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Original Research Article

The effect of high salt and oil consumption on heart health in an urban area of India: a community-based, cross-sectional study

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ABSTRACT

Background: The average salt and oil intake of the Indian population is substantially higher than WHO and national dietary recommendations. This has been linked to increased blood pressure, cardiovascular diseases (CVDs), and stroke.
Methods: This community-based cross-sectional study was carried out in an urban area among adults aged ≥40 years to note the association between high dietary salt/oil intake (measured using Consumption units) with future risk CVDs and other non-communicable diseases. A semi-structured questionnaire adapted from WHO STEPS, and food frequency questionnaire (FFQ) was used to collect data.
Results: The average daily salt intake (10.1±4.13 g/d) was >5 grams in 95.5% of the study participants. A significant association was found between salt consumption with gender, overall tobacco use, and waist circumference using Chi Square (or Fischer Exact). The average daily oil consumption (24.3±14.04 ml/d) was >25 ml in 37% of the individuals. Refined Soybean was the most commonly used oil for cooking. A positive association was found between oil consumption and gender, occupation, type of family, tobacco, and alcohol consumption. There was a positive linear association between CVD risk score (using WHO ISH risk charts) and salt/oil intake using Pearson's correlation and scatter plots. This was further tested in the linear regression model which showed that 6.3% of the changes in CVD risk could be predicted by salt intake in the adjusted model.
Conclusions: Increasing awareness and implementing health policies targeting lower salt and oil intake in the population is crucial for decreasing heart diseases.

Keywords: Cardiovascular disease risk, Dietary factors, Hypertension, Oil intake, Salt consumption

INTRODUCTION

Dietary factors such as high salt and oil consumption on a day-to-day basis have been linked to the epidemic of noncommunicable diseases in recent years. WHO recommends less than 5 grams of salt (equivalent to 2300 mg of sodium) and less than 25 ml of oil consumption per day.[1] However, in India, the average salt and oil consumption is much higher than the recommended values. Indian food intake data indicates that the average consumption of salt ranges from 3g to 10g/day in different states with about 45% of the population consuming more than 5g/day.[2] According to some other studies in India, the average salt intake is significantly higher than the WHO recommendation, with most studies reporting that Indians consume around 11 grams of salt per day, which is double the recommended 5 grams per day.[3] This high salt intake is a major concern due to its link to increased blood pressure, cardiovascular diseases, and stroke.[4] According to Global Burden of Disease Data (2019), around 18.6 million deaths were attributed to CVD globally.[5] A majority of deaths from noncommunicable diseases may be prevented by addressing their associated risk factors, such as salt intake. The primary source of salt in the Indian diet is added salt rather than salt naturally present in food.[3]

Salt intake is an easily modifiable risk factor.[6] Thus, an interim target of a 30% reduction in population salt intake has been included as one of nine targets set in the World Action Plan on Prevention and Control of NCDs 2013-2020. This plan aimed to achieve a 25% reduction in premature death from NCDs including CVDs by 2025.[1] India has committed to a 30 % reduction in sodium intake by 2025.[7]

Fats or oils used in cooking or added to foods during consumption or as a dressing are referred to as 'visible' fats. In contrast, fats naturally present in foods like nuts, seeds, pulses, cereals, and millets are called 'invisible' fat8. According to the Indian Council of Medical Research (ICMR) Dietary Guidelines for Indians, the intake of visible fat (cooking oil) should be restricted to 20-50g (4-10 teaspoons) per person per day, depending on individual energy (calorie) needs, which are influenced by physical activity and physiological condition. The oils should contain both n-6 and n-3 polyunsaturated fatty acids, essential for heart health, as they help reduce cholesterol levels and enhance HDL.[2] The per capita annual consumption of edible oil has risen to over 20 kg in India in 2025.[9]

Several studies have explored multisectoral strategies for addressing NCDs. Alselrod et al which included case studies like salt reduction in the UK and edible oils regulation in Iran emphasized commercial interests, stakeholder engagement, and the need for strong political leadership.[10] A similar study about the effect of food and nutrition policies to assess their support for salt reduction in preventing NCDs was carried out in Ethiopia by Tekle et al.[11] The study by Perera et al modeled the potential impact of reducing salt intake in the Eurasian Economic Union (EEU) to meet WHO NCD mortality reduction targets.[12] According to Wang et al, higher sodium intake was associated with an increased risk of cardiovascular events, particularly stroke and heart failure.[13] The risk of CVD increased with each 1g/day increase in sodium intake, showcasing significant dose-response relationships. High sodium and low potassium diet are reported to be independently associated with an increased risk of developing high blood pressure and consequent CVDs. The use of iodized salt is essential.[14]

Other risk factors for cardiovascular health include abdominal obesity, dyslipidemia, insulin resistance with or without glucose intolerance, elevated blood pressure, and proinflammatory and prothrombotic states, which are linked to atherosclerosis.[15] WHO ISH risk chart is an important risk prediction tool for categorizing the risk of nonfatal and fatal cardiovascular events among individuals who require early interventions.[16] Several indigenous food items in the Chhattisgarh state of India, such as Chilla and Iddhar have high salt and oil in their preparation. Information on salt and oil intake and their link to cardiovascular health has been lacking in this area. Thus, the rationale of the study was to fill this knowledge gap.

The objectives of the current study were 1) To estimate the intake levels of table salt and cooking oil in food in a representative sample of an urban area of Raipur, Chhattisgarh, India 2) To examine the association of dietary salt intake and oil intake on the occurrence of chronic diseases such as hypertension, type II diabetes and cardiovascular disease risk 3) To correlate high dietary salt and oil consumption with risk factors for chronic diseases such as Body Mass Index (BMI), blood pressure (BP), blood glucose and other anthropometric measurements.

METHODS

This study was a cross-sectional study of two years duration carried out in the urban field practice area of a tertiary care hospital in Raipur. The entire study duration was two years from June 2022 to June 2024. Adults ≥40 years old who had stayed in that area for at least six months, were not pregnant or lactating during data collection, and not suffering from fatal CVDs like myocardial infarction or stroke were included in the study. Individuals who could not comprehend the questionnaire and who were unavailable during household visits were excluded from the study. The sample size was estimated by using the formulae $Z^2 P(1-P)/d^2$, and taking the prevalence of high salt consumption from the National NCD Monitoring Survey (NNMS) in India.[17] Finally, 408 participants with complete data were included in the study.

A representative sample of the study population from the study area was drawn by simple random sampling. The streets and households were selected by rotating bottle method and lottery method. Only one participant was selected per household. In case any house was locked, the next house was considered. The current study was conducted according to the guidelines proposed by the Institute Ethics Committee. Written and verbal informed consent was obtained from all participants. A participant information sheet was administered to every participant. A semi-structured questionnaire adapted from WHO STEPS survey and food frequency questionnaire (FFQ) was used for data collection. Data was collected on sociodemographic profiles, behavioral information pertaining to addictions and physical activity, information on chronic diseases, etc., followed by dietary data, anthropometric and biochemical measurements.

Type II diabetes mellitus was defined by a cutoff of more than equal to 126 mg/dl fasting glucose, 200 mg/dl of postprandial glucose, and 200 mg/dl of random blood glucose.[18] A cutoff of 140/90 mm Hg was taken for blood pressure in adults <60 years of age. For adults aged ≥60 years of age without diabetes, chronic kidney diseases, or heart diseases, the cutoff was taken as 150/90 mmHg.[19] Participants with both previous histories of type II diabetes and hypertension as well as those newly diagnosed during screening in the current study were considered as cases. For anthropometry, a digital weighing machine, weighing to the nearest 100 g was used. Height was measured with the help of a stadiometer or an inextensible tape. Waist and hip circumference were measured using proper technique and used to calculate waist hip ratio.[20] Three BP readings were recorded for every participant using a digital sphygmomanometer and the average of the last two recordings was taken. The cardiovascular disease risk of the participants was plotted using the updated WHO ISH risk prediction charts.[16]

The operational definitions were fixed before the commencement of the study by a review of the literature. In adults, salt intake must be less than 5 grams per day. Both increased sodium consumption (>2 grams/day, equivalent to 5 g salt/day) and insufficient potassium intake (less than 3.5 grams/day) can cause HTN and heart problems. In adults, oil consumption in the form of total visible fats must be less than equal to 25 grams per day 2.

The calculation of average salt and oil intake per participant was done by using Consumption units.

Consumption Units (CU) definition: One consumption unit is how much calorie is consumed by an average adult man, with the weight of 60 kg, and doing sedentary work. The other coefficients are determined on the basis of calorie requirement proportionately. These coefficients were developed by ICMR for different groups of age, sex, and physical activity.[210]

The method is as follows

First, the total salt and oil consumption of the family was collected. Secondly, the number of family members, the age group of each family member, and the type of work done by them (Heavy/Moderate/Sedentary) were collated. In this study, this information was collected in a tabular format in the questionnaire. Thirdly, the total consumption unit of the family was calculated. The monthly salt and oil intake of the family was divided by the total consumption unit to obtain the value of one consumption unit for that family. Table 1 below shows the consumption units based on age and gender.[22] Finally, the value of one consumption unit of salt or oil for a family was multiplied by the consumption unit of the participant to obtain his or her monthly salt or oil consumption. It was divided by 30 to obtain the daily salt or oil consumption of each individual participant.

Table 1: Consumption units according to age and sex developed by Indian council of medical research (ICMR).[21]

Age (years)	Adult heavy worker	Adult moderate worker	Adult sedentary worker	Adolescent 12-21	9-12	7-9	5-7	3-5	1-3
Male	1.6	1.2	1.0	1.0	0.8	0.7	0.6	0.5	0.4
Female	1.2	0.9	0.8						

Statistical analysis

The interview data was compiled into Microsoft Excel and analyzed using Excel and statistical software IBM SPSS version 27.[23] The qualitative variables are expressed as frequencies and percentages. The continuous variables are expressed as mean, median, mode, standard deviation, and interquartile range for which Independent Sample T test and one way ANOVA test were used. Chi square test of significance was applied to test the association between oil and salt categories with various categorical variables. Any p value of <0.05 was taken as significant and <0.001 was taken as highly significant. Fisher's Exact test was applied if values in any cell came to be <5. For continuous variables, after testing for normality and linearity, Pearson's Correlation was used. Scatter plots were constructed and then Pearson's correlation coefficient was found. The variables that came to have a positive association in Pearson's Correlation were further used to perform univariate linear regression analysis and multivariate linear regression analysis to estimate the adjusted R2 values.

RESULTS

Sociodemographic profile of the study participants

The cutoff of 5 grams of salt intake per day was considered to classify participants into high and low salt intake groups as shown in Table 2. The median age of the participants was 50 years. About 44.6% were males and the rest were females. The majority belonged to the Hindu religion (94.6%), were literate (72.5%) and married (79.4%). Only 60.5% of the participants were employed. The majority of the females in the study were homemakers.

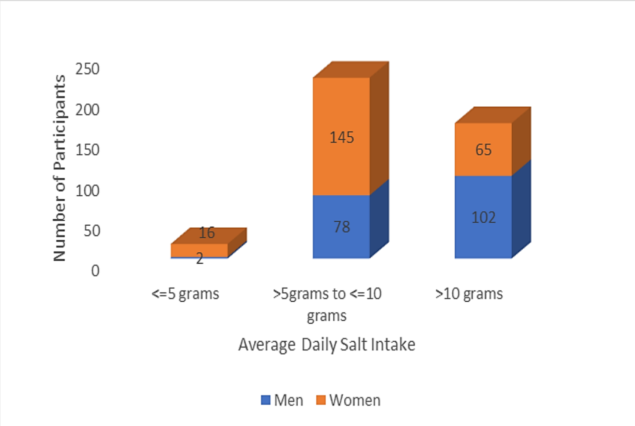

Figure 1: Average daily salt intake among the study participants (n=408).

According to the updated Modified Kuppuswamy scale, 45.8% of the participants belonged to the lower and lower middle socioeconomic groups. About half of them were from the OBC caste and lived in nuclear families.

Average salt intake

The average daily salt consumption was very high among the participants. About 390 (95.5%) of the participants had an average daily salt intake of greater than 5 grams. The distribution of average salt intake is shown in Figure 1. More than ninety percent of the individuals had a salt intake of more than the recommended amount of less than or equal to 5 grams per day as shown in Table 2. This finding is not very different from the national average of salt consumption. The average salt consumption of Indians is about 11 grams per day 3.

Table 2: Association of salt consumption with different variables.

Variable	Groups	Salt consumption >5 g/d (n=390)	≤5 g/d (n=18)	Total (n=408)	P value
		N (%)	N (%)	N (%)	
Age (years)	50-74	222 (56.9)	7 (38.9)	229 (56.1)	0.132
	40-49	168 (43.1)	11 (61.1)	179 (43.9)	
Gender	Male	180 (46.2)	2 (11.1)	182 (44.6)	0.003*#
	Female	210 (53.8)	16 (88.9)	226 (55.4)	
Religion	Hindu	371 (95.1)	15 (83.3)	386 (94.6)	0.066#
	Others**	19 (4.9)	3 (16.7)	22 (5.4)	
Education	Illiterate	105 (26.9)	7 (38.9)	112 (27.5)	0.266
	Literate	285 (73.1)	11 (61.1)	296 (72.5)	
Occupation	Employed	240 (61.5)	7 (38.9)	247 (60.5)	0.055
	Unemployed	150 (38.5)	11 (61.1)	161 (39.5)	
Socioeconomic status	Upper	78 (20.0)	4 (22.2)	82 (20.1)	0.952#
	Middle	133 (34.1)	6 (33.3)	139 (34.1)	
	Lower	179 (45.9)	8 (44.4)	187 (45.8)	
Caste	UR	116 (29.7)	5 (27.8)	121 (29.7)	0.325
	OBC	199 (51.0)	7 (38.9)	206 (50.5)	
	SC/ST	75 (19.2)	6 (33.3)	81 (19.9)	
Marital status	Others***	82 (21.0)	2 (11.1)	84 (20.6)	0.549
	Married	308 (79.0)	16 (88.9)	324 (79.4)	
Family type	Nuclear	209 (53.6)	6 (33.3)	215 (52.7)	0.092
	Extended	181 (46.4)	12 (66.7)	193 (47.3)	
Smoking	Ever smoker	67 (17.2)	0 (0.0)	67 (16.4)	0.053
	Non smoker	323 (82.8)	18 (100.0)	341 (83.6)	
Smokeless tobacco	Ever user	233 (59.7)	7 (38.9)	240 (58.8)	0.079
	Non user	157 (40.3)	11 (61.1)	168 (41.2)	
Overall tobacco use	Ever user	254 (65.1)	7 (38.9)	261 (64.0)	0.023*
	Non user	136 (34.9)	11 (61.1)	147 (36.0)	
Alcohol	Current or past alcoholic	97 (24.9)	1 (5.6)	98 (24.0)	0.086#
	Non-alcoholic	293 (75.1)	17 (94.4)	310 (76.0)	
Exercise	<150 min/week	301 (77.2)	14 (77.8)	315 (77.2)	1.000#
	≥150 min/week	89 (22.8)	4 (22.2)	93 (22.8)	
Body mass index (Kg/m^2)	Raised (≥25)	204 (52.3)	9 (50.0)	213 (52.2)	0.848
	Normal (<25)	186 (47.7)	9 (50.0)	195 (47.8)	

Continued

Variable	Groups	Salt consumption >5 g/d (n=390) N (%)	Salt consumption ≤5 g/d (n=18) N (%)	Total (n=408) N (%)	P value
Waist circumference (cms)	High	231 (59.2)	15 (83.3)	246 (60.3)	0.049*#
	Normal	159 (40.8)	3 (16.7)	162 (39.7)	
Waist hip ratio	High	300 (76.9)	15 (83.3)	315 (77.2)	0.774#
	Normal	90 (23.1)	3 (16.7)	93 (22.8)	
Chronic diseases					
Type II diabetes	Diabetic**	134 (34.4)	7 (38.9)	141 (34.6)	0.693
	Non diabetic	256 (65.6)	11 (61.1)	267 (65.4)	
Hypertension	Yes	184 (47.2)	7 (38.9)	191 (46.8)	0.491
	No	206 (52.8)	11 (61.1)	217 (53.2)	
Cardiovascular risk group	Orange/red	86 (22.1)	2 (11.1)	88 (21.6)	0.392#
	Yellow	114 (29.2)	4 (22.2)	118 (28.9)	
	Green	190 (48.7)	12 (66.7)	202 (49.5)	
Other chronic diseases€	Yes	62 (15.9)	3 (16.7)	65 (15.9)	1.000#
	No	328 (84.1)	15 (83.3)	343 (84.1)	

*Significant p value <0.05 by Chi Square test; #Fisher's Exact Test has been used instead of Chi Sq if any number in the cells is less than 5. In such cases, Fisher's Exact two tailed p value of significance has been considered; **Others include Christians, Muslims, and Sikhs; ***Others in marital status include widowed, separated, divorced, or single; €Other Chronic diseases include diseases like Tb, COPD, Asthma, Thyroid Disorders, and Other diseases like chronic migraine and Osteoarthritis (excluding Type II Diabetes and Hypertension)

Table 3: Association of oil consumption with different variables.

Variable	Groups	Oil Consumption >25 ml/d (n=151) N (%)	Oil Consumption ≤25 ml/d (n=257) N (%)	Total (n=408) N (%)	P value
Age (years)	50-74	91 (60.3)	138 (53.7)	229 (56.1)	0.197
	40-49	60 (39.7)	119 (46.3)	179 (43.9)	
Gender	Male	79 (52.3)	103 (40.1)	182 (44.6)	0.016*
	Female	72 (47.7)	154 (59.9)	226 (55.4)	
Religion	Hindu	143 (94.7)	243 (94.6)	386 (94.6)	0.949
	Others	8 (5.3)	14 (5.4)	22 (5.4)	
Education	Illiterate	42 (27.8)	70 (27.2)	112 (27.5)	0.900
	Literate	109 (72.2)	187 (72.8)	296 (72.5)	
Occupation	Employed	104 (68.9)	143 (55.6)	247 (60.5)	0.008*
	Unemployed	47 (31.1)	114 (44.4)	161 (39.5)	
Socioeconomic status	Upper	31 (20.5)	51 (19.8)	82 (20.1)	0.968
	Middle	52 (34.4)	87 (33.9)	139 (34.1)	
	Lower	68 (45.0)	119 (46.3)	187 (45.8)	
Caste	UR	36 (23.8)	85 (33.1)	121 (29.7)	0.113
	OBC	80 (53.0)	126 (49.0)	206 (50.5)	
	SC/ST	35 (23.2)	46 (17.9)	81 (19.9)	
Marital status	Others	38 (25.2)	46 (17.9)	84 (20.6)	0.080
	Married	113 (74.8)	211 (82.1)	324 (79.4)	
Family type	Nuclear	68 (45.0)	147 (57.2)	215 (52.7)	0.017*
	Extended	83 (55.0)	110 (42.8)	193 (47.3)	
Smoking	Ever smoker	37 (24.5)	30 (11.7)	67 (16.4)	0.001*
	Non smoker	114 (75.5)	227 (88.3)	341 (83.6)	
Smokeless tobacco	Ever user	99 (65.6)	141 (54.9)	240 (58.8)	0.034*
	Non user	52 (34.4)	116 (45.1)	168 (41.2)	
Overall tobacco	Ever user	107 (70.9)	154 (59.9)	261 (64.0)	0.026*
	Non user	44 (29.1)	103 (40.1)	147 (36.0)	
Alcohol	Current or past	51 (33.8)	47 (18.3)	98 (24.0)	0.000*

Continued.

Variable	Groups	Oil Consumption >25 ml/d (n=151)	Oil Consumption ≤25 ml/d (n=257)	Total (n=408)	P value
		N (%)	N (%)	N (%)	
	Alcoholic				
	Non alcoholic	100 (66.2)	210 (81.7)	310 (76.0)	
Exercise	<150 min/week	109 (72.2)	206 (80.2)	315 (77.2)	0.064
	≥150 min/week	42 (27.8)	51 (19.8)	93 (22.8)	
Body mass index (kg/m^2)	Raised (≥25)	78 (51.7)	135 (52.5)	213 (52.2)	0.865
	Normal (<25)	73 (48.3)	122 (47.5)	195 (47.8)	
Waist circumference (cms)	High	89 (58.9)	157 (61.1)	246 (60.3)	0.668
	Normal	62 (41.1)	100 (38.9)	162 (39.7)	
Waist hip ratio	High	119 (78.8)	196 (76.3)	315 (77.2)	0.554
	Normal	32 (21.2)	61 (23.7)	93 (22.8)	
Chronic diseases					
Type II diabetes	Diabetic**	54 (35.8)	87 (33.9)	141 (34.6)	0.695
	Non diabetic	97 (64.2)	170 (66.1)	267 (65.4)	
Hypertension	Yes	66 (43.7)	125 (48.6)	191 (46.8)	0.335
	No	85 (56.3)	132 (51.4)	217 (53.2)	
Cardiovascular risk group	Orange/red	41 (27.2)	47 (18.3)	88 (21.6)	0.062
	Yellow	45 (29.8)	73 (28.4)	118 (28.9)	
	Green	65 (43.0)	137 (53.3)	202 (49.5)	
Other chronic diseases€	Yes	21 (13.9)	44 (17.1)	65 (15.9)	0.392
	No	130 (8.1)	213 (82.9)	343 (84.1)	

*Significant p value <0.05 by Chi Square test; #Fisher's Exact Test has been used instead of Chi Sq if any number in the cells is less than 5. In such cases, Fisher's Exact two-tailed p value of significance has been considered.; **Others include Christians, Muslims, and Sikhs.; ***Others in marital status include widowed, separated, divorced, or single; €Other Chronic diseases include diseases like Tb, COPD, Asthma, Thyroid Disorders, and Other diseases like chronic migraine and Osteoarthritis (excluding Type II Diabetes and Hypertension)

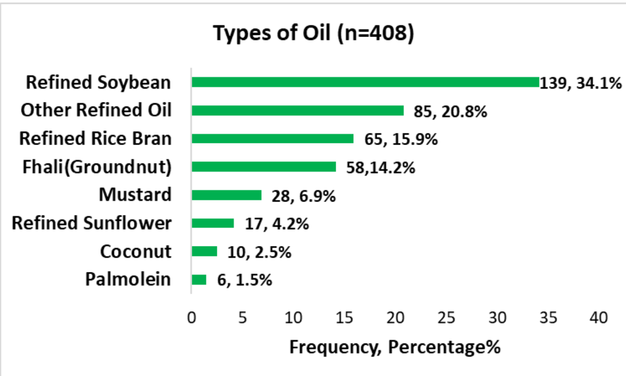

Figure 2: Types of cooking oil used by the study participants.

Addiction and anthropometric profile

Smoking history was prevalent in 16.4% of the participants. The usage of smokeless variety (58.8%) of tobacco was very high in the population. Alcohol use was more prevalent among males. Only one-fourth of the participants did adequate recommended exercise of greater than or equal to 150 minutes per week. Half of the participants had a BMI of more than 25 kg/m^2. Similarly, using WHO South Asian cutoffs of waist circumference and waist-hip ratio for males and females 24, both these parameters were high in more than half of the participants.

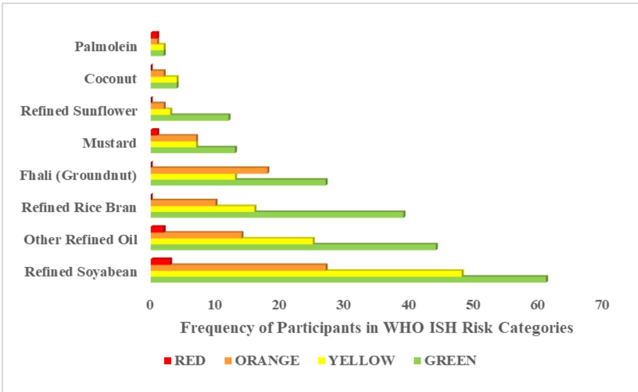

Figure 3: Distribution of types of cooking oil used by participants in different cardiovascular risk categories using the WHO ISH risk chart.

Salt consumption was high across all age categories, in both males and females, socioeconomic statuses, and literacy levels. A significant association was found between salt consumption and gender, overall tobacco use (including smoking and smokeless variety), and waist circumference of the participants (Table 2).

Average oil consumption

The recommended Oil Consumption per day was fulfilled by 257 (63.0%) of the participants. The overall oil consumption of more than equal to 25 ml per day was found in 151 (37.0%) of the participants. Oil consumption was high in the 50-74 years age group (60.3%). It was almost even in males and females. Among those with high oil consumption, 72.2% were literate. Three-fourths of the participants with high oil consumption also had a history of tobacco consumption, especially of the smokeless variety. Further, one-third (33.8%) had a current or past history of alcohol consumption.

A positive association was found between variables like gender, occupation of the participant, type of family, smoking and smokeless variety of tobacco consumption, and alcohol consumption with oil consumption with p values <0.05, using Chi square. However, no association was found between anthropometric variables with oil consumption as shown in Table 3.

No significant association was obtained between salt and oil consumption cutoffs with the prevalence of diseases like type II diabetes mellitus, hypertension, and other chronic diseases as well as cardiovascular risk groups using WHO ISH risk prediction charts, as shown in Tables 2 and 3.

The participants were also asked about the type of cooking oil that they used mainly in the household. Refined soybean oil (139, 34.1%) was used by maximum participants, under various brand names such as Kirti gold. The next most commonly used oils were other refined oils (85, 20.8%) with unspecified brand names or type, Refined rice bran oil, e.g. Hareli (65, 15.9%), and Fhali or Groundnut oil (58, 14.2%). Mustard oil (28, 6.9%) and Refined sunflower oil (17, 4.2%) was also used by some of the households. Coconut (10, 2.5%) and Palmolein oil (6, 1.5%) were used the least by the participants (Figure 2).

The mean daily average salt intake of the participants was 10.1±4.13 g/d. The median daily salt intake was 9.26 g/d. The mode was 7.41 g/d. The interquartile range was 7.25 to 12.1 g/d. Using the Independent Sample T test, the mean daily average salt intake among men was 11.33±4.15 g/d and among women was 9.11±3.85 g/d respectively and this was statistically significant with p value <0.001.

The mean daily average oil intake of the participants was 24.3±14.04 ml/d. The median daily oil intake was 20.9 ml/d. The mode was 14.81 ml/d. The interquartile range was 14.81 to 20.9 ml/d. Using the Independent Sample T test, the mean daily average oil intake among men was 25.6±14.58 ml/d and among women was 23.24±13.54 ml/d respectively but this was statistically insignificant.

Thus, we see that the average salt and oil intake per day was slightly less in women compared to men.

The mean CVD WHO ISH risk score among the participants was 6.38±5.05. The median score was 5 and the mode was a score of 2. The interquartile range was a score of 3 to 9.

Table 4: Relationship between linear variables.

Variable	Salt consumption (g/d)		Oil consumption (g/d)	
	Correlation coefficient	P value	Correlation coefficient	P value
Age (years)	0.014	0.782	0.047	0.341
Weight (Kgs)	0.077	0.122	-0.012	0.804
Height(cms)	0.149	0.003*	0.079	0.111
Body mass index (Kg/m^2)	-0.01	0.834	-0.062	0.209
Waist circumference(cms)	0.042	0.392	-0.023	0.643
Waist hip ratio	0.148	0.003*	0.047	0.342
Avg. systolic BP	0.089	0.074	0.045	0.367
Avg. diastolic BP	0.119	0.017*	0.036	0.470
Random blood sugar (mg/dl)	0.058	0.244	0.031	0.537
Exercise duration (mins/week)	0.141	0.004*	0.201	0.000*
WHO ISH risk score	0.080	0.106	0.072	0.148

*Significant p value <0.05 by Pearson correlation coefficient

Using one way ANOVA test, the average daily salt intake in the various CVD risk categories using the WHO ISH risk chart was 10.12±3.56 g/d in the Orange/Red category, 10.84±5.05 g/d in the yellow category and 9.66±3.7 g/d in green category respectively and this was statistically significant with p value of 0.047. Similarly, the average daily oil intake in the various CVD risk categories using the WHO ISH risk chart was 24.9±12.92 ml/d in the Orange/Red category, 25.36±15.5 ml/d in the yellow category, and 23.42±13.63 ml/d in green category respectively but this was not significant with p value of 0.445. These findings suggest that the participants in the moderate or yellow CVD risk category had more average daily intake of salt and oil in their diets. However, this intake decreased in the severe CVD categories of Orange/Red, possibly because of treatment advice to these patients to reduce their salt and oil intakes.

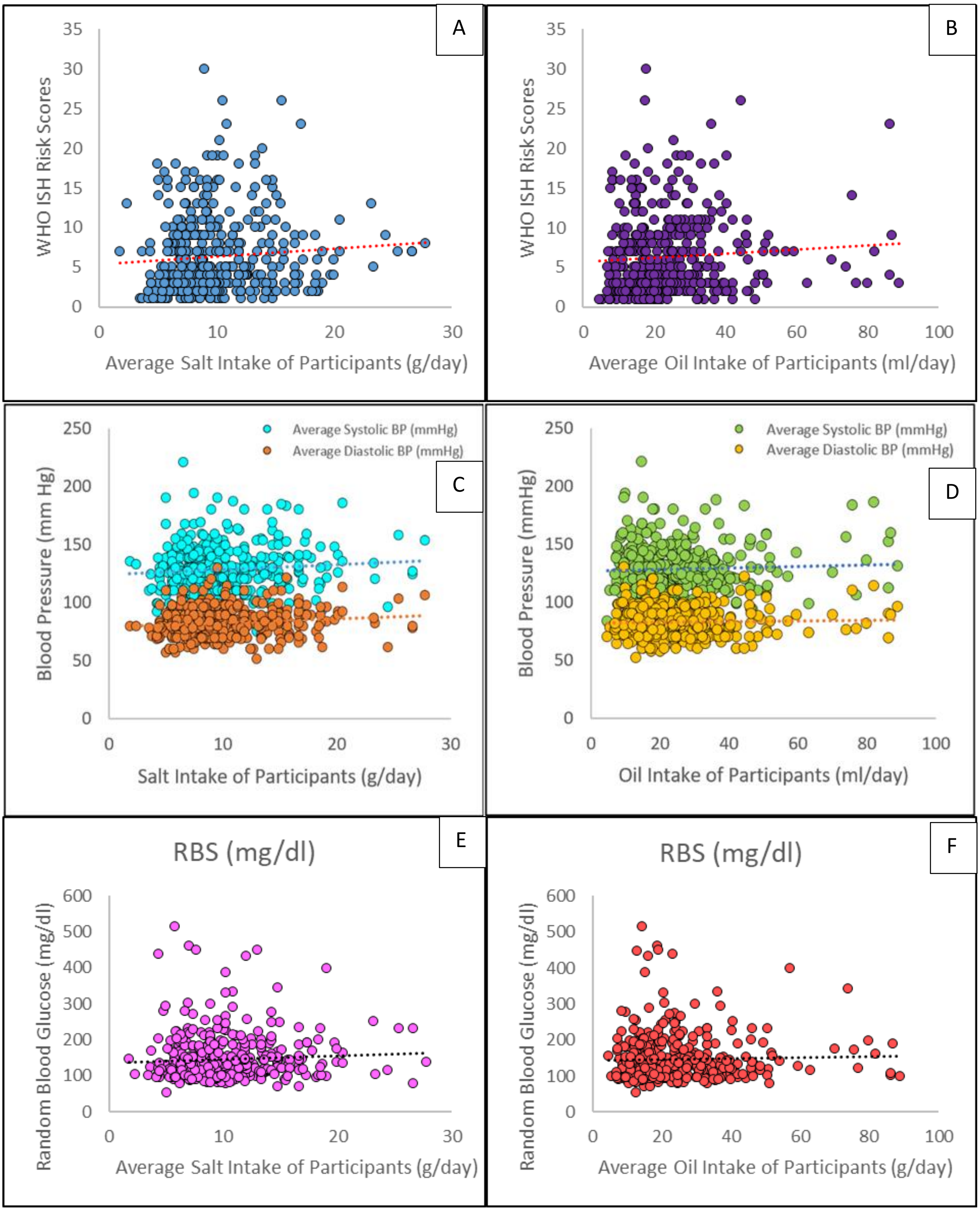

Figure 4: Linear relationship between (ToA) cardiovascular WHO ISH risk scores with average daily salt, B) Cardiovascular WHO ISH risk scores with average daily oil intake, C) Systolic and diastolic blood pressure with average daily salt, D) Systolic and diastolic blood pressure with average daily oil, E) Random blood glucose with average daily salt, F) Random blood glucose with average daily oil intake of the study participants.

Table 5: Association of salt and oil intake with cardiovascular risk scores using linear regression analysis in various models.

Variables	WHO ISH risk scores					
	Model 1 (Unadjusted)			Model 2 (Adjusted)		
	Adjusted R^2	95% CI	P value	Adjusted R^2	95% CI	P value
Salt consumption**	0.004	-0.021-0.217	0.106	0.063	-0.067-0.168	<0.001*
Oil consumption***	0.003	-0.009-0.061	0.148	<0.001	-0.011-0.061	0.341

*Significant by Linear Regression Analysis, p value <0.05; **Model 2 for Salt Consumption adjusted for waist-hip ratio and exercise duration (in mins/week) of the participant; ***Model 2 for Oil Consumption adjusted for exercise duration (in mins/week) of the participant

As salt and oil consumption are continuous variables, Pearson's Correlation was used to test for correlation with other continuous variables. Salt or oil consumption of the participant per day was used as the dependent variable on the Y axis and other quantitative independent continuous variables such as age, weight, height, body mass index, waist circumference, waist-hip ratio, average systolic blood pressure, average diastolic blood pressure, random blood glucose levels, duration of exercise per week and cardiovascular WHO ISH risk score were plotted on X axis. It is shown in Table 4.

Some significant association was found but the correlation coefficients were only weakly positive.

The linear relationship between WHO ISH risk scores to predict cardiovascular disease risk and the average daily salt and oil consumption of the participants is depicted in Figure 4. There was a positive linear association between the risk score and salt or oil intake.

The variables with p value <0.02 in Table 4 were taken for further linear regression analysis in Table 5. Weight, height, BMI, and blood pressure were not included as they have been already included in predicting the WHO ISH risk score.

Following linear regression in the unadjusted model, both Salt Consumption with F(1,406)=2.632, p=0.106 and Oil Consumption with F(1,406)=2.098, p=0.148 were found to be non-significant predictors for WHO ISH risk scores. For Oil consumption, the p value remained non-significant after adjusting for duration of exercise [F(2,405=1.078, p=0.341] in model 2. However, after adjusting for waist-hip ratio and duration of exercise in minutes per week, in model 2, salt consumption was found to be a significant predictor for cardiovascular risk score [F(3,404)=10.066] with a p value of <0.001 and Adjusted R2 of 0.063. Thus, 6.3% changes in the cardiovascular risk score could be predicted by salt consumption in the adjusted model 2 (Table 5).

DISCUSSION

A cross-sectional study by Khan et al in a Dhaka slum in 2021 found that the mean dietary salt intake among adults was 10.1 g/day, significantly higher than the WHO's recommended 5 g/day.[25] Salt intake was positively correlated with hypertension (OR 1.98) and negatively correlated with education level (OR 0.73). Ghimire et al conducted a study in Nepal and found that the average salt intake was 8.0 g/day, with 81.6% of participants exceeding the WHO's recommended limit of 5 g/day.[26] People from upper castes (aOR=0.7), larger families (aOR=0.6), and those advised to lower salt intake (aOR=0.6) were less likely to consume excessive salt. He et al in Taiyuan City in 2022 found that 19.5% of residents had hypertension, with 68.27% of hypertensive patients classified as having excessive oil and salt intake.[27] The study identified three lifestyle clusters: smoking and drinking (13.35%), excessive oil and salt intake (68.27%), and healthy behavior (18.38%). In the study by Lin et al of 2,811 adults in Ningbo in 2020, the average daily salt intake was 13.0 g, exceeding the Chinese dietary reference intake of 6 g/day.[28] Han et al assessed oil and salt use in Chinese-style canteens based on consumer perceptions of the nutrition environment.[29] Results showed that consumers were generally unaware of high oil and salt content in meals, with 78% of canteens using excessive amounts of both. Mellisa et al. estimated significant relationships between high oil and salt consumption patterns and central obesity.[30]

Notably, Perera et al found that reducing salt intake by 30% could prevent 94,150 cardiovascular disease deaths, while achieving the WHO-recommended level of 5g/day could prevent 193,155 deaths.[12] Ma et al, in a study of 176,570 adults in the UK, found that a lower frequency of adding salt to foods was linked to a reduced risk of CVDs.[31] Compared to those who always added salt, the adjusted hazard ratios (HRs) were 0.81 for "usually," 0.79 for "sometimes," and 0.77 for "never/rarely" (P trend < 0.001). The strongest association was observed with heart failure and ischemic heart disease, but not with stroke.

Santos et al, in a systemic review evaluated the progress of salt reduction initiatives.[32] They identified various interventions in 74 countries such as food reformulation (68 countries), consumer education (50 countries), front-of-pack labeling (48 countries), and salt taxation (5 countries). However, only 3 countries reported a substantial decrease (>2 g/day) and no country met the 30% reduction target. Kaushik et al conducted a similar study in Southeast Asia and Latin America and found only a few dedicated policies.[33] Most policies were integrated into broader health or NCD frameworks, hindering progress tracking. Harun et al proposed strengthening Malaysia's 2021-2025 Salt Reduction Strategy by focusing on the out-of-home sector to reduce salt intake through strategies like monitoring, education, enforcement, and product reformulation.[34] Starting in 2003, the UK established a voluntary salt reduction collaboration with the food industry, which was promoted by the non-governmental organization Consensus Action on Salt and Health (CASH, now known as Action on Salt) and the Food Standards Agency.[10] In Korea, patients with major NCDs exhibited higher low-salt preference than the general population, with diabetes patients showing the highest preference at 15.6%.[35] A mass-media campaign in South Africa aimed at reducing discretionary salt use resulted in a significant awareness increase, with 72% of participants reporting having seen or heard the campaign. Post-campaign, 30% of respondents reported reducing their salt intake, and 50% were aware of the recommended daily salt intake.[36] Recognizing the significant carcinogenic effects of palm oil derivatives that arise from the refining process, the Iranian Food and Drug Administration worked with the oil industry to substitute palm oil with other vegetable-based oils.[37]

Strengths

Measuring the salt quantity used in cooking is sometimes difficult to estimate. The advantage of using consumption units in this study is that it factors for both added salt in the diet and that used in cooking.

Limitations

Nonetheless, some limitations of this study need to be considered. First, causality cannot be inferred in a cross-sectional study design. Second, FFQ is not an accurate assessment of collecting infrequently consumed foods. Moreover, information on dietary information relies on individuals' memory and might be biased towards misreporting. Reduction of edible salt and oil was often indicated in the treatment of certain chronic disease conditions such as hypertension and diabetes, but these could not be accounted for potential dietary modifications made by these individuals due to the cross-sectional design of the study.

CONCLUSION

Reduction in average oil and salt intake is essential to prevent the epidemic of CVDs and other chronic diseases. Despite numerous recommendations and health awareness campaigns, adherence to decreased oil and salt intake remains poor among the Indian population, especially in urban areas. Based on the positive association of CVD risk with high oil and salt intake in this study, the following recommendations are proposed.

Robust awareness and education campaigns for dietary changes, for example, teaching households how to measure their salt and oil intakes. Inclusion of screening of high oil/salt intake in community assessment by frontline workers. Inclusion of dietary modification education from an early age, for example, in schools such that children are trained early on to adapt healthy palates. Policies to limit the provision of salt/oil per family and early screening and referral for CVDs.

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