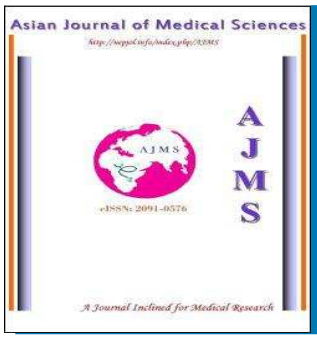

DIET PREFERENCE WITH REGIONAL VARIATION OF BODY MASS INDEX AND HAND GRIP STRENGTH OF INDIAN FEMALES

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"Non vegetarian group had higher BMI values and greater chance of being obese, but they also had greater grip strength than the vegetarians"

ABSTRACT

Introduction: Nutritional content of diet of vegetarian and non-vegetarian differs in terms of food composition and vegetarian diets are often low in protein, probably causing a difference in body composition, structure and strength characteristics.

Purpose of study: To study anthropometric, body composition and hand strength differences among 641 vegetarian and 424 non-vegetarian Indian women, aged 20–60 yrs.

Methods: ANOVA, t-test, multivariable stepwise regression and logistic regressions were performed to analyse association between BMI, hand grip strength and potential confounders using SPSS Version 17 for Windows. $p < 0.05$ referred to as statistically significant.

Results: Vegetarians had less body fat than non-vegetarians. Statistically significant difference was found in their grip strength (GS) ($t = 2.459$, $p < 0.05$) and BMI ($t = 2.188$, $p < 0.05$). Height and weight were positively associated with grip strength in the vegetarian group while height and fat free mass were seen to be positively associated with grip strength in the non-vegetarian group. Grip strength was greater in non-vegetarian group and the vegetarians had lower BMI (25.33 kg/mt^2 ± 4.56) than non-vegetarians (25.95 kg/mt^2 ± 4.45, t-test = 2.188, $p<0.05$).

Conclusion: Those with greater grip strength (non-vegetarian group) had greater chance of being obese than those with lower grip strength (vegetarian group). (OR = 2.609, 95% CI 1.487 - 4.577). However, lower levels of body mass indices of the vegetarian women suggest that they are healthier than non-vegetarians in terms of BMI.

Keywords: Body Mass Index, Grip Strength, Body Composition, Vegetarian, Non-Vegetarian.

INTRODUCTION

A large number of individuals around the world follow vegetarian diets, but in most countries vegetarians comprise only a small proportion of the population. India is a notable exception because a substantial proportion of the population, perhaps approximately 35%, follow a traditional vegetarian diet and has done so for many generations[1]. However, vegetarian diet is often low in protein compared to non-vegetarian diets. Since the dietary supplements or nutritional content of vegetarian and non-vegetarian diet differ in terms of food composition, we hypothesize that this may result in differences in their anthropometry, body composition parameters and hand strength measurements. It has often been reported that vegetarians are leaner in terms of BMI, but it is not clear whether vegetarians are leaner because of not eating meat[2]. There are many published papers dealing with health effects of vegetarians[3,4,5,6]. However, in India, there are not yet enough data from large studies to allow more than broad conclusions about the health effects of vegetarian diets and region wise dietary preference, body composition and strength parameter study of Indian women is not there. Hence, the present study was undertaken on 1065 female of Indian population which includes vegetarians and non-vegetarians in Indian context for understanding the difference between the two groups in terms of strength and body composition parameters for female population only.

The objective of the present study was to compare vegetarian to non-vegetarian female individuals in terms of anthropometry, hand strength and body composition parameters among the women belonging to the North, East, West, Central and Southern regions of the country aged 20–60 yrs.

MATERIALS AND METHODS

A total of 1065 female employees of Defence Research and Development Organization spread over seventeen labs all across the country were volunteers for the present study. Anthropometric data, body composition parameters like Fat percent (Fat%), Fat Mass (FM), Fat Free Mass (FFM) and Total Body Water (TBW), Grip Strength (GS), Pinch Strength (PS) and Thumb Strength (TS) of these females were taken and descriptive statistics were used to characterize the participants.

In this study, we have included vegan and lacto-ovo vegetarian in the vegetarian group and pesco-vegetarian in the non-vegetarian group. Dietary preference data are self-reported. Vegetarian status was defined purely on self-reported exclusion of red meat, poultry and fish.

Anthropometric assessment

Height of the subject was measured to the nearest mm, using SECA 767 electronic personal scale (Medical Scales and Measuring Systems, Germany). Weight was measured by the Tanita TBF-310 Body Composition Analyzer (Tanita Corporation, Tokyo, Japan). BMI was calculated by dividing the subject's weight in kilograms by height in metres squared [kg/mt^2] and in this study we have used the BMI classification according to classification of WHO for Ethnic Asian populations[7,8] where underweight is <18.50 kg/mt^2, normal is 18.50 – 22.99 kg/mt^2, overweight is 23.00 – 24.99 kg/mt^2, pre obese is 25.00-29.99 kg/mt^2 and obese (obesity) is >30 kg/mt^2.

Body Composition assessment

Bioelectric impedance measurements were made using Tanita TBF-310 Body Composition Analyzer (Tanita Corporation, Tokyo, Japan). Subjects were asked to stand without footwear and bare minimum clothing on the body composition analyser. This method uses a tetrapodal device with inbuilt scales for measuring body weight. Age, gender and height details were entered manually into the system. Impedance measurements allow assessment of the FFM and by difference with body weight, assessment of FM. BMI, Fat %, body

weight and TBW were estimated using the standard built in prediction equation for the given age group and was displayed on the machine. Subjects refrained from food and drink for at least 12 hours prior and voided urine prior to the measurement session. The Tanita Body Composition Analyser has been found to provide estimates of %BF that are within 2% of body fat estimation by DXA [9] and is very reliable, with <1%variation within itself [10].

Grip, pinch and thumb strength assessment

The pinch strength (PS) and thumb strength (TS) was measured with a JAMAR® Hydraulic Pinch Gauge, (Sammon Preston, Bollingbrook, IL, USA). Subjects were asked to hold the pinch gauge with their fingers between the thumb and forefinger and were asked to apply pressure with maximum strength for recording of thumb strength. For the pinch strength, the forefinger is placed above and the thumb below the pinch gauge and in the same manner, maximum pinch pressure was applied and this records the pinch strength. The thumb and pinch meter measures finger prehension force in kilograms.

For measuring grip strength (GS), the subjects were asked to hold or grip the dynamometer in their hand with the arm suspended in the natural position hanging on the side and asked to apply their maximum grip. This grip strength was measured using a Grip Strength Dynamometer (TKK 5001, Japan). Only the dominant hand strength was assessed in the present study. Two consecutive determinations were performed and the mean of the two measurements was considered as individual value for statistical analysis.

Ethical clearance: The study was approved by the Ethical Committee of the Institute. Informed consents were obtained at the initial data collection.

Statistical analysis

Independent *t*-test was used to test the difference in Age, Height, Weight, Strength (GS), Pinch Strength (PS), Thumb Strength (TS), BMI, Fat%, FM, FFM and TBW between vegetarian (V) and non-vegetarian (NV) groups. Analysis of variance (ANOVA) was used to examine how Strength (GS), Pinch Strength (PS), Thumb Strength (TS), BMI, Fat%, FFM, FM and TBW varied according to the region-wise distribution of the population. The relation between BMI, Grip Strength and potential confounders were verified through Pearson's correlation. Variables showing a statistically significant correlation with BMI and Grip Strength ($p< 0.05$) were introduced in a multivariable stepwise regression. Odds ratios (OR) for relationship between dietary habits, Grip Strength and BMI were computed by logistic regression analyses. Statistical analyses were performed using SPSS statistical package Version 17 for Windows and $p< 0.05$ is referred to as statistically significant.

RESULTS

In the present study, participants were categorised into two main diet groups: 641 vegetarian (mean age (±SD), 40.05±10.70 years; mean BMI=25.33±4.56 kg/mt^2) and 424 non vegetarian (mean age (±SD) 40.54±10.43 years; mean BMI=25.95 4.45 kg/mt^2) persons matched for age and BMI. Out of the 1065 female workers, 3.2% were underweight, 27.3% were having normal BMI, 17.8% were overweight 36.5% pre-obese and 15.1% were classified as obese (Table I). Table II shows the mean BMI category as being between 17.06 to 33.40 kg/mt^2 among the five regions, and although we see difference in mean BMI among them, statistically there are no significant difference among them. Table II also shows the mean BMI category divided according to dietary habits. Although the non-vegetarian groups had higher BMI in all the categories except the obese category,

the differences in mean BMI among the vegetarian and non-vegetarian are not statistically significant. Table III shows the (mean ± SD) distribution of anthropometric and body composition parameters of Indian females in five regions of the country. From the table it is clear that except for the grip strength, all other parameters showed a statistically significant difference in the five different regions. Post-hoc analysis (using Bonferonni adjustment) showed that for Age, Weight, Grip Strength (GS), Pinch Strength (PS), BMI, Fat%, FFM and TBW, the Southern Zone showed a markedly statistically significantly difference from the Northern zone. The Central zone was statistically significantly different from the Northern zone for Age, Height, Pinch Strength (PS), Thumb Strength (TS), while the Eastern zone was statistically significantly different from the Northern zone for Age, BMI, Fat%, and FM. For Pinch Strength (PS) and Thumb Strength (TS), the Western region had significantly lower values than the other regions.

The Grip Strength (GS) is not statistically significant among the five regions. However, when we compared the Grip Strength (GS) difference between the vegetarian and non-vegetarian groups (Table IV), there is a statistically significant difference between the two dietary groups (t = 2.459, $p<0.05$). In other words, non-vegetarian group exhibited stronger Grip Strength (GS) than the vegetarian group. It is of interest to note that the mean BMI values among the vegetarian and non-vegetarian groups also show a statistically significant difference (t = 2.188, $p< 0.029$).

Multivariable stepwise regression analysis (table V) revealed that Fat% was seen to be negatively associated with BMI in the vegetarian group, while age and FM were seen to be positively associated with BMI in both the vegetarian (ß = 0.035, $p< 0.000$; ß = - 0.613, $p< 0.000$) and non-vegetarian groups (ß = 0.147, $p< 0.000$; ß = 0.326, $p< 0.000$). TBW was positively associated with BMI only in the non-vegetarian group. (ß = - 0.180, $p< 0.000$).

Table V also shows the predictors of Grip Strength (GS) where age was seen to be negatively associated with Grip Strength (GS) in both the vegetarian and non-vegetarian group. Height and weight were positively associated with grip strength in vegetarian group (ß = 0.211, $p<0.000$; ß = 0.086, $p<0.000$), while in the non-vegetarian group, height and FFM were positively associated with Grip Strength (GS) (ß = 0.190, $p< 0.000$; ß = 0.174, $p< 0.001$).

Table VI shows both unadjusted and age adjusted bivariate odds ratios for obesity based on BMI working women. For both the vegetarian and non-vegetarian groups, no statistically significant difference was seen in terms of the non-vegetarian been more predisposed to obesity compared to the vegetarian group. However, when we divided the population into two groups based on Grip Strength (GS) (below and above 30kg/F), we see that the odds of being obese was statistically significant (OR= 1.775, 95% CI 1.045 - 3.014) for the 'above 30kg/F hand grip strength group' compared to the 'below 30kg/F hand grip strength group'. After adjusting for age, this chance increased to a highly statistically significant chance (OR= 2.609, 95% CI 1.487 - 4.577).

DISCUSSION

The aim of the present study was to explore differences in anthropometric characteristics, hand grip strength and body composition parameters in a sample of 1065 Indian women who were categorised as vegetarian and non-vegetarian according to their food habits. In addition, the female population under study was from five different regions of the country and their anthropometric parameters, body composition and strength parameters were compared.

Table I: Distribution of BMI category in the population under study with mean and SD. (n=1064)

BMI category	N	%	Mean	SD
<18.5 kg/mt^2	34	3.2	17.41	0.813
18.5-22.99 kg/mt^2	291	27.3	21.10	1.245
23-24.99 kg/mt^2	190	17.8	23.96	0.579
25-29.99 kg/mt^2	389	36.5	27.30	1.401
>30 kg/mt^2	161	15.1	33.16	3.058

Table II: Mean BMI category classified according to WHO's Asian standards for Indian populations zone-wise and according to dietary habits.

ZONE-WISE						
BMI Category	North (299) Mean ± SD (95%CI)	East (62) Mean ± SD (95%CI)	West (152) Mean ± SD (95%CI)	South (360) Mean ± SD (95%CI)	Central (192) Mean ± SD (95%CI)	F values, *p* value
Underweight (<18.5) (kg/mt^2)	17.49± 0.75 (17.04-17.95)	17.80[n] (-)	17.53± 0.06 (17.39-17.68)	17.06± 1.00 (16.39-17.74)	17.73±0.73 (16.96-18.50)	0.83, 0.52
Normal (18.5-22.99) (kg/mt^2)	21.01± 1.36 (20.74-21.28)	21.31± 1.08 (20.84-21.79)	20.90±1.27 (20.47-21.32)	21.30±1.15 (21.03-21.56)	21.07±1.20 (20.75-21.39)	1.02, 0.40
Overweight (23.00-24.99) (kg/mt^2)	23.92± 0.53 (23.77-24.06)	24.00± 0.52 (23.67-24.33)	23.97±0.64 (23.72-24.21)	23.97±0.59 (23.83-24.12)	23.97±0.64 (23.73-24.21)	0.10, 0.98
Pre Obese (25.00-29.99) (kg/mt^2)	27.21± 1.41 (26.91-27.51)	27.03± 1.38 (26.45-27.61)	27.10±1.44 (26.72-27.47)	27.39±1.38 (27.17-27.62)	27.49±1.40 (27.16-27.81)	1.11, 0.35
Obese (>30.00) (kg/mt^2)	33.40± 3.51 (32.32-34.38)	31.07± 1.08 (28.39-33.75)	33.07±3.13 (31.75-34.39)	33.36±2.97 (32.62-34.09)	32.57±2.52 (31.55-33.58)	0.73, 0.57

DIETARY HABIT				
BMI Category	Vegetarian (641) Mean ± SD (95%CI)	Non Vegetarian (424) Mean ± SD (95%CI)	t value	*p* value
Underweight (<18.5) (kg/mt^2)	17.26±0.76 (16.92-17.61)	17.65±0.87 (17.12-18.17)	1.84	0.19
Normal (18.5-22.99) (kg/mt^2)	21.01±1.29 (20.83-21.20)	21.27±1.14 (21.05-21.49)	2.95	0.09
Overweight (23.00-24.99) (kg/mt^2)	23.95±0.58 (23.84-24.06)	23.97±0.55 (23.84-24.10)	0.09	0.77
Pre Obese (25.00-29.99) (kg/mt^2)	27.29±1.39 (27.11-27.47)	27.32±1.42 (27.10-27.54)	0.04	0.83
Obese (>30.00) (kg/mt^2)	33.24±3.23 (32.56-33.92)	33.05±2.85 (32.38-33.73)	0.15	0.70

Statistical test used: F ratio to test the zonal differences and t-test for the dietary difference. [n] =only 1 sample

Many publications have claimed that vegetarians are healthier than non-vegetarians, as evidenced by their greater longevity and lesser disorders related to morbidity[3,5,6,11]. In the present population, the non-vegetarian group also had higher BMI than the vegetarian group. In many studies, population with high BMI are predisposed to diabetes, high blood pressure[5,6] and it has been reported that protection against type 2 diabetes associated with vegetarian diets is partly due to the lower BMI of vegetarians [12]. With regard to BMI and dietary habits, many studies have shown considerable differences in BMI

Table III. Anthropometric and body composition parameters (mean ± SD) of Indian women of different regions of the country.

Variables	North (299)	East (62)	West (152)	South (360)	Central(192)	p- values
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Age (years)	38.77 ±.10.72	36.87± 9.95*	41.16 ± 10.16	42.15±10.17*	39.34± 0.43*	0.000**
Height (cm)	154.49 ± 6.08	155.10 ± 5.99	154.52 ± 6.29	154.58 ± 6.29	156.07±5.62*	0.038**
Weight (kg)	59.50 ± 11.55	58.96 ± 9.43	61.43 ± 10.58	62.59±10.58*	62.10 ± 10.04	0.003**
Grip Strength (kg)	22.99 ± 4.69	23.18 ± 4.88	22.62 ± 4.35	22.47 ± 4.35*	22.97 ± 4.41	0.527
Pinch Strength (kg)	4.42 ± 1.04	4.32 ± 1.127	3.92 ± 0.97*	4.19 ± 0.97*	4.41 ± 1.05*	0.000**
Thumb strength (kg)	6.46 ± 1.34	6.50 ± 1.84	5.93± 1.40*	6.16 ± 1.40	6.37 ± 1.27*	0.001**
BMI (kg/mt^2)	25.00 ± 4.77	24.46 ± 3.21*	25.75 ± 4.44	26.26 ± 4.44*	25.45 ± 4.29	0.002**
FAT%	29.87 ±7.82	28.74 ± 6.38*	31.21 ± 7.33	31.73 ± 7.33*	31.09 ± 7.30	0.003**
Fat Mass (kg)	18.63 ± 8.14	17.49± 6.36*	20.03 ± 8.04	20.68± 8.03*	19.91 ± 7.34	0.002**
FFM (kg)	41.01± 3.80	41.74 ± 3.89	41.07 ± 4.90	42.16 ± 4.90*	41.93 ± 3.17	0.002**
TBW (kg)	29.99 ± 2.83	30.57 ± 2.82	30.43 ± 2.65	30.98 ± 2.65*	30.71 ± 2.35	0.001**

**p<0.05 Statistical test done using ANOVA Post hoc analysis: Bonferonni adjustment. *Mean difference is significant at the 0.05 level as compared to the mean of North zone.

and nutrient intakes between vegetarians and non-vegetarians[3,13]. Studies of western vegetarians have consistently reported that vegetarians have lower BMI than comparable non-vegetarians and the reasons for this difference is not well understood, but may include differences in the composition of the diet such as a higher fibre intake and a lower protein intake[14]. Some studies have shown a difference in body composition between vegetarians and non-vegetarians and others have not. Despite these consistently-observed differences in BMI between vegetarians and non-vegetarians, obesity is common among some populations that follow largely vegetarian diets, such as Indians living in the UK[15] and in India[16]. Regarding body composition, in one comparative study on anthropometric and metabolic indexes among Italian male and female, no significant differences between groups were found in terms of hand grip and back strength, suggesting that there was no association between vegetarian diet and body composition[17]. However, in the present study, we found that the grip strength was statistically significantly higher among the non-vegetarian groups as compared to the vegetarian groups.

The present study being a cross-sectional analysis, no inferences about causation can be made. For example, women with poorer health may have changed to a vegetarian diet or vice versa. Despite these limitations, this study provides data on the health and dietary habit of Indian women. Women who were vegetarian among the present study were less heavy than their non-vegetarian counterparts. We have shown that vegetarian diets are associated with lower BMI and lower levels of obesity than diets which include meat. The grip

Table IV: Anthropometric and body composition parameters (mean ± SD) of vegetarian and non -vegetarian Indian women of different regions.

Variables	Vegetarian (V)		Non Vegetarian (NV)		
	N	Mean ± SD	N	Mean ± SD	
Age (years)	641	40.05 ± 10.70	424	40.54 ± 10.43	0.466
Height (cm)	641	155.00 ± 5.98	424	154.61 ± 6.12	0.299
Weight (kg)	641	60.81 ± 11.01	424	61.91 ± 11.45	0.118
Grip Strength (kg)	641	22.49 ± 4.49	424	23.20 ± 4.77	0.014*
Pinch Strength (kg)	641	4.254 ± 1.02	424	4.28 ± 1.10	0.752
Thumb strength (kg)	641	6.21 ± 1.33	424	6.36 ± 1.51	0.092
BMI(kg/mt^2)	641	25.33 ± 4.56	424	25.95 ± 4.45	0.029*
Fat (%)	641	30.50 ± 7.61	424	31.36 ± 7.27	0.068
Fat Mass (kg)	641	19.32 ± 7.74	424	20.24 ± 8.02	0.063
FFM (kg)	641	41.53 ± 3.83	424	41.75 ± 4.47	0.415
TBW (kg)	641	30.45 ± 2.80	424	30.70 ±3.28	0.187

* $p<0.05$ Statistical test used: t-test

strength of the non-vegetarian group is more even though their BMI is more. Vegetarians had lower BMI (25.33 kg/mt^2 ± 4.56) than non-vegetarians (25.95 kg/mt^2 ± 4.45). The lower levels of body mass indices of the vegetarian women suggest they are healthier than non-vegetarian in terms of BMI. However, the greater reports of grip strength of these women (non-vegetarian group) may be of clinical significance.

Limitations of study:

Dietary intake was not assessed and therefore vegetarian and non-vegetarian status could not be confirmed. The frequency of taking non-vegetarian diet was not included in the present study.

Moreover, this is a cross-sectional analysis, and a longitudinal study would have drawn a clearer picture on the long term effect of dietary differences in the population. Physical strength was assessed only by hand grip, pinch grip and thumb strength though there are other physical tests like standing long jump, sit-ups in 30 seconds, and heart-rate recovery following a step test which was not performed here.

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Table V: Predictors of BMI and Grip Strength (GS) variable (multivariable stepwise regression among vegetarian and non-vegetarian)

BMI[1]							
Vegetarian (adj. R^2= 0.850)				Non Vegetarian (adj.R^2= 0.846)			
Variables	**ß**	**SE**	***p***	**Variables**	**ß**	**SE**	***p***
Age	**0.035**	**0.008**	**0.000**	**TBW**	**0.180**	**0 .044**	**0.000**
Fat%	**-0.097**	**0.032**	**0.002**	**Fat%**	**0.147**	**0.039**	**0.000**
Fat Mass	**0.613**	**0.030**	**0.000**	**Fat Mass**	**0.326**	**0 .042**	**0 .000**
GRIP STRENGTH[2]							
Vegetarian (adj. R^2= 0.257)				Non Vegetarian (adj. R^2= 0.158)			
Variables	**ß**	**SE**	***p***	**Variables**	**ß**	**SE**	***p***
Age	**-0.134**	**0 .016**	**0 .000**	**Age**	**-0.086**	**0.021**	**0 .000**
Ht	**0 .211**	**0.028**	**0.000**	**Ht**	**0.190**	**0.040**	**0 .000**
Weight	**0 .086**	**0 .016**	**0.000**	**FFM**	**0.174**	**0 .054**	**0.001**

[1] **Dependent variable:** Body Mass Index (BMI) **Predictors:** (Constant): Age, FM, TBW, Fat% [2] **Dependent variable:** Grip Strength (GS) **Predictors:** (Constant): Age, Height (Ht), Weight, FFM **Statistical test done:** Multivariable stepwise regression

Table VI. Unadjusted and age-adjusted bivariate odds ratios for obesity based on BMI.

	Unadjusted		**Adjusted**	
	Odds Ratio	95% CI	Odds Ratio	**95% CI**
Dietary habits				
Vegetarian	-	-	-	-
Non Vegetarian	1.259	0.895 - 1.772	1.247	**0.878 - 1.771**
Grip strength				
Below 30kg/F	-	-	-	-
Above 30kg/F	**1.775***	**1.045 - 3.014**	**2.609***	**1.487 - 4.577**

Obesity is based on BMI >30 kg/mt^2 Binary logistic regression analysis

Conflict of interest:

The authors declare that there are no competing financial interests in relation to the study.

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