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RESEARCH ARTICLE

Inter-linkages among socioeconomic deprivation, food insecurity, physical and psychosocial status in urban geriatric subjects: Varanasi, India

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Abstract : Geriatric subjects are vulnerable to Socio Economic Deprivation (SED), food and nutrition insecurity, poor nutritional status , morbidities, physical dependence, cognitive impairment and depression. Their inter-linkages is a least explored area of research. This aspect has been explored in this study by adopting a cross-sectional study design on 616 geriatric subjects selected by multistage sampling procedure from urban Varanasi, India. Pre-designed, pre-tested proforma and appropriate tools and standard techniques were used for assessing socioeconomic deprivation, food insecurity, nutritional status, morbidities, functional and psychological status of subjects. In order to find out inter-linkages, all significant variables in univariate (χ^2) analysis were subjected to logistic regression model. In logistic regression analysis higher odds of severe (AOR 14.98; 95% CI 5.62–39.96) and moderate (7.89; 95%CI 4.19–14.86) food insecurity at household level prevailed in subjects with SED. Besides Chronic Energy Deficiency (CED) (2.18; 95% CI 1.32–3.60), moderate/severe depression (5.06; 95% CI 2.02–12.66) has been linked with household food insecurity. Higher odds for moderate and severe (2.45; 95% CI 1.13–5.34) and mild (1.75; 95% CI 1.08–2.82) depression were identified in CED victims. There existed a significant linkage between presence of morbidity and assisted as well as severe physical dependency. Higher adjusted odds (2.37; 95% CI 1.54–3.65) for depression prevailed in subjects with physical dependency. Policy shift from socio economic upliftment to food security and sensitivities of families and community for geriatric care in illness and physical dependency are required for wellbeing of geriatric subjects.

Keywords: Depression, food insecurity, morbidities, nutritional status, socio economic deprivation.

INTRODUCTION

Globally, most significant social change of improved standard of living is population ageing. The consequences of contributing factors like significant decline in fertility rate, increase in life expectancy, advancement in medical treatment and technology, prevention and eradication of many infectious diseases and improved nutrition, hygiene and sanitation have enhanced the growth rate of older population worldwide. The proportion of the world's elderly population in 2000 was 11% and it is estimated that it will be almost doubled (i.e. 20%) by 2050. In case of developing countries, 9% of the population is aged 60 years or above and this proportion will be more than doubled (i.e. 19%) by 2050, reaching 27% by 2100 (United Nations, 2012; 2013). India is also not far from this process; it is the second largest country in the world in terms of geriatric population (Swarnalatha, 2013). The rising trend in proportion of aged 60 years and above exists in India; it was 7.4% in 2001; 8.6% in 2011 and it is expected to rise upto 10.7% by 2021(India, Registrar General and Census Commissioner of India, 2011).

India is going through rapid economic and socio cultural transitions. Although these transitions are considered as significant indicators of progress, they have brought many challenges to the geriatric subjects as well. These rapid changes may force geriatric subjects to experience loss of social roles, loss of self esteem, limit their economic resources and depleted social networks.

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Being of old age, acomplicated period of life, one has to deal not only with the physical aging, but also with the challenges affecting their mental and social well-being. The problems faced by geriatric subjects are often complex than adults; and differ according to socio-cultural, economic and health of individuals. These complicated life changes in old age substantially give rise to negative emotions such as hopelessness, anxiety, loneliness, which in turn lead to social withdrawal and apathy and further contribute to a more serious outcome in form of depression.

Besides various physiological changes; geriatric subjects are vulnerable to Socio Economic Deprivation (SED), food and nutrition insecurity, poor nutritional status, morbidities, physical dependence, mental and psychological problems like cognitive impairment and depression; these have significant influence on their overall wellbeing and may lead them to a disadvantaged position. Paucity of explicit information about interlinkages of these issues among geriatric subjects may further jeopardise their condition due to lack of focused policies and programmes related to geriatric health.

In the context of sustainable development goals addressing socio economic deprivation, food and nutrition insecurity, under nutrition, morbidities, physical dependence, cognitive impairment and depression are of paramount importance for human health (United Nations, 2018). In old age, socio economic deprivation tends to be more permanent than other age groups and the subjects from this group are unlikely to come out of the poverty trap (Hurd, 1990). Their peace and prosperity are at stake due to their vulnerability to physical and mental health as well as high social dependence. Several authors reported that geriatric subjects faces a higher incidence of poverty ("U" shaped of relationship of age and poverty) in comparison to other age groups (Barrientos *et al.,* 2003; Mujahid *et al.,* 2008). Geriatric subjects in general and very old subjects in particular are vulnerable to disease onset (Joshi *et al.,* 2003; Prakash *et al.,* 2004) and disease increase the risk of poor nutritional status (Hickson, 2006). Poor nutritional status (malnutrition) are common in poor socio economic status (Pryer & Rogers, 2006). According to Cabrera *et al*. (2007), Clark *et al.* (2007) and Manju & Krishnababu (2013), poor nutritional status (malnutrition) of geriatric subjects are associated with several neuropsychological problems such as depressive symptoms, as well as impaired cognitive function, which are very common in old age. Apart from poor and/or limited financial status as strong associate of depression in old age, functional impairment, cognitive impairment, co/morbidities and chronic illness are also considered as potential risk factors of depressive state of geriatric subjects (Anand, 2014; Goyal & Kajal, 2014; Manju & Krishnababu, 2013; Sanjay, 2014; Sengupta & Benjamin, 2015).

In spite the available evidence of interlinked problems in geriatric subjects, the comprehensive inter-linkages of the problems in old age have been a least explored area of research. Therefore, it is worthwhile to assess inter-linkages of above mentioned problems in old age. With this background, the present study was conducted among urban geriatric subjects with the objective of examining inter-linkages among socio-economic deprivation, food insecurity, nutritional status, self-reported morbidities, physical dependency, as well as cognitive impairment and depression in urban geriatric subjects.

METHODOLOGY

Study design and setting

This community based cross sectional study was conducted in urban Varanasi, India. Total population of Varanasi district is 3,682,194, of which urban population was 1,599,260 (43.4%). Average literacy rate of Varanasi district was 77.05%. The geriatric population covers 7% of the total population of the district. This district administers 1,535 square kilometers of areas with density of 2,395 people per square meter (India, Registrar General and Census Commissioner of India, 2011).

Subjects and sample size

Urban geriatric subjects of age 60 years and above were selected for this study. Through literature search Socio Economic Deprivation (SED) was found as the main cause of major issues (viz., food insecurity, poor nutritional status, self-reported morbidities and physical dependency as well as cognitive impairment and depression) occurred in urban geriatric subjects (Jung *et al*., 2001; Pandey, 2009; Anand, 2014; Sengupta *&* Benjamin, 2015). Therefore, it was taken as the basis for estimation of the sample size. Taking a prevalence of 40% for SED (Pandey, 2009), 5% permissible error (absolute), design effect of 1.5 and non response rate allowance (10% of estimated sample size), the final sample size worked out to be 616. Of 616 selected subjects complete information was obtained from 604 subjects in the first visit. In 12 subjects information could not be obtained due to their non availability at the time of first visit. In order to get complete information from all (616) subjects additional visits (1-2) were made for these remaining 12 subjects.

Data collection and sampling technique

This study was approved by the Institute Ethical Committee of Banaras Hindu University, India. Geriatric subjects consenting for the study were included in the study, whereas subjects with any terminal illness or having serious mental abnormality and also if their duration of stay in the study area was less than six months, he/she were excluded from the study. Only those subjects satisfying inclusion and exclusion criteria were considered for selection as study subjects. All 616 subjects were selected for this study through multistage sampling procedures with following steps: [i] Out of 90 census enumeration wards in the Varanasi city, 9 wards were selected by simple random sampling; [ii] In the selected census enumeration wards households were selected according to probability proportion to size adopting systematic random sampling method; [iii] In the selected households one family was selected randomly using lottery method and [iv] In the selected family one study subject was selected randomly using lottery method. Before interviewing the subjects, written consent was taken from them using informed bilingual (Hindi & English) consent form and necessary support and counseling was extended to them.

Tools and techniques

The primary tool used to obtain information of the study subjects was predesigned and pretested proforma. Through this proforma subjects were specifically interviewed about SED, food insecurity status, self-reported morbidities, physical dependency, cognitive impairment and depression. Socio Economic Deprivation was assessed through interview of the head of the family or any responsible member of the family. Subjects with SED were assessed based on the norms of Below Poverty Line (BPL) criteria proposed by Rangarajan Committee, Government of India (2014). Subjects with per capita income less than Rs. 1410/- per month were considered having SED (Rangarajan Committee, 2014). Household Food Insecurity Access Scale developed by Food and Nutrition Technical Assistant (FANTA III) project was used to access household food insecurity. This scale explored anxiety and uncertainty about the household food supply, insufficient quality of food and insufficient food intake through 9 questions. Subject/ any responsible family member was interviewed using this scale and based on their response the scores were calculated and households were categorised in to four categories (viz., food secure, mildly food insecure, moderately food insecure and severely food insecure) (Coates *et al.,* 2007). Anthropometric measurements (viz., weight and height) were done to assess nutritional status of the subjects. Recording of weight through Libra weighing scale (100 gm) and height by Steel anthropometric rod with parallel bars (0.01 cm) were done following standard techniques (Jelliffe, 1966). Body Mass Index (BMI) of each subject was calculated using formula BMI= weight (kg) / height $(m)^2$ and their nutritional status was categorised as Chronic Energy Deficiency (< 18.5 kg/m^2), Normal (18.5-22.99kg/m^2), Over weight (23-24.99kg/m^2) and Obese ($\geq$25 kg/m^2), based on World Health Organisation (2000) criteria for Asian population.

Morbidities reported by subjects were assessed by interviewing them; whereas information about physical dependency of subjects was assessed through Barthel's Index of Activity of Daily Living (ADL) (Mahoney & Barthel, 1965). This scale was used to measure the physical dependency of the geriatric subject's performance in ten activities of daily life (i.e., feeding, grooming, bathing, dressing, bowel and bladder care, toilet use, mobility, transfer, and stair climbing), which served as the basis for categorisation of physical dependency as no physical dependency (no ADL involvement), assisted physical dependency (assisted ADL performance) and severe physical dependency (restriction of any ADL with maximum severity) (Keshari & Shankar, 2017). In order to find out cognitive impairment, Mini-Mental State Examination (MMSE) was used (Cullen *et al*., 2007). For assessment of depression status of subjects, Geriatric Depression Scale (GDS) was administrated on them (Kakrani *et al.,* 2015)**.** Different scales (viz, Household Food Insecurity Access Scale, Barthel's Index of Activity of Daily Living, Mini-Mental State Examination and Geriatric Depression Scale) were used in this study to elicit information were pretested in non-study area and necessary changes were done.

Statistical analysis

Data thus obtained were entered in a personal computer; cross tables and figures were generated by using Statistical Package (SPSS) version 22.0 IBM Corp., Armonk, NY. For inferential purpose Pearson's Chi square test and logistic regression analysis (Adjusted Odds Ratio and 95% Confidence Interval) were applied. Association among SED, food insecurity, nutritional status, self-reported morbidities, physical dependency, cognitive impairment and depression were established through Pearson's Chi square test. Variables having p value <0.05 were considered as statistically significant and were put in the logistic regression model. In the logistic regression analysis, all significant variables were stepwise put to pin-point the inter-linkages among them. To identify the inter-linkages of SED with household

food insecurity, nutritional status, cognitive impairment and depression were used as dependent variables. In case of household food insecurity, SED, nutritional status, cognitive impairment and depression status were used as dependent variables, whereas for nutritional status, SED, household food insecurity, self-reported morbidities, physical dependency and depression status were taken as dependent variables. For self-reported morbidities, nutritional status, physical dependency, cognitive impairment and depression status were taken as dependent variables. Adjusted Odds Ratio (AOR) for physical dependency was assessed by putting nutritional status; self-reported morbidities and depression status as dependent variables. In case of cognitive impairment, except nutritional status all other variables were used as dependent variables. For depression status, all variables were taken as dependent variables.

RESULTS

Characteristics of study subjects

This study was conducted on 616 geriatric subjects. Of those subjects, 63.6% belonged to age group 60-69 years. Gender wise 54.7% subjects were female; 14.8%

Table1: Association of socio-economic deprivation with food insecurity, nutritional status, self-reported morbidities and physical dependency as well as cognitive impairment and depression.

Particulars	With SED (N=234)		Without SED (N=382)		Total (N=616)		Test of significance
	No	(%)	No	(%)	No	(%)	
Household Food insecurity							
Food secure	9	3.8	187	49.0	196	31.8	χ^2:3148.2
Mild	32	13.7	147	38.5	179	29.1	df:3
Moderate	102	43.6	40	10.5	142	23.1	p:<0.01
Severe	91	38.9	8	2.0	99	16.1	
Nutritional Status							
CED	138	59.2	136	35.9	274	44.8	χ^2:38.90
Normal	78	33.5	161	42.5	239	39.1	df: 2
Over weight/Obese	17	7.3	82	21.6	99	16.2	p:<0.01
Self-reported physical morbidities							
Nil	74	31.6	135	35.3	209	33.9	χ^2:1.87
1-2	96	41.0	136	35.6	232	37.7	df: 2
≥ 3	64	27.4	111	29.1	175	28.4	p:>0.05
Physical dependency on the basis of ADL involvement							
No Physical dependency	100	42.7	186	48.7	286	46.4	χ^2:3.58
Assisted Physical dependency	105	44.9	142	37.2	247	40.1	df:2
Severe Physical dependency	29	12.4	54	14.1	83	13.5	p:>0.05
Cognitive impairment							
Without cognitive impairment	170	72.6	308	80.6	478	77.6	χ^2:5.31
With cognitive impairment	64	27.4	74	19.4	138	22.4	df: 1
							p:<0.05
Depression status							
Normal	133	56.8	300	78.5	433	70.3	χ^2:38.98
Mild depression	59	25.2	62	16.2	121	19.6	df:2
Moderate/Severe depression	42	17.9	20	5.2	62	10.1	p:<0.01

and 20.6% subjects were widower and widowed, respectively. Majority (82.6%) of them were Hindu whereas, 51.6% belonged to Other Backward Caste (OBC). As much as 35.2%, 29.6% and 35.2% subjects were from nuclear, joint and three generation families, respectively. In all 16.5% subjects were self-employed, whereas 17.9% were unemployed. Nearly 4 out of 10 subjects (40.9%) were illiterate. As much as 41.9% subjects belonged to upper lower plus lower class.

The results of interlinkages among variables are presented in the following sections:

[A] Linkages of socio-economic deprivation

There is a significant ($p<0.05$) association of SED with food insecurity at household level, nutritional status, cognitive impairment and depression status of the study subjects (Table 1). As much as 3.8% subjects with SED and 49.0% subjects without SED were from food secure houses; in the respective categories mild food insecurity at household level prevailed in 13.7% and 38.5% subjects. Out of 234 subjects with SED, 82.5% had food insecurity at household level as moderate/severe. Chronic Energy Deficiency and overweight/obesity were present in 59.2% and 7.3% in subjects with SED, respectively. As much as 72.6% subjects with SED and 80.6% subjects without SED were without cognitive impairment. Mild and moderate/severe depression was present in 25.2% and 17.9% subjects with SED, respectively.

Logistic regression for SED (Table 2) revealed that in comparison to subjects having food security at household level as food secure + mild food insecure, AOR for SED was significantly more for subjects with household food security as severe food insecure (AOR 14.98; 95% CI 5.62-39.96) and moderate food insecure (AOR 7.89; 95%CI 4.19-14.86). For nutritional status, cognitive impairment, moderate/severe depression and mild depression, AOR for SED were 1.48 (95% CI: 0.81-2.72), 1.19 (95% CI: 0.52-2.63), 1.55 (95% CI: 0.54-4.41) and 1.41 (95% CI: 0.68-2.94), respectively.

[B] Linkages of food insecurity at household level

Associations of household food insecurity with nutritional status, self-reported morbidities and physical dependence as well as psychosocial status are given in Table 3. Prevalence of nutritional status, in geriatric subjects increased considerably with increasing levels of food insecurity. Nutritional status was least (28.9%) in subjects whose household food security was categorised as food secure; whereas, this was maximum (80.6%) in subjects having household food security as severe food

Table 2: Logistic regression analysis for linkages of socio-economic deprivation

Particulars	Estimate of β	SE of β	P value	AOR	95% CI	
					Lower	Upper
Household insecurity						
Severe food insecurity	2.71	0.50	0.000	14.98	5.62	39.96
Moderate food insecurity	2.07	0.32	0.000	7.89	4.19	14.87
Food secure+ Mild food insecurity (Reference)	----	----	----	----	----	----
Nutritional status						
CED+ overweight/obese	0.39	0.31	0.203	1.48	0.81	2.72
Normal (Reference)	----	----	----	----	----	----
Cognitive impairment						
With Cognitive impairment	0.18	0.40	0.652	1.19	0.52	2.63
Without Cognitive impairment (Reference)	----	----	----	----	----	----
Depression status						
Moderate/severe depression	0.44	0.54	0.416	1.55	0.54	4.41
Mild depression	0.35	0.37	0.354	1.41	0.68	2.94
Normal (Reference)	----	----	----	----	----	----

insecure. Prevalence of overweight/obese was 27.3%, 20.1% and 7.1% in subjects having household food security as secure, mild and moderate food insecurity, respectively. None of the study subjects having severe food insecurity at household level had overweight/ obese. There existed significant ($p<0.01$) association between nutritional status of study subjects and food security at household level. As much as 85.2% subjects from food secure houses were without cognitive impairment, whereas from food insecure houses 74.0% were without cognitive impairment ($p<0.01$). As much as 75.4%, 67.6% and 80.8% subjects having mild, moderate and severe food insecurity at household level, respectively, were without cognitive impairment. With increasing grade of food insecurity there has been a significant decline in subjects without depression; this is supported by the observation that 82.7%, 76.0%, 59.9% and 50.5% subjects from food secure, mild food insecure, moderate and severe food insecure houses, respectively, were without depression ($p<0.01$). There existed no significant ($p>0.05$) association between household food insecurity and physical dependency of study subjects as well as their self-reported morbidities.

Besides significant linkage between SED and household food insecurity stated earlier (Table 2), logistic regression for household food insecurity further revealed that when normal + overweight/obese subjects were taken as reference; AOR for chronic energy deficiency was 2.18 (95% CI: 1.32–3.60). In comparison to subjects without depression AOR for household food insecurity in subjects with moderate and severe depression was 5.06 (95% CI: 2.02–12.66). Taking subjects without cognitive

Table 3: Association of household food insecurity with nutritional status, self-reported morbidities and physical dependency as well as cognitive impairment and depression.

Particulars	Food insecurity										Test of significance
	Food secure (N=196)		Mild (N=179)		Moderate (N=142)		Severe (N=99)		Total (N=616)		
	No	(%)	No	(%)	No	(%)	No	(%)	No	(%)	
Nutritional status											
CED	56	28.9	72	40.2	67	47.5	79	80.4	274	44.8	χ^2:92.09
Normal	85	43.8	71	39.7	64	45.4	19	19.4	239	39.1	df: 6
Overweight	53	27.3	36	20.1	10	7.1	0	.0	99	16.2	p:<0.01
Self- reported morbidities											
Nil	59	30.1	73	40.8	39	27.5	38	38.4	209	33.9	χ^2:11.29
1-2	73	37.2	62	34.6	57	40.1	40	40.4	232	37.7	df: 6
≥ 3	64	32.7	44	24.6	46	32.4	21	21.2	175	28.4	p:>0.01
Physical dependency on the basis of ADL involvement											
No Physical dependency	104	53.1	77	43.0	62	43.7	43	43.4	286	46.4	χ^2:5.28
Assisted Physical dependency	69	35.2	76	42.5	59	41.5	43	43.4	247	40.1	df: 6
Severe physical dependency	23	11.7	26	14.5	21	14.8	13	13.1	83	13.5	p:>0.01
Cognitive impairment											
Without cognitive impairment	167	85.2	135	75.4	96	67.6	80	80.8	478	77.6	χ^2:15.75
With cognitive impairment	29	14.8	44	24.6	46	32.4	19	19.2	138	22.4	df: 3
											p:<0.01
Depression status											
Normal	162	82.7	136	76.0	85	59.9	50	50.5	433	70.3	χ^2:55.77
Mild	24	12.2	37	20.7	32	22.5	28	28.3	121	19.6	df:6
Moderate/Severe	10	5.1	6	3.4	25	17.6	21	21.2	62	10.1	p:<0.01

Table 4: Logistic regression analysis for linkages of household food insecurity

Particulars	Estimate of β	SE of β	P value	AOR	95% CI	
					Lower	Upper
Nutritional status						
Chronic Energy Deficiency	0.78	0.26	0.002	2.18	1.32	3.60
Normal+ Over weight/ Obese (Reference)	---	---	---	---	---	---
Cognitive impairment						
With Cognitive impairment	0.15	0.34	0.651	1.17	0.59	2.28
Without Cognitive impairment (Reference)	---	---	---	---	---	---
Depression						
Moderate/Severe depression	1.62	0.47	0.001	5.06	2.02	12.66
Mild depression	0.50	0.32	0.111	1.65	0.89	3.06
Normal (Reference)	---	---	---	---	---	---

Table 5: Logistic regression analysis for linkages of nutritional status

Particulars	Estimate of β	SE of β	P value	AOR	95% CI	
					Lower	Upper
Self reported morbidities						
3 & above	0.02	0.27	0.947	0.98	0.58	1.66
1-2	0.13	0.23	0.569	1.14	0.72	1.79
Nil (Reference)	---	---	---	---	---	---
Physical dependency on the basis of ADL involvement						
Severe physical dependency	0.38	0.37	0.295	0.683	0.33	1.39
Assisted physical dependency	0.12	0.22	0.562	0.883	0.58	1.35
No physical dependency (Reference)	---	---	---	---	---	---
Depression status						
Moderate/Severe depression	0.89	0.39	0.023	2.45	1.13	5.31
Mild depression	0.56	0.25	0.22	1.75	1.08	2.82
Normal (Reference)	---	---	---	---	---	---

impairment as reference AOR for household food insecurity was 1.17 (95% CI: 0.59–3.28) for subjects with cognitive impairment (Table 4).

[C] Linkages of nutritional status

In univariate analysis nutritional status was significantly associated with SED, household food insecurity; self-reported morbidities and physical dependency on the basis of ADL involvement, as well as cognitive impairment and depression status. As much as 42.3%, 31.0% and 26.8% subjects, characterised as normal on the basis of their BMI, had nil, 1-2 and ≥ 3 self-reported morbidities ($p < 0.01$). Of 239 normal subjects, on the basis of BMI, 49.0% were without any physical dependency, whereas 38.1% and 13.0% subjects had assisted physical dependency and severe physical dependency, respectively. Of 99 overweight/obese subjects, 55.6%, 39.4% and 5.1% subjects had no physical dependency, assisted physical dependency and severe physical dependency, respectively ($p<0.05$). Out of 274 subjects with chronic energy deficiency, 58.4%, 25.5% and 16.1% were characterised as normal, with mild and moderate/severe depression, respectively; corresponding values for normal subjects were 76.2%, 18.0% and 5.9%. As much as 90.9%, 7.1% and 2.0% overweight/obese subjects were characterised as normal, with mild and moderate/severe depression, respectively ($p<0.01$). As much as 75.2% CED, 78.7% normal and 82.8% overweight/obese subjects were without any cognitive impairment. There existed no significant ($p>0.05$) association between nutritional status of subjects and their cognition.

Besides, significant linkage with household food insecurity (section B), logistic regression for nutritional status further identified significant linkage with depression status of study subjects (Table 5); AOR for moderate and severe depression was 2.45 (95% CI: 1.13–5.34), whereas for mild depression this was 1.75 (95% CI: 1.08–2.82). There existed no significant linkage between nutritional status and morbidity as well as physical dependence identified on the basis of performance of ADL.

[D] Linkages of self-reported morbidities

There existed a significant ($p < 0.01$) association between self-reported morbidities and physical dependency. As much as 70.8%, 38.8% and 27.4% subjects with nil, 1–2 and ≥ 3 self-reported morbidities were with no physical dependency, whereas 1.9%, 15.5% and 24.6% subjects from respective categories had severe physical dependency. In case of 12.4% subjects without self-reported morbidities, there was cognitive impairment, whereas this was 25.0% and 30.9% in subjects having 1–2 and ≥ 3 self-reported morbidities, respectively. As much as 79.9%, 72.4% and 56.0% subjects having self-reported morbidities as nil, 1–2 and ≥ 3, respectively, were categorised as normal on depression status. Out of 175 subjects with ≥ 3 self-reported morbidities, 26.3% subjects had mild depression. In contrast to this, 18.2% without any self-reported morbidity and 15.9 % subjects with 1–2 self-reported morbidity had mild depression. As much as 19%, 11.6% and 17.7% subjects having self-reported morbidities nil, 1–2 and ≥ 3, respectively, had moderate/severe depression.

The linkages between presence of morbidity and physical dependency was significant both in univariate and logistic regression analysis. In comparison to no physical dependency, AOR for self-reported morbidities in subjects with severe physical dependency and assisted physical dependency were 2.31 (95% CI: 1.22–4.39) and 1.97 (95% CI: 1.28–3.04), respectively (Table 6). As presented earlier, no significant association existed between self-reported morbidity and SED (Section A) and household food insecurity (Section B) in univariate analysis. The significant association between self-reported morbidity and nutritional status got eliminated in logistic regression analysis (Section C).

[E] Linkages of physical dependency

Cognitive impairment increased significantly ($p<0.01$) with involvement of ADL; 16.1% subjects with no physical dependency, 22.3% with assisted physical dependency and 44.6% subjects having severe physical dependency had cognitive impairment. Out of 286 subjects without physical dependency, 84.3%, 14.0% and 1.7% were categorised as normal, with mild and moderate/severe depression, respectively, whereas in case of 83 subjects having severe physical dependency corresponding values were 38.6%, 26.5% and 34.9%. Mild and moderate/severe depression was present in 23.9% and 11.3% subjects having assisted physical dependency, respectively. A significant ($p<0.01$) association existed among physical dependence, cognitive impairment and depression status of subjects.

Besides, significant linkage of physical dependency with self-reported morbidities as presented section D revealed that, in the event of physical dependency, AOR for depression was 2.37 (95% CI: 1.54–3.65). There was no significant linkage between ADL involvement and cognitive impairment (Table 7).

Table 6: Logistic regression analysis for linkages of self-reported morbidity

Particulars	Estimate of β	SE of β	P value	AOR	95% CI	
					Lower	Upper
Physical dependency on the basis of ADL involvement						
Severe physical dependency	0.84	0.33	0.010	2.31	1.22	4.39
Assisted physical dependency	0.68	0.22	0.002	1.97	1.28	3.04
No physical dependency (Reference)	---	---	---	---	---	---
Cognitive impairment						
With Cognitive impairment	0.07	0.26	0.79	0.93	0.56	1.56
Without Cognitive impairment (Reference)	---	---	---	---	---	---
Depression status						
Moderate severe depression	0.02	0.35	0.951	0.98	0.49	1.95
Mild depression	0.29	0.24	0.237	1.34	0.83	2.16
Normal (Reference)	----	----	---	----	----	----

Table 7: Logistic regression analysis for linkages of physical dependency

Particulars	Estimate of β	SE of β	P value	AOR	95% CI	
					Lower	Upper
Cognitive impairment						
With Cognitive impairment	0.09	0.24	0.69	1.09	0.69	1.75
Without Cognitive impairment (Reference)	---	---	---	---	---	---
Depression status						
Depressed	0.86	0.22	0.000	2.37	1.54	3.65
Normal (Reference)	---	---	---	---	---	---

[F] Linkage of cognitive impairment

In comparison to subjects without cognitive impairment mild (17.8% versus 26.1%) and moderate/severe (6.9% versus 21.0%) depression were more present in subjects with cognitive impairment. In respective categories, 75.3% and 52.9% did not have depression. A significant ($p<0.01$) association existed between cognitive impairment and depression status of study subjects. As mentioned in the previous sections (A to E), results of logistic regression analysis revealed that cognitive impairment was not significantly linked with SED, food insecurity, nutritional status, self-reported morbidities and physical dependence. Significant association of cognitive impairment with depression status of subjects got eliminated in the logistic model**.**

[G] Linkages of depression status of study subjects

Results presented earlier reveal in summative manner on the basis of logistic regression that there existed significant linkage between depression and household food insecurity (Section B), nutritional status (Section C) and physical dependence (Section E). Other significant parameters in univariate analysis (viz; socio economic deprivation, self-reported morbidity and cognitive impairment) were eliminated in the logistic model.

Summative figure of inter-linkages among socio-economic deprivation, food insecurity, nutritional status, self-reported morbidities and physical dependence, as well as cognitive impairment and depression are given in Figure 1.

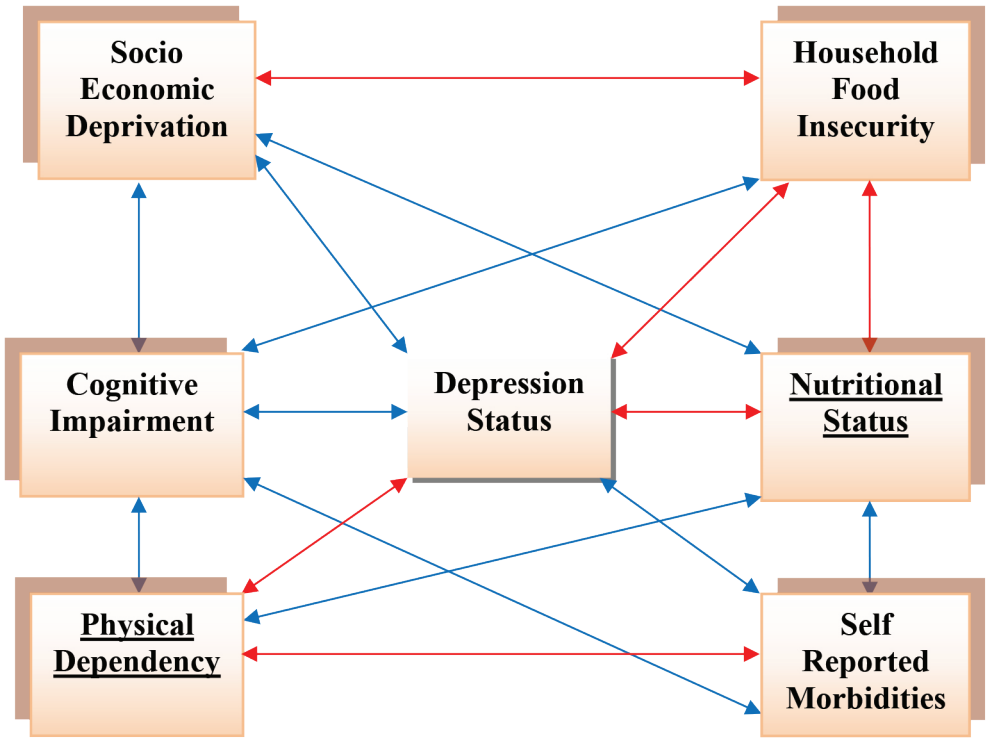

Figure 1: Summative figure of inter-linkages

Note: Significant (cursor): significantly associated in univariate analysis.
Significant (cursor): significantly linked in logistic regression analysis.

DISCUSSION

In this study, higher odd of moderate/severe food insecurity at household level prevailed in subjects with SED. In India, aging diminishes capacity to participate in the work force (Pandey, 2009). Growing risk of serious illnesses in elderly population increase risk of SED. Being not engaged in income generation activities provides a sense of insecurity, unless there is economic support from the family

Household food insecurity is likely to exert significant influence on nutritional status of its members in general, and geriatric subjects, in particular. Findings of this study are in consonance with this statement. Predictors of experienced household food insecurity are directly or indirectly related to low income/ poverty/socio economic deprivation as supported by study in North India and another study in the United States of America (Agarwal *et al.,* 2009; Lee & Frongillo, 2001). Household food insecurity is also significantly linked to chronic energy deficiency. This is also supported by findings of research in Turkey (Simsek *et al.,* 2013) and Malaysia (Suzana *et al.,* 2002). The significant linkage between household food insecurity and moderate/severe depression in geriatric subjects of this study could be due to worry and stress caused by not being able to provide enough meals to the members of their family, in terms of quality and quantity. According to a study in United States, household food insecurity may affect ADL performance (Lee & Frongillo, 2001). This could be attributed to severe under nutrition, decreased immunity and more number of illnesses and their severity.

In conformity with the findings of this study (viz. significant association of CED and functional status of subjects), reports within India (Mathew *et al.,* 2016) and outside India (Brownie, 2006) also provided existence of significant association between nutritional status and ADL involvement. Studies from Turkey (Simsek *et al.,* 2013) and South India (Reddy *et al.,* 2004) also confirmed that self-reported morbidities/health status increased the risk of malnutrition in geriatric subjects. Linkage of CED with depression has been observed in this study.

A study from South India reported that depression was more among those with poor nutritional status (Manju & Krishnababu, 2013).

Risk of undernutrition is enhanced by the presence of food insecurity (Brownie, 2006; Simsek *et al.,* 2013). Food insecurity and not having enough money for food expenses are associated with under nutrition in elderly subjects (Suzana *et al.,* 2002). CED has been found to be linked to the presence of number of chronic diseases in elderly and their perception about health status as bad/ very bad. Being orthopedically disabled was found to significantly increase the risk of malnutrition in geriatric subjects (Simsek *et al.,* 2013). Brownie *et al.* (2006) reported that lack of mobility, chronic diseases, medicine use and hospitalisation were putting elderly at the risk of malnutrition. A study from South India reported that among functional characteristics Instrumental Activity of Daily Living (IADL) dependence was significantly associated with malnutrition (Mathew *et al.,* 2016). In this study logistic regression analysis identified significant linkage between CED and depression in geriatric subjects. Elderly subjects with unintentional weight loss are likely at a higher risk of depression.

In conformity to the finding of present observation, studies conducted in South India (Manju & Krishnababu, 2013; Sharma *et al.*, 2016; Sanjay *et al.,* 2014), West region of India (Seby *et al.,* 2011), North eastern region of India (Saika & Mahanta, 2013) have also reported that multiple co-morbid conditions in geriatric subjects were associated with high rate of depression. A study in Southern part of Punjab, North India also reported that chronic illness was associated with depression status of elderly subjects (Goyal & Kajal, 2014). According to a study in six low middle income countries (viz., China, India, Ghana, Mexico, Russia and South Africa), the presence of multiple morbidity condition was positively associated with depressive symptoms (Anand, 2014)**.** Presence of morbidity (blood pressure) was associated with cognitive impairment, whereas dementia was associated with several chronic diseases (Samuel *et al.,* 2016; Seby *et al*., 2011).

Some reports from outside India (Brownie, 2006; Simsek *et al.,* 2013) have pinpointed linkage between nutritional status (CED) and self-reported morbidity. This has been supported by a study conducted in South India (Srinivasan *et al.,* 2010). Linkages of physical dependency with self-reported morbidities in geriatric subjects have been also reported in studies in Nigeria (Gureje *et al.,* 2006) and Shimla Hills of North India (Sharma *et al.*, 2013). Physical dependency with self-reported morbidities is understandable. Any illness of serious nature in geriatric subjects is likely to affect physical capacity adversely. In conformity with the finding of this study that physical dependencey is associated with cognitive impairment. Studies from South India (Samuel *et al.,* 2016; Srinivasan *et al.,* 2010) and North India reported that a putative relationship exists between cognitive impairment and functional status (Kumar *et al.,* 2014).

Linkage of physical dependency with depression in geriatric subjects may be attributed to their feeling of helplessness or seeking help for daily activities. According to a study in urban tea garden of India, higher probability of disability prevailed in subjects with BMI > 25 kg/m^2 (Medhi *et al.,* 2006) However, this linkage was not substantiated by the logistic model in this study.

In the present study, significant association of cognitive impairment with SED (Section A), household food insecurity (Section B), self-reported morbidity (Section D), physical dependency (Section E) and depression status got eliminated in logistic model. However, a number of studies have pinpointed linkages of cognitive impairment with nutritional status (Sharma *et al.,* 2013), presences of chronic conditions (Villarreal *et al.,* 2015), ADL involvement (Holz *et al.,* 2013; Villarreal *et al.,* 2015) and depression (Holz *et al.,* 2013)**.**

Linkage between depression and ADL involvement has also been reported in a study conducted in Panama (Villarreal *et al.,* 2015)**.** Linkage of depression with chronic illness in elderly subjects has been identified in studies conducted in China (Cong *et al.,* 2015), Ethiopia (Grima *et al.,* 2016) and Panama (Villarreal *et al.,* 2015) in logistic model. However, this was not substantiated in the present study on the basis of logistic model. A study among elderly people of Peoples Republic of China found cognitive impairment to be associated with increased risk of depression in adjusted model (Giri *et al.,* 2016). However, logistic regression analysis has not substantiated this linkage in the present study.

In a classical model, socioeconomic deprivation predisposes to food insecurity. This has been substantiated by the findings of the present study as well. There is evidence that direct linkage exist between household food insecurity and SED. Surprisingly, no significant linkage has been observed between SED and CED in the logistic model. Several anti poverty and employment generation programmes were instituted in India to remove poverty (Mishra, 2012). However, they could not reduce under nutrition to the desired extent. Several programmes with impressive infrastructure having intention to improve nutrition have been planned in the

country but due to lack of coherent monitoring/tracking systems and absence of intersectoral corporation they were not properly implemented and their translational effect was not noticed adequately (Keshari & Shankar, 2016).

Summative figure of this study emphasises that socioeconomic upliftment per se may not improve nutritional status of geriatric subjects. Other underlining processes are responsible for household food security which is linked to CED in logistic model in this study. Elderly people are vulnerable to disease onset (Joshi *et al.,* 2003; Prakash *et al.,* 2004) which leads to CED (Hickson *et al.,* 2006). CED in elderly is linked to depression (Cabrera *et al.,* 2007) as well as impaired cognitive function (Clark *et al.,* 2007). Although cause and effect relationship cannot be established precisely by this cross sectional study, findings of this study provide significant inputs for planning and execution of geriatric services.

Issues prevailing to household food security are critical for geriatric health. Therefore, this should be taken into account by all stakeholders in programme planning and its execution. Community members need to be sensitive about problems of elderly so that a great commitment and involvement in extending support to them be assured to address the issues of health care, functional disability and psychosocial problems. There is a need to strengthen geriatric care services in the existing public health system so that the increasing physical and mental health care demands of elderly can be met.

CONCLUSION

This study primarily explored interlinkages among socio-economic deprivation, food insecurity, nutritional status, self-reported morbidities, physical dependency as well as cognitive impairment and depression in urban geriatric subjects. Although this comprehensive study has been conducted on an adequate and representative sample size, and captured the nutritional, social, mental as well as psychosocial issues pertaining to old age and pinpointed interlinkages among them, being cross sectional in nature, it poses a limitation, as cause and effect relationship cannot be established precisely. For establishment of cause and effect relationship a longitudinal study is required. Despite this limitation, the current study provides an interplay of issues affecting physical, mental and social dimensions of health of geriatric subjects. This study further emphasises that ensuring household food security, rather than socioeconomic upliftment, improves nutritional status of geriatric subjects and call for critical scrutiny for underlying mechanism. Nutritional status of geriatric subjects exerts significant influence on extent of depression, which in turn has direct linkage with physical dependency consequent to multiple morbidities. Based on the findings of the current research work, it can be recommended that there should be a policy shift from socioeconomic upliftment to food and nutrition security through multisectoral involvement and participation of stakeholders. A geriatric-sensitive environment needs to be created to cope with morbidities, functional incapacities and psychosocial problems in geriatric subjects. Focused interventional programmes should be designed and implemented, giving due consideration to interlinkages of issues having direct bearing on health and functional capacity of geriatric subjects.

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