

PHYSICAL FITNESS INDEX OF NON-VEGETARIAN AND LACTO-VEGETARIAN ADULTS: A COMPARATIVE STUDY OF HARVARD STEP TEST

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ABSTRACT

A pure vegetarian, consumes the food of plant origin, reportedly has lower risk of chronic diseases and may have enhanced athletic performance compared to omnivorous. Lacto-vegetarian consumes dairy products and plant-based foods where as lacto-ovo-vegetarians, being categorized as vegetarian, consumes egg as well. Considering vegan diet as healthy food habit and appropriate medication, world is directing towards vegan diet. Lacto-vegetarian and non-vegetarian participants were included in this study based on inclusion criteria from various streams; MBBS, BDS, CTEVT and a randomized cross-sectional study was performed among selected students and independent sample 't' was used for analysis. Total enrolled participants (n=100), lacto-vegetarians (LV=50, male= 15, female=35) group and non-vegetarians (NV=50, male= 22, female=28) group were separated, age 16-27 years. Comparing the variables, result showed (NV=18.28±2.09, LV=19.14±1.43yrs, P=0.01), weight (NV=53.76±9.02, LV=50.16±4.82kg, P=0.01) and BMI (NV=29.63±4.49, LV=28.03±2.52kg/m², P=0.03). Lacto-vegetarians reported greater exercise duration (NV=224.24± 52.13s, LV=248.50±42.33s, P=0.01) and physical fitness index score (NV=62.14±14.86, LV=72.41±16.80, P=0.002) which was statistically significant. Waist circumference (77.32±4.22, 70.48±3.95, P=0.00), hip circumference (86.97±3.7, 81.76±5.65, P=0.00), waist hip ratio (0.88 ±0.04, 0.86±0.05, P=0.01), exercise duration (263.51±43.5, 220.43±44.76, P=0.00) and physical fitness index score (74.03±14.42, 63.3±16.61, P=0.00) were significantly greater in male (n=37) than female (n=63). The present study concludes, lacto-vegetarians are physically fit compared to non-vegetarian so as male compared to female.

KEYWORDS

Vegetarian, athlete, physical fitness, Omnivorous, lacto-ovo-vegetarian

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INTRODUCTION

Vegans are basically those people who do not consume food of animal origin. A pure vegetarian only consumes the food of plant origin. They are broadly categorized into lacto-vegetarians, lacto-ovo-vegetarians and ovo-vegetarians. Lacto-vegetarian community only consumes dairy products and plant-based foods. A lacto-ovo-vegetarian are those who consume milk, dairy products and eggs. Ovo-vegetarian consumes both eggs and plant-based foods.^{1,2}

Non-vegetarians consume all kinds of meat, fish and egg as well. Vegetarians not only avoid meat but adopt high amounts of plant-based foods including other healthy lifestyles eg. exercise, balance diet, and reportedly have lower risks of chronic diseases such as coronary heart disease, hypertension, diabetes, obesity and cancer as well as having a longer lifespan than the non-vegetarians.³ Epidemiological data suggests that plant-based dietary patterns are associated with a significantly lower prevalence of hypertension.⁴

Vegetarian diet is worldwide considered as healthy with appropriate medication. A very recent study revealed favorable lipoprotein status among rural Bangladeshi vegetarians indicating the importance of consumption of vegetable-based diet.⁵ Vegetarian diets have minimal atherogenic lipoproteins, and have been reported to have 32% and 44% low lipoproteins and low-density lipoprotein (LDL) cholesterol respectively compared to omnivores.⁶ Childhood obesity and fitness are strong predictors of cardio-metabolic risk factors.⁷

It has been hypothesized that a vegetarians have enhanced athlete's performance due to the high carbohydrate intake leading to improved glycogen stores in the body.⁸ There was positive impact of vegetarian diet on athletic performance and health itself.⁹ The world is directing towards total veganism from partial exclusion of vegan diet (pure vegetarian/lacto-ovo-vegetarians). The trend of plant-based diets is increasing.^{10,11}

Though the multiple concerns have been raised on vegetarian and non-vegetarian diets regarding the physical fitness, various biochemical markers (creatinine, vit D, vit B12) and nutrients level of the body, the body fitness is also associated with BMI and waist circumference that measures adiposity of individual in general.¹² Thus, it is of utmost important to know about the dietary

requirement of the human together with BMI and waist circumference to become healthy.

With this concern, the present study is an attempt to compare the body mass index, basal heart rate, waist hip ratio, and physical fitness level among lacto-vegetarians and non-vegetarians. This study hypothesized that in comparison to non-vegetarians, lacto-vegetarians have lower BMI, lower resting heart rate, lower Waist hip ratio (WH ratio) and better performance by Harvard step test.

MATERIALS AND METHODS

This is a randomized cross-sectional study where the subjects were selected with convenient sampling technique among the students of Nobel Medical College and Teaching Hospital from different streams; MBBS, BDS and CTEVT programs. The study was conducted from July 2019 to December 2019 at the Department of Physiology, Nobel Medical College and Teaching Hospital. Ethical approval was taken from the Institutional research committee. Clinically healthy participants without any present or past history of chronic diseases like hypertension, diabetes mellitus, and ischemic heart disease were included in the study. Informed written consent to voluntarily participate in the study was obtained from all participants. Sample size was calculated at 95% CI with 5% of error assuming sample proportion (p)= 0.5 with the following formula, sample size (n)= $N \cdot Z^2 \cdot p \cdot (1-p) / e^2(N-1) + Z^2 \cdot p \cdot (1-p)$. Calculated sample size was 72; we included 100.

This was a single blind study based on effect of diet consumed by the participants. The participants were selected based on consumption of type of diet: only vegetables (A), vegetables with dairy products (B), vegetables and eggs (C), vegetables with animal products (at least twice a week for > 10 yrs, D). Here, we have included only type 'B' and 'D' and others were excluded from the study. Selected participants were named as lacto-vegetarians (LV) and non-vegetarians (NV) in our study and were not aware of group distribution since it may affect the exercise performance during the procedure. Thus, participants were kept blind for group distribution.

Fifty non-vegetarians (male= 15, female= 35) and 50 lacto-vegetarians (male= 22, female=28) participated in the study. Demographical datas such as age, sex were recorded and anthropometric datas; height, body weight, waist circumference, hip circumference were measured. The body mass index (BMI, Kg/m²) and waist hip circumference ratio were

calculated. Weight was measured in kilogram using Equinox BR9201 weighing machine while wearing light clothing and height was measured using wall height chart with bare foot.

BMI was calculated dividing body weight (kg) by the square of height (m²). Hip and waist circumferences: waist circumferences were measured in centimeters (cms) at the level of midpoint between the last rib and the iliac crest, in a relaxed abdomen, at the end of normal expiration with non-stretchable measuring tape. Hip circumference was measured in cms with same instrument at the gluteus maximum extension. Waist-Hip ratio (WHR) was calculated by dividing the waist circumference by the hip circumference. All circumferences were measured twice and averaged to minimize error. Pulse rate was measured for 1 minute on radial artery in sitting posture after complete 1-minute of relaxation in a normal room temperature maintained at 27 ± 2°C with air condition.

Harvard step test was done for assessment of physical fitness index score of every participant. The instruments for physical fitness were: stool of 18 inches height (for female), stool of 20 inches height (for male), a stop watch and a metronome. Based on principle of Harvard step test; participants were instructed to step up and down on stool; male (20 inches) and female (18 inches). The recording of step test was done where the rhythm of metronome was set as 1 cycle (left foot up-right foot up-left foot down-right foot down) in 2 seconds and in same speed, participants were instructed for performing the exercise. The mentioned

rhythm (1 cycle in 2 second) of metronome; left foot up on first tick of metronome, right foot up on second tick, subsequently left foot down and then right foot down in third and fourth tick respectively was set to complete each cycle. As per rule of exercise (up, up, down, down), the stop watch was used to record the time duration of exercise (second) where recording continue till the subject get exhausted to step anymore. After completion of one minute of exercise, the pulse was recorded in sitting posture.

- A. PR1 (Pulse Rate 1) 1 min after exercise
- B. PR2 (Pulse Rate 2) 3 min after exercise.
- C. PR3 (Pulse Rate 3) 5 min after exercise.

The physical fitness score was calculated using a standardized formula given below.¹³

$$PFI = \frac{\text{Duration of exercise in seconds} \times 100}{2(\text{pulse 1} + \text{pulse 2} + \text{pulse 3})}$$

The score card of physical fitness index

SCORE (PFI)	INFERENCE
<55	Poor physical condition
55-64	Below average
65-79	Average
80-89	Good
>90	Excellent

Data were entered in SPSS version 17 and analyzed. Descriptive analysis of variables (age, height, weight, BMI, WC, HC, WHR), PR, duration of exercise and fitness index was done in terms of mean ± SD. Independent sample T-Test was applied to compare those variables between lacto-vegetarians and non-vegetarians.

Table 1: Comparison of variables between Non-vegetarian and Lacto-vegetarian (N= 100)

Variables	minimum		maximum		Mean±SD		Mean Difference	SDED	95%Confidence Interval		P value
	LV	NV	LV	NV	LV	NV			Lower	Upper	
Age (yrs)	16	16	24	27	19.14±1.43	18.28±2.09	-0.86	0.35	-1.57	-0.14	0.01
Ht(m)	1.25	1.22	1.6	1.57	1.34±0.08	1.35±0.09	0.01	0.01	-0.02	0.04	0.67
Wt(kg)	40	35	63	72	50.16±4.82	53.76±9.02	3.6	1.44	0.73	6.47	0.01
BMI(kg/m ²)	19.53	23.52	34.1	41.6	28.03±2.52	29.63±4.49	1.6	0.72	0.16	3.05	0.03
WC(cm)	64	64	84	87	73.1±5.04	72.92±5.46	-0.18	1.05	-2.26	1.9	0.86
HC(cm)	74	70	93	93	83.44±5.25	83.94±5.98	0.5	1.12	-1.73	2.73	0.65
WHR	0.79	0.75	0.94	1.01	0.88±0.04	0.87±0.06	-0.01	0.01	-0.02	0.01	0.58
BPR(b/min)	62	68	92	92	76.38±6.21	77.6±4.97	1.22	1.12	-1.01	3.45	0.28
ED(sec)	175	135	300	300	248.5±42.33	224.24±52.13	-24.26	9.49	-43.1	-5.41	0.01
PFIS	43	31	118	93	72.41±16.81	62.14±14.86	-10.26	3.17	-16.56	-3.97	0.002

BMI= body mass index, WC=waist circumference, HC= hip circumference, WHR= waist-hip ratio

BPR=Basal Pulse Rate, ED =Exercise duration, PFIS=Physical fitness index score, NV= non-vegetarian, LV=lacto-vegetarian.

RESULTS

Independent sample 't' analysis of demographic variables; age (NV=18.28±2.09 yrs, LV=19.14±1.43 yrs, P=0.01), weight (NV=53.76±9.02 kg, LV=50.16±4.82 kg, P=0.01) and BMI (NV=29.63± 4.49, LV=28.03±2.52 kg/m², P=0.03) showed significant difference on comparison between lacto-vegetarian (n=50) and non-vegetarian (n=50) subjects which has been tabulated in table 1.

LV=19.14±1.43 yrs, P=0.01) was more among lacto-vegetarians. Weight (NV=53.76± 9.02 kg vs LV=50.16± 4.82 kg, p=0.01) and BMI (NV=29.63± 4.49 kg/m² vs LV=28.03 ± 2.52 kg/m², p=0.03) were significantly more in non-vegetarian.

Eshete *et al*¹⁴ compared vegetarian and non-vegetarians diet in 75 participants for 7-weeks and the test result found significant difference in body weight (56.57±8.58 vs. 57.69±8.92 kg, p=0.011), BMI (19.96 ±2.13 vs. 20.73 ± 2.16 kg/

Table 2: Comparison of variables between male and female in total population (N=100)

Variables	Mean ± SD		Mean Difference	Std. Error Difference	95% Confidence Interval		P Value
	male (37)	female (63)			Lower	Upper	
BMI(Kg/m ²)	28.23 ±3.24	29.18 ±3.94	-0.95	0.77	-2.48	0.57	0.22
WC (cm)	77.32 ±4.22	70.48 ±3.95	6.85	0.84	5.18	8.52	0
HC (cm)	86.97 ±3.7	81.76 ±5.65	5.21	1.04	3.14	7.28	0
WHR	0.88 ±0.04	0.86 ±0.05	0.03	0.01	0.01	0.05	0.01
BPR (b/min)	76.97 ±4.53	77±6.21	-0.03	1.17	-2.35	2.3	0.98
ED (sec)	263.51 ±43.5	220.43 ±44.76	43.08	9.18	24.87	61.3	0
PFIS	74.03±14.42	63.3±16.61	10.73	3.28	4.22	17.25	0

BMI= body mass index, WC=waist circumference, HC= hip circumference, WHR=waist hip ratio, BPR= basal pulse rate, ED=exercise duration, PFIS=physical fitness index score

On performing the Harvard step test, exercise duration (NV=224.24±52.13s, LV=248.50±42.33s, P=0.01) and physical fitness index score (NV=62.14±14.86, LV=72.41±16.80, P=0.002) showed significant difference where lacto-vegetarians (n=50) performed exercise for longer duration and their fitness score were higher than non-vegetarians (n=50). Results were tabulated in table 1.

Table 2 compared the variables between male (n=37) and female (n=63) where WC (77.32 ±4.22 vs 70.48 ±3.95, P=0.00), HC (86.97 ±3.7 vs, 81.76 ±5.65, P=0.00), WHR (0.88 ±0.04 vs 0.86 ±0.05, P=0.01), ED (263.51±43.5 vs 220.43± 44.76, p=0.00) and PFIS(74.03 ±14.42 vs 63.3±16.61, p=0.00) were significantly greater in male.

DISCUSSION

Present study was a cross-sectional study where the lacto-vegetarians and non-vegetarians were compared for physical fitness index score and anthropometric variables.

On comparison of non-vegetarians and lacto-vegetarians, age (NV=18.28±2.09yrs vs

m2, p=0.00), % Body Fat (16.67± 6.11 vs. 18.43 ± 5.90 %, p=0.00) where non-vegetarian had significantly higher value. In a study performed in Pakistan, the BMI of non-vegetarians (n=93) were significantly high (p<0.001) compared to vegetarians (n=83).¹⁵ Present study reported very close finding to above result which showed less BW (p=0.01) and BMI (p=0.03) of LV over NV however our study has no reports of percentage body fat.

Results also showed difference in duration of exercise (LV=248.5±42.33 sec NV=224.24±52.13 sec, P=0.01) and physical fitness index (LV=72.41±16.81, NV=62.14±14.86, P=0.002) where lactovegetarian showed longer duration and greater fitness index for exercise which were statistically significant. There are no studies to assess exercise performance (fitness index and duration of exercise) for vegetarians and non-vegetarians but has compared the VO₂ max (maximum oxygen consumption) . A reliability and validity study by Elsaidy¹⁶ had shown that the value of correlation coefficient between the Harvard step test and the VO₂ max laboratory test was r = 0.818, which indicates that method is valid to predict maximum

oxygen consumption (vo_2max). Thus our result can be compared with Vo_2max .

A cross-sectional study was conducted to compare the exercise capacity (participants performed an incremental exercise test on a bicycle ergometer until voluntary exhaustion) of vegan (VEG, $n=24$), lacto-ovo-vegetarian (LOV, $n=26$) and omnivorous (OMN, $n=26$) recreational runners. The maximum power output observed in these groups were, OMN: $4.15 \pm 0.48 \text{W/kg}$, LOV: $4.20 \pm 0.47 \text{W/kg}$, and VEG: $4.16 \pm 0.55 \text{W/kg}$; $p=0.917$.⁸ Above mentioned study revealed the power output of individual with bicycle ergometer exercise test which has a comparable result. There was no significant difference of power output between vegetarians and omnivorous.

Nieman reported the maximal oxygen consumption (VO_2max) of 19 vegetarians ($23.8 \pm 1.5 \text{ml/kg}\cdot\text{min}$) and 12 non-vegetarians ($21.9 \pm 0.8 \text{ml/kg}\cdot\text{min}$), respectively whereas BMI were $22.5 \pm 0.6 \text{kg/m}^2$ and $24.2 \pm 0.8 \text{kg/m}^2$ among participants with mean age 71 years.¹⁷ The study reported increased VO_2max for vegetarian group compared to non-vegetarian, suggestive of greater endurance strength. The lacto-vegans in the present study showed average value of physical fitness whereas non-vegetarian, the fitness value was below average. Thus, our study was comparable to above findings and concluded similar trend but significantly greater endurance strength of lacto-vegetarian. One of the reasons for the result being significant could be due to the mean age of participants being 18.28 years in present study

Hietavala *et al*¹⁸ examined the effect of a 4-day low-protein vegetarian diet (LPVD) compared to normal diet (ND), ($0.8 \pm 1.11 \text{g/kg}$ body weight vs. $1.59 \pm 0.28 \text{g/kg}$ body weight) in recreationally active men. VO_2max was significantly higher after LPVD compared to ND (2.03 ± 0.25 vs. $1.82 \pm 0.21 \text{l/min}$, $p=0.035$; 2.86 ± 0.36 vs. $2.52 \pm 0.33 \text{l/min}$, $p<0.001$ and 4.03 ± 0.50 vs. $3.54 \pm 0.58 \text{l/min}$, $p<0.001$ although there was no significant effect on exercise time.

A research finding concluded no significant effect in duration of exercise test in vegetarian group assessed for anaerobic and aerobic capacity by Hanne *et al*¹⁹. No significant difference was reported in aerobic performance either for maximum oxygen consumption and rating of perceived exertion (RPE). Raben *et al*²⁰ also reported no significant differences in maximum oxygen consumption, maximal voluntary contraction, endurance performance or muscle glycogen concentrations between a

LOV (lacto-ovo-vegetarian) diet and mixed diet (both diets controlled for carbohydrate 57%, protein 14% and fat 29%).

Although the retrieved findings express similar trend of greater strength of exercise among vegetarians, there are contradictory results among studies. The present study showed significantly higher physical fitness index and duration of exercise where the subjects were vegetarians since birth and no intervention was done. There are other studies above with differences in performance (aerobic performance, vo_2max) among vegetarians and non-vegetarians which are non-significant. Some with lesser sample size and others having interventional study could be some factors to show the contradictory result.

Present study also compared WC ($M=77.32 \pm 4.22$ vs $F=70.48 \pm 3.95$, $P=0.00$), HC ($M=86.97 \pm 3.7$ vs $F=81.76 \pm 5.65$, $P=0.00$), WHR ($M=0.88 \pm 0.04$ vs $F=0.86 \pm 0.05$, $P=0.01$), ED ($M=263.51 \pm 43.5$ vs $F=220.43 \pm 44.76$, $P=0.00$) PFIS ($M=74.03 \pm 14.42$ vs $F=63.3 \pm 16.61$, $P=0.00$) between male ($n=37$) and female ($n=63$) respectively. Result showed significantly higher WC, HC, WHR, ED, PFIS among male. Reported waist-hip ratio in vegetarian and non-vegetarian male showed 0.91 ± 0.01 vs 0.94 ± 0.04 and female showed 0.90 ± 0.01 vs 0.90 ± 0.06 in a study by Deriemaeker *et al*.²¹ The waist-hip ratio of female compared to male was less which was similar to our study.

Another study reported VO_2max by Eshete *et al*¹⁴ in males and female vegetarians, $43.81 \pm 3.71 \text{ml/kg/min}$ and $30.81 \pm 3.05 \text{ml/kg/min}$, respectively and non-vegetarians, $42.02 \pm 2.32 \text{ml/kg/min}$ and $31.29 \pm 3.73 \text{ml/kg/min}$, respectively. Male showed greater vo_2max compared to female which was not different than present study where physical fitness index of male was also greater regardless of type of food consumed.

Lack of dietary records and biochemical analysis of each participant limits the study. This study can be more extensive and precise by means of studying the biochemical markers (creatinine, lactic acid etc). On the basis of the present study including previous researches, it is recommended that vegetarian diet is healthier and better for improving the physical strength over non-vegetarian. Hereby, our study recommends the vegan diet compared to non-vegetarian in general.

In conclusion, present study compares non-vegetarian and lacto-vegetarians for the physical fitness index based on Harvard step

test. the findings are suggestive that lacto-vegetarian diet has better impact on physical performance as fitness score was significantly higher as well as the duration of exercise. Thus, vegan diet can be a choice in general regarding fitness particularly.

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