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**Original Research Article**

# Dietary habits and selected noncommunicable disease risk factors among middle-aged adults in rural Kerala

**Balasankar J. M.[1], Hanudha N. K.[1], Neethu M. S.[2], Biju Soman[1]***

[1]Achutha Menon Centre for Health Science Studies, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum, Kerala, India
[2]Central University of Kerala, Kasaragod, Kerala, India

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***Correspondence:**
Dr. Biju Soman,
E-mail: bijusoman@sctimst.ac.in



## ABSTRACT

**Background:** Noncommunicable disease (NCD) risk factors are increasing in Kerala. The science of Ayurveda emphasizes lifestyle modification rather than treating the disease. We aim to explore the correlation between selected ayurvedic dietary risk factors with NCD risk factors like hypertension, diabetes, dyslipidemia and obesity.
**Methods**: Using cluster sampling, a community-based cross-sectional study was conducted among 410 middle-aged adults in the rural Kollam district, Kerala. The participants underwent biochemical tests for fasting blood sugar (FBS) and serum cholesterol (S. Cholesterol). WHO STEPs questionnaire, food frequency questionnaire (FFQ), and a checklist to assess the usage of dietary risk factors proposed by Ayurveda for NCDs were used. All analyses were done using R software version 4.1.2.
**Results**: The mean age of the participants was 46±5.4 years. The rates of regular intake of salty foods (*ati-lavana*) (77.1%), sour foods (*ati-amla*) (80.5%), heavy foods (*guru-annapaana*) (87.3%), oily foods (*snigdha annapaana*) (67.3%), frequency of food intake more than 4 times day (80%) were found to be high in population. On multivariate analysis, increased frequency of food intake was found to be associated with diabetes (AOR-1.9, CI: 1.2-3.2).
**Conclusions**: Some of the risk factors that Ayurveda has been proposing are found to have an association with the NCD risk factors considered. Interventions to reduce the prevalence of selected NCD risk factors that incorporate the stipulations of alternative systems could have a significant public health impact.

**Keywords**: Ayurveda, NCD risk factors, Food frequency, Food habits

## INTRODUCTION

Noncommunicable diseases (NCDs) are the leading public health concern, contributing to 71% of deaths globally. More than 15 million people who die from an NCD are between 30-69 years of age. Among these premature deaths, 85% occur in low- and middle-income countries.[1] Cardiovascular diseases account for most NCD deaths, or 17.9 million people annually, followed by cancers (9.3 million), respiratory diseases (4.1 million), and diabetes (1.5 million).[2] In India, one in every four people risks dying from a NCD before 70 years. In the report named "India: health of the nation's states" by the Ministry of Health and Family Welfare (MoH and FW), Government of India, it is stated that there is a considerable increase in the contribution of NCDs from 30% of total disease burden disability adjusted life years (DALY) in 1990 to 55% in 2016 and also an increase in the proportion of deaths from 37.9% in 1990 to 61.8% in 2016.[3] Kerala has been a hub of NCDs due to rampant urbanization and modernization which had infiltrated even to the grass root levels of the state, irrespective of the region and economic strata, influencing the population's lifestyle for the increased prevalence of NCDs.[4] Presently, one in five is diabetic, and one in three is hypertensive, which could be attributed to

unhealthy dietary patterns and lack of physical activity.[5] The main metabolic changes that give rise to NCDs comprise raised blood pressure, overweight/obesity, dyslipidaemia and hyperglycaemia.

Dietary patterns are usually associated with NCDs. Consumption of high-salt food, especially among middle-aged adults, makes them prone to NCDs, especially hypertension.[6] Although morbidity and mortality from NCDs mainly occur in adulthood, exposure to risk factors begins in early life, especially during middle ages. However, there is a misconception among the young that they need not worry about unhealthy food at their age. This implies need to follow up on these high-risk populations to control alarming increase in disease.[7] In case of rural communities, they have comparatively more distribution of NCD risk factors.[8] Also, many studies show that higher prevalence of smoking, smokeless tobacco usage and reduced fruit and vegetable intake had been seen among rural communities compared to urban communities.[9]

Ayurveda gives more emphasis on the prevention of disease, which means maintaining the health of a healthy person (Swasthasya swasthya rakshanam).[10] Food (ahara), which is one of the three pillars of life (Trayopasthambha) is fundamentally preventive in nature.[11] That means the majority of diseases can be put under control only by making adjustments in dietary habits. The unique thing is that it considers the combination of food articles, environmental considerations (desa), method of preparation, nature of the consumer, quantity (maatra), time (kaala) etc. Ayurveda advises taking food only twice a day, preferably once in the morning and once in the evening. Food should not be taken within three hours (1 yaama) after the previous meals. Ayurveda categorizes food as wholesome (pathya) and unwholesome (apathya).[12] The main food habits which pose the risk of NCDs include regular intake of salty foods (ati-lavana aahaara sevana), sour foods (ati-amla aahaara sevana), heavy foods (guru-annapaana), oily foods (snigdha-annapaana) and uncongenial foods (asaathmya aahara sevana).[13] The increased prevalence of NCD risk factors can be attributed to dietary risk factors. Ayurveda proposes; that the adherence of an individual to deleterious food habits will be positively related to his chances of getting affected by NCDs. Therefore, what Ayurveda proposes is a lifestyle intervention.[14]

The epidemiological transition in Kerala has been more advanced compared to other states, with an increased burden of NCDs. Lifestyle changes are the primary necessities for the control of NCDs. Alternative medical streams like Ayurveda have been focussing on diet and regimen as these are the common reasons for NCDs, in the case of middle-aged adults, whose dietary habits and sedentary lifestyles are in a worrying stage, especially in the case of rural communities. So, rather than curing the diseased elder population, equal importance is given to the middle-aged rural population, who have been exposed to the risk factors of NCDs. The study aims to study the dietary patterns and the practice of dietary stipulations in Ayurveda and its correlation with selected NCD risk factors like hypertension, diabetes, obesity and dyslipidemia among middle-aged adults in rural Kerala.

## METHODS

A cross-sectional study using a structured interview questionnaire drafted based on the WHO STEP-wise approach for surveillance of NCD risk factors version 3.2, FFQ, and a checklist to assess ayurvedic dietary risk factors, physical examinations and laboratory investigations was conducted in rural Kollam district, Kerala. The study period was from March 2022 to June 2022. Participants were middle-aged adults aged 35-54 years; who were permanent residents of that place. Those with debilitating disease conditions, tenants and migrant workers were excluded. The sample size was calculated to be 410 using Open Epi software 3.0.1, considering the prevalence of selected NCDs in rural Kerala as 28.25% with 95% CI and 5% precision and 10% non-response rate.[15] The total population in the selected panchayat was 51,384 in all its 23 wards, as per the Census data 2011. The participants were selected using the cluster random sampling method. The required sample is achieved by selecting two clusters from each of the 23 wards. The population-adjusted random locations were created using the GIS map option in R (*sf* package) to get the starting points of each cluster (Figure 1). The nearest household to the identified random geolocation (computer generated using the R software) was the first household for each cluster. The household on the right was selected as the next house, and it continued till we got nine eligible subjects. One person was recruited from each household, and if more than one eligible person were present in a household, the alternate sex or younger than the previous one was recruited. The eligible participant from the household is selected without any gender difference.

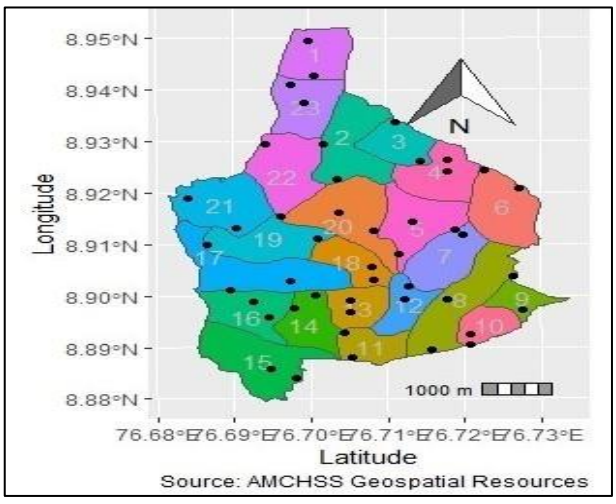


**Figure 1: Cluster points are randomly generated on Panchayat map in R. Dots represent the cluster points.**

The Accredited Social Health Activists (ASHAs) took anthropometric measurements like height and weight on a later day, and body mass indexes (BMI) were estimated. Later the participants were asked to report to the community health centre to assess their FBS and S. cholesterol levels.

Those with systolic blood pressure (SBP) ≥ 130 mmHg or with the diastolic blood pressure (DBP) ≥85 mmHg were considered hypertensive, as well as those with the BMI ≥ 25 kg/m$^2$ were considered as obese as per the cut-off for the South Asia region. A laboratory value of serum cholesterol level ≥ 200 mg/dL was taken as hyperlipidaemia, and that of FBS ≥ 100 mg/dL was considered diabetic. All cut-off values were based on the international diabetic federation (IDF) criteria except in the case of BMI.

Data analyses were done using R software version 4.1.2. Descriptive statistics of all variables like socio-demographic profile, frequency of food intake, ayurvedic dietary risk factors for NCDs like regular usage of salty foods (Ati-lavana), sour foods (Ati-amla), heavy foods (Guru-annpaana), oily foods (Snigdha-annapaana) and uncongenial foods (Asaathmya aahara) were done. Bivariate and multivariate analyses were performed to determine the significant association between all variables.

The dietary patterns of the participants and their association with age, BMI, BP, FBS, and S. Cholesterol were explored. A correlation analysis was done between ayurvedic dietary risk factors and noncommunicable disease risk factors with the help of laboratory tests to prove whether the objective is true.

## RESULTS

The participants ranged in age from 36 to 54 years old, with a mean age of 46±5.4 years. Most participants (76.6%) were women, and 23.4% were men. Most (96.8%) were married, and only 3.17% were unmarried or widowed. About 86.4% of the participants had secondary or higher levels of education. Around 48% of the participants were employed, 34.1% were unemployed, and 17.8% belonged to the other category, predominantly homemaker women. Based on economic status, half the participants (50.4%) belong to the above poverty line (APL) category, 41.7% to the below poverty line (BPL) category, and 7.8% are abysmally poor, having the Anthyodaya Anna Yojana (AAY) cards. The socio-demographic characteristics of the study population stratified by sex are given in the Table 1.

The mean and standard deviation (SD) of height, weight, and BMI of the participants were 164.6±6.0 cm, 64.7±6.7 kg, and 23.9±1.9 respectively, and the systolic (SBP) and diastolic blood pressures (DBP) were 127.1±11.3 and 79.5±7.9 mmHg, respectively.

**Table 1: Distribution of participants by socio-demographic characteristics.**

| Characteristics | Men, (n=96, 23.5%) | Women, (n=314, 76.5%) | Total, (n=410) (%) |
|---|---|---|---|
| **Age group (years)** | | | |
| 35-39 | 16 (17) | 47 (15) | 63 (15.3) |
| 40-44 | 22 (23) | 53 (17) | 75 (18.3) |
| 45-49 | 29 (30) | 124 (39) | 153 (37.3) |
| 50-54 | 29 (30) | 90 (29) | 119 (29.1) |
| **Marital status** | | | |
| Married | 92 (95.8) | 305 (97.1) | 397 (96.8) |
| Others (unmarried/ widowed) | 4 (4.2) | 9 (2.9) | 13 (3.2) |
| **Education** | | | |
| Below secondary level | 9 (9.4) | 47 (15) | 56 (13.7) |
| Secondary level and above | 87 (90.6) | 267 (85) | 354 (86.3) |
| **Occupation** | | | |
| Employed | 85 (89) | 112 (36) | 197 (48) |
| Unemployed | 10 (10) | 130 (41) | 140 (34.2) |
| Others (primarily homemakers) | 1 (1.0) | 72 (23) | 73 (17.8) |
| **SES based on ration card** | | | |
| APL | 57 (59.3) | 151 (48.1) | 207 (50.5) |
| BPL | 32 (33.3) | 139 (44.2) | 171 (41.7) |
| AAY card | 7 (7.4) | 24 (7.7) | 31 (7.8) |

APL- above poverty line; BPL- below poverty line; AAY- anthyodaya anna yojana.

The findings from laboratory and physical investigations (including anthropometric measurements) showed that 27.8% of the participants had diabetes, based on FBS values and the usage of anti-diabetic drugs (as reported). Based on S. cholesterol levels or a history of treatment, 25.6% of participants had hyperlipidemia, with no significant difference between sexes. Based on blood pressure values or usage of anti-hypertensive drugs (as reported), 49.3% were hypertensive. As per the BMI estimates, one-third (33.2%) of the participants were obese.

In the case of ayurvedic dietary risk factors for NCDs, regular usage adherence does not differ significantly between sexes. Regular intake of salty foods (Ati-lavana) was found among 77.1% of the participants. Those who have the habit of regular intake of sour (Ati-amla), hard-to-digest foods (Guru-annapaana) and oily foods (Snigdha aahara) were 80.5%, 87.3% and 67.3%, respectively. In the case of regular intake of uncongenial foods (asaathmya), only 16.3% have such dietary practices, with men having a higher percentage (Table 2).

The frequency of daily food intake was more than four times a day among 70.7% of the participants.

**Table 2: Distribution of participants based on usage of ayurvedic dietary risk factors.**

| Ayurvedic dietary risk factors | Men, (n=96, 23.5%) | Women, (n=314, 76.5%) | Total (n=410) (%) |
|---|---|---|---|
| **Salty food (*ati-lavana*)** | 74 (77) | 242 (77) | 316 (77) |
| **Sour food (*ati-amla*)** | 80 (83.3) | 250 (79.6) | 330 (80.5) |
| **Heavy food (*guru-annapaana*)** | 86 (89.6) | 272 (86.6) | 358 (87.3) |
| **Oily food (*snigdha aahara*)** | 70 (73) | 206 (65.6) | 276 (67.3) |
| **Uncongenial foods (*asaathmya aahara*)** | 23 (23.9) | 44 (14) | 67 (16.3) |

A bivariate analysis was done using hypertension, diabetes mellitus, dyslipidemia, and obesity as outcome variables. The outcomes of hypertension, dyslipidemia, and obesity were found to be positively associated with age, with more participants with selected NCDs like hypertension (p=0.007), hyperlipidemia (p=0.012), and obesity (p=0.023) in higher age groups.

The meal frequency per day was found to be positively associated with the FBS values of the participants. The majority of participants have a high frequency of food intake. Table 3 shows the trend of its association with selected NCD risk factors.

Heavy food consumption (Guru-annapaana) has been found to be positively associated with hyperlipidemia. Regular use of heavy foods (Guru-annapaana) was 83% among the hypertensives. Also, among the diabetic population, 60% have a regular intake of oily foods (Table 3).

**Table 3: Association of ayurvedic dietary risk factors with NCD risk factors.**

| Risk factors | | Hypertension, n (%) | Diabetes, n (%) | Dyslipidemia, n (%) | Obesity, n (%) |
|---|---|---|---|---|---|
| **Frequency of food intake** | ≤4 | 60 (30) | 23 (20) | 35 (33) | 37 (27) |
| | >4 | 142 (70) | 91 (80) | 70 (67) | 99 (73) |
| **P value** | | 0.8 | 0.014* | 0.3 | 0.6 |
| **Heavy food (guru-annapaana)** | Users | 168 (83) | 97 (85) | 85 (81) | 117 (86) |
| | Non-users | 34 (17) | 17 (15) | 20 (19) | 19 (14) |
| **P value** | | 0.013* | 0.4 | 0.023* | 0.6 |
| **Oily foods (Snigdha)** | Users | 127 (63) | 68 (60) | 63 (60) | 87 (64) |
| | Non-users | 75 (37) | 46 (40) | 42 (40) | 49 (46) |
| **P value** | | 0.059 | 0.04* | 0.064 | 0.3 |

In multivariate logistic regression analysis, hypertension was found to be 2.4 times more among older (50-54 years of age) subjects than younger subjects (35-39 years of age). Also, diabetes mellitus was twice as common among those with a meal frequency of more than four times a day (adjusted odds ratio: 1.9 (1.1-3.2) than among those with a food frequency of less than or equal to four.

## DISCUSSION

This study explored the correlation between ayurvedic dietary beliefs in food intake and NCDs risk factors like hypertension, diabetes mellitus, dyslipidemia and obesity. It was found that the practices of dietary risk factors, as stipulated by Ayurveda, were high among the study population. The dietary risk factors considered were regular intake of salty foods (*ati-lavana sevanam*), sour foods (*ati-amla sevanam*), hard-to-digest foods (*guru annapaana*), oily foods (*snigdha-annapaana*), uncongenial foods (*asaathmya aahara*), frequency of food intake.[16] It has been found that some of the risk factors proposed by Ayurveda have an association with the status of NCDs in this rural setting. This study also documents the level of NCDs in the study population through biochemical tests like FBS and serum cholesterol and through other physical measurements.

The study found that in the rural population, habitually, 77.1% use salty foods (*ati-lavana*), 80.5% use hard-to-digest foods (*guru-annapaana*), 67.3% use oily foods (*snigdha- annapaana*), and 16.3% use uncongenial foods (*asaathmya aahaara*). It was found that 70.7% of people consume food more than four times daily. There was not much difference in this pattern among men and women. The participants with selected NCD risk factors were found through self-reporting, biochemical test values for FBS, S. cholesterol, systolic or diastolic blood pressure values, and body mass index (BMI). The overall prevalence of selected NCD risk factors was 33.9%, which is quite higher than the 28.5% reported in previous studies.

Here, the majority of participants with hypertension have a regular intake of heavy foods (83%). This is similar to what we have seen in previous studies in India, which show a positive relationship between heavy foods (as per ayurvedic definition) and hypertension.[17] Thrift et al

report that people with higher education were less affected by hypertension, which is similar to the findings from this study.[18]

Edavalath et al report that reduced daily meal frequency positively impacts type 2 diabetes control.[19] Despite the evidence on diabetes control, relatively low-rate adherence to the reduced meal frequency (less than or equal to four) per day was reported in the present study (29%). Prakash et al recommend that food intake at particular times is better than eating frequently.[20] In this setting, 60% of diabetic people have heavy food intake regularly, which is associated with diabetes, as reported by Liese et al in the US population.[21] Diabetes control was found to be poor among these participants in a study conducted by Brugnara et al in a Spanish setting.[22] These findings indicate the need for immediate action regarding health education to create awareness regarding the importance of dietary modification.

Chaudhari et al report that the excessive intake of heavy foods, especially carbohydrate-rich diets, enhances the chances of getting hyperlipidemia, which is consistent with our findings.[23] Apart from that, the elderly age group is found to be more obese compared to the younger age group, which is similar to what Sarvottam et al found through a study conducted in Varanasi in which age progression was associated with increased adiposity.[24] Our study findings stress the need for developing specific educational programmes to improve knowledge regarding dietary control, the practice of a wholesome regimen, and its importance in the control of NCDs like hypertension, diabetes, dyslipidemia and obesity.

Adherence to ayurvedic dietary risk factors may be a separate predictor of NCD control. In our study, blood pressure control was relatively lower in individuals who regularly consumed heavy foods. Diabetic participants were found to be more committed to eating more frequently. Arena et al recommend that lifestyle modification can significantly control NCDs and reduce the risk of complications when combined with pharmacological interventions.[25] Middle-aged people are to be given prime importance in this epidemiological transition stage, as it could have severe implications on their health status, as stated by Syauqy et al.[26]

### *Limitations*

The main limitations of this study include chances of recall and response bias due to self-reported dietary patterns; the associations observed do not infer causality due to the cross-sectional study design and reduced male participation (23.5%).

## CONCLUSION

The study explored the correlations between selected ayurvedic dietary stipulations and NCD risk factors like hypertension, diabetes mellitus, dyslipidemia, obesity, and selected biochemical risk factors. We found definite correlations between NCD risk factors and many dietary risk factors, as advocated by Ayurveda. Notably, these dietary risk factors are present among apparently healthy people and are modifiable with lifestyle interventions.

Dietary interventions, as suggested by Ayurveda, can have a significant public health impact in achieving better control of the rates of NCDs in Kerala. So, it is necessary to adopt a holistic approach, which could significantly benefit the population's health status. Some salient dietary recommendations are reducing the frequency of food intake to two-three times a day, limiting 'Guru-annapana' and avoiding 'asathmya-aahaara', et cetera.

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