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Dietary Intake, Lifestyle Factors, and Metabolic Risk: Insights from Health Check-Ups at a Private Healthcare Facility in Coimbatore, India

Asupan Makanan, Faktor Gaya Hidup, dan Risiko Metabolik: Wawasan dari Pemeriksaan Kesehatan di Fasilitas Kesehatan Swasta di Coimbatore, India

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ABSTRACT

Background: Over the last decade (2014–2024), the global prevalence of metabolic risk factors such as dyslipidemia (5-8%), hypertension (5-10%), obesity (10-15%) and elevated blood glucose levels (10-15%) has been steadily increasing.
Objectives: To determine the correlation among the dietary consumption, lifestyle factors, and metabolic risk factors among the respondent of age 18-65 years.
Methods: The respondent (n=419) were enrolled from August 2023 to February 2024 in Coimbatore, India. The sociodemographic characteristics, dietary intake, stress levels, and physical activity were measured using questionnaires. The respondent's anthropometry, HbA1c level, blood pressure, and liver function tests were examined, and those with abnormal liver enzymes underwent abdominal ultrasonography for fatty liver diagnosis. The descriptive, Chi square and Kendall's tau correlation coefficient were performed for statistical analysis.
Results: This research showed a weak correlation among protein intake of the respondent and obesity (r=0.084 and p-value=0.026). A significant association was observed among blood pressure range and the consumption of fat (r=0.079, p-value=0.039), protein (r=0.158, p-value<0.001). Correspondingly, the intake of nutrient such as energy (r=0.102, p-value<0.001), carbohydrate (r=0.089, p-value<0.001), and fat (r=0.156, p-value<0.001) was positively correlated with an increased hyperglycaemic risk. Further, energy (r=0.202, p-value<0.001), carbohydrate (r=0.146, p-value<0.001) consumption level had positive correlation with fatty liver disease.
Conclusions: A significant positive correlation as observed between and metabolic risk factors and dietary intake. Modifying the interventions to target these risk factors may aid lower the risk of hypertension, obesity, hyperglycaemia, and fatty liver disease in diverse inhabitants.

INTRODUCTION

Metabolic risk factors, which include metabolic abnormalities such as insulin resistance, hypertension, dyslipidemia and central obesity, significantly elevate the chance of emerging type II diabetes mellitus and atherosclerotic cardiovascular illnesses[1]. In 2024 worldwide the prevalence of obesity is 3 billion[2], hypertension (19%)[3], diabetes (10.5%)[4]. Fatty liver (32%)[5,6]. In South India, the prevalence rates are higher for hypertension (>30%)[3], diabetes (11.4%)[7,8] and fatty liver (53%)[9] and obesity affecting is 30 million[2].

Preventing disease, improving health, and minimizing morbidity and mortality are all effectively addressed by routine medical checks, or RMCs. Regular check-ups and diagnostics can identify the illnesses early, preventing them from developing chronic conditions that require more expensive and time-consuming care[11]. In recent decades, the prevalence of metabolic illnesses has been impacted by the global pattern of unhealthy diets[12]. A well-balanced diet is known to reduce the incidence of chronic metabolic abnormalities. Dietary patterns analysis focuses on the diet and its impact on well-being outcomes, emphasizing that people consume

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combinations containing a mixture of nutrients, the leading to the primary cause of major metabolic risk factors[13]. Chronic metabolic syndromes such as diabetes mellitus, atherosclerotic cardiovascular disease, obesity, and certain malignant tumours have been scientifically linked to the Western diet[14]. The Western diet, categorized by excessive intake of preserved foods, red meat, sugars and saturated fats, is closely allied to various metabolic risk factors, including obesity, hypertension, and increased serum triglycerides and low-density lipoprotein cholesterol (LDL-C). This dietary pattern has been shown to exacerbate health issues globally, particularly in populations transitioning to such eating habits[41].

The timing of nutrient consumption has been positively associated with blood pressure, particularly regarding the sodium-to-potassium ratio at lunch and calorie, lipid, and saturated fatty acid intake at dinner. Adjusting the timing of nutrient intake, especially focusing on sodium, potassium, and saturated fats, may help prevent the development of hypertension[15]. Skipping breakfast and consuming late meals are linked to increased risks of diabetes and cardiovascular diseases[42]. Stress levels, interleukin levels, and diet-related behaviours point to a significant risk of acquiring Non-Communicable Diseases (NCDs) among IT-related workers in India, emphasizing underlining the importance of changing lifestyle and corporate food culture, as well as physical exercise[16]. Taking above into consideration the current research intended to investigate the correlation between age, sex, occupation, education, alcohol and smoking, physical activity, and dietary intake among metabolic risk factors.

METHODS

Design and Respondent

This cross-sectional research included 4500 patients who visited the outpatient department for health check-ups over a six-month span (August 2023 to February 2024) in a private medical institute in Coimbatore, India. The respondent size calculation was done using Cochran's respondent size formula (Za/2p(1-p)/d2)[17]. The calculation assumed a prevalence (p) of 50%, a 95% confidence level (Z=1.96), and a 5% margin of error (d)[17]. The required respondent size was determined to be 364 with 15% of dropouts. A total of 419 respondent with metabolic risk factors such as hypertension, obesity, fatty liver, and hyperglycemia were involved in the research. Informed consent was collected from all the research respondents by providing essential information and measurements required for the data curation. To ensure the quality and accuracy of data collection, close monitoring and supervision was maintained by the investigators. This research was approved by the Institutional Human Ethics Committee (IHEC) PSG IMS&R (Ref. No.: PSG/IHEC/2022/Appr/FB/010) dated 16/03/2022 and informed consent was sought from all respondent.

The patients aged 18 to 65 years enrolled in the research were received a health checkup at a private hospital throughout the research period, which included measurements of metabolic markers. Patients who were willing to provide detailed dietary intake information, physical activity and stress levels included in the research and the availability of metabolic risk factor data, such as blood glucose, blood pressure, liver function test and Body Mass Index (BMI) from the health check-up records. The respondent who provided informed consent to participate in the research and allowed to access their health records for research purposes. Individuals with diagnosed with cancer, advanced kidney disease or acute illnesses that may significantly alter dietary intake or metabolic parameters were excluded. Respondents unwilling to comply with research protocols and additional dietary assessments. Pregnant or breastfeeding women were excluded, as their dietary requirements and metabolic parameters differ significantly from the general population.

In this research, the respondent's dietary intake and eating behaviours were collected by asking them with open-ended questions. The daily intake of food composition, fluid intake, and dietary consumption over a 24-hour period were recorded using the 24-hour recall method. The pilot research (n=10) was conducted to find out whether the questions were understandable by the respondents. This approach aimed to evaluate potential nutritional problems and their association with metabolic disorders and metabolic risk. The physical activity levels of the respondents were assessed using the Rapid Assessment of Physical Activity (RAPA)[18] questionnaire. The questionnaire consists of nine items with a close-ended question (yes or no) covering the wide ranges of physical activity levels and scores light/low active (2-3), moderate/somewhat active (4&6), and vigorous/very active (5&7). It also includes pictures illustrating various types of physical activities within each category[18]. The Perceived Stress Scale (PSS)[19] was used to assess the stress levels of the respondents. There are ten questions on the PSS scale, with answer options extending from 0 (never), 1 (nearly never), 2 (sometimes), 3 (quite often), and 4 (very often). There are three levels of perceived stress, with low levels (0–13), moderate levels (14–26), and high levels (27–40) determined by the total score[20]. Anthropometric measurements, including body weight, height, and BMI, were obtained using standardized instruments. To ensure accurate weight measurement, the patients were instructed to wear minimal clothing and remove foot wear and heavy accessories; the weight was recorded in kilograms (kg). Height was measured using a tape-down scale, with respondents standing upright against the wall, feet together, heels touching the base, and head level. The height was recorded at the point where the top of the head met the tape. BMI was then calculated based on the recorded height and weight. Sphygmomanometers and stethoscopes were used to measure the blood pressure range, with both systolic and diastolic readings recorded in millimeters of mercury (mmHg). Blood respondents were collected to measure Fasting Blood Glucose (FBG) and Glycated Hemoglobin (HbA1c) to assess respondents' blood glucose levels. Respondents who had abnormal Aspartate Transaminase (AST) and Alanine Transaminase (ALT) levels were further studied with abdominal ultrasound to identify fatty liver disease. The socio-demographic variables such as age and sex (male or female), education status (primary, secondary and post-secondary level), occupational status

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was considered as 1. teachers, bank staffs, IT workers, 2. homemakers, and 3. retirees, assessed on a continuous scale. Respondents were also asked about their monthly income as well as their alcohol and smoking consumption (yes/no).

The data was encrypted and then imported into Statistical Package for the Social Sciences (SPSS) version 28 for inferential analysis, including chi-square tests and correlation, as well as descriptive analysis such as percentages and frequencies. A significance level of p-value<0.05 indicated that the tests demonstrated typically excellent respondent adequacy. Chi square test was used to find out the correlation between the metabolic risk factors, lifestyle factors and demographics. Kendall's tau correlation coefficient was used to examine the correlation between the metabolic risk factors and the variables such as physical activity, stress levels, and nutritional intake. The correlation was found to be significant at the p-value<0.01 level.

RESULTS AND DISCUSSIONS

The research was conducted in Coimbatore, India because the research location is rapidly urbanizing, with significant changes in dietary pattern, including consumption of processed foods, confectionaries, and sedentary lifestyle. These factors are known to elevate metabolic risk. Researching the dietary intake, and lifestyle factors such as physical activities alcohol consumption, smoking and stress levels will help to understand how urbanization is influencing metabolic health. The research location has a diverse population and varied demographics. This research examined the varied socio-economic groups, education levels, dietary choices and lifestyle factors influence their metabolic health.

Table 1. Frequency distribution based on demographic characteristic and lifestyle factors (n=419)

Variables	n (%)
Gender	
Male	221 (53)
Female	198 (47)
Age	
18-44 years	208 (49.6)
≥45 years	211 (50.4)
Education	
Primary	23 (5.5)
Secondary	69 (16.5)
Post Secondary	327 (78)
Occupation	
Teachers, Bank Staffs, IT Workers	294 (70)
Homemaker	104 (25)
Retired	21 (5)
Monthly Income (Rs)	
<20000	149 (35.5)
>20000	270 (65)
Body Mass Index	
Underweight (<18.5)	19 (4.5)
Normal (18.5-24.9)	142 (33.9)
Overweight (25-29.9)	123 (29.4)
Obesity (>30)	135 (32.2)
Smoking	
Yes	26 (6.2)
No	393 (93.8)
Alcohol	
Yes	26 (6.2)
No	393 (93.8)
Food Habits	
Vegetarian	60 (14.3)
Non-Vegetarian	346 (82.6)
Ova-Vegetarian	13 (3.1)

n=number of respondents, %=percentage

This research registered 419 respondent, female (47%) and male (53%) with the age of 18-44 years (49.6%) and ≥45 years (50.4%). Most of the respondent (78%) had post secondary education, and 70% were employed as teachers, bank employees, or IT professionals, while 25% were homemakers with income (65%) more than Rs. 20,000 monthly. The assessment of BMI indicated the overweight (29.4%) and obese (32.2%) among respondents. Most of the respondent were non-vegetarian (82.6%), 14.3% are vegetarian and 3.1% are ova-vegetarian (vegetarian diet with addition of egg). The consumption of smoking and alcohol among the respondent was found to be 6.2% (Table 1).

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Table 2. Multivariate relationship between the predictors and metabolic risk factors among adults ≤18 years in India

Predictors	Obesity n (%)	p-value	Hypertension n (%)	p-value	Hyperglycaemia n (%)	p-value	Fatty Liver n (%)	p-value
Gender								
Male	125 (29.8)	**<0.001***	65 (15.5)	**0.002***	93 (22.2)	0.915	120 (28.6)	**0.003***
Female	95 (22.7)		69 (16.5)		85 (20.3)		136 (32.5)	
Age								
18-44 years	111 (26.5)	**0.021***	43 (10.3)	**<0.001***	69 (16.5)	**<0.001***	119 (28.4)	**0.008***
≥45 years	147 (35.1)		89 (21.2)		107 (25.5)		138 (32.9)	
Education								
Primary	15 (3.6)	0.583	10 (2.4)	0.090	14 (3.3)	0.069	9 (2.1)	**<0.001***
Secondary	42 (10)		25 (6)		37 (8.8)		32 (7.6)	
Post Secondary	201 (48)		96 (22.9		125 (29.8)		213 (50.8)	
Occupation								
Teachers, Bank Staffs, IT Workers	177 (42)	**0.041***	76 (18)	**0.001***	112 (26.7)	**0.008***	185 (44.15)	**0.005***
Other- Driver, Agriculture	69 (16.5)		41 (9.8)		49 (11.7)		62 (14.8)	
Retired	12 (2.9)		15 (3.6)		15 (3.6)		5 (1.2)	
Monthly Income								
<20000	98 (23.4)	0.153	64 (15.3)	0.165	78 (18.6)	0.228	75 (17.9)	**0.010***
>20000	160 (38.2)		68 (16.2)		98 (23.4)		177 (42.2)	
Smoking								
Yes	15 (3.6)	0.521	5 (1.4)	0.621	12 (2.9)	0.142	22 (5.3)	**0.030***
No	243 (58)		99 (23.6)		64 (15)		233 (56)	
Alcohol								
Yes	27 (6.4)	0.650	20 (4.8)	0.547	25 (6)	**<0.001***	19 (4.5	0.550
No	231 (55)		89 (21.2)		62 (14.7)		235 (56)	
Food Habits								
Vegetarian	32 (7.6)		19 (4.5)		22 (5.3)		33 (7.9)	
Non-Vegetarian	219 (52.3)	0.143	108 (25.8)	0.965	146 (34.8)	**0.043***	213 (50)	0.629
Ova-Vegetarian	8 (1.9)		5 (1.2)		9 (2.1)		8 (1.9)	

n=number of respondents, %=percentage, Results are based on nonempty rows and columns in each innermost suitable, *) The Chi-square statistic is significant at the p-value=0.05 level

The table 2 investigates the relationship between various sociodemographic, lifestyle, and metabolic risk factors (hypertension, obesity, fatty liver and hyperglycemia) among adults aged ≥18 years. Gender showed a positive significance association, with male respondents exhibiting a higher incidence of obesity (29.8%, p-value<0.001) and fatty liver (28.6%, p-value<0.05), hyperglycemia (22.2%) compared with female respondents. Whereas the levels of hypertension are higher in female respondents (16.5%, p-value<0.05). Similarly, adults ≥45 years were more likely to develop obesity (35.1%, p-value<0.05), hypertension (21.2%, p-value<0.05), hyperglycemia (25.5%, p-value<0.05), and fatty liver (32.9%, p-value<0.05) than younger adults, clearly indicating a significant influence of age on these metabolic risk factors. The research finding was similar with other research research highlighted that the metabolic dysfunction is especially higher in geriatric, insist the necessity for targeted interventions for the older adults[21].

The finding showed that education had a significant association with the higher risk for fatty liver (50.8%, p-value<0.05). Whereas the inverse relationship was found that higher education correlates with healthier behaviours, including reduced smoking and increased physical activity, which contribute to lower fatty liver risk[22]. Teachers, bank staffs, and IT-related workers showed higher rates of obesity (42%), hypertension (18%), hyperglycemia (26.7%), and fatty liver (44.15%), indicating occupation involving a sedentary lifestyle had a significant association with metabolic health (p-value<0.05). Similar findings were reported in other studies[23] where the employees of the banking institution exhibited a 21% incidence of hypertension and a 35% incidence of obesity, with notable correlations to lifestyle characteristics including elevated BMI, alcohol intake, longer working hours, and lack of physical activity. IT-related workers exhibited a 16.85% likelihood of being obese, with 44.02% categorized as overweight and 3.89% identified with hyperglycemia, underscoring the effects of idle work settings[16]. The results also indicated that respondents earning above ₹20,000 had a higher prevalence of fatty liver (42.2%), which was significantly associated with higher income groups (p-value<0.05). This may reflect greater access to high-caloric foods among higher-income individuals. Salaried and deskbound working individuals are more exposed to fatty liver, with metabolic disorder being more prevalent[24].

Smoking showed a positive significance with fatty liver (p-value<0.05), while alcohol consumption showed a significant association only with hyperglycemia (p-value<0.05). A meta-analysis of multiple observational studies[25] confirmed that individually both existing and past smoking habits are associated with an augmented risk of fatty liver, while alcohol consumption is a significant risk factor for hyperglycemia (p-value<0.001). Chronic intake of alcohol disrupts glucose breakdown, leading to hypoglycemia, insulin resistance, and an elevated risk of hyperglycemia[26]. In this research, non-vegetarians reported a higher prevalence of obesity (52.3%) and other metabolic risk factors. A significant association between vegetarian diets and lower hyperglycemia (p-value<0.05) suggests that dietary choices might help to lower certain metabolic risks. Furthermore, increased intake of processed foods and red meats was positively correlated with the risk of fatty liver disease and type 2 diabetes mellitus[27].

Table 3. Correlation between dietary intake and metabolic risk factors among adults ≤18 years in India

Variables	RDA	Mean Nutrient Intake	Minimum	Maximum	Excess (+) Deficit (-)	r	p-value
Obesity							
Energy (kcal)	1500	1814	800	2609	+314	0.038	0.306
CHO (g)	168	243	105	1800	+75	0.065	0.084
Protein (g)	112	58	20	367	-54	**-0.084***	0.026
Fat (g)	41.6	56.8	16	99	+15.2	0.25	0.507
Hypertension							
Energy (kcal)	2000	1619	1110	2464	-381	0.022	0.558
CHO (g)	275	218	150	343	-57	0.003	0.931
Protein (g)	75	57	28	85	-18	**0.158****	**<0.001**
Fat (g)	55	53	29	91	-2	**0.079***	0.039
Hyperglycaemia							
Energy (kcal)	1500	1656	772	2668	+156	**0.102****	0.008
CHO (g)	130	236	104	1800	+106	**0.089***	0.021
Protein (g)	75	56.1	20	367	-18.9	**0.147****	<0.001
Fat (g)	50	53	17	99	+3	**0.156****	<0.001
Fatty Liver							
Energy (kcal)	1500	1535	772	2921	+35	**0.202****	<0.001
CHO (g)	187	223	104	1800	+36	**0.146****	<0.001
Protein (g)	75	45	20	367	-30	**0.447****	<0.001
Fat (g)	50	47	14	98	-3	**0.246****	<0.001

RDA=Recommended Dietary Allowance, **) Correlation is significant at the 0.01 level (2-tailed), *) Correlation is significant at the 0.05 level (2-tailed)

Table 3 summarizes the relationship between dietary intake and metabolic risk factors, such as hypertension, obesity, fatty liver and hyperglycemia among adults aged ≤18 years in India. In the obese group, mean energy (+314 kcal), carbohydrate (+75 g), and fat (+15.2 g) intake exceeded the recommended daily allowance (RDA), while the protein intake shows a deficit (-54 g) and a negative associated with obesity (r=-0.084, p-value<0.05). This proposes that inadequate protein may contribute to weight gain. Higher protein intake may contribute to obesity prevention, demonstrating a positive correlation with reduced obesity metrics and improved food quality[28]. Conversely, low-protein diets may lead to increased food consumption and fat mass, suggesting a complex relationship among energy balance and protein intake[29].

In hypertensive patients, mean energy (-381 kcal), carbohydrate (-57 g), protein (-18 g), and fat (-2 g) intake fall below the RDA. A statistically significant association is observed between hypertension and protein intake (r=0.158, p-value<0.01), highlighting the importance of adequate protein for vascular health. Dissimilarities in protein consumption are allied to changes in hypertension risk. The finding of the research was consistent with previous research[30], which suggested a diverse consumption of protein sources is inversely related to the development of newly diagnosed hypertension. This indicates that varying protein sources and meal timing may lower the risk of hypertension[16]. The correlation coefficient (r=0.079) and p-value (0.039) indicate a weak but statistically significant relationship between fat intake and blood pressure. This suggests that fat consumption may affect blood pressure levels, with a positive association between fat intake and high blood pressure levels. This significant association further supports the influence of dietary fat in affecting blood pressure regulation[31].

The respondent who were hyperglycemic, consumed energy (+156 kcal), carbohydrate (+106 g), and fat (+3 g) which exceeded RDA, with a significant positive

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association for carbohydrate (r=0.089, p-value=0.021) and fat (r=0.156, p-value<0.01) intake. This is likely due to the impact of unhealthy carb and fat consumption on insulin sensitivity. Protein intake is deficient (-18.9 g) but shows a positive correlation with hyperglycemia (r=0.147, p-value<0.01), suggesting that insufficient protein may impair glycemic control. Additionally, the significant positive correlation was found with elevated HbA1C levels indicated that a higher intake of these macronutrients may increase the risk of hyperglycemia[32].

In fatty liver respondents, energy (+35 kcal, r=0.202, p-value<0.001) and carbohydrate (+36 g, r=0.146, p-value<0.001) intake is slightly elevated and shows a significant positive correlation, indicating that even minor excess energy and carbohydrate consumption may contribute to the progress of fatty liver. Protein deficiency (-30 g) shows a strong positive correlation with fatty liver (r=0.447, p-value<0.001), emphasizing the critical role of adequate protein intake in maintaining liver health. Fat intake is somewhat lesser than the RDA (-3 g) but still positively correlated with fatty liver (r=0.246, p-value<0.001), suggesting that fat quality may play a greater role than quantity in liver-related conditions, indicating that the quality of fat may be more significant than its quantity in liver-related conditions. Research further supports these findings, showing that excessive caloric consumption is positively associated with the severity of fatty liver disease[34]. Higher fatty liver were associated with increased intake of carbohydrates, particularly from carbonated beverages and canned foods[34].

This research shows the relationship between physical activity, perceived stress, and smoking. Alcohol consumption and metabolic risk factors (hypertension, obesity, fatty liver, and hyperglycemia). Light physical activity showed a significant negative correlation with obesity (r=-0.204, p-value<0.001) and hyperglycemia (r=-0.139, p-value<0.001), suggesting that even low-intensity activity may reduce the risk of obesity and high blood sugar levels. Sedentary lifestyles are a key cause of obesity worldwide, and physical inactivity has been related to a progressive chronic diseases[35]. Absence of physical activity not only raises the risk of obesity but also aggravates linked health conditions such as diabetes and heart disease[35]. As a result, increasing physical activity can aid maintain a healthy body weight and lower blood sugar levels[36].

Low perceived stress was positively correlated with reduced hypertension (r=0.348, p-value<0.001), hyperglycemia (r=0.362, p-value<0.001), and fatty liver (r=0.493, p-value<0.001). This suggested that individuals experiencing lower stress levels are protective against these metabolic conditions. Moderate stress levels were associated with higher rates of hypertension (15.2%) and hyperglycemia (10%), underscoring the detrimental role of stress in metabolic health. Chronic stress in hyperglycemic patients may trigger "diabetes distress," increased blood sugar levels, and mental deficits due to oxidative stress in the brain[37], supporting our findings that stress is linked to diabetes. Research also shows that stress is a major element in hypertension, with an adjusted prevalence ratio of 3.963 for stress as a risk factor[38], emphasizing the importance of adequate stress management in hypertension[39]. People with the severe stress levels had a 17% highest risk of having fatty liver[40].

Alcohol use had a substantial positive connection with obesity (r=0.121, p-value<0.001), hypertension (r=0.173, p-value<0.001), and hyperglycemia (r=0.191, p-value<0.001). This suggests that alcohol consumption raises the risk of several metabolic disorders, possibly due to its effects on weight growth and glucose metabolism. There was a weak negative connection between smoking and fatty liver (r=-0.106, p-value<0.001). Smoking habit showed the inverse correlation with the metabolic risk factors and alcohol intake is positively correlated with obesity (r=0.121, p-value<0.001), hypertension (r=0.173, p-value<0.001), and hyperglycaemia (r=0.191, p-value<0.001), indicating that consumption of alcohol is linked with elevated risk for metabolic disorders (Table 4).

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Table 4. Correlation between physical activity, stress levels, and metabolic risk factors

Variables	Obesity n (%)	Kendall Correlation	Hypertension n (%)	Kendall Correlation	Hyperglycaemia n (%)	Kendall Correlation	Fatty liver n (%)	Kendall Correlation
Physical Activity								
Light Activity	210 (50)	**p-value<0.001 r=-0.204****	80 (19)	p-value=0.475 r=-0.33	65 (15.5)	**p-value<0.001 r=-0.139****	192 (46)	p-value=0.075 r=0.087
Moderate Activity	48 (11.4)		24 (5.7)		8 (1.9)		63 (15)	
Perceived Stress								
Low	123 (29)	p-value=0.168 r=0.063	40 (9.5)	**p-value<0.001 r=0.348****	31 (7.3)	**p-value<0.001 r=0.362****	180 (43)	**p-value<0.001 r=0.493****
Moderate	135 (32)		64 (15.2)		42 (10)		148 (35)	
Smoking								
Yes	15 (3.5)	p-value=0.942 r=0.003	5 (1.2)	p-value=0.306 r=-0.047	9 (2)	p-value=0.363 r=0.043	21 (5)	p-value=0.030 r=-0.106
No	243 (58)		99 (23.6)		64 (15)		233 (56)	
Alcohol								
Yes	27 (6.4)	**p-value<0.001 r=0.121****	15 (3.5)	**p-value<0.001 r=0.173****	11 (2.6)	**p-value<0.001 r=0.191****	19 (4.5)	p-value=0.556 r=0.029
No	231 (55)		89 (21.2)		62 (14.7)		235 (56)	

n=number of respondents, %=percentage, r=correlation, **) Correlation is significant at the 0.01 level (2-tailed)

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Strength and Limitations of Research

Respondents likely represent a varied socioeconomic and cultural demographic within Coimbatore, enriching the generalizability of findings, particularly in urban Indian settings. The research can provide tailored insights into regional dietary patterns, such as the influence of traditional South Indian diets on metabolic health. The findings can inform targeted interventions (e.g., dietary counselling, health promotion) to address metabolic risks in urban private healthcare users, who may represent a significant proportion of the population at risk. People may unintentionally omit foods they consumed or include foods they did not eat. RAPA relies on reported data, which can lead to overestimation or underestimation of physical activity due to recall bias or social desirability bias.

CONCLUSIONS

The results related to metabolic syndromes such as obesity, hyperglycemia, hypertension, and fatty liver disease indicate a strong and significant association between nutrient intake and the progression of disease. Low-protein diets are often tended to elevate the fat mass and food intake, indicating a negative correlation between the consumption of protein and obesity, which may aid in preventing obesity by increasing the consumption of protein. Findings on hypertension indicate a significant association between fat and protein intake and increased blood pressure, implying that time and balancing of protein sources are critical for reducing hypertension risk. Furthermore, elevated levels of stress are strongly associated with hypertension, indicating that stress is an independent risk factor.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

The authors have no conflicts of interest to disclose. The research is self-funded.

AUTHOR CONTRIBUTIONS

SD: responsible for conceptualization, supervision in data collection, writing original draft, drafted the initial manuscript and revised it based on feedback from co-authors; KA: supervision of data collection, review of literature, and contributed to the interpretation of findings related to dietary patterns and metabolic risk factors; SS: prepare research concepts and designs, data collection and compilation; CLV: conducted a critical review of the manuscript, prepare research concepts and designs, make revisions and write methodology and make revisions; VY: assisted with data curation, compilation and statistical analysis; VK: provided guidance on the clinical implications of the research findings, input and suggestions for writing manuscripts, makes revisions in the chapter discussing the manuscript.

REFERENCES

1. Swarup, S., Ahmed, I., Grigorova, Y. *et al.* Metabolic syndrome. In: StatPearls [Internet]. StatPearls Publishing; 2024. Available from: https://www.ncbi.nlm.nih.gov/books/NBK459248/ (accessed 7 March 2024).
2. Saxena, V. Rising trends of overweight and obesity among women in India. *Healthline J. Indian Assoc. Prev. Soc. Med.* **13**, 390 (2022). https://doi.org/10.51957/healthline_390_2022
3. Mohammad, R., Dhananjay, W. & Bansod, H. Hypertension in India: A gender-based research of prevalence and associated risk factors. *Preprint* at https://doi.org/10.21203/rs.3.rs-4303137/v1 (2024).
4. Agrawal, A. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. *Diabetes Res. Clin. Pract.* **186**, 109119 (2022). https://doi.org/10.1016/j.diabres.2021.109119
5. Riazi, K., Azhari, H., Charette, J.H. *et al.* The prevalence and incidence of NAFLD worldwide: a systematic review and meta-analysis. *Lancet Gastroenterol. Hepatol.* **7**, 851–861 (2022). https://doi.org/10.1016/S2468-1253 (22)00165-0
6. Teng, M.L., Ng, C.H., Huang, D.Q. *et al.* Global incidence and prevalence of non-alcoholic fatty liver disease. *Clin. Mol. Hepatol.* **29** (Suppl), S32–S42 (2023). https://doi.org/10.3350/cmh.2022.0365
7. Varghese, J.S., Mohammed, K. & Ali, M.K. Abstract 13817: Diabetes prevalence, screening, diagnosis, treatment and control in India: A cross-sectional research of individuals aged 18 years and older. *Circulation* **146** (Suppl 1), A13817 (2022). https://doi.org/10.1161/circ.146.suppl_1.13817
8. Anjana, R.M., Unnikrishnan, R., Deepa, M. *et al.* Metabolic non-communicable disease health report of India: The ICMR-INDIAB national cross-sectional research (ICMR-INDIAB-17). *Lancet Diabetes Endocrinol.* **11**, 474–489 (2023). https://doi.org/10.1016/S2213-8587 (23)00119-5
9. Elhence, A.S., Bansal, B., Gupta, H. *et al.* Prevalence of non-alcoholic fatty liver disease in India: A systematic review and meta-analysis. *J. Clin. Exp. Hepatol.* **12**, 818–829 (2022).
10. Liss, D.T., Uchida, T., Wilkes, C.L. *et al.* General health checks in adult primary care: A review. *JAMA* **325**, 2294–2306 (2021). https://doi.org/10.1001/jama.2021.6524
11. Olatona, F.A., Onabanjo, O.O., Ugbaja, R.N. *et al.* Dietary habits and metabolic risk factors for non-communicable diseases in a university undergraduate population. *J. Health Popul. Nutr.* **37**, 21 (2018). https://doi.org/10.1186/s41043-018-0152-2
12. Reinhardt, S.L., Boehm, R., Blackstone, N.T. *et al.* Systematic review of dietary patterns and sustainability in the United States. *Adv. Nutr.* **11**, 1016–1031 (2020). https://doi.org/10.1093/advances/nmaa026

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13. Gutiérrez-Pliego, L.E., Camarillo-Romero, E., Montenegro-Morales, L.P. *et al.* Dietary patterns associated with BMI and lifestyle in Mexican adolescents. *BMC Public Health* **16**, 850 (2016). https://doi.org/10.1186/s12889-016-3527-6
14. Cordain, L., Eaton, S.B., Sebastian, A. *et al.* Origins and evolution of the Western diet: Health implications for the 21st century. *Am. J. Clin. Nutr.* **81**, 341–354 (2005). https://doi.org/10.1093/ajcn.81.2.341
15. Imamura, M., Sasaki, H., Shinto, T. *et al.* Association between Na, K, and lipid intake in each meal and blood pressure. *Front. Nutr.* **9**, 853118 (2022). https://doi.org/10.3389/fnut.2022.853118
16. Sanz-Valero, J., Banerjee, P.G., Reddy, B., Panda, H.K., Kumar, T.S., Reddy, J., & SubbaRao, M.G. Diets, lifestyles and metabolic risk factors among corporate information technology (IT) employees in South India. Nutrients 15, 3404 (2023). https://doi.org/10.3390/nu15153404
17. Charan, J., Kaur, R., Bhardwaj, P., Singh, K., Ambwani, S. & Misra, S. Respondent size calculation in medical research: A primer. Ann. Natl. Acad. Med. Sci. India 57, 74–80 (2021).
18. Topolski, T.D., LoGerfo, J., Patrick, D.L., Williams, B., Walwick, J. & Patrick, M.B. The Rapid Assessment of Physical Activity (RAPA) among older adults. Prev. Chronic Dis. 3, A118 (2006).
19. Cohen, S., Kamarck, T. & Mermelstein, R. A global measure of perceived stress. J. Health Soc. Behav. 24, 386–396 (1983).
20. Taufik, M. A. et al. Reducing Perceived Stress of Family Caregivers of Older Adult: The Role of Caregiving Self- Efficacy and Social Support. International Journal of Academic Research in Business and Social Sciences 13, (2023).
21. Zhang, K. et al. Metabolic diseases and healthy aging: Identifying environmental and behavioral risk factors and promoting public health. Front. Public Health 11, 1253506 (2023). https://doi.org/10.3389/fpubh.2023.1253506
22. Hu, J., Du, Y., Zhou, Y. & Wang, H. High sensitivity troponins and mortality in the population with metabolic dysfunction-associated steatotic liver disease. Sci. Rep. 14, 19541 (2024).
23. Nayak, D., Mayappanavar, R. & Sonavane, R. Assessment of risk factor profile of non-communicable diseases among bank employees in the Gadag district. Int. J. Community Med. Public Health 10, 2160–2164 (2023). https://doi.org/10.18203/2394-6040.ijcmph20231697 (Accessed: 9 September 2024).
24. Gupta, S., Ramtej, K.S.J., & Verma, J. Prevalence of alcoholic and non-alcoholic fatty liver disease among different occupations and associated metabolic changes: A hospital-based research. J. Med. Pharm. Allied Sci. 11, 2338 (2022). https://doi.org/10.55522/jmpas.v11i2.2338
25. Zhang, F. et al. Smoking and risk of non-alcoholic fatty liver disease: A meta-analysis of observational studies. Liver Int. 40, 1350–1360 (2020). https://doi.org/10.1111/liv.14411
26. Knop, J.A., Vølund, K., O'Donnell, M.M. et al. Chronic alcohol consumption and its effects on glucose metabolism: A review. Alcohol. Clin. Exp. Res. 42, 119–129 (2018). https://doi.org/10.1111/acer.13516
27. Reuter, A.M., Lee, S.E. & Roberts, J.T. Associations of meat consumption with risk of non-alcoholic fatty liver disease and type 2 diabetes. Am. J. Clin. Nutr. 111, 662–671 (2020). https://doi.org/10.1093/ajcn/nqz287
28. Arini, H.R.B., Leech, R.M., Tan, S-Y. & McNaughton, S.A. Association between protein intake, diet quality, and obesity in Australian adults: A comparison of measurement units. Proc. Nutr. Soc. (2024). https://doi.org/10.1017/s0029665124001290
29. Pezeshki, A., Zapata, R.C., Singh, A., Yee, N.J., & Chelikani, P.K. Low protein diets produce divergent effects on energy balance. Sci. Rep. 6, 25145 (2016). https://doi.org/10.1038/srep25145
30. Zhou, C., Wu, Q., Ye, Z. et al. Inverse association between variety of proteins with appropriate quantity from different food sources and new-onset hypertension. Arter. Gipertenz. (2022). https://doi.org/10.1161/HYPERTENSIONAHA.121.18222
31. Coelho-Júnior, H.J. et al. High protein intake at lunch is negatively associated with blood pressure in community-dwelling older adults: A cross-sectional research. Nutrients 15, 1251 (2023). https://doi.org/10.3390/nu15051251
32. Furukawa, T. et al. Effect of the interaction between physical activity and estimated macronutrient intake on HbA1c: Population-based cross-sectional and longitudinal studies. BMJ Open Diabetes Res. Care 10, e002479 (2022). https://doi.org/10.1136/bmjdrc-2021-002479
33. Batten, T. Systematic review and meta-analysis: The role of diet in the development of nonalcoholic fatty liver disease. Clin. Gastroenterol. Hepatol. 21, 1–20 (2023). https://doi.org/10.1016/j.cgh.2021.11.026
34. Szilagyi, A. Is increased caloric intake a feature of NAFLD regardless of the presence of obesity? Clin. Gastroenterol. Hepatol. (2023). https://doi.org/10.1016/j.cgh.2023.08.032
35. Hamberger, U. Physical activity and obesity: Underlying mechanisms and practical actions. (2024). https://doi.org/10.23785/tu.2024.03.003
36. Amirudin, I. Physical activity and blood glucose levels in diabetes mellitus patients. J. Bina Sehat 7, 483 (2023). https://doi.org/10.29082/ijnms/2023/vol7/iss2/483
37. Asonye, C.C. Diabetes distress: The untold hidden struggle of living with diabetes mellitus. Afr. J. Health Nurs. Midwifery 7, (2023). https://doi.org/10.52589/ajhnm-98vrwpip
38. Halim, R. et al. Stress is the dominant factor of hypertension. East Asian J. Multidiscip. Res. 1,

1612 (2022). https://doi.org/10.55927/eajmr.v1i9.1612
39. Firanggi, Z.A. et al. Correlation between socio-economic factors and stress with hypertension cases during the COVID-19 pandemic. Poltekita: J. Ilmu Kesehatan 16, (2023). https://doi.org/10.33860/jik.v16i4.1626
40. Kang, D. et al. Perceived stress and non-alcoholic fatty liver disease in apparently healthy men and women. Sci. Rep. 10, 57036 (2020). https://doi.org/10.1038/S41598-019-57036-Z
41. Manish, V., Madhulika, T. & Brijesh, K. S. Dietary determinants of metabolic syndrome: Focus on obesity and metabolic dysfunction-associated steatotic liver disease (MASLD). IntechOpen (2024). https://doi.org/10.5772/intechopen.114832
42. Beeke, P., Vahlhaus, J. & Pivovarova-Ramich, O. Meal timing and its role in obesity and associated diseases. *Front. Endocrinol.* (2024). https://doi.org/10.3389/fendo.2024.1359772

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