



A study on association of nutritional status of the elderly with immune function, infectious diseases and metabolic disorders of Mumbai city

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Abstract:

Background: The global elderly population is growing rapidly, with Mumbai's elderly expected to reach 8.8% by 2030. Nutrition is crucial for their health, yet malnutrition persists due to socioeconomic factors and lifestyle changes.

Aim: To study the association of nutritional status of the elderly with immune function, infectious diseases and metabolic disorders of Mumbai city.

Methodology: A cross-sectional study in Mumbai with 100 elderly participants aged 65 and above included anthropometric measurements, sociodemographic data, medical history, and validated tools like MNA, ISQ, ICC, and 24-hour dietary recall. SPSS software was used for analysis with Independent Sample Z-tests and Pearson's correlation. Significant findings were determined with a p-value < 0.05.

Results: The study identified 36% of participants as Obese Grade 1 and 26% as Overweight, with males having higher average weight (p=0.012). Females exhibited more hypertension and autoimmune disorders (p=0.035 and p=0.003), while 50% were malnourished and 44% at risk, with females showing higher magnesium and zinc intakes (p=0.001). Additionally, males reported more gums and nosebleeds with higher ISQ scores (p=0.005), and a higher prevalence of 'Other Infections' (p=0.023), with energy intake and protein inadequacy, indicating that more males had inadequate protein intake (p=0.013) and lower energy intake (p<0.001) compared to females. Females were more likely than males to meet the recommended fiber intake (p=0.000).

Conclusion: In conclusion, the study highlights the urgent need for nutritional interventions and health education among Mumbai's elderly. There were elevated rates of malnutrition, weakened immune systems, and infections were high, calling for targeted interventions. Females had more hypertension, autoimmune issues, and better nutrition; males lacked enough protein and energy, facing gum/nosebleed problems and infections. These findings stress the need for tailored interventions based on gender and age.

Keywords: Elderly population, Nutritional status, Immune function, Infectious diseases, Metabolic disorders.

Introduction:

The global elderly population, aged 65 years and above, is projected to reach 1.5 billion by 2050, up from 524 million in 2022 (WHO, 2022). This demographic shift presents challenges across health and social domains. In India, the proportion of individuals aged 65 and above is expected to reach 8.8% by 2030 He et al., 2016. Nutritional status in the elderly refers to a balanced, tailored dietary intake aiming to maintain health and prevent disease. As individuals age, altered nutritional requirements and factors like malnutrition become prevalent, leading to health complications Ala'a Kerwin et al., 2016; Ganesh et al., 2020. Elderly individuals face obstacles like limited social security, health problems, and inadequate nutrition. In India, these challenges are exacerbated by malnutrition and a high burden of diseases Agarwalla et al., 2015. Physiological changes, financial constraints, and functional limitations contribute to nutritional challenges among the elderly, affecting their overall well-being Wardwell, L et al., 2008. Cardiovascular diseases, hypertension, cancer, diabetes, COVID-19, and autoimmune disorders are prevalent among older adults, requiring tailored management approaches Wang et al., 2012; Odden et al., 2014. Urbanization and lifestyle changes have shifted dietary patterns towards energy-dense, nutrient-poor foods, increasing the risk of non-communicable diseases (World Health Organization; Justin B. Echouffo-Tcheugui et al., 2019. Nutrition plays a vital role in supporting immune function. Aging leads to immunosenescence, compromising immune responses and increasing susceptibility to infections Kevin P. High et al., 2023. Factors like older age, environmental toxins, excess weight, poor diet, chronic diseases, chronic stress, and lack of sleep can impair immune function Andersen et al., 2016; Childs et al., 2019 Nutritional deficiencies weaken defense mechanisms against infections. Elderly individuals' declining immune function and underlying health issues increase susceptibility to infectious diseases Abdulah, D. M., & Hassan, A. B. et al., 2020. Metabolic disorders like obesity and diabetes pose health risks for the elderly. Dietary interventions and healthy lifestyle choices are essential for managing these conditions and reducing infection risks Jeżewska-Zychowicz & Gajda et al., 2023

Methodology:

A cross-sectional study was carried out among 100 geriatric participants Inclusion criteria were both genders and aged 65 years and above were included in the study. Exclusion criteria were participants suffering from any severe illness critically ill or in the intensive care unit. Offline mode via physical meeting was used for data collection. The research proposal entitled "A study on association of nutritional status of the elderly with immune function, infectious diseases and metabolic disorders of Mumbai city." was approved by the ethics committee of Inter System Biomedical Ethics Committee (ISBEC). Purposive sampling method was used for the participant selection. Self-structured Sociodemographic questionnaire, anthropometric characteristics Medical history and validated tools Mini Nutritional assessment (MNA), Immune status questionnaire (ISQ) and Infection criteria checklist (ICC), 24-hour dietary recall were responded to by the target groups. The data analysis was conducted using the Statistical Package of Social Software Program (SPSS). Data were presented as frequency, mean and standard deviation. P-value (<0.05 , <0.001) was considered to be statistically significant.

Results

Table 1 : Demographic Details of the study participants

Demographic Details			
Total no. of participants N=100			
Demographic data	Categories	Frequency (N)	Percentage (%)
Age Group (in years)	65-70 years	32	32
	71-75 years	40	40
	76 years and above	28	28
Gender	Males	50	50
	Females	50	50
Marital Status	Married	47	47
	Unmarried	8	8
	Divorced	4	4
	Widowed	41	41
Occupation	Housewife	49	49
	Retired	39	39
	Others	12	12
Educational level	Illiterate	13	13
	Primary school	19	19
	Middle school	35	35
	High school	25	25
	Intermediate	6	6
	Graduated	2	2
Total monthly income	<10,001	14	14
	10,002-29,972	35	35
	29,973-49,961	21	21
	49,962-74,755	15	15
	74,756-99,930	12	12

	99,931-199,861	3	3
	>199862	14	14
Family type	Joint family	31	31
	Nuclear family	25	25
	Living with spouse	22	22
	Living alone	22	22
Access to food	Homemade food	38	38
	Ordered food	8	8
	Tiffin-setup	54	54
	Others	38	38

Table 1 presents a comprehensive demographic profile of the study participants. The age distribution indicates a balanced representation across older age groups, with 40% falling within the 71-75 years bracket, 32% between 65-70 years, and 28% aged 76 years and above. The gender distribution demonstrates a balanced sample, with males and females each constituting 50% of the participants. In terms of marital status, a significant portion of participants were Married (47%) or Widowed (41%). The Unmarried and Divorced participants were less prevalent, comprising 8% and 4% respectively. Occupationally, the study predominantly captured Housewives (49%), followed by Retired individuals (39%), and a smaller fraction categorized as 'Others' (12%). Educationally, the sample exhibited a diverse range of educational attainments. A majority had completed Middle school (35%) or High school (25%). Primary school graduates accounted for 19%, while Illiterate participants constituted 13%. A minority had Intermediate (6%) or Graduate (2%) qualifications. Family structure among participants varied, with Joint families being the most common (31%). This was followed by Nuclear families and participants living with a spouse, each constituting 25% of the participants. Those living alone comprised 22% of the participants. Regarding dietary habits, the majority of participants relied on Tiffin-setup meals (54%), followed by Homemade food and Other sources, each at 38%. Ordered food was the least favored option, with only 8% of participants opting for it.

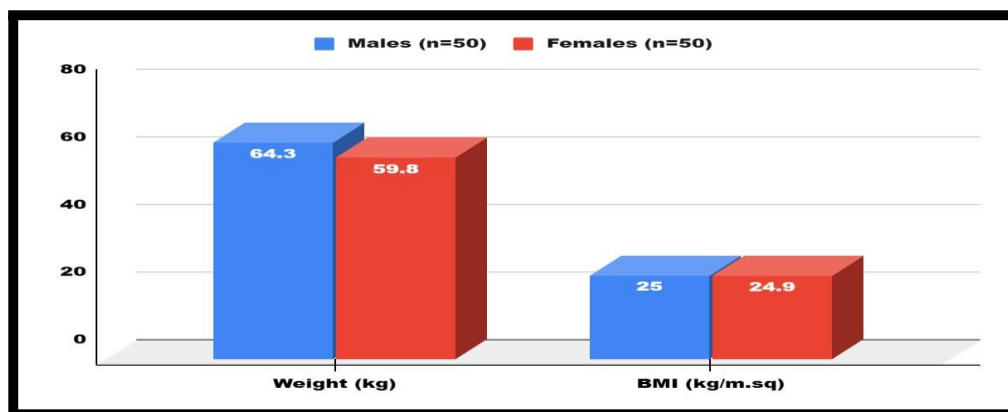


Figure 1: Anthropometry of study participants when classified according to Gender
Data presented as Percentage *Indicate statistically significant($p < 0.05$)

Figure 1 illustrates the differences in weight and Body Mass Index (BMI) between male and female participants. The average weight for males was 64.3 kg, whereas females had an average weight of 59.8 kg. This weight difference was found to be statistically significant with a p-value of 0.012, indicating that males had a higher average weight compared to females at a significance level of < 0.05 . However, there was no significant difference in BMI between the two genders, with a p-value greater than 0.05.

Table 2: Prevalence of Health Conditions Among Participants when Classified according to gender

Health Conditions	Males (n=50)		Females (n=50)		P value
	N	%	N	%	
Obesity	34	68	36	72	0.663
Diabetes	24	48	17	34	0.155
Hypertension	12	24	22	44	0.035*
Heart diseases	3	6	1	2	0.307
Cancer	0	0	1	2	0.315
Kidney diseases	1	2	1	2	1.000
Autoimmune disorders	4	8	16	32	0.003*
Corona	0	0	1	2	0.315
Others	4	8	11	22	0.050*

***Indicate statistically significant($p < 0.05$), **Indicate statistically significant($p < 0.001$)**

Table 2 presents the prevalence of health conditions by gender among participants. Hypertension exhibited a significant disparity between genders, with 44% of females affected compared to 24% of males ($p = 0.035$). Similarly, autoimmune disorders were significantly more prevalent among females at 32%, whereas only 8% of males reported the condition ($p = 0.003$). For the 'Others' category (skin diseases), although not strongly significant, there was a notable difference with 22% of females and 8% of males affected ($p = 0.050$). On the other hand, conditions like Obesity, Diabetes, Heart diseases, Cancer, Kidney diseases, and Corona did not show significant differences in prevalence between males and females ($p > 0.05$).

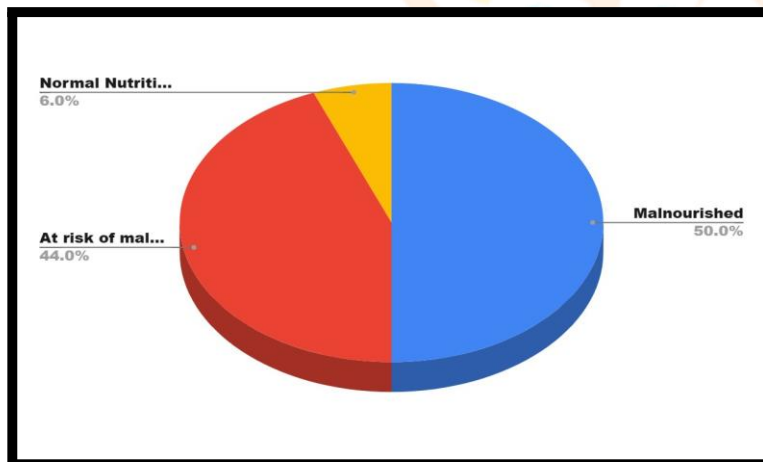


Figure 2: Mini Nutritional Assessment (MNA) of study participants when classified according to level of malnutrition

Figure 2 presents the Mini Nutritional Assessment (MNA) classifications of the study participants. A significant number of participants (50%) were classified as malnourished, while 44% were at risk of malnutrition. Only a small percentage (6%) had a normal nutritional status.

Table 3: Macro-nutrient intake of elderly participants when classified according to gender

Macronutrients	Males (n=50)	Females (n=50)	Total (n=100)	P value
Energy (kcal/d)	1124 (173)	1134 (172)	1129 (172)	0.778
Protein (g/d)	38.2 (6.8)	38.5 (7.3)	38.4 (7)	0.826
CHO (g/d)	143.9 (22.7)	142.9 (20.9)	143.4 (21.7)	0.824
Fat (g/d)	42.1 (9.3)	43.5 (10.3)	42.8 (9.8)	0.466

Total Fiber (g/d)	20.9(4.2)	21.4(3.4)	21.2(3.8)	0.547
EAR energy (%)	66.1 (10.2)	75.6 (11.5)	70.9 (11.8)	0.001**
EAR Protein (%)	88.9(15.8)	106.1(20.2)	97.5(20.0)	0.001**
RDA Fiber (%)	69.8(14.1)	85.6(13.7)	77.7(16.0)	0.001**

(*Indicate statistically significant($p < 0.05$), **Indicate statistically significant($p < 0.001$))

Table 3 presents the daily nutrient intake of 100 elderly participants, split by gender.

Energy intake was similar between males and females, with means of 1124 kcal/d and

1134 kcal/d, respectively. Protein, carbohydrate (CHO), fat, and total fiber intakes also showed no significant gender differences. However, when comparing the energy and protein intake to the Estimated Average Requirement (EAR), significant differences were observed. Males consumed only 66.1% of the recommended energy intake, while females consumed 75.6%. For protein, males consumed 88.9% of the EAR, whereas females consumed 106.1%. Both these differences were statistically significant with a p-value of less than 0.001. Similarly, the Recommended Dietary Allowance (RDA) for fiber showed significant differences between genders. Males met only 69.8% of the RDA, while females met 85.6%, with a p-value of less than 0.001 indicating meaningful gender differences in meeting nutritional needs among the elderly.

Table 4 Correlation between Macro-nutrients among the study participants

	Energy		CHO		Protein		Fats		Fiber	
	R value	P value	R value	P value	R Value	P Value	R value	P value	R value	P value
Energy	1	0.001**	0.820	0.001**	0.774	0.001**	0.875	0.001**	0.530	0.001**
CHO	0.820	0.001**	1	-	0.409	0.001**	0.457	0.001**	0.668	0.001**
Protein	0.774	0.001**	0.409	0.001**	1	-	0.784	0.001**	0.242	0.001**
Fat	0.875	0.001**	0.457	0.001**	0.784	0.001**	1	-	0.262	0.009*
Fiber	0.530	0.001**	0.668	0.001**	0.242	0.016*	0.262	0.009*	1	-

Correlation – Pearson's correlation. Correlation value – r , p value

Correlation value -1 to + 1 (*Indicate statistically significant($p < 0.05$))

****Indicate statistically significant($p < 0.001$)**

Table 4 provides an overview of the Pearson correlation coefficients (r values) and corresponding p-values examining the relationship between key nutritional components: Energy, CHO (Carbohydrates), Protein, Fats, and Fiber. Energy demonstrated robust positive correlations with both Fats ($r=0.875$, $p < 0.001$) and CHO ($r=0.820$, $p < 0.001$). Additionally, Energy exhibited a strong positive correlation with Protein ($r=0.774$, $p < 0.001$). When examining CHO, it displayed a positive correlation not only with Energy ($r=0.820$, $p < 0.001$) but also with Protein ($r=0.409$, $p < 0.001$). Similarly, Protein showed a positive association with both Energy ($r=0.774$, $p < 0.001$) and CHO ($r=0.457$, $p < 0.001$). Fats presented the strongest positive correlation with Energy ($r=0.875$, $p < 0.001$) and a moderate positive correlation with Protein ($r=0.784$, $p < 0.001$). On the other hand, Fiber showed its weakest correlation with Protein ($r=0.242$,

$p < 0.001$) and Fats ($r = 0.262$, $p = 0.009$). However, it had a moderate positive correlation with CHO ($r = 0.668$, $p < 0.001$). Notably, no negative correlations were detected among these nutritional components.

Table 5: Immune Status Questionnaire (ISQ) of study participants when classified according to gender

Immune Status Questionnaire (ISQ)	Males (n=50)	Females (n=50)	P value
Chronic swollen lymph gland	1.42(1.162)	1.4(1.03)	0.949
Frequent sore throat	0.52(0.863)	0.44(0.861)	0.628
Cold sores or fever	1(0.948)	0.92(0.944)	0.667
Gums and/or Nose bleed easily	0.96(0.989)	0.48(0.909)	0.005*
Experience frequent runny nose	0.3(0.614)	0.4(0.728)	0.546
Muscle aches or joint pain	2.42(0.609)	2.48(0.544)	0.699
Easily susceptible to infections	1.14(1.03)	1.06(1.077)	0.654
Suffers from asthma/ breathing difficulties	1.28(0.809)	1.14(0.833)	0.431
Eczema or Skin acne/rashes	0.96((1.029)	0.74(0.965)	0.273
Recurrent fungal infections	0.68(0.978)	0.66(1.022)	0.929
Coated or Sore tongue	0.4(0.756)	0.22(0.648)	0.132
Respiratory problems	0.4(0.67)	0.22(0.418)	0.251
Frequently catch cold or flu	0.64(0.485)	0.7(0.463)	0.526
Difficult to recuperate from cold and flu	0.34(0.479)	0.24(0.431)	0.273
Frequent diarrheal episodes	0.58(0.499)	0.54(0.503)	0.688

(*Indicate statistically significant($p < 0.05$), **Indicate statistically significant($p < 0.001$))

Table 5 illustrates the prevalence of various health symptoms among study participants categorized by gender. The data encompasses responses from 50 males and 50 females. Notably, females reported significantly higher rates of gums and/or nosebleeds compared to males, with a p-value of 0.005. However, for most other symptoms, including chronic swollen lymph glands, frequent sore throat, and cold sores or fever, there were no significant differences between genders. The p-values for these symptoms ranged from 0.628 to 0.949, indicating no statistically significant gender-based disparities. Other conditions such as muscle aches or joint pain, respiratory problems, and frequent cold or flu also showed no significant differences between males and females, with p-values ranging from 0.251 to 0.699.

Table 6: Infection Criteria Checklist (ICC) of study participants when classified according to gender

ICC	Males (n=50)	Females (n=50)	P value
Urinary Tract Infection	1.64(0.59)	1.6(0.67)	0.898
Common Cold Syndrome	1.02(0.95)	1.16(0.91)	0.469
Influenza like illness	1.66(0.71)	1.74(0.63)	0.585
Bronchitis or Tracheobronchitis	0.78(0.88)	0.78(0.88)	1
Pneumonia	0.14(0.35)	0.14(0.35)	1
Recurrent Lung Aspiration	0.7(0.50)	0.76(0.43)	0.478
Ear Infection	0.34(0.47)	0.4(0.49)	0.536
Unexplained Febrile Illness (Fever)	0.42(0.49)	0.4(0.49)	0.840
Gastrointestinal Infections	0.62(0.5)	0.66(0.51)	0.692
Viral hepatitis	0.52(0.50)	0.62(0.49)	0.315
Wound Infection	0.38(0.4)	0.46(0.50)	0.420
Fungal Skin Infection	0.46(0.54)	0.42(0.49)	0.776
Herpes Simplex and zoster	0.28(0.57)	0.16(0.37)	0.379
Scabies	0.06(0.24)	0.08(0.26)	0.697
Conjunctivitis	0.12(0.32)	0.14(0.35)	0.767
Primary Bloodstream Infection (septicemia)	-	-	-
Other Infections	0.36(0.48)	0.16(0.37)	0.023*

(*Indicate statistically significant($p < 0.05$), **Indicate statistically significant($p < 0.001$))

Table 6 provides a gender-based comparison of infection prevalence among 100 study participants, with 50 males and 50 females. The data indicates that for most infections, there is no significant difference between males and females, as evidenced by p-values greater than 0.05. Notably, Other Infections (Skin infections) showed a significant difference between the genders with a p-value of 0.023. Specifically, 36% of males reported other infections compared to 16% of females. Overall, the study suggests that gender may not be a predominant factor influencing infection prevalence among the surveyed participants.

Table 7 Correlation between weight, BMI, Total MNA, Total ISQ, and Infection Checklist**Total among study participants**

	MNA		ISQ		Infection check list	
	R value	P value	R value	P value	R Value	P Value
Weight	0.288	0.004*	0.024	0.816	-0.007	0.947
BMI	0.327	0.001**	0.005	0.964	0.030	0.770
MNA	1	-	-0.355	0.001**	-0.371	0.001**
ISQ	-0.355	0.001**	1	-	0.695	0.001**
Infection check list	-0.371	0.001**	0.695	0.001**	1	-

Correlation – Pearson’s correlation. Correlation value – r , p value**Correlation value -1 to + 1 (*Indicate statistically significant(p<0.05)**

Table 7 presents the Pearson correlation coefficients (r values) and associated p-values for the relationship between weight, BMI, Total MNA, Total ISQ, and Infection Checklist. Weight displayed a modest positive correlation with BMI ($r=0.288$, $p=0.004^*$) and was not significantly associated with ISQ ($r=0.024$, $p=0.816$) or the Infection checklist ($r=-0.007$, $p=0.947$). BMI showed a stronger positive correlation with Weight ($r=0.327$, $p=0.001^{**}$) and no significant correlation with ISQ ($r=0.005$, $p=0.964$) or the Infection checklist ($r=0.030$, $p=0.770$). The nutritional status as assessed by MNA had a positive correlation with ISQ ($r=-0.355$, $p=0.001^{**}$) and a negative correlation with the Infection checklist ($r=-0.371$, $p=0.001^{**}$), indicating that better nutritional status was associated with higher immune system scores and fewer reported infections. ISQ also showed a positive correlation with MNA ($r=0.355$, $p=0.001^{**}$) and a strong positive correlation with the Infection checklist ($r=0.695$, $p=0.001^{**}$). This suggests that higher immune system scores (lower ISQ values) were associated with better nutritional status and fewer reported infections. Lastly, the Infection checklist demonstrated a strong positive correlation with ISQ ($r=0.695$, $p=0.001^{**}$) and also a positive correlation with MNA ($r=-0.371$, $p=0.001^{**}$), indicating that higher infection reports were associated with higher immune system scores and poorer nutritional status.

Discussion

The present study included participants across a balanced age distribution, with 40% aged 71-75 years, 32% between 65-70 years, and 28% 76 years and above. Gender distribution was equal. While males had a higher average weight than females (64.3 kg vs. 59.8 kg), BMI showed no significant difference between genders. Previous research involving 441 elderly participants found most were in the 65-69 and 60-64 age groups, with many engaged in agriculture or housework and lacking literacy skills Diganth C, et al 2022.

Using the Mini Nutritional Assessment (MNA), the current study revealed alarming rates of malnutrition and risk thereof, with 50% malnourished and 44% at risk. This contrasts with a previous study which found 21% malnourished and 65% at risk. Additionally, a high prevalence of overweight and obesity was noted, particularly among older participants (Kimaya R., et al 2013).

In present study micronutrient intake, females had higher zinc and magnesium intake than males ($p = 0.001$). Older adults often show inadequate intake of essential nutrients, including vitamins A, D, C, iron, zinc, and selenium Mensink et al. 2013. Vitamin D supplementation has shown immune benefits Aranow et al., 2020, and dietary zinc

is associated with immune status Waad Alfawaz. et al., 2023. Micronutrient supplementation improved zinc and magnesium levels in elderly individuals Robinson & Davis 2015.

Health conditions like Hypertension and autoimmune disorders showed gender disparities, with females having higher rates. Obesity, Diabetes, and other conditions had universal prevalence among genders. Previous research linked hypertension and diabetes to cognitive decline Taylor et al., 2023 and autoimmune disorders to nutritional deficiencies Martin & Clark., 2022.

In the current study, Immune status questionnaire (ISQ) 36% of males reported other infections compared to 16% of females. Differences were observed in gum and nosebleed frequency ($p=0.023$), but no nutritional intake differences across age groups. However, significant gender differences were found in energy and protein intake ($p<0.05$), with males consuming less than recommended and females consuming more. Past research also highlighted dietary interventions' efficacy in improving protein and fiber intake Thomas et al., 2018.

The study found a correlation between nutritional status (MNA) and immune function (ISQ), with better nutritional status associated with higher ISQ scores ($r=0.355$, $p=0.001$). Participants with better nutritional status reported fewer infections ($r=-0.371$, $p=0.001$). Past studies supported these findings, showing higher MNA scores linked to better overall well-being (Johnson & Williams et al, 2015) and the ISQ's effectiveness in predicting infection susceptibility and mortality in the elderly Fernandez et al., 2022; Johnson et al., 2019; Clark & Lewis et al., 2018.

Conclusion

In conclusion, the study highlights the urgent need for nutritional interventions and health education among Mumbai's elderly. There were elevated rates of malnutrition (MNA), compromised immune function (ISQ scores), and increased infection rates, emphasizing targeted interventions. Females showed higher rates of hypertension, autoimmune disorders, and better nutrient intake, while males had more inadequate protein and energy intake, alongside issues like gums/nosebleeds and 'Other Infections' linked to age-related nutrient decline. These findings stress the importance of tailored interventions for gender-specific and age-related health needs.

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