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Exploring Nutritional and Socio-demographic Linkages of Hypocalcaemia in Urban Geriatric Subjects: Evidence from Community Based Study

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Background: Hypocalcaemia in geriatric subjects is a global health issue. Hypocalcaemia can is serum calcium deficiency and diagnosed when serum calcium levels are less than 8.8 mg/dL. Limited exposure of sunlight, inadequate dietary intake and sedentary life style prevail among community-dwelling geriatric subjects may predispose them to subclinical or mild hypocalcaemia. **Aim:** To explore nutritional and sociodemographic linkage of hypocalcaemia in geriatric subjects. **Materials and Methods:** This community based cross sectional study was done on 557 urban geriatric subjects (≥60 years) of Prayagraj district, Uttar Pradesh. Multistage sampling procedure was adopted for selection of subjects. Tools and Techniques: Predesigned and pretested proforma was used to obtain socio demographic information and serum calcium content was assessed through Spectrophotometry-Ortho-Cresol phthalein Complex one method**. Data analysis:** Statistical Package for Social Sciences was used for data analysis; Chi-square test was used for statistical significance. **Results:** Out of 552 subjects 31.3% had hypocalcaemia. Hypocalcaemia among geriatric subjects showed significant associations with marital status, family type, educational level, waist circumference, and body fat percentage. The highest prevalence of hypocalcaemia was observed among males (32.5%), subjects belonging to SC/ST categories (35.9%), living in joint families (34.8%), and subjects with intermediate-level education (46.8%), unskilled labourers (50.0%), and subjects from lower middle socioeconomic class (37.0%). Subjects with high body fat percent and low muscle mass had more hypocalcaemia. **Conclusion:** Five out of 16 subjects had hypocalcaemia. Significant associations with key sociodemographic and anthropometric factors, including marital status, family type, educational level, waist circumference, body fat percentage and muscle mass, indicating a substantial public health concern.

Key Words: Body fat percent, Geriatric subjects, Hypocalcaemia, Muscle mass, Public health, Urban area.

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Introduction

Hypocalcaemia, refers to reduction in serum calcium below the normal physiological ranges. It is a notable but often under-recognized metabolic disturbance in geriatric subjects. Although it generally linked with endocrine disorders or medication use and acute illness, existing scenario advocates that even apparently healthy geriatric subjects living independently in the community are vulnerable to calcium imbalance. The likelihood of this condition is influenced by reduced intestinal calcium absorption with aging, impaired activation of vitamin D and decreased renal function. Besides this, lifestyle factors such as limited exposure of sunlight, inadequate dietary intake and sedentary life style more prevalent among community-dwelling geriatric subjects may further predispose them to subclinical or mild hypocalcaemia.

Despite these risks, hypocalcaemia in apparently healthy geriatric subjects often remains undetected since its manifestations are subtle, nonspecific and erroneously attributed to normal aging. Lower mineral density, cognitive issues and

neuromuscular symptoms are repercussion of mild chronic hypocalcaemia which can increase the likelihood of risk of falls, frailty, and future morbidity. Globally, the occurrence of hip fractures in elderly is estimated to rise from 1.66 million in 1990 to 6.26 million by 2050.[1] Early identification of calcium abnormalities in this population is therefore crucial for prevention strategies and timely intervention.

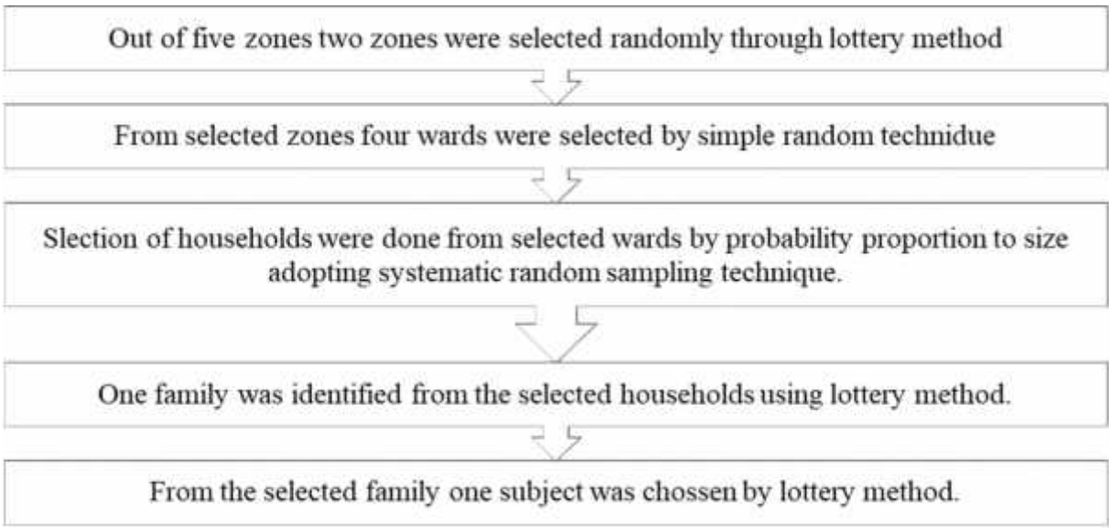
Studies done on hypocalcaemia focus on hospitalized patients or subjects with known chronic diseases [2, 3, 4], leaving a significant knowledge gap regarding its extent and correlates among community dwelling apparently older adults. Understanding calcium status in this group is essential as they may possess unrecognized biochemical vulnerabilities that contribute to long-term health deterioration. Assessing hypocalcaemia in apparently healthy geriatric subjects can offer valuable insights into early metabolic alterations, guide public health strategies for nutritional and lifestyle interventions and aid in designing targeted screening programs. This research aims to address this gap by assessing the extent and associates of hypocalcaemia in community-living urban geriatric subjects, thereby contributing evidence crucial for early preventive care and healthy aging initiatives.

Materials and Methods:

Study area and participants: This community based cross-sectional study was done in urban Prayagraj, India. As per the census (2011) population of the Prayagraj district was 59, 54,390. There were 1,212,395 urban residents, of which 654,487 were men and 557,908 were women [5]. The reference population for this study was urban geriatric subjects (≥ 60 years).

Sample size: Sample size calculation was done taking prevalence of hypocalcaemia 32%, (obtained from pilot study), acceptable level of error of 5%, 1.5 design effects and non-response rate10%, and the final sample size worked out to be 557. However, this study was done on 552 participants as 5 subjects refused for taking their blood sample.

Sampling Procedure: A multistage sampling procedure was adopted for selection of subjects. Zones, wards, household, family, and subjects were the different stages of sampling procedure. Following steps were included in the study for selection of subjects:



Inclusion Criteria: Urban subjects ≥ 60 years, willing to participate and gave their consent were included in study.

Exclusion Criteria: Subjects residing < 6 months in the study area or having serious physical and mental illness/ abnormalities were not included in the study.

Ethical Approval: Ethical approval was obtained from the Institutional Ethics Review Board (IERB), University of Allahabad (IERB ID: FAM-D-21-002). Informed written consent was obtained from subjects.

Tools and techniques of the study: Information pertaining to socio demographic characteristics was obtained by interviewing subjects using predesigned and pretested proforma. Socio-economic status (SES) of the subject was assessed using Kuppuswamy Socio-economic classification (2020). Based on the score subjects were divided into upper, upper-middle, middle, upper-lower, and lower SES[6]. Anthropometric measurements (viz., weight, height, waist, and hip circumference) were done following standard techniques. The Omron HBF 214 Digital Full Body Composition Monitor Machine was used to measure weight, visceral fat percentage and body fat percentage of subjects. Height and waist as well as hip circumference were measured through stadiometer and a flexible, non-stretchable tape, respectively. In order to estimate serum calcium level, venous blood sample (5ml) was aseptically drawn from each subject. Serum calcium estimation was done in a NABL-accredited laboratory. Serum was separated by centrifugation, and calcium level was measured using the spectrophotometric Ortho-Cresol Phthalein Complex one (OCPC) method. A serum calcium level of 8.8–10.2 mg/dL was considered normal, while values below 8.8 mg/dL were classified as low [7].

Data analysis: Data were entered in personal computer and analysis was done with the help of SPSS version 22. Linkages of hypocalcaemia were obtained through chi square test; a p value of < 0.05 was considered as significant.

Results

Out of 552 subjects, 68.7% had normal serum calcium levels (8.8–10.2 mg/dL), while 31.3% had hypocalcaemia (<8.8 mg/dL).

Significant (p <0.05) linkage between hypocalcaemia and marital status, education and size of family was observed. All unmarried subjects (100.0%) had hypocalcaemia, whereas 30.3% married and 32.0% without spouse had low serum calcium. As much as 33.3%, 22.2%, 34.6%, 27.8%, 23.3% 46.8%, 25.0% and 31.7% subjects having educational status as illiterate, just literate, primary, secondary, high school, intermediate, graduation and post-graduation had hypocalcaemia, respectively. In 29.5%, 31.4% and 33.8% subjects with family size 2-4, 5-7, 8-10 had hypocalcaemia, respectively. None of the subject had hypocalcaemia from family size >10 (p<0.05). The highest deficiency was observed among subjects with an intermediate level of education (46.8%), whereas no deficiency was observed among those with a Ph.D. degree. There existed no significant (p>0.05) linkage between serum calcium and age, gender, religion, caste, type of family, occupation and SES of subjects. Prevalence of hypocalcaemia was almost similar across all age groups. As much as 31.2% 31.6% and 31.6% subjects from age group 60-69, 70-79 and ≥80 years had hypocalcaemia. Hypocalcaemia was present in 32.5% male subjects. Of all, 32.7% Hindu, 27.6% Muslim, 16.7% Sikh and 10.0% Christian had hypocalcaemia. In all, 50.0% unskilled, 39.1% skilled workers, 36.8% subjects engaged in service and 32.2% homemakers had hypocalcaemia. Calcium deficiency varied from 18.8% in the lower SES to 37% in the SES **(Table-1)**.

Table-1: Sociodemographic Associates of Hypocalcaemia

Socio Demographic Status		Serum Calcium (unit/dl)						Test of Significance
		Normal		Deficiency		Total		
		No.	%	No.	%	No.	%	
Age (yrs)	60-69	212	68.8	96	31.2	308	100.0	χ^2 =0.10; df = 2 p =0.99
	70-79	128	68.4	59	31.6	187	100.0	
	≥80	39	68.4	18	31.6	57	100.0	
Gender	Male	189	67.5	91	32.5	280	100.0	χ^2 = 0.35; df = 1 p =0.55
	Female	190	69.9	82	30.1	272	100.0	
Religion	Hindu	302	67.3	147	32.7	449	100.0	χ^2 = 3.695; df = 3 p = 0.30
	Muslim	63	72.4	24	27.6	87	100.0	
	Christian	9	90.0	1	10.0	10	100.0	
	Sikh	5	83.3	1	16.7	6	100.0	

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Caste	SC/ ST	66	64.1	37	35.9	103	100.0	χ^2 = 1.90; df = 2 p =0.39
	OBC	107	67.3	52	32.7	159	100.0	
	Others	206	71.0	84	29.0	290	100.0	
Marital Status	Unmarried	0	0.0	4	100.0	4	100.0	χ^2 = 8.98; df = 2 p = 0.01
	Married	262	69.7	114	30.3	376	100.0	
	Without Spouse	117	68.0	55	32.0	172	100.0	
Educational status	Illiterate	18	66.7	9	33.3	27	100.0	χ^2 =21.45; df = 8 p = 0.01
	Just Literate	14	77.8	4	22.2	18	100.0	
	Primary	17	65.4	9	34.6	26	100.0	
	Secondary	26	72.2	10	27.8	36	100.0	
	High school	33	76.7	10	23.3	43	100.0	
	Intermediate	66	53.2	58	46.8	124	100.0	
	Graduation	159	75.0	53	25.0	212	100.0	
	Post-Graduation	43	68.3	20	31.7	63	100.0	
	Ph.D.	3	100.0	0	0.0	3	100.0	
Occupation	Service (Private)	60	63.2	35	36.8	95	100.0	χ^2 =5.45; df = 6 p = 0.49
	Business	81	69.2	36	30.8	117	100.0	
	Unskilled Labour	2	50.0	2	50.0	4	100.0	
	Skilled worker	14	60.9	9	39.1	23	100.0	
	Retired	93	72.7	35	27.3	128	100.0	
	Homemaker	105	67.7	50	32.3	155	100.0	
	Unemployed	24	80.0	6	20.0	30	100.0	
Type of Family	Nuclear	190	72.5	72	27.5	262	100.0	χ^2 =3.45; df = 1 p = 0.06
	Joint	189	65.2	101	34.8	290	100.0	
Size of Family	2 - 4	179	70.5	75	29.5	254	100.0	χ^2 = 9.36; df = 3 p = 0.02
	5 - 7	151	68.6	69	31.4	220	100.0	
	8 - 10	49	66.2	25	33.8	74	100.0	
	>10	0	0.0	4	100.0	4	100.0	
Socio Economic Status (SES)	Upper	27	73.0	10	27.0	37	100.0	χ^2 = 3.63; df = 4 p = 0.46
	Upper Middle	205	70.0	88	30.0	293	100.0	
	Lower Middle	80	63.0	47	37.0	127	100.0	
	Upper Lower	54	68.4	25	31.6	79	100.0	
	Lower	13	81.3	3	18.8	16	100.0	

Hypocalcaemia was significantly ($p<0.05$) linked with waist circumference, body fat percentage and muscle mass percentage. As much as 34.5% and 27.0% subjects with normal and at risk (high) waist circumference had hypocalcaemia, respectively. In all 27.6%, 40.9% and 30.9% subjects with normal, high and very high body fat percentage had hypocalcaemia, respectively. A strong significant linkage exists between muscle mass percentage and calcium status. Subjects with low muscle mass had more calcium deficiency (40.4%); corresponding value in normal and high muscle mass was 27.4% and 23.5%, respectively. This indicates that lower muscle mass may be linked to poorer calcium status. There existed no significant ($p>0.05$) linkage between hypocalcaemia and food habit, waist hip ratio, body mass index and visceral fat%. In case of, 31.9% vegetarians' hypocalcaemia was present. As much as 29.3% and 33.0% subjects with normal and high waist hip ratio had hypocalcaemia. The prevalence of serum calcium deficiency remains almost identical across all BMI groups. Of all, 30.9%, 31.6% and 31.3% subjects classified as underweight, normal and overweight/obese on the basis of BMI had hypocalcaemia, respectively. Subjects with normal visceral fat%, 30.4% had hypocalcaemia. In those with high visceral fat%, the deficiency proportion was similar (30.9%).

However, subjects with very high visceral fat% had higher prevalence of hypocalcaemia (44.1%). Despite this apparent increase in deficiency in the very-high visceral fat % group, the linkage between visceral fat percentage and serum calcium status was not statistically significant (Table 2).

Table- 2: Nutritional parameters and hypocalcaemia

Nutritional Parameters		Serum Calcium status						Test of Significance
		Normal		Deficiency		Total		
		No.	%	No.	%	No.	%	
Food Habit	Vegetarian	233	68.1	109	31.9	342	100.0	$\chi^2 = 1.12$; df = 1 p = 0.40
	Non-Vegetarian	146	69.5	64	30.5	210	100.0	
Waist Circumference	Normal	211	65.5	111	34.5	322	100.0	$\chi^2 = 3.52$; df = 1 p = 0.04
	At Risk	168	73.0	62	27.0	230	100.0	
Waist-Hip Ratio	Normal	174	70.7	72	29.3	246	100.0	$\chi^2 = 0.89$; df = 0.35 p = 0.20
	At Risk	205	67.0	101	33.0	306	100.0	
Body Mass Index	Underweight	76	69.1	34	30.9	110	100.0	$\chi^2 = 0.02$; df = 2 p = 0.99
	Normal	193	68.4	89	31.6	282	100.0	
	Overweight/Obese	110	68.8	50	31.3	160	100.0	
Body Fat Percent	Normal	197	72.4	75	27.6	272	100.0	$\chi^2 = 6.66$; df = 2 p = 0.04
	High	68	59.1	47	40.9	115	100.0	
	Very High	114	69.1	51	30.9	165	100.0	
Visceral Fat Percent	Normal	295	69.6	129	30.4	424	100.0	$\chi^2 = 0.71$; df = 1 p = 0.23
	High	65	69.1	29	30.9	94	100.0	
	Very high	19	55.9	15	44.1	34	100.0	
Muscle Mass Percent	Low	118	59.6	80	40.4	198	100.0	$\chi^2 = 12.29$; df = 2 p = 0.00
	Normal	183	72.6	69	27.4	252	100.0	
	High	78	76.5	24	23.5	102	100.0	

Discussion

In the present study, nearly 5 out of 16 subjects had hypocalcaemia. According to a hospital-based study from Nepal 6 out of 25 geriatric subjects had hypocalcaemia[8]. The relatively high proportion of subjects with hypocalcaemia is noteworthy, as it highlights a potential public health concern. A hypocalcaemia prevalence of over 30% advocates that a considerable segment of the geriatric population may be at risk of complications such as reduced bone mineral density, muscle cramps, fatigue, and long-term vulnerability to osteoporosis. A significant linkage was observed between serum calcium status and selected sociodemographic variables, including marital status, education, and family size. Hypocalcaemia was present in all unmarried subjects whereas, 8 out of 25 subjects without spouse and approximately 3 out of 10 married subjects had hypocalcaemia, indicating that marital status may influence nutritional adequacy. Marriage contributes to household stability, regular meal patterns and better dietary diversity, which may lead to the lower extent of hypocalcaemia among married subjects. Nonlinear, association of education with calcium deficiency was observed in this study. Eleven out of 33, 11 out of 50, 7 out of 20, 7 out of 25, 23 out of 100, 8 out of 17, 1out of 4 and 6 out of 19 subjects having educational status as illiterate, just literate, primary, secondary, high school, intermediate, graduation and post-graduation had hypocalcaemia, respectively. The highest prevalence of hypocalcaemia present in subjects with intermediate level education, whereas subjects with doctoral degree had no deficiency. Higher education has been linked with better health literacy and healthier food choices [9, 10] which may explicate the lower prevalence or absence of hypocalcaemia among highly educated subjects. Family size also emerged as an important factor influencing calcium status of geriatric subjects. The extent of hypocalcaemia increased with increasing family size. In comparison to subjects from family size 2-4 (29 out of 100) and 5-7 (31 out of 100) subjects having family size 8-10 (1 out of 3) had more hypocalcaemia.

All geriatric subjects from families with >10 members had hypocalcaemia, although the small sample size in this group limits firm inferences. The relationship between family size and nutritional status has been documented in earlier research, where moderate family sizes often experience *resource dilution*, affecting dietary diversity and micronutrient adequacy[11,12]. These findings suggest that increasing family size may pose nutritional challenges, particularly for geriatric subjects. Hypocalcaemia (low serum calcium) is significantly high in subjects with normal waist circumference, high and very high body fat percentage and lower muscle mass. One out of 3 subjects with normal waist circumference, 2 out of 5 and 3 out of 10 subjects with high and very high body fat percent and 2 out of 5 subjects with low muscle mass had hypocalcaemia. A study done on urban adolescents also revealed that bone mineral content (BMC) had an association with lean muscle mass than with fat mass. It doesn't directly address serum calcium. However, highlight the interplay between lean muscle mass and bone[13]. Inadequate calcium might impair muscle function, potentially leading over time to muscle loss or poor maintenance[14]. Being a cross-sectional design, study limits causality whether lower muscle mass contribute to hypocalcaemia or low calcium could impair muscle maintenance, or both could be driven by a third factor. In this study BMI and waist hip ratio did not influence significantly the serum calcium status. In contrast to this a hospital-based study from Uttar Pradesh done on 30-60 years subjects reported positive correlation of hypocalcemia with increased BMI and waist hip ratio[15].

Conclusion

Hypocalcemia was present in 3 out of 33 urban geriatric subjects, indicating a substantial public health concern. The condition had significant association with sociodemographic and anthropometric factors, including marital status, family type, educational level, waist circumference, body fat percentage and low muscle mass. Findings emphasize the role of social determinants and body composition in influencing calcium status among geriatric subjects and underscore the need for targeted screening, nutritional interventions, and health education strategies focused on vulnerable geriatric populations.

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