Original Article

Interaction among body composition, self-rated health and functional status of the elderly in an Indian population

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The present study examined the relationship among body composition, measures of self-rated health and activities of daily living in a group of free living poor elderly aged ≥60 years with a sample size of 147 subjects (82 males, 65 females) from Tirupati suburbs of Andhra Pradesh, India. The subjects were divided into three age groups i.e. 60-69, 70-79 and ≥ 80 years for comparison. Mean height, weight, circumferences of waist and hip and waist hip ratio (WHR) were higher in males than females with no difference in body mass index (BMI). However, none of the anthropometric variables showed significant association with age. The majority of the subjects rated themselves as 'poor' or 'fair' self-rated health and this corresponds well with the lower mean values of anthropometry as well as activities of daily living, well-being and memory and cognitive function, impaired health aids and in general health. Polytomous logistic regression showed that subjects with the highest score on well-being compared to the lowest score rated 0.325 times (CI: 0.124, 0.851; $P<0.05$) good vs fair. The odds ratio was 0.519 times (CI: 0.206, 1.306) between good vs poor. Regarding BMI, subjects who rated their health as good/fair tended to have BMI in the normal range. In the poor self-rated health group a maximum of 55% of males and 47% of females were below 19 units of BMI, which was reflected in the increase in odds ratio of 1.361 in males and 1.134 in females between good vs poor health ratings. The findings reveal that well-being and BMI are related to self-reported health status.

Key Words: elderly, anthropometry, self-rated health, activities of daily living, well-being, Andhra Pradesh, Tirupati, India

Introduction

Aging presents many challenges to society and individuals. With gradual and sustained increase in life expectancy, the number of elderly, both relative and absolute, is increasing all over the world. With this increase, is emerging newer needs of this group, which are being felt in all sectors of human sustenance, be it health, social or economic etc.[1] Majority of the world's older people (61%) live in developing countries, a proportion that will increase to nearly 70% by 2025. The elderly population of India rose from 5.5% of the general population in 1950 to 6.5% in 1991 and 7.7% by 2001. In other words, one out of every seven elderly persons would be from India by 2001.[2] The above statistical description suggests that the growth rate of elderly populations, in terms of absolute number and proportion, is faster than younger age groups. This is a great challenge to the health service systems. Chronic illness is endemic among many older people in the developing world, where technical advances in medicine have far outrun the social and economic development which in industrialized countries have enabled disease-free living.[3] Nutritional status and impaired functional ability among the elderly, especially from poorer sections of the developing countries, must receive attention. Research results have shown a relationship between health and nutritional status in the elderly.[4,5] Body fat content and its distribution are helpful in assessing the risks for cardiovascular disease,[6] hypertension,[7] diabetes[7] and dislipidaemia,[8,9] Therefore, information on body composition is essential in delineating the nutrition and health relationship.[10]

Global self-ratings of health are among the most commonly assessed and simplest measures for ascertaining an individual's health. Self-rated health has been shown to be an independent predictor of survival among the aged.[11] Several studies on nutritional status and health among the elderly population have been conducted from the different corners of the globe. To the best of our knowledge, only one study is available on the elderly population's perception of self-rated health and nutritional status from the Indian context.[12] In the light of this

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of this background the present study aimed to assess the the relationships between nutritional status with functional ability, well-being and self-rated health in a group of free living poor elderly subjects, residing in a semi-urban community of Tirupati, Andhra Pradesh, India. This study has been conducted based on the recommendations of the "Food habits in later life (FHILL): A cross cultural study" under the au-spices of Committee II/8 of the International Union of Nutritional Sciences for the Developing Nations to begin documenting the health and nutritional status of the elderly population.[13]

Subjects and methods

The study population comprised 147 subjects from poor socio-economic status groups aged ≥60 years (82 males, mean age: 72.7 ± 7.3; 65 females, mean age: 69.6 ± 5.3), from the suburbs of Tirupati town, Andhra Pradesh, India. The age differences between sexes was statistically significant (P<0.001). Subjects were classified into three age groups: 60-69, 70-79 and ≥80 years. This study was approved by the ethics committee of our Institute. Informal consent was taken from all the subjects before participation. A common protocol was adapted from the FHILL and contents were translated into local language "Telugu" and utilised in the collection of the data.

Information on individual health history in the present and past was obtained from each subject, along with data on health aids (spectacles, hearing, walking and dentures), level of education, physical activity etc. Forty three per cent of males and 71% of females had no formal education. A maximum of 6% attained education up to 10^{th} standard in females, while in males 36% up to 5^{th}, 13% up to 10^{th}, 6% up to pre-degree, and 1% to the level of graduation. Sixty two to 67% of both males and females were sedentary and 32 to 37% were mildly active. The physical assessment included height, weight and circumferences of waist and hip, as specified by Reddy *et al.*[14] Body mass index (BMI) was calculated as weight in kg/height in metre^2 (kg/m^2) and waist hip ratio (WHR) was calculated in cm as waist circumference/hip circum-ference.

Self-rated health

As a part of general structured interview conducted in the subject's own home, several questions were asked about self-rated health (SRH), activities of daily living (ADL), memory and cognitive function (MCF) and well-being (WB). Self-rated health was evaluated using the response to the question, "How would you rate your health at the present time?" with possible responses being poor, fair, good or excellent.[15] The last two categories were combined and labelled as good, due to the limited sample size in the excellent category for the present study.

Activities of daily living

Physical function was assessed using an instrument adapted from the WHO 11 Country Study.[16] The 15-item questionnaire is as follows; a) walk between rooms b) use stairs c) walk at least 400 meters d) get to places out of walking distance [e.g., bus stop, shops] e) use the toilet f) wash and bathe your self g) dress and undress h) take care of your appearance I) get in and out of bed j) do your own cooking k) feed your self l) do light house work m) do heavy house work n) take medicine by your self o) manage finances. These questions included about physical functional limitations (item a-d), basic activities of daily living including self-care (items e-k), and instrumental activities of daily living (items i-o). For each item, the level of competence was measured on a four-point scale. Degree of difficulty scores were assigned to categories defined in terms of the ability to perform an activity within a numerical range from one to four. A score of one denoted that the subject was unable to perform the activity, whereas a score of four indicated that the subject could accomplish the activity without any difficulty. The other two possible responses indicated the ability to perform activities only with outside help (score=2) and with difficulty, but without help (score=3). The aggregate scores on the ADL questions ranged from 15 to 60. From the ADL questions, a mobility index (MI) was calculated as the sum of items a-d , based on a model used in the Euronut Survey in Europe on Nutrition and the Elderly, a Concerted Action (SENECA) Study on Nutrition and the Elderly.[17] Scores ranged from 4 to 16 with higher scores indicating better mobility.

Well-being

In addition to physical function, well-being was included to help describe the subject's emotional status.[18] Well-being was measured by a seven-item, binary-coded, closed-ended questionnaire.[13] Item scores were summed to develop the WB index with aggregate scores ranging from seven to 14, with higher scores indicating a higher sense of WB. Questions were recoded so that a positive response was indicated by a higher score (e.g "Do you worry more than usual about little things?' Yes=1; No=2 and "Do you laugh easily?; No=1; Yes=2). The questions included were as follows: Do you worry more than usual about little things?; Have you lost interest in doing things you usually cared about or enjoyed in the past?; Have you ever felt so sad or depressed that you thought you wanted to die?; Do you feel tired most of the time?; Are you happy with every day of your life?; Do you laugh easily?; Do you enjoy listening to music?

Memory and cognitive function

Memory and cognitive function was measured by a five-item questionnaire. Item scores were summed to develop the MCF index with aggregate scores ranging from five to 10, with higher scores indicating a higher sense of MCF. The questions included were as follows: What year is it (now)? ; What month is it (now)?; What day or date of the month is it (now)?; What is your address?; Do you forget where you left things more than you used to or forget the names of close friends or relatives?.

Statistical analysis was carried out via SPSS-10.1 and alpha levels were set at P<0.05. Differences in mean values between sexes were analysed using the students "t" test and differences between age groups and categories of self-rated health were checked by analysis of variance. Bivariate relationships between self-rated health with anthropometry and other factors using pearson correlation coefficients and χ^2 analysis. Further, multivariate logistic regression was fitted (χ^2 value; males: 83.02; P<0.001;

females: 54.11; $P<0.001$) to investigate the relationships that affect an individual SRH. The variables entered into the model were: BMI, and scores of MI, ADL, WB and MCJ controlled for age, level of education and physical activity.

Results

Descriptive statistics for sex according to categories of self-rated health status is presented in Table 1. For the question "How would you rate your health at the present time", the majority of the subjects answered "fair" and "poor". In males 40% rated as poor and 54% as fair; in females 29% rated as poor and a maximum of 48% as fair health. Only 6% of males and 23% of females rated themselves as enjoying good health.

Table 1. Descriptive statistics for sex according to categories of self-rated health

Sex	Poor	Fair	Good	χ^2	*P* value
Male	40.2%	53.7%	6.1%	9.18	>0.010
Female	29.2%	47.7%	23.1%		

Table 2. Comparison of anthropometric data between males and females

Variable	Males *N*= 82	Females *N*= 65	*P* value
Height *(cm)*	165.7 ± 6.0 (152-182)	155.0 ± 5.3 (135-163)	<0.0001
Weight *(kg)*	59.2 ± 11.2 (38-85)	52.4 ± 7.7 (35-68)	<0.0001
BMI *(kgm^{-2})*	21.4 ± 3.1 (15.04-29.07)	21.8 ± 2.9 (16.6-30.1)	<0.529
Waist circumference *(cm)*	81.7 ± 11.8 (58-110)	71.9 ± 8.0 (57-86)	<0.0001
Hip circumference *(cm)*	90.7 ± 12.1 (62-125)	84.5 ± 7.7 (68-102)	<0.0001
WHR	0.90 ± 0.04 (0.81-1.02)	0.85 ± 0.05 (0.76-.95)	<0.0001

Data as mean ± S.D. ( ) = range

Comparison of mean differences for anthropometry between males and females are shown in Table 2. The means for height, weight, waist and hip circumference and WHR were significantly higher in males, while BMI failed to show significant difference between genders. Further, descriptive statistics for anthropometry across the age groups (Table 3) indicated that none of the variables in either sex showed variation within age groups.

Comparison of anthropometric data across the self-rated health categories for both males and females is presented in Table 4. In males, mean height, weight and BMI tended to increase from "poor" to "fair" but decreased in the "good" category ($P<0.05$). In females, only weight and BMI were found to increase across categories of SRH with minor fluctuations in BMI. On the other hand, circumferences of waist and hip and WHR in males tended to increase from "poor" to "good" health status, but in females no such differences were observed, though some minor fluctuations in mean values were noticed across the categories of SRH.

Mean scores for MCF, WB, ADL and MI for both sexes in different age groups are shown in Table 5. Even though the mean scores for MCF and WB tended to fall in the very old age group, they did not reach statistical significance. However, in both sexes, ADL and MI tended to fall sharply in the very old age group. Across the categories of SRH (Table 6), significant decreases in the mean scores for variables like MCF, WB, ADL and MI are observed for both sexes ($P<0.001$).

Women had a higher level of impairment in vision (70% vs 55 %) and walking (66% vs 62%), while men had a higher level of impairment in hearing (4% vs 2%) - only one man used dentures in the present study (Table 7). Regarding morbidity, nearly 80% of the study subjects had no ailment in the past or present. General weakness was prevalent in 7% of males and 20% of females and a few had

suffered from blood pressure, diabetes and arthritis. Currently only 44% of males and 26% of females have no impairment and the rest are prone to different ailments with different percentages (Table 8). General weakness accounted for 41-54%, followed by 6% diabetes, 4% arthritis, 2 to 7% blood pressure, 3% heart problems and one had undergone treatment for cancer.

Table 3. Gender wise comparison of anthropometry across the age groups

Variable	Sex	60-69 Males *N*=35 Females *N*=37	70-79 Males *N*=25 Females *N* =26	80+years Males *N* =22 Females *N* =2	*F* value	*P* value
Height	M	165.1±5.3	167.2±6.1	164.9±7.0	1.14	0.324
	F	154.4±5.5	155.8±4.9	157.5±6.4	0.81	0.449
Weight	M	58.8±10.4	61.2±13.5	57.4±9.8	0.71	0.495
	F	52.2±8.2	52.7±7.2	49.5±9.2	0.17	0.847
BMI	M	21.5±3.0	21.7±3.6	21.0±2.8	0.29	0.750
	F	21.9±3.3	21.7±2.4	19.9±2.1	0.49	0.616
Waist circumference	M	83.7±10.1	81.4±13.8	79.1±11.8	1.03	0.360
	F	71.1±7.4	72.9±8.9	72.5±12.0	0.40	0.672
Hip circumference	M	92.4±9.7	90.9±14.1	87.9±13.2	0.93	0.397
	F	84.1±7.	85.0±8.0	85.0±17.0	0.11	0.893
WHR	M	0.91±0.05	0.89±0.05	0.90±0.04	0.43	0.652
	F	0.85±0.05	0.86±0.05	0.86±0.03	0.40	0.672

Data as mean ± S.D; M = males F = females

Table 4. Comparison of anthropometry with categories of self-rated health for males and females

Variable	Sex	Poor Males *N*=33 Females *N* =19	Fair Males *N* =44 Females *N* =31	Good Males *N*=5 Females *N*=15	*F* value	*P* value
Height	M	163.7±5.7	167.1±6.3	165.8±2.2	3.01	0.054
	F	154.1±6.2	154.7±5.0	157.0±4.1	1.48	0.236
Weight	M	53.3±9.3	63.7±11.1	58.4±2.0	9.78	0.000
	F	47.0±6.1	54.3±6.7	55.2±8.5	8.09	0.001
BMI	M	19.8±3.0	22.7±2.8	21.2±0.5	9.41	0.000
	F	19.7±1.9	22.7±2.8	22.4±3.1	7.84	0.001
Waist	M	75.9±9.1	85.6±12.0	86.0±11.5	7.81	0.001
circumference	F	72.3±8.4	72.6±8.3	69.9±7.3	0.56	0.573
Hip	M	85.4±10.6	94.4±12.1	93.8±10.6	5.17	0.004
circumference	F	84.7±8.4	85.8±7.0	81.5±7.7	1.61	0.208
WHR	M	0.89±0.04	0.91±0.05	0.92±0.04	1.53	0.224
	F	0.85±0.04	0.84±0.05	0.86±0.07	0.47	0.627

Data as mean ± SD; M = males F = females

Table 5. Mean scores for MCF, WB, ADL and MI across the age groups for males and females

Variable	Sex	60-69 Males *N*=35 Females *N* =37	70-79 Males *N* =25 Females *N* =26	80+ years Males *N*=22 Females *N*=2	*F* value	*P* value
MCF	M	3.7±1.5	3.6±1.4	3.0±1.5	1.58	0.213
	F	3.3±1.5	3.4±1.4	1.0±0.0	2.46	0.094
WB	M	4.9±2.1	4.4±1.8	4.7±1.8	0.41	0.663
	F	4.7±1.6	5.2±1.0	3.0±1.4	0.91	0.062
ADL	M	43.8±5.6	40.4±6.5	38.4±6.7	5.61	0.005
	F	40.7±7.4	42.8±6.7	31.5±2.1	2.68	0.077
MI	M	12.4±2.6	10.6±3.3	9.9±2.7	6.35	0.003
	F	10.6±3.2	11.9±2.9	7.5±0.7	2.81	0.068

Data as mean ± SD

Table 9 shows the results of χ^2 test for linear association for age, level of education, PA,MCF,WB, ADL, MI, BMI and WHR with categories of SRH for both sexes. In males, only WHR failed to show significant association with SRH, while in females, apart from WHR, the variables like age and level of education have also shown insignificant association.

Table 10 presents the odds ratio for ADL, WB, MI, MCF and BMI by categories of SRH for males and females. These odd ratios are adjusted for age, level of education and PA. In males, subjects with the highest scores for ADL were 1.054 times (CI:0.770, 1.443) better when comparisons were made between the good vs fair SRH groups. In contrast, the odds ratio for ADL score increased to 1.291 times (CI: 0.918, 1.815) when the good vs poor SRH categories were compared. Similarly, subjects with highest scores for well-being compared to the lowest scores rated 0.325 times (0.124, 0.851: $P<0.05$) for the good vs fair SRH. The odds ratio was 0.519 times (CI: 0.206, 1.306) between good vs poor. Mobility index, MCF and BMI also exhibited similar trends. With regards to the females, similar trends were noted with different odds ratios. In the logistic regression model, well-being, body mass index and MCF (only in males) were statistically significant.

Discussion

The present work provides findings on anthropometry, self-rated health and functional status for the sub-urban poor elderly of the Tirupati town, Andhra Pradesh, India. It is believed that the present study is the first of its kind from South India. Only one study has been carried out by Manandhar *et al.,*[12] on the poor elderly of Mumbai slums, North India. Since it is a preliminary study, the results reported here may provide a baseline for developing reference data on Indian populations.

Sex differences in anthropometry are persistent in the present sample, but across the age groups the differences are not significant. This is supported by our earlier studies on the people of Tirupati.[9] Cross-sectional studies of elderly subjects report varying degrees of relationships between different anthropometric variables and age.[19,20] Comparison of our data with similar age groups of Guatemala elderly,[11] it is found that the subjects in the present study are taller with no differences in weight, however, their BMI is lower. Furthermore, height, weight and BMI values of our study group are considerably lower than reference data from USA[21], Europe[22] and even economically advanced and urban populations of India.[23] On the other hand, these data are similar to nationally representative Indian data on low income groups.[24]

Table 6. Mean scores for MCF, WB, ADL and MI with categories of self-rated health, by gender

Variable	Sex	Poor Males *N*=33 Females *N*=19	Fair Males *N* =44 Females *N* =31	Good Males *N* =5 Females *N* =15	*F* value	*P* value
MCF	M	2.4 ± 1.4	4.1±1.1	4.8±0.5	21.73	0.000
	F	2.1 ± 1.3	3.6±1.4	4.1±1.0	11.18	0.000
WB	M	3.5 ± 1.8	5.4±1.5	6.2±1.3	14.89	0.000
	F	3.6 ± 1.5	5.1±1.2	5.9±0.6	17.50	0.000
ADL	M	36.8 ± 6.3	44.4±4.5	43.8±7.3	18.94	0.000
	F	34.3 ± 5.2	42.6±6.3	47.3±3.1	26.14	0.000
MI	M	9.2 ± 2.4	12.6±2.6	11.6±3.4	16.20	0.000
	F	8.5 ± 2.3	11.4±3.1	13.4±1.8	15.41	0.000

Data as mean ± SD

Table 7. Usage of health aids, by gender (%)

	Male	Female
Spectacles	54.9	70.8
Hearing	3.7	1.5
Walking	62.2	66.2
Dentures	1.2	-

However, mean values of these data are still higher than those of elderly poor in Mumbai slums[25] and Kerala.[26] In general, the weight and BMI reflects the nutritional status of this elderly group, which is poorer than that found in developed countries, vis-a-vis more economically developed societies. Despite lower weights and BMIs, the present sample had higher waist hip ratios when compared to those of USA[27], Europe[28] and Asia.[2,9] Some of the Indian studies[30,31] suggest that a lower BMI may apply to define increased abdominal obesity in Indian populations. This suggests that a low BMI may correlate better with the risk of developing coronary heart disease in Indian populations.

Representation of poor and fair SRH categories are predominant (χ^2 =9.18; P<0.01) in the study sample. The results of the present study are in good agreement with the work on poor elderly from Mumbai slums.[12] On the contrary, most of the elderly European subjects,[17,32] and Guatemalan elderly[11] considered themselves to have good health and to be physically normal.[33] These observations, however, are not applicable to the present study, as various factors combined, such as poverty, lack of care from other family members due to the breakdown of a joint family system, running out of medical care facilities, personal hygiene and number of meals per day compel the elderly to develop stoic or cynical attitudes towards life and to usually suffer ill health during old age. This situation is further intensified in the presence of health aids, as noticed in the present study and the study on Mumbai elderly.[12] Several studies on Indian elderly stressed the need for sharing their knowledge, skills, values and life experiences with younger generations, and on the necessity of providing opportunities for them to serve as volunteers in positions appropriate to their interests and skills with a view to providing at least mental health for them.[34]

Mean scores for ADL, WB, MI and MCF were lower in subjects who rated their health as "poor" compared to the subjects who rated their health as "good". In general, females had lower aggregate scores for ADL and MCF than males. Elderly women from European countries[17] are also experiencing similar setbacks. This phenomenon could be attributed to illiteracy, limited mobile life and lack of exposure to the outside world.

Though many studies documented a decline in ADL and other interactions with advancing age,[35,36] the present study has not shown any significant decrease in ADL and associated factors with advancing age. However, a decrease, particularly after 7th decade of life is persistent. This is in accordance with reports that ADL can be used to predict morbidity and mortality in elderly subjects.[35,36] Further, the proportion of individuals craving for independence was slightly higher for males than for females, as evidenced in the Seneca Study of European elderly.[17]

Self-assessment of health is largely dependant on an individual's functional ability and psychological processes, as evaluated by analysis of life satisfaction.[37] This was in agreement with the mechanism, as suggested by Kaplan and Camacho[38], that the subject's self-rating of health depends on different psychosomal processes. The subject either accepts or denies the status of 'sick person'. This affects the subject's health through the body's ability to resist disease. The predictive variables in the present sample seem to support this mechanism.

Logistic regression demonstrates a statistically significant association between SRH and WB and BMI. An

Table 8. Health problems in the present and past, by gender (%)

	Present		Past	
	Males	Females	Males	Females
Nil	44.0	26.2	80.0	75.4
General Weakness	41.5	53.9	7.3	20.0
Blood Pressure	2.4	7.7	2.4	3.1
Diabetes	6.1	6.2	6.1	1.5
Arthritis	4.9	3.1	3.7	-
Heart Diseases	-	3.1	-	-
Cancer	1.2	-	-	-

Table 9. Test of linear association for different variables with self-rated health for males and females

Variable	Males		Females	
	χ^2	*P* value	χ^2	*P* value
Age	4.05	0.044	0.09	0.762
Level of Education	14.35	0.000	3.41	0.065
PA	6.41	0.011	14.13	0.000
ADL	21.34	0.000	28.27	0.000
WB	21.10	0.000	22.18	0.000
MI	17.05	0.000	21.00	0.000
MCF	27.42	0.000	15.42	0.000
BMI	9.78	0.002	7.76	0.005
WHR	2.97	0.085	0.11	0.736

Table 10. Adjusted[@] odds ratio (95% CI) for each variable, by self-rated health and gender

	ADL OR (95%CI)	WB OR (95%CI)	MI OR (95%CI)	MCF OR (95%CI)	BMI OR (95%CI)
Males					
Good vs Fair	0.054 (0.77, 1.443)	0.325* (0.124,0.851)	0.770 (0.365, 1.622)	0.164* (0.039,0.676)	0.237 (0.912,1.677)
Good vs Poor	0.291 (0.918,1.815)	0.519 (0.206,1.306)	0.315 (0.678, 2.553)	0.386 (0.991,1.506)	0.361* (0.981,1.890)
Females					
Good vs Fair	0.085 (0.831,1.417)	0.400* (0.135,1.189)	0.528 (0.248,1.126)	0.456 (0.220,0.947)	1.125 (0.927, 1.365)
Good vs Poor	0.312 (0.958,1.797)	0.644 (0.271,1.526)	0.805 (0.458,1.413)	0.878 (0.488,1.577)	0.134 (0.903, 1.425)

[@]Adjusted for age, level of education, physical activity; ADL= Activities of daily living, WB= Well-being, MI= Mobility index, MCF= Memory and cognitive function, BMI= Body mass index, OR= Odds ratio, CI= Class intervals, **P*<0.05

association between SRH and MCF was also observed in males. Nevertheless, subjects with high scores on both well-being and mobility indices perceived their global health to be superior to those who had lower scores.[39] Therefore, for the elderly people, an individual evaluation of health is substantially influenced by his or her level of emotional well-being and physical function. Similar reports are also available elsewhere.[18,40,41]

Psychological variables and measures of disability in terms of activities of daily living are the strongest predictors of self-rated health as revealed in a French population.[37] A study on Mexican-American disabled elderly reported that the subjects exhibited increased concern with respect to posing a burden to their families and expressed to lead independent lives.[42] Since the Indian culture is entirely different from Latin and other European cultures, maintaining independence is not rooted in the minds of the elderly who automatically enjoy the dependency on the nearest kin, especially during old age.

Statistical significance of BMI in SRH is a significant feature of this study. On examining the relationship between SRH and BMI, it is found that subjects who rated themselves in good/fair health tended to have BMIs in the normal range, while in the category of poor self-rated health a maximum of 55% of males and 47% of females were below 19 units of BMI, which was reflected in the increase in odds ratio of 1.361 in males and 1.134 in females between good vs poor health ratings. Indians in general are not obese and especially among poorer sections the majority fall below normal or under weight as indicated in the present study. Though no specific conclusion can be drawn, based on this small sample size, prevalence of under weight may contribute to the claim by the majority that their health is poor. In contrast, elderly populations from Guatemala and USA have higher BMIs and remain physically active and independent, even in their seventh decade, which may help to explain their higher ratings for self-rated health.[43,44]

The present findings on Tirupati elderly reveal that well-being and BMI are strongly associated with self-rated health. Hence, improved self-perceptions of health may have a positive effect on one's well-being and independence. However, evaluation of causal association between self-rated health, well-being and nutritional status requires both longitudinal and cross-sectional studies with larger sample sizes and on different population sub sets, especially in a multi-ethnic and multi-lingual Indian context.

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