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Impact of nutritional status on hand grip strength among elderly population in India

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Abstract
Objectives: In the present study an attempt was made to find out the influence of sex and age on nutritional status and handgrip strength. Beside that relationship between nutritional status and hand grip strength was also evaluated irrespective of age and sex.
Methods: Two stage cluster sampling method was employed for the study. 493 elderly subjects having the age range 51 and above were selected from different places of West Bengal state, India. Height, weight, Body mass index, Nutritional status (24-hour recall method) and hand grip strength were taken from the selected elderly population by standardized methods.
Results: Hand grip strength found to be significantly higher in males than in females and so also it was significantly decreases with the advancement of age (p<0.001). Nutrient intake was significantly higher in males than in females (p<0.001, p<0.05). The present study stated that as the age increases the nutrient intake was decreases (p<0.001, p<0.05). There was a significant negative correlation between hand grip strength and age for both sexes (p<0.05). A positive correlation was observed between hand grip strength and nutritional status (p<0.05). After controlling for potential confounder (i.e., age), nutritional status was not remained a significant contributor for the variation of hand grip strength.
Conclusion: The present study concluded that sex and age had significant influence on nutritional status as well as hand grip strength. Poor nutritional status is associated with poor hand grip strength independent of sex but in dependence of age among the selected elderly population.

Keywords: Elderly, nutrition, hand grip strength, age, sex

Introduction
Geriatric population is a rapidly growing segment all over the World but unfortunately, they are the neglected portion of the society (Sharma *et al* 2018; Sarkar *et al*. 2006) [36, 35]. Specialized geriatric health services have to be developed, to educate, develop and maintain healthy lifestyles and to provide comprehensive health care. Dietary diversity should be promoted as a way of ensuring adequate amounts of nutrients to maintain bone health. Older people are at a higher risk of malnutrition, not only because of food insecurity, but also due to various social, physiological and health changes with ageing (Sheng *et al*, 2017; Sanz *et al* 2013; Araujo *et al*. 2015) [37, 34, 2].
The nutritional status of an individual is open the result of many interrelated factors. It is influenced by the adequate of food intake of both in terms of quantity and quality and also by the physical health of the individual (WHO 1995) [46]. With increasing age, the natural drive to eat and drink decreases, resulting in the so-called anorexia of aging. This is partly because of the decline in smell and taste sensations that accompanies aging (Volkert 2013) [43]. Previous studies reported that poor nutrient intake (i.e., energy, protein, vitamins and minerals) can impact on an older person's functional and cognitive ability and thus their ability to participate in activities of daily living (Ministry of Health 2013) [25] by decreasing the muscular strength. Muscular strength presumably affects nutritional status by its impact on mobility, physical activity level and energy expenditure, as well as basic functional ability tasks such as transferring (Rantanen *et al* 1994) [33]. The age-related reduction in muscular skeletal function effects individuals' ability to perform even day-to-day activities and their quality of life (Cayley *et al*. 2008) [7] and promotes dependency on others (Nourollahnajafabadi *et al*. 2013) [29].

There is a serious lack of research in the use of dietary interventions (i.e., improving nutritional intake through the use of food) among older people (Jones *et al* 2009) [19]. As per the results of the previous studies both the nutritional status and hand grip strength are related to each other (Vittala *et al* 2021) [42], thereby it is necessary to evaluate nutritional aspect of the elderly along with the hand grip strength. Assuming that, the aim of the present study was to find out the impact of the nutritional status on hand grip strength among the selected elderly population.

Materials and Methods

Site and subjects: The proposed research work was conducted in different places of Paschim Medinipur, Purba Medinipur, Bankura, Bishnupur, Purulia, North 24 Parganas and Howrah districts of West Bengal state, India. Total 493 elderly subjects having the age range 51 years and above were selected for the study. Two stage cluster sampling method was employed in the study. In the first stage, four clusters in each of the selected districts of the West Bengal state were identified. In the second stage, a systematic random sampling method was used to identify 20 families per cluster and it should be mentioned here that there should be at least one elderly person (having the age range mentioned above) in the selected family. All families in the cluster were enlisted. To obtain the sampling interval, the number of families in the cluster was divided by the required number of participants. The first family was selected randomly and then the subsequent families were identified by adding a sampling interval to the random number. At last, according to the inclusion criteria, 493 subjects were selected. The sample included 46.7% (n=230) males and 53.3% (n=263) females.

Inclusion and exclusion criteria- The elderly subjects having age related health problems were included in the study. Those who had any acute illness, undergone recent surgery, had visual, hearing, or cognitive impairments, a recent history of cancer, physically handicap interfering with the assessments were excluded from the study. Those who were receiving artificial enteral or parenteral nutrition were excluded as well.

Anthropometric measurements: Height was taken with the help of an anthropometric rod (Hindustan Minerals, The Hindustan Mineral Products Co. Ltd, Kolkata, India) and weight was obtained by a portable weighing machine (Libra, Libra Weighing Machine Limited, Bangkok, Thailand). Standard techniques were applied during taking the data (Weiner and Lourie 1981) [44].

The body mass index was calculated from the collected height (mt) and weight (kg) data by applying standard formula (Jhonson and Nelson 1986) [18].

Hand grip strength: The static hand grip strength was measured by using maximal grip with the help of a Hand Grip Dynamometer (Lafayette, USA). Before taking the measurement, the subject was requested to stand in a comfortable position. The subject was asked to squeeze the dynamometer as hard as possible without moving the rest of the body. Thus, the final grip strength was measured for both hand and the reading were taken from the dynamometer scale, when the pointer was still. From the previous studies it was found that hand grip strength is recorded higher in elbow 90^0 angle among all the angles of shoulder and elbow (De *et al*. 2011, Su *et al*. 1994) [8, 39]. So, for the present study elbow 90^0 angle was adapted.

Nutritional status: Nutritional status was evaluated by 24 hours recall method (Swaminathan 1999) [40]. The amount of different food items consumed by the elderly subjects in last 24 hours was recorded. The nutrients consumed by the respondents were determined through a food consumption table (ICMR 2009) [17].

Analysis of Data: Data were summarized into mean and standard deviation (SD) values, using Microsoft Excel (Office 2010). The differences were determined by studying the level of significance after performing t-tests between two groups and one way ANOVA using Tukey's test among more than two groups. To address the potential for confounding, univariate and multivariate regression analysis were performed. Hand grip strength was taken as dependent variable and nutritional parameters and age of the participants were entered in the model as independent variables. At first correlation were performed between hand grip strength and all the other parameters. The variables which had significant correlation with hand grip strength were retained in the model. For the regression analysis the *p*-value was set at <0.05 level. Statistical analyses were performed using the statistical software IBM SPSS version 20.

Results

Briefing of table 1- In the present study the selected elderly population were further classified in different age and sex groups. It was observed from the results that there was no significant difference of BMI between sex groups and among the age groups. However, there were significant differences of hand grip strength for both sex and age groups. Hand grip strength data was significantly higher for males when compared with females. A significant difference of hand grip strength was observed among the age groups. Hand grip strength was significantly decreases with the advancement of age. The nutritional status was significantly differed between the sex groups as well as among the age groups. Nutrient intake was significantly higher among males than in females and significantly decreases with the increasing age.

Briefing of table 2- Correlation was performed between hand grip strength and other parameters i.e., age, BMI and nutritional status. Significant negative correlation was observed between hand grip strength and age for both the sexes. However no significant correlation was observed between hand grip strength and BMI. A positive correlation was observed between hand grip strength and some of the nutritional parameters i.e., energy, carbohydrates and protein for both sexes. However no significant relationship was observed between hand grip strength and other nutritional parameters (fat, calcium and iron) in case of male subjects. But in case of female subjects' correlation was observed for iron intake.

Briefing of table 3- Linear regression analysis of hand grip strength as dependent variable with nutritional parameters and age as independent variables were performed separately. The results depicted that hand grip strength had significant association with the nutritional status and age of the participants. Multiple regression analysis was also performed after controlling the effect of age and the results

showed that nutritional parameters had no significant impact on the hand grip strength of the participants. However, the multiple regression analysis demonstrated that the age of the participants had strong significant impact on hand grip strength.

Discussion

In the present study no significant difference of BMI was observed between sex and among the age groups. However significant difference was observed for both the sex and age groups in case of hand grip strength. The results showed that males had significantly higher hand grip strength than females (Puh 2010) [32]. Similar sex differences were seen in previous studies (Sharma *et al*. 2018; Westropp *et al*. 2011, Dhara *et al*. 2011, Dodds *et al*. 2014) [36, 45, 9, 10]. Higher hand grip strength among males may be explained by the higher levels of androgenic hormones (Graafmans *et al*. 1996) [15], greater muscle mass (Page *et al*. 2005) [30] and greater height and weight (Kallman *et al* 1990) [21]. However, in the year 2002 Pieterse *et al* reported that the sex difference was not entirely explained by muscle mass as women had significantly lower strength per cm2 arm muscle area. Better physical performance by men is common at all ages but in older populations it may partly be ascribed to a higher occurrence of health problems in women which may have reduced the level of customary physical activity in women. And this reduced physical activity in turn decreases the muscular strength due to inactivity. Findings of the present study indicated that the hand grip strength data was significantly decreased with the advancement of age. Same trends of results had also been reported in previous studies performed in different developing as well as developed countries (Sharma *et al*. 2018; Newman *et al*. 2006, Günther *et al*. 2008, Budziareck *et al*. 2008) [36, 27, 16, 6]. In explanation some of the studies revealed that the decline may be related to various normal aging processes, lifestyle and vocation, behavioural, cultural and physical activities (Bohannon 1997, Martin *et al*. 2012) [5, 24]. However, the degree and pattern of decline differ from one community to another. Reduction in total muscle mass of older adults was also found in the amount of 1/3 of the total mass of age 50 (Angst *et al*. 2010, Bohannon *et al* 2006, Westropp *et al*. 2011, Kallman *et al*. 1990) [1, 3, 45, 21]. Age related reduction in muscle mass is a major contributor of the age-related decline of muscle strength (Kaur 2009, Vianna *et al*. 2007) [22, 41]. Previous studies explained the cause of age-related muscle atrophy is disuse, under nutrition and diseases (Ferdous *et al*. 2009, Bohannon 2008) [11, 4].

In this study nutritional status was compared between sexes and found that males had significantly higher nutrient intake than females. This finding was in disagreement with the study of Landi *et al*. (2010) [23] who opposed the results of the present study. While compared among the age groups it was found that nutrient intake was significantly decreased with increasing age (Godbole *et al* 2020) [14]. Similar trends of result were reported in the study of Soini *et al*. in Finland (2004) [38]. The probable causes of the age-related decline in nutritional status might be because of the lower levels of activity and metabolism. There are many physiological factors involved in the ageing process affecting both hunger and satiety which also contribute to a poor nutrient intake and weight loss. Slower gastric emptying and poorer function of the central feeding control system affected by changing levels of signalling hormones can cause early satiety and reduced feelings of hunger. Furthermore, the sense of smell and taste deteriorate with ageing due to chemosensory losses which may have major impact on appetite and food intake (Morley 1997) [26].

Significant negative correlation was observed between hand grip strength and age for both the sexes. Similar trends of results were observed in the study of Kallman *et al*. (1990) [21]. Whereas no significant correlation was observed between hand grip strength and BMI for both sexes. The results of the present study were in conformity with some previous studies (Kadir *et al*. 2005, Gabbard and Patterson 1989) [20, 13].

Positive correlation was observed between hand grip strength and the nutritional parameters. The finding of the present study was in agreement with some previous studies (Norman *et al*. 2011; Flood *et al*. 2014) [28, 12]. It was observed from the linear regression analysis that hand grip strength had a significant association with both the nutritional status and age. But when performing multiple regression analysis after controlling age no significant association was observed between hand grip strength and nutritional status. Which means nutritional status did not emerged as a significant determinant of hand grip strength for both sexes. In multiple regression analysis it was found that the age of the participants had a strong significant effect on hand grip strength. These findings were in conflict with the study of Pieterse *et al*. (2002) [31]. Present investigation supports the hypothesis that poor hand grip strength is associated with poor nutritional status independent of sex but in dependence of age (Sheng *et al*, 2017) [37].

Table 1: Age and sex wise comparison of BMI, Hand grip strength and nutrient intake among the elderly subjects

Variable		Gender	Age group (years)					Total M-230 F-263
			51-60 M-58 F-67	61-70 M-53 F-62	71-80 M-48 F-55	81-90 M-39 F-43	>90 M-32 F-36	
Age		M	54.7±2.97	62.6±1.13	73.3±1.51	85.9±3.21	93.8±2.96	71.1±14.2
		F	51.5±0.50	63.4±1.53	73.4±1.53	86.4±3.25	95.3±2.36	70.6±15.3
BMI (Kg/m^2)		M	21.6±4.26	21.5±3.86	20.0±3.31	20.0±3.83	21.3±4.10NS	21.0±3.92
		F	21.6±6.11	21.1±4.31	21.6±4.42	21.0±4.20	20.4±4.76NS	21.2±4.88NS
HGS (Kg)		M	28.0±9.78	26.3±7.00	22.1±6.19	15.0±5.07	9.88±2.65##	21.7±9.50
		F	17.8±5.76	16.6±4.42	15.9±4.62	6.19±1.79	12.7±4.64##	14.7±5.96**
Nutrient intake	Energy (Kcal)	M	2634.6±538.8	2364.8±286.0	2137.8±345.7	1605.7±312.6	1449.6±270.7##	2129.4±514.7
		F	2361.6±436.3	1929.9±265.1	1781.9±493.0	1759.6±181.9	1322.8±182.7##	1898.0±480.4**
	CHO (gm)	M	512.6±120.8	433.1±80.7	384.4±78.2	295.5±61.3	258.7±77.0##	395.4±126.3
		F	445.0±92.1	374.7±57.3	333.0±85.0	344.5±46.2	244.1±45.7##	361.1±94.59*
	Protein (gm)	M	72.3±19.9	64.6±12.7	55.7±12.3	43.3±14.0	37.0±9.28##	57.2±19.3
		F	61.1±21.4	48.5±11.4	45.3±18.1	43.2±6.62	34.4±6.48##	48.3±17.3**

	Fat (gm)	M	30.3±20.2	33.6±13.6	30.2±11.7	25.8±11.5	25.5±8.88#	29.6±14.59
		F	29.6±19.1	25.9±11.3	24.0±17.9	23.3±11.4	22.8±12.0NS	25.6±15.3*
	Calcium (mg)	M	619.3±424.5	658.3±223.4	535.7±244.1	425.3±198.4	444.4±177.7**	553.6±295.6
		F	535.1±261.8	484.4±249.4	475.3±278.48	414.4±227.0	418.7.7±221.4NS	475.0±254.0*
	Iron (mg)	M	27.5±6.97	24.5±4.13	23.3±5.68	18.7±5.05	16.9±4.71**	23.0±6.62
		F	23.7±7.26	21.2±5.45	21.1±12.7	18.2±5.23	15.8±5.23**	20.6±8.25*

***p*<0.001 w.r.t. Male **p*<0.05 w.r.t. Male
##*p*<0.001 Among the age groups #*p*<0.05 Among the age groups
M=Male, F=Female, HGS=Hand Grip Strength

Table 2: Gender wise correlation between hand grip strength and all other variables

Hand grip strength (Kg)	Variables							
	Age (years)	BMI (Kg/m^2)	Energy (Kcal)	CHO (gm)	Protein (gm)	Fat (gm)	Calcium (mg)	Iron (mg)
Male (n=230)	-0.66*	0.13NS	0.24*	0.25*	0.23*	0.11NS	0.12NS	0.09NS
Female (n=263)	-0.57*	0.04NS	0.20*	0.16*	0.18*	0.05NS	0.10NS	0.15*

**p*<0.05

Table 3: Regression analysis of hand grip strength as an independent variable with other variables as dependent

Variables		Unadjusted					Adjusted			
		B	SeB	β	R^2	t (p)	B	SeB	β	t (p)
Male	Age	-0.446	0.033	-0.666	0.443	13.471 (0.000)	-0.45	0.036	-0.672	12.332 (0.000)
	Energy	0.004	0.001	0.24	0.057	3.727 (0.000)	-1.794E-005	0.003	-0.001	0.007 (0.994)
	CHO	0.019	0.005	0.249	0.062	3.875 (0.000)	-0.001	0.009	-0.012	0.097 (0.923)
	Protein	0.114	0.032	0.231	0.053	3.579 (0.000)	-0.002	0.047	-0.004	0.042 (0.967)
Female	Age	-0.221	0.02	-0.568	0.323	11.151 (0.000)	-0.219	0.021	-0.563	10.349 (0.000)
	Energy	0.002	0.001	0.2	0.04	3.305 (0.001)	0.001	0.002	0.101	0.782 (0.435)
	CHO	0.01	0.004	0.16	0.026	2.624 (0.009)	-0.009	0.007	-0.139	1.215 (0.225)
	Protein	0.063	0.021	0.183	0.034	3.013 (0.003)	0.003	0.026	0.007	0.099 (0.921)
	Iron	0.11	0.044	0.152	0.023	2.484 (0.014)	0.054	0.04	0.075	1.337 (0.182)

Conclusion

The findings of the present study also concluded that both the nutrient intake and hand grip strength were decreases with the advancement of age. Further researches are required to find out whether the gradually decreasing nutritional status and hand grip strength can affect the activities of daily living among the elderly population.

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