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Consumption of Fermented Rice and Metabolic Health in Adult Persons, West-Bengal, India: A Retrospective Rank-Wise Association

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Abstract

The study is to determine whether eating fermented rice every day improves metabolic health. This retrospective study was conducted in order to compare two groups of people's daily dietary consumption of fermentation rice and their metabolic health in Kolkata, West Bengal, India. The study observed patients in between the age of 35-60, from various departments, including neurology, cardiology, dermatology, gastroenterology, etc., who visited the tertiary care facility at one of the largest hospitals, SSKM, located in Kolkata from March 2022 to October 2022. Dietary. A validated questionnaire was developed to know the presence and amount of fermented rice in participant's diet. HEI-2015 (Healthy Eating Index 2015) was used to determine the dietary quality of two groups. Then a semi food frequency questionnaire was developed. Then Man-Whitney U, Goodman Gamma, JonckhereTepstra Test were performed to know whether there was a significant difference between the two groups in terms of biochemical and clinical indicators. Goodman-Krushkal gamma test were also performed to examine the association between consumption of fermented rice and the prevalence of obesity, hypertension, cardio vascular disorders, and type II diabetes. This research is the first to demonstrate how elder persons who regularly consume fermented rice experience improved blood lipid levels and favourable impacts on body weight maintenance.

Keywords: Fermentted rice; Metabolic; Health; Obesity; Ethenic food; Processing.

INTRODUCTION

Rice is the most common staple food eaten by the greatest number of people on the earth. Over 60% of the population of India is fed on rice, making it one of the most significant food crops.[1] In India, Fermented Rice (FR) dishes like tangalanna in Kannada, shelenSheeth in Konkani, pazham Kanji in Malayalam, pazhayadu in Tamil etc. are also widely consumed and performed.[2] The fermented rice dish called pantabhat is one of the favourite breakfast items of West Bengal, India.[3] It is made by soaking cooked rice overnight in water to allow for fermentation.[4] This fermented rice is frequently eaten in rural and semi-urban areas of West Bengal, India. Every person is free to practice and eat fermented rice everywhere in the world. Human diets contain a sizable portion of fermented foods from ancient times. Although

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their influence on health is considered favourably, an impartial assessment is still lacking.[5] Numerous cohort studies and random control trials (RCT) have been conducted in the past to determine the impact that various fermented foods, such as yogurt, kefir, kimchi, etc., have good impact on metabolic disorders.[6] Metabolic health can be modified by changing diet. These days functional foods, those have extra function in our body than giving only energy, are employed in the prevention and treatment of a number of chronic illnesses, including metabolic syndrome.[7]

The metabolic syndrome is a group of metabolic risk factors including obesity, hypertension, hyperglycaemia, and insulin resistance.[8] It increases a person's risk of type 2 diabetes by five times and of CVD by two times. The World Health Organization (WHO), National Cholesterol Education Programme-Adult Treatment Panel III (NCEP ATP III)[9], Indian Diabetes Federation (IDF), modified NCEP ATP III, and Harmonized criteria are the most frequently used in determining metabolic health.

It will be one of the first phase papers to establish the relationship to elaborate the role of fermented rice in metabolic health because there hasn't been much research done yet. The purpose of this study is to determine whether eating fermented rice every day improves metabolic health.

METHOD AND MATERIALS

Study Overview: This retrospective study was conducted in order to compare two groups of people's daily dietary consumption of fermented rice and their metabolic health. Fermented Rice Group (FRG) refers to the group that consumes

Allocation process of two groups

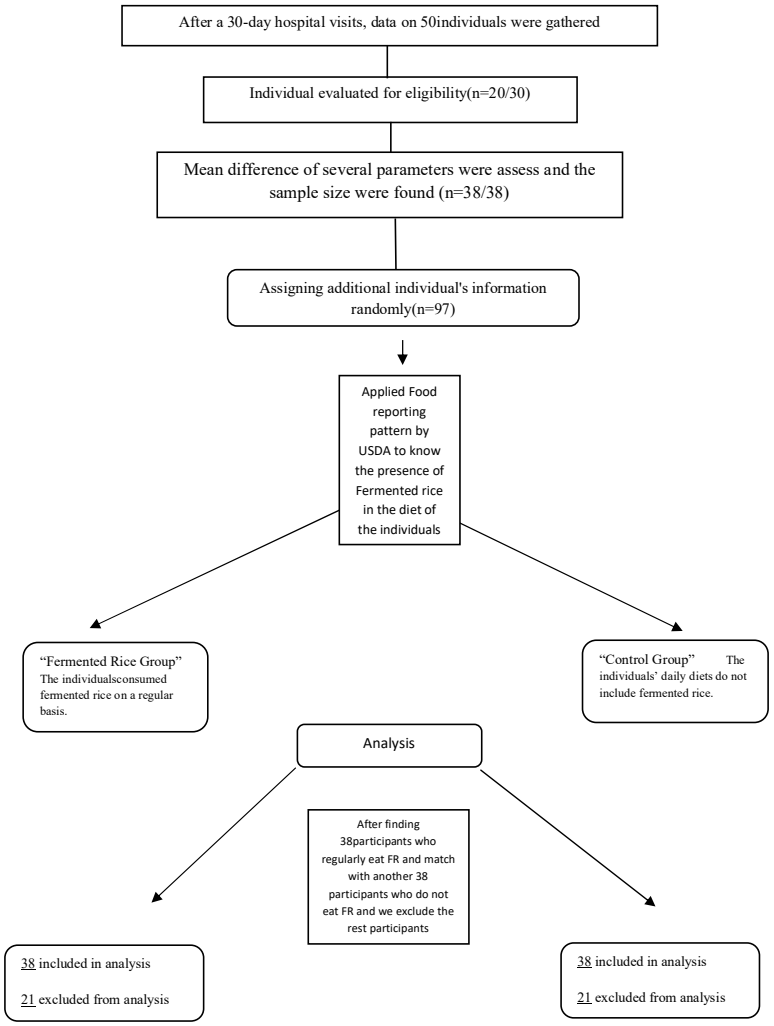


Fig. 1: Screening, enrolment, random assignment of study participants

fermented rice daily, whereas Control Group refers to the group that does not consume fermented rice on a regular basis. The entire assignment of participant information was shown in *Fig. 1*.

Study Population: In the current hospital-based study observed, patients in between the age of 35-60, from various departments, including neurology, cardiology, dermatology, gastroenterology, who visited the tertiary care facility at one of the largest hospitals, Institute of Post-Graduate Medical Education and Research and Seth Sukhlal Karnani Memorial Hospital, located in Kolkata, West Bengal, from February 2023 to September 2023. Participants are selected on the basis of their rural living standards.

Ethics Statement: The participants underwent all procedures under the supervision of proficient medical professionals, adhering to ethical guidelines and receiving approval from the Indian Council of Medical Research's Institutional Human Ethical Committee at the University of Calcutta (Ref. No. CUIEC/02/02/2022-2023, dated 05.01.2023). The subjects were given an information sheet to read that explained the purpose of the study and their rights as persons. Each participant was then asked to sign a written informed permission form or leave a thumb impression.

Exclusion criteria were: As determined by the participant's medical history and clinical laboratory results, uncontrolled renal, hepatic, or endocrine disease; use of statins or dietary supplements containing plant sterols/stanols; sensitivity to soy or brown rice; alcoholism or drug abuse; insulin-dependent diabetes; and inability or unwillingness to adhere to the study protocol. Women who were expecting, nursing, or who might get pregnant but weren't ready to be married were also excluded.

Matching the Groups: Due to the retrospective nature of the study group matching is crucial, thus the two groups are matched according to age range (35-60) and demographic living conditions.

Sample size calculation: Using OpenEpi's independent mean difference option, the sample size was determined[10] (*OpenEpi Menu*, n.d.). Every parameter that was tested was calculated by 95% confidence interval and the usual power of 80, for two groups.[11] G-power software was used to calculate the sample size. As a result of the calculation's greatest sample size being 38/38 for

Diagram of Data Collection:

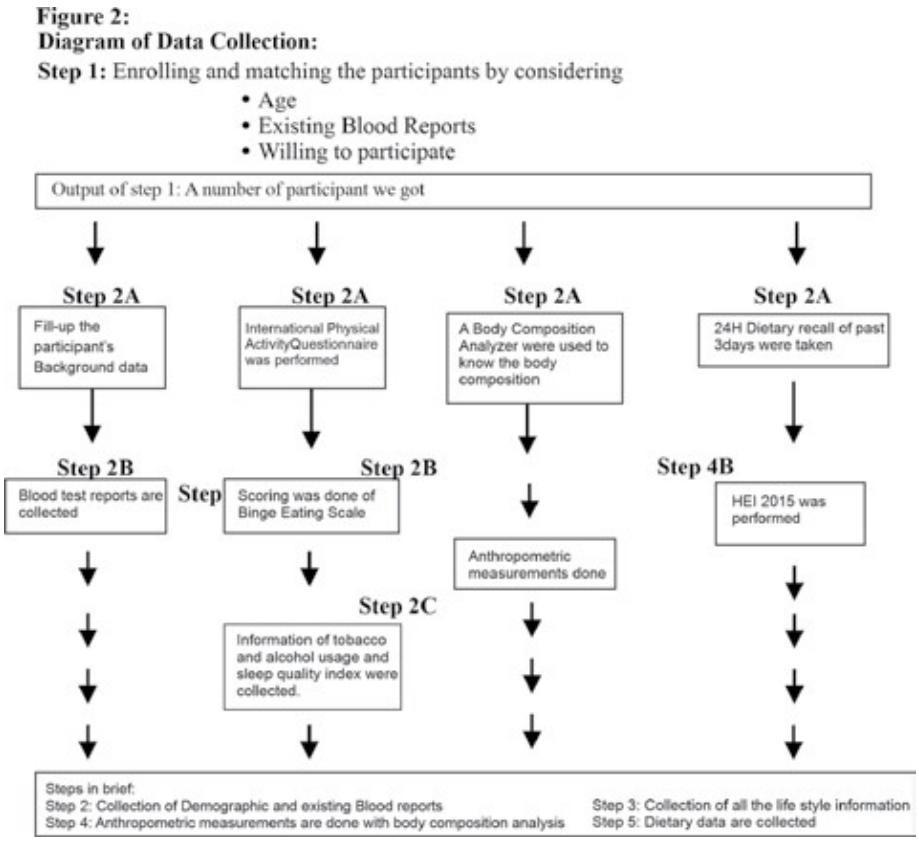


Fig. 2: Screening, enrolment, random assignment of study participants
(After allocation the participants went through the mentioned steps and data were collected subsequently)

both groups, so this study had 38 individuals in both groups.

Data collection: *Fig. 2* represents how the data collection was done step by step. Three separate questionnaires were used to gather the data: one for socio-demographic information, one for clinical history, and one for nutritional information with fermented rice frequency questionnaires (in accordance with "NIN standards'").[12] All the questionnaires are validated through the Parson's correlation co-efficient test.

Elements that restricting the study's target population were excluded, including confounding variables like recent hospitalizations, dietary changes, and other parameters. Additionally, unfinished surveys were disregarded. After eliminating some confounding factors, the data were compared between the two groups, and other confounding factors like sex, socio-economic factors, and daily dietary patterns were adjusted in the analysis part.

MEASUREMENTS

Characteristic traits: At the onset of the study, each participant was interviewed for demographic information such as sex, age and other lifestyle factors such as past smocking, drinking and medical histories. *Table 1* presents the general characteristics of the participants.

Anthropometric Measurements: Body weight composition (fat mass and fat-free mass) was measured by body composition analyser (Crompton machine), height measured by a calibrated stadiometer. Body Mass Index (BMI) was calculated by dividing body weight (in kilograms) by the square of height (in meter). The waist circumference was measured by the midpoint between the lower ribs and the iliac crest, and hip circumference was measured horizontal at the largest circumference of hip. Waist to hip ratio (WHR) was calculated.

Biochemical and Blood Pressure evaluation: All the recent blood reports that are done from the hospital's testing lab are taken from the participants. Total lipid profile, Fasting and postprandial blood glucose levels are noted in the questionnaire further analysis. Systolic (SBP) and Diastolic blood pressure (DBP) were measured at the brachial artery of the right upper arm after 15 minutes rest. Both blood pressures were measured twice at 5-min intervals and recorded on average.

Table 1: Characteristics of the Participants

Characteristic		FRG	CG FRG	Mean Rank		Rank Sum		p-Value	Decision
				CG	FRG	CG	FRG		
Age		46.45 ± 7.32	46.74 ± 9.25	37.54	39.46	1426.50	1499.50	0.704	$H_{0\ is\ accepted}$
Male/Female		17/21	18/20						
Household Income		7726.33 ± 3344.35	8315.83 ± 3528.84	36.88	40.12	1401.50	1524.50	0.522	$H_{0\ is\ accepted}$
Total Calorie Count		1620.93 ± 404.69	1.626.84 ± 373.30	37.21	39.79	1414.00	1512.00	0.611	$H_{0\ is\ accepted}$
Current Smoking Habits	No	71.06%	73.69%						
	Yes	28.94%	26.31%						
Current Alcohol Consumption	No	82.74%	89.52%						
	Yes	17.26%	10.48%						
Physical Activity Level	Score	26.76 ± 8.32	25.08 ±7.84	40.66	36.34	1545.00	1381.00	0.394	$H_{0\ is\ accepted}$
	Sedentary	46.56%	48.64%						
	Moderate	33.81%	28.51%						
	Heavy	19.63%	22.85						

(Mean ± SD value were shown to have an idea, Man-Whitney U test were done in between the two groups, Mean rank & Sum of Rank are also mentioned)

Dietary Assessment: A validated questionnaire was formed to know the frequency and amount of fermented rice present in the participant's diet. Daily dietary pattern analysis was done by 24 hr recall and past 3-day recall method. 24 hr recall of the past 3 days are done by the help of food reporting pattern of USDA.[13] Another questionnaire was validated to know the binge eating habit and tendency of outside food intaking.[14] HEI-2015[15] were used to determine the dietary quality of two groups.[16]

Fermented Rice Intake Assessment: At first AMPM USDA food reporting steps were done to know the presence of fermented rice in the diet of participants.[13] Then A fermented rice semi food frequency questionnaire was developed to know the presence of fermented rice in every participant's diet. The participants who had the habit of daily intaking a medium portion of fermented rice were considered in the fermented rice group.

Covariates: Information on sociodemographic and lifestyle factors in each group was collected using a structured questionnaire. In the analyses, the following constructed variables were used as indicators of socio-economic status: education (junior high school; high school; diploma/ certificate; university degree) and. If a variable had missing values, a specific category was assigned instead of excluding the record. Physical activity level was measured by IPAQ (International Physical Activity Questionnaire),[17] frequency of taking leisure-time physical activity (strenuous exercise, moderate exercise or mild exercise for more than 20 min, walking for at least 10 min) was recorded as times/week (for each type of activity). The current smoking and alcohol consumption was noted as yes or no and the percentage were mentioned in the *Table. 5.1.* Family history of any of the major four metabolic disorders are noted from mother side and father side, also the presence of any met syndrome in their siblings are noted well.

Statistical analysis: To compare the participants' background characteristics and dietary analysis between the two groups of individuals, Man Whitney U test is applied. The outcomes of the experimental data analysis performed with SPSS software (version 16; SPSS Inc., Chicago, IL), Medcalc and R statistics. The data were displayed as mean, standard deviation, or number. The Kolmogorov-Smirnov test was used to assess if the variable distribution was normally distributed or not, given that the data were not normally distributed. To verify the homoscedasticity, Lavence's test for equality of variance was also performed. Both the groups were homoscedastic in nature. The link between consuming fermented rice and the metabolic health of older persons is evaluated using all non-parametric methods.

Man-Whitney U, Goodman Gamma, Jonckhere Tepstra Test were used to determine whether there was a significant difference between the two groups in terms of biochemical and clinical indicators. Odd Ratios are calculated in R studio to know the relation between fermented rice exposure and prevalence of diseases. Goodman-Krushkal gamma tests were performed to know if the increase of fermented rice in diet has any effect on total metabolic risk factors.

1. **Hypothesis Statement**: Daily intake of the Fermented Rice leads to decreased the levels of Metabolic risk factors.

Hypothesis testing example

1. $\boldsymbol{\mu_1}$ be the one of the average variables of the people of CG and $\boldsymbol{\mu_2}$ be the one of the average variables of the people of FRG. Therefore, to test

   $\mathbf{H_0}: \boldsymbol{\mu_1} = \boldsymbol{\mu_2}$ **vs** $\mathbf{H_A}: \mathbf{H_A}: \boldsymbol{\mu_1} \neq \boldsymbol{\mu_2}$

   Similarly, the study tested this hypothesis to generate the results in **Table 5.1, 5.2, 5.3, 5.4, 5.5 & 5.6** todistinguish the difference between the two groups.
2. Then the FRG participants are divided according to having average daily fermented rice intake, where $\boldsymbol{\mu_1}$ is still CG, $\boldsymbol{\mu_2}$ is those participants from FRG who take average less than 50 gms fermented rice daily, μ_3 is those participants from FRG who take average 50 gms- 100 gms fermented rice daily, μ_4 is those participants from FRG who take average more than 100 gms fermented rice daily. There for to test

   $\mathbf{H_0}: \boldsymbol{\mu_1} = \boldsymbol{\mu_2} = \boldsymbol{\mu_3} = \boldsymbol{\mu_4}$ vs $\mathbf{H_A}: \boldsymbol{\mu_1} \neq \boldsymbol{\mu_2} \neq \boldsymbol{\mu_3} \neq \boldsymbol{\mu_4}$ / $\boldsymbol{\mu_1} > \boldsymbol{\mu_2} > \boldsymbol{\mu_3} > \boldsymbol{\mu_4} / \boldsymbol{\mu_1} < \boldsymbol{\mu_2} < \boldsymbol{\mu_3} < \boldsymbol{\mu_4}$.

The study tested this hypothesis to know if increasing quantity of fermented rice can also have any effect on metabolic health or not.

RESULTS

All of the subject's data (76 participants, 35 males, and 41 women) were collected using a step-by-step data collecting approach and entered into the designated study proforma. Blood triglycerides, high-density lipoprotein, fasting blood sugar, and blood pressure were the key metabolic risk

variables that needed to be evaluated, the study also used BMI, body fat percentage, and other incidental factors.

General Characteristics: The mean age of the Fermented Rice Group and Control group was 46.45 and 46.75, respectively. Other characteristics like age, sex, sociodemographic, and lifestyle characteristics did not significantly differ between the two groups.

Dietary intakes: Tche daily Dietary intakes of participants are shown in *Table 2* based on a three-day dietary record, there were no appreciable variations between the two groups in terms of calorie or macronutrient consumption.[18] The table also included the total energy intake percentages of the macronutrients, and from this The study could observe that both groups' general dietary habits are largely the same.

The intake of dietary fatty acids by two groups is shown in *Table 3*. There are no obvious statistical discrepancies in the estimates, which are based on percentages of total calorie intake. With the use of the HEI 2015 food frequency questionnaire, the study was able to gather all relevant data on the participants' dietary habits. The HEI 2015 scores are shown in *Fig. 3* and *Table 4*.

Anthropometric measurements and Body Composition: ***Table 5*** shows the difference of all anthropometric measurements of two groups:

Hei 2015 Scoring of Two Groups

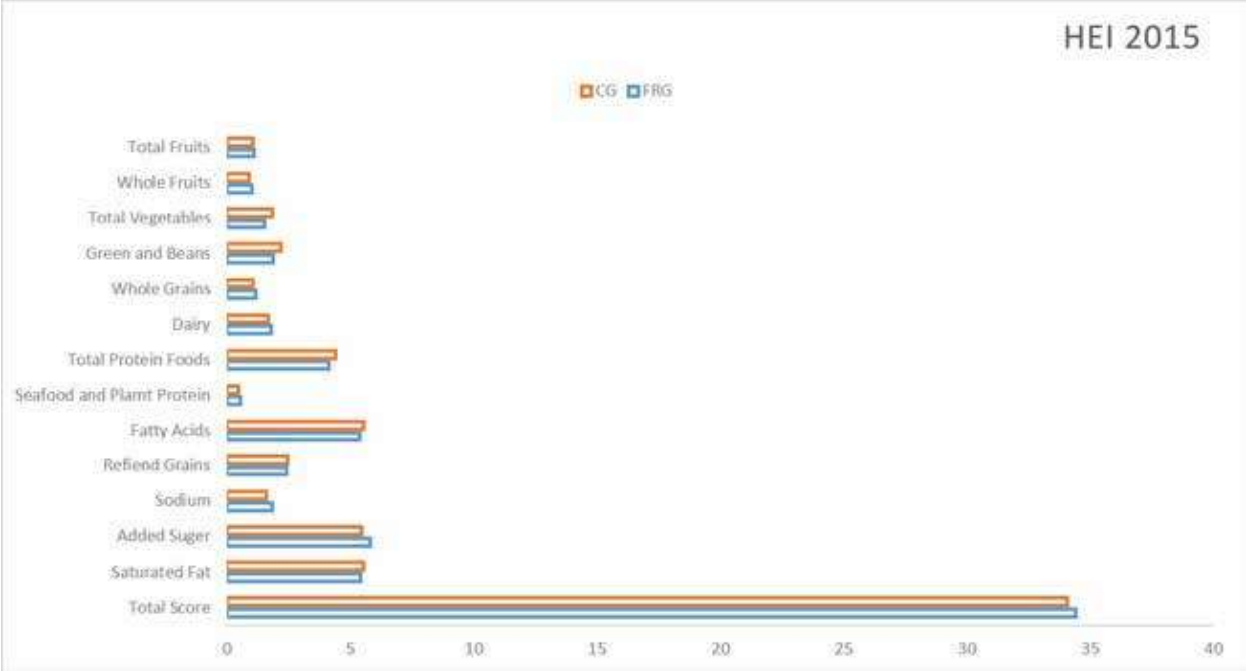


Fig. 3: Comparison of the Healthy Eating Index-2015 (HEI-2015) component scores between Fermented Rice Group and Control Groups participants, values are means. In HEI-2015, a higher score indicates a higher diet quality. For all components, the mean value was not significantly different between the two countries (P <0.0001).

Biochemical and biophysical analysis: ***Table 6***

shows the five key factors that make up the NCEP ATP III metabolic risk score, where the values for DBP, SBP, and FBS in the two groups did not substantially differ from one another. The study could detect a substantial difference between the two groups in other variables including WC and total lipid profile with the exception of VLDL.

Fermented Rice intake and Disease Prevalence: The study employ odd-ratio testing to examine the association between consumption of fermented rice and one of the key four metabolic illnesses, such as obesity, hypertension, cardiovascular disorders, and the prevalence of type II diabetes. It specifically measures how likely it is for a disease to strike people exposed to fermented rice as opposed to people not exposed. When analysing the odds ratio of fermented rice consumption and illness prevalence, the study take into account a number of variables, including the participant's extensive medical history and the length of time they have had the ailment.

Table 2: Macro Nutrients in Diet

Variables	Measurements	FRG	CG	Mean Rank		Rank Sum		p-Value	Decision
				FRG	CG	FRG	CG		
Energy	Per Day(kcal)	1620.93 ± 404.69	1.626.84 ± 373.30	37.21	39.79	1414.00	1512.00	0.943	$H_{0 \text{ is accepted}}$
Carbohydrate	Per Day(g)	205.07 ± 59.32	211.94 ± 61.95	36.24	40.76	1377.00	1549.00	**0.372**	$\mathbf{H_{0 \text{ is accepted}}}$
	Energy from CHO	51.11%	53.10 %						
Protein	Per Day(g)	112.26 ± 36	112.50 ± 29	36.74	40.26	1396.00	1530.00	**0.486**	$\mathbf{H_{0 \text{ is accepted}}}$
	Energy from Pro	28.20%	27.82%						
Fat	Per Day(g)	34.55 ± 8.97	35.49 ± 12.91	42.33	34.67	1608.50	1317.50	**0.131**	$\mathbf{H_{0 \text{ is accepted}}}$
	Energy from Fat	20.18%	19.06%						
Fibre	Per Day	27.96 ± 5.21	29.27 ± 5.86	35.92	41.08	1365.00	1561.00	**0.309**	$\mathbf{H_{0 \text{ is accepted}}}$

(Mean ± SD value were shown to have an idea, Man-Whitney U test were done in between the two groups, Mean rank & Sum of Rank are also mentioned)

Table 3: Dietary Fatty Acids

Components	FRG	CG	Mean Rank		Rank Sum		p-Value
			FRG	CG	FRG	FRG	
SFA	5.52 ± 1.60	5.73 ± 2.10	36.77	39.31	1397.00	1422.00	**0.512**
PUFA	4.29 ± 2.05	4.10 ± 1.9	38.09	37.88	1338.00	1488.00	**0.892**
MUFA	4.43 ± 1.09	4.11 ± 1.16	40.81	38.11	1501.00	1427.00	0.665

(Mean ± SD value were shown to have an idea, Man-Whitney U test were done in between the two groups, Mean rank & Sum of Rank are also mentioned)

Table 4: Healthy Eating Index 2015

Components	FRG	CG	Mean Rank		Rank Sum		p-Value
			FRG	CG	FRG	CG	
Adequacy Components:							
Total Fruits (5)	1.08 ± 0.85	1.05 ± 0.83	38.84	38.16	1476.00	1450.00	0.885
Whole Fruits (5)	1 ± 0.77	0.87 ± 0.74	40.33	36.67	1532.50	1393.50	0.430
Total Vegetables (5)	1.50 ± 0.98	1.82 ± 0.83	33.91	43.09	1637.50	1288.50	0.061
Greens and beans (5)	1.87 ± 0.93	2.16 ±0.97	35.28	41.72	1340.50	1585.50	0.051
Whole grains (10)	1.16 ± 0.91	1.03 ± 0.91	40.14	36.86	1525.50	1400.50	0.493
Dairy (10)	1.79 ± 0.77	1.68 ±0.73	39.84	37.16	1514.00	1412.00	0.565
Total Protein Foods (5)	3.13 ± 1.81	3.39 ± 1.88	35.53	41.47	1350.00	1576.00	0.213
Seafood and Plant Protein	0.55 ± 0.64	0.47 ± 0.50	39.83	37.79	1490.00	1436.00	0.750
Fatty Acids (10)	5.36 ± 1.45	5.53 ± 1.42	36.76	40.24	1397.00	1529.00	0.493
Moderation Components							
Refined Grains (10)	2.39 ± 2.45	2.45 ± 0.87	38.11	38.89	1448.00	1478.00	0.876
Sodium (10)	1.84 ± 0.46	1.58 ± 0.56	43.18	33.82	1641.00	1285.00	0.064
Added Sugar (10)	5.80 ± 1.84	5.54 ± 0.56	39.83	37.17	1513.50	1412.50	0.600
Saturated Fats (10)	5.93 ± 1.47	5.51 ± 1.20	41.01	35.99	1558.50	1367.50	0.321

(Mean ± SD value were shown to have an idea, Man-Whitney U test were done in between the two groups, Mean rank & Sum of Rank are also mentioned)

Table 5: Anthropometric variables and Body Composition:

Components	FRG	CG	Mean Rank		Rank Sum		p-Value
			FRG	CG	FRG	CG	
Body Weight(kg)	64.26 ± 10.18	69.08 ± 9.92	38.74	38.26	1472.00	1454.00	0.05
BMI	24.35 ± 6.61	27.96 ± 8.32	34.54	42.46	1312.50	1613.50	0.03
WHR	0.90 ± 0.89	1.01 ± 0.99	39.18	37.82	1489.00	1437.00	0.04
Visceral fat (cm2)	3.90 ± 2.21	4.82 ± 2.74	27.74	49.26	1054.00	1872.00	0.009
Body fat rate	26.01 ± 5.46	28.73 ± 5.28	31.57	45.43	1199.50	1726.50	0.03
Body fat (%)	29.22 ± 8.71	33.78 ± 9.39	34.97	42.03	1329.00	1597.00	0.031
Fat free Body weight	44.74 ± 7.52	41.30 ± 7.33	28.62	48.38	1087.50	1838.50	0.61
Body Water	48.36 ± 4.64	48.53 ± 5.50	40.14	36.76	1529.00	1397.00	0.88
Bone Mass	2.80 ± 0.71	2.68 ± 0.39	35.04	41.96	1331.50	1594.50	0.36
Muscle mass	43.99 ± 8.48	49.32 ± 13.04	48.51	28.49	1843.50	1082.50	0.038
Skeletal muscle	56.74 ± 10.35	52.47 ±10.69	43.33	33.67	1646.50	1279.50	0.08

(Mean ± SD value were shown to have an idea, Man-Whitney U test were done in between the two groups, Mean rank & Sum of Rank are also mentioned)

Effects of Fermented Rice amount on metabolic Variables: Further to figure out the amount of fermented rice in the diet of participants of FRG have any relation with all metabolic the rank wise association was measured by Goodman-Krushkal Gamma test. Here the participant of FRG is ranked by the presence of average daily fermented rice in their diet.

Hypothesis Testing Results:

In order to test A hypothesis and discover commonalities between two groups, ***Table 1-4***. Shows no difference between the groups in. Whereas ***Table 5 & 6*** the A hypothesis testing shows there are difference in terms of Body Weight, Body Mass Index (BMI), Waist Hip Ratio (WHR), Body Fat Rate, Body Fat Percentage, Muscle Mass, Waist Circumference (WC), High Density Lipoprotein (HDL), Fasting Blood Sugar (FBS), Total Cholesterol (TC).

In B hypothesis testing, out of the five-risk scores Waist Circumference (WC), Fasting Blood Sugar (FBS) are decreasing in nature and High-Density Lipoprotein (HDL) have increasing association.

DISCUSSION

Numerous studies have examined the effects of fermented foods such as yogurt, kimchi, kefir, etc., on lipid lowering capacity, blood sugar maintenance, obesity management, etc.[19,20] This is one of the first attempts to determine the relationship between Fermented Rice and metabolic health retrospectively. Since there isn't a single random control study that looks for the real effect of FR on human metabolic health. Our hypothesis states that frequent consumption of FR would enhance adults' blood lipid profiles, reduce body fat, blood sugar levels and have a positive overall influence on metabolic health. In this retrospective comparison of two groups with no significant effects on blood triglyceride, diastolic pressure and systolic blood pressure. However, in other variables, FRG has a significantly lower rate of anthropometric measurements and increase in HDL level.

It has been shown that ingesting probiotics can help prevent or lessen the severity of a number of illnesses, mostly by re-establishing microbiota.[21] This is one conceivable reason for the observed decline in metabolic risk factors following interventions including the supplementation of fermented foods.[22] Rice that has undergone fermentation is thought to be healthier than conventional rice since the procedure reduces excess fat and improves certain nutrients.[1] Since the dawn of time, humans have been making fermented rice meals, particularly in rural India where people developed a wide range of cuisines using leftover rice that was left out overnight and allowed to ferment.[3] Rice that has been fermented is high in potassium, salt, chloride, and selenium, which lowers blood pressure and fends against metabolic problems. Increased levels of selenium and magnesium, both of which are good for bone

Table 6: Biochemical and Biophysical variables

Components	FRG	CG	Mean Rank		Rank Sum		p-Value
			FRG	CG	FRG	FRG	
NCEP ATP III Score							
WC (cm)	85.76 ± 11.08	93.04 ± 13.14	34.95	42.05	1328.00	1598.00	0.017
Triglyceride	116.38 ± 25.78	125.02 ± 30.85	36.89	40.11	1402.00	1524.00	0.062
HDL	53.29 ± 15.27	43.05 ± 15.81	40.09	36.91	1523.50	1402.50	0.028
FBS	100.44 ± 18.55	111.91 ± 22.82	33.36	43.64	1267.50	1658.50	0.042
DBP (mm/Hg)	126.50 ± 12.04	130.79 ±14.882	35.63	41.37	1354.00	1572.00	0.257
SBP (mm/Hg)	87.18 ± 11.342	90.32 ± 10.249	35.20	41.80	1337.50	1588.50	0.192
Other Parameters							
Total Cholesterol	152.50 ± 39.33	182.69 ± 8.55	34.63	42.37	1316.00	1610.00	0.010
LDL	99.53 ± 20.72	115.99 ± 36.88	32.18	44.82	1223.00	1703.00	0.073
VLDL	28.69 ± 9.47	29.63 ± 10.53	30.92	46.08	1175.00	1751.00	0.063
PBS	102.22 ± 18.38	111.91 ± 22.82	34.11	42.89	1296.00	1630.00	0.083

(Values are presented as means ± SD, P-value denotes differences between the two groups using Man-Whitney U Test)

Table 7: Odd Ratio between consumption of fermented rice and any four of the major metabolic diseases, such as obesity, hypertension, diabetes, and cardiovascular disease

Groups	Obesity		Total
	Obese	Non-obese	
FRG	3	35	38
CG	8	30	38
Total	11	65	76
Odd Ratio	0.326 (67.4%)		

Groups	Hypertension		Total
	Hypertensive	Non-Hypertensive	
FRG	12	26	38
CG	18	20	38
Total	25	51	76
Odd Ratio	0.646 (35.4%)		

Groups	CVD		Total
	CVD	Non-CVD	
FRG	7	31	38
CG	18	20	38
Total	25	51	76
Odd Ratio	0.256 (74.4%)		

Groups	Diabetes		Total
	Diabetic	Non- Diabetic	
FRG	12	26	38
CG	18	20	38
Total	25	51	76
Odd Ratio	0.572 (42.2%)		

(Odd Ratio tables are created from SPSS)

Table 8. Rank wise association of Fermented Rice Intake and Counter of Diseases

Disease Condition		CG (n=38)	Less Than 50g/day (n=14)	In-Between 50-100g/day (n=13)	More Than 100g/ day (n=11)	Gamma Value	Approx Sig.
Obesity	Non-Obese	15	11	9	9		
	Pre-Obese	15	1	3	2	-0.464	0.001
	Obese	8	2	1	0		
Hypertension	Non-Hypertensive	17	6	9	8		
	Pre- Hypertensive	4	1	0	1	-0.225	0.173
	Hypertensive	17	8	4	1		

table cont...

Disease Condition		CG (n=38)	Less Than 50g/day (n=14)	In-Between 50-100g/day (n=13)	More Than 100g/ day (n=11)	Gamma Value	Approx Sig.
Diabetes	Non- Diabetic	18	7	6	4		
	Pre-Diabetic	2	3	3	3	-0.106	0.304
	Diabetic	18	5	5	2		
CVD	Non-CVD	13	11	8	7		
	Pre-CVD	7	1	2	2	-0.410	0.007
	CVD	18	2	3	2		

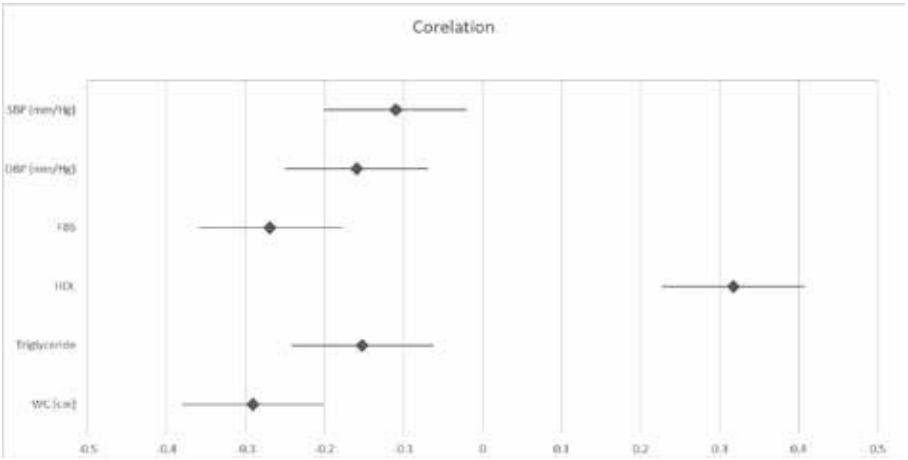
Good Man Gamma Test were performed)

Table 9: Rank wise association of Fermented Rice Intake NCEP ATP III Metabolic Risk Factors

Variable	Mean Rank				Std J-T Statistics	p-value	Outcome	Decision
	CG (n=38)	Less Than 50g/day (n=14)	In-Between 50-100g/day (n=13)	More Than 100g/day (n=11)				
WC (cm)	53.86	42.05	27.62	19.55	-2.851	0.004	μ1> μ2> μ3> μ4	Decreasing
Triglyceride	40.11	40.82	39.81	28.45	-1.172	0.241	μ1 = μ2 = μ3 = μ4	No Difference
HDL	36.91	23.46	42.77	58.09	-2.172	0.030	μ1> μ2> μ3> μ4	Increasing
FBS	43.64	42.07	29.38	26.95	-2.568	0.010	μ1> μ2> μ3> μ4	Decreasing
DBP (mm/Hg)	41.37	35.43	38.58	32.41	-1.212	0.226	μ1 = μ2 = μ3 = μ4	No Difference
SBP (mm/Hg)	41.80	36.50	35.35	33.36	-1.406	0.160	μ1 = μ2 = μ3 = μ4	No Difference

Jonckhere Tepstra Test were performed to know the association)

Table 10: Forest Chart of Correlation of Eating Fermented Rice and Variable:



(Correlation- Coefficient Test were performed and plot it)

health, are also seen. Additionally, as a probiotic, it aids in enhancing the production of white blood cells, which strengthen the immune system and guard against infections and cancer. These findings showed that a higher intake of Fermented Rice might reduce the risk of obesity, Fasting Blood Sugar and increase High Density Lipo-Protein in healthy individuals and could help to maintain an ideal Metabolic Health.

CONCLUSION

Our research is one of the first to demonstrate how elder persons who regularly consume fermented rice experience improved blood lipid levels and favourable impacts on body weight maintenance.

Future views: There are a plethora of other

popular fermented rice products on the market, including rice yoghurt and rice beer. Different types of rice fermentation are previously known to us, but these new truths will undoubtedly provide a fresh perspective on rice fermentation in the future.

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