Fig. 1 The prevalence of each electrolyte abnormality across different frailty status groups

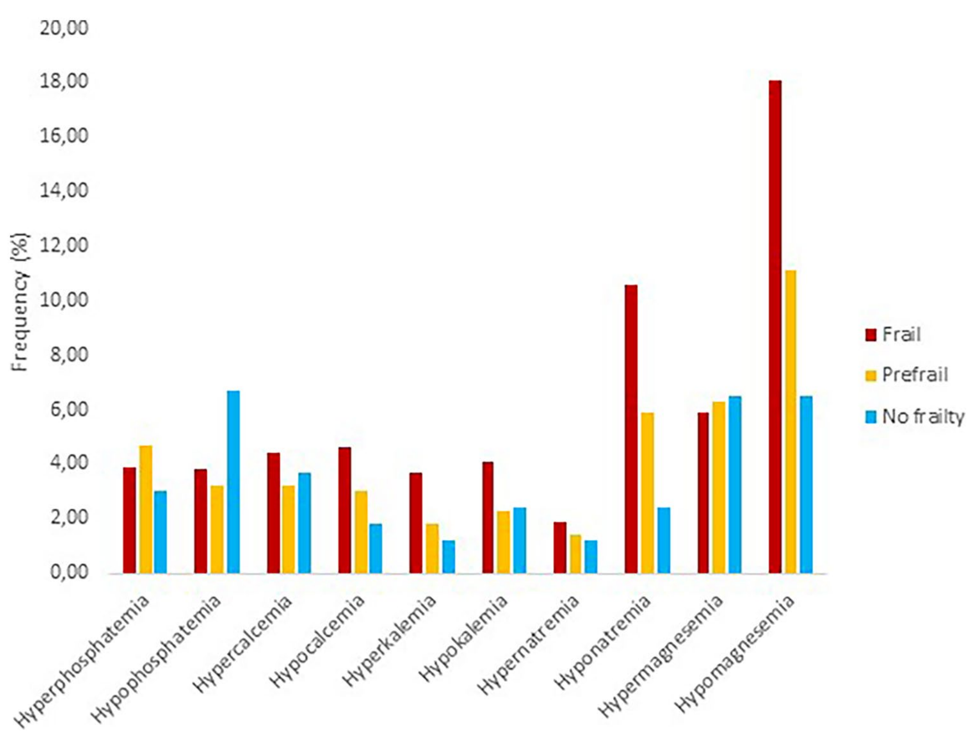

Table 3 Associations between frailty status groups with hyponatremia and hypomagnesemia

	Hyponatremia						Hypomagenesemia					
	Model 1			Model 2			Model 1			Model 2		
	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*
Frailty vs No-frailty	2.02	1.20–3.39	0.008	2.86	0.57–14.25	0.200	1.84	1.30–2.61	< 0.001	2.34	0.82–6.69	0.111
Frailty vs Pre-frailty	1.75	1.13–2.70	0.012	1.34	0.77–2.33	0.295	1.83	1.27–2.63	< 0.001	1.63	1.03–2.57	0.037
Pre-frailty vs No-frailty	2.54	0.86–7.49	0.091	2.03	0.55–7.50	0.289	1.65	0.79–3.46	0.185	0.83	0.35–1.99	0.677

Model 1 adjusted for age and sex. Model 2 adjusted for age, sex, age-adjusted Charlson comorbidity index, the number of drugs used, MNA score, Lawton index, and Barthel index

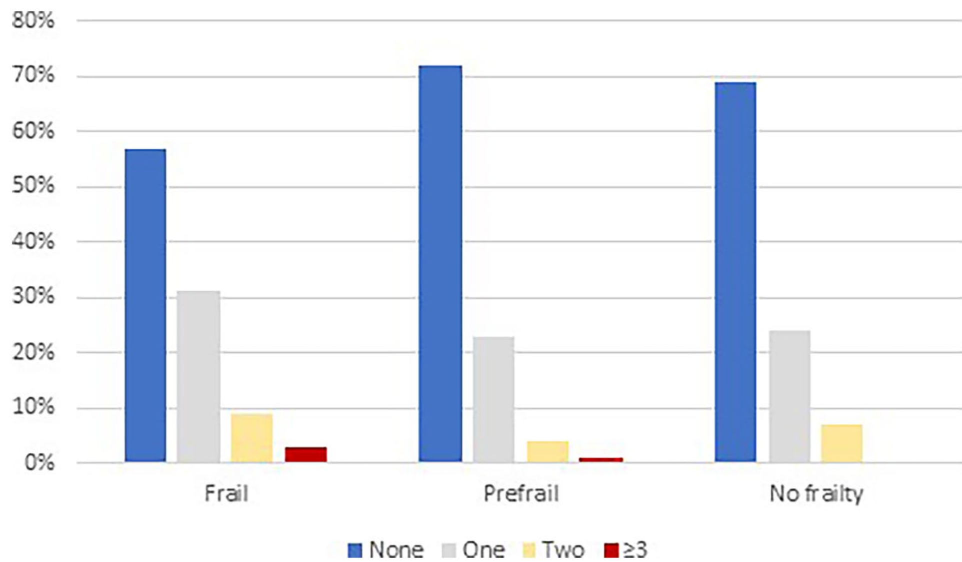

Fig. 2 The prevalence of one, two, and three or more electrolyte abnormalities within frailty status groups

unexpected. One study evaluated the relationship between age, frailty, and dysnatremia among 8,911 participants from the 2003–2004 and 2005–2006 cross-sectional National Health and Nutrition Examination Survey [23]. Dysnatremia was related to both age and frailty, and the relationship between age and hyponatremia was lost after adjustment for frailty. It was concluded that increasing frailty was associated with dysnatremia and confounded the association between age and dysnatremia.

Hypomagnesemia appears to be the most common electrolyte disorder in the outpatient setting among older adults [6]. Our results are in line with those reported by Kocyigit and colleagues, who demonstrated an association between hypomagnesemia and frailty. The prevalence of hypomagnesemia in their cohort was approximately 14%, similar to findings from the present study [24]. Possible common causes of hypomagnesemia include drug exposures, comorbidities, and malnutrition. The possible impact of low magnesium on frailty status may be related to nutritional characteristics. We previously reported that low serum magnesium levels are associated with dynapenia only among patients with altered nutrition, but not among those who were well-nourished [9]. Hypomagnesemia is also associated with excessive daytime sleepiness in older adults, which may lead to a sedentary lifestyle and consequently contribute to frailty [25]. For this reason, hypomagnesemia may also have an impact on its effects on frailty.

One of our findings was that frail patients were more likely to have multiple electrolyte abnormalities. Some electrolyte problems may be more likely to exist (e.g., hypokalemia and hypomagnesemia, hyperkalemia and hypermagnesemia, or hypocalcemia and hyperphosphatemia). Comorbidities such as diabetes and chronic kidney disease, drug exposures such as diuretics, or nutritional problems may explain some of these coexistent abnormalities. Our study is the first to show that multiple electrolyte impairments are more common in frail older adults than their non-frail counterparts. Although multiple electrolyte problems appeared to be more prevalent in frail older adults, a significant association could not be found between frailty states with multiple electrolyte abnormalities versus single abnormality. One reason for this may be the lower number of patients in the multiple abnormality subgroup, and different impact of each electrolyte impairment on frailty status.

Table 4 Impact of the number of electrolyte impairments on frailty status

	Multiple vs None						One vs None						Multiple vs One					
	Model 1			Model 2			Model 1			Model 2			Model 1			Model 2		
	OR	CI	P	OR	CI	P	OR	CI	P	OR	CI	P	OR	CI	P	OR	CI	P
Frailty vs No-frailty	2.03	1.00–4.15	0.05	0.66	0.17–2.64	0.555	2.01	1.28–3.14	0.002	1.20	0.58–2.52	0.622	1.04	0.49–2.21	0.928	–	–	–
Frailty vs Pre-frailty	2.11	1.37–3.25	0.001	1.13	0.64–2.02	0.671	1.61	1.24–2.09	<0.001	1.37	1.00–1.90	0.05	1.30	0.82–2.06	0.273	–	–	–
Pre-frailty vs No-frailty	0.95	0.45–2.02	0.903	0.74	0.28–1.96	0.548	1.23	0.78–1.95	0.377	–	–	–	0.75	0.33–1.69	0.485	–	–	–

Model 1 adjusted for age and sex. Model 2 adjusted for age, sex, age-adjusted Charlson comorbidity index, the number of drugs used, MNA score, Lawton index, and Barthel index

We could not analyse differences between patients who had over two electrolyte impairments versus lower number of impairments due to the low sample size in the former. This issue requires further investigation.

The prevalence of frailty increases with age independently of the assessment instrument and ranges between 4 and 59% in community-dwelling older people [26], and is higher in women than in men. The prevalence in our study was on the high side, affecting over 60% of our sample. The higher percentage of women and the relatively old mean age in our study may partially explain this high rate. The prevalence is likely to be influenced by the comorbidity burden, socioeconomic status, and other geriatric syndromes, including malnutrition.

Our study has a cross-sectional design, and a cause-and-effect relationship can not be shown. A bidirectional relationship between frailty and electrolyte problems may exist, but this needs to be tested in future research. The majority of our patients were females, and all were white. Results can not be generalized to other races. Data was obtained retrospectively from medical files. Etiologies of electrolyte impairments are probably different and multifactorial in some of the patients, which further makes evaluation complex. One of the limitations was the lack of data on specific drug exposures. Although we evaluated impact of polypharmacy, exposures to particular drug classes such as selective seronunin reuptake inhibitors were not available. Such drugs are known to increase tendency to develop hyponatremia in a considerable number of patients. However, our study is one of the few to analyse associations between electrolyte impairments and frailty, and is the first to evaluate all electrolytes in the analysis.

In conclusion, frailty is associated with hypomagnesemia and hyponatremia among community-dwelling older adults. The possible benefits of correcting or preventing each electrolyte abnormality and the impact of the etiology of each electrolyte problem on frailty management should be further studied.

Disclosure

No potential conflict of interest was reported by the authors.

Author contributions Conception and Design, DUA, CH, HUA, PS; Analysis and Interpretation of the data, CH, NV, LS, HUA, DUA, IA, EE; Drafting of the paper, DUA, HUA, IA, EE; Revising the paper for critical intellectual content, LS, CH, PS, NV; final Approval of the version to be published, all authors. All authors agree to be accountable for all aspects of the work.

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Data availability The data that supports the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Conflict of ınterests The authors declare no competing interests.

Informed consent Written informed consent was obtained from the patients or their relatives/caregivers.

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