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RESEARCH ARTICLE

A Community-Based Cross-Sectional Study on the Prevalence and Associated Factors of Pre-Diabetes and Pre-Hypertension Among Persons Aged 18 to 40 Years in the Rural Field Practice Area of Government Medical College, Tamil Nadu, 2025

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Abstract

Background: Pre-diabetes and pre-hypertension are early, reversible stages in the natural course of diabetes and hypertension, yet they are often overlooked. Addressing these early stages among young adults is essential to halt the progression to full-blown diabetes, hypertension, and their associated complications, such as cardiovascular and renal diseases. Identifying the prevalence and associated risk factors in this age group can guide timely public health interventions and strengthen preventive efforts at the primary care level. **Aim:** This study aimed to assess the prevalence and associated factors of pre-hypertension and pre-diabetes among individuals aged 18-40 years in a rural area in Tamil Nadu. **Methods:** A community-based cross-sectional study was conducted among 147 adults aged 18-40 years from Medavakkam village, Chengalpattu district, between May and August 2025. Participants were selected using multistage sampling. Data were collected using a semi-structured questionnaire adapted from the WHO STEPS tool. Anthropometric measurements, fasting capillary blood glucose, and blood pressure were assessed using standard protocols. Statistical analysis was performed using Epi Info v7.2.6.0. **Results:** The prevalence of pre-hypertension was 38.8% (95% CI: 30.9% - 47.2%), and pre-diabetes was 21.8% (95% CI: 15.4% - 29.3%). Pre-hypertension was significantly associated with male gender, married status, inadequate physical activity, and obesity (BMI). Pre-diabetes was significantly associated with abdominal obesity as measured by waist circumference. **Conclusion**: A high burden of pre-diabetes and pre-hypertension was observed among young adults in a rural setting, with lifestyle and obesity-related factors contributing significantly. Strengthening early screening and targeted health promotion under the existing population-based screening framework is essential to prevent progression to full-blown NCDs.

Keywords: Non-Communicable Disease, Pre-Diabetes, Pre-Hypertension, Risk Factors

1. Introduction

Noncommunicable Diseases (NCDs) account for 74% of all deaths worldwide, killing around 41 million people every year[1]. Among these, Cardiovascular Diseases (CVDs) and diabetes mellitus take up a significant proportion, contributing to substantial morbidity and mortality globally[1]. Hypertension (HTN), which is a key risk factor for CVDs, is characterised by elevated pressure in the blood vessels. Globally, an estimated 1.28 billion persons between the ages of 30 and 79 have hypertension[2]. The prevalence of hypertension in India is around 28.1%[3]. Diabetes Mellitus (DM), a chronic metabolic disease, is characterised by a hallmark of persistently high blood sugar levels, which over time

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can cause serious damage to the heart, blood vessels, eyes, kidneys and nerves[4]. The global prevalence of DM is 9.3% in 2019 and is projected to rise to 10.9% by 2045[5]. In 2021, 9.6% of Indians had diabetes, according to the IDF Diabetes Atlas, and it is further expected to reach 10.9% by 2045[6].

According to the TN STEPS survey conducted in 2020, the prevalence of HTN in Tamil Nadu was around 33.9% and it was higher in the age group of 45-69 years (48.8%) as compared to those aged 18-44 years (21.8%)[7]. Similarly, the prevalence of DM in Tamil Nadu was around 17.6% and it was nearly 27.5% among those aged 45-69 years as compared to 9.6% among 18-44 years of age[7].

Both DM and HTN are closely interrelated and share similar risk factors like obesity, dyslipidemia, sedentary lifestyles, unhealthy eating habits, and they frequently coexist[8].

Prediabetes and prehypertension, intermediate conditions on the spectrum of disease progression, offer a critical window for preventive interventions. Addressing these early stages is essential to halt the progression to full-blown diabetes, hypertension, and their associated complications, such as cardiovascular and renal diseases.

The global prevalence of Impaired Glucose Tolerance (IGT) in 2021 was 9.1% (464 million people) and is projected to rise to 10.0% (638 million) by 2045. High-income countries currently have the highest prevalence, but the largest growth is expected in low-income countries[9]. Further, the prevalence of prediabetes in India was 8.3% in Tamil Nadu, 12.8% in Maharashtra, 5.3% in Jharkhand, and 14.6% in Chandigarh[10].

The age group of 18–40 years represents a critical period in life where modifiable risk factors for NCDs, such as physical inactivity, unhealthy diet, and obesity, begin to manifest and become ingrained. However, health-seeking behaviour and awareness regarding prediabetes and prehypertension remain poor in rural areas, leading to delayed diagnosis and intervention.

Focusing on this younger age group provides an opportunity for early detection and timely intervention, preventing the progression to diabetes and hypertension, which would otherwise increase the long-term burden on healthcare systems.

Given this background, the proposed study aims to estimate the prevalence of prediabetes and prehypertension among individuals aged 18 to 40 years in the rural field practice area of a Government Medical College in Tamil Nadu. Additionally, the study seeks to identify the associated factors for these conditions, which will aid in developing tailored preventive interventions and public health policies to address the growing burden of NCDs in rural India.

2. Aim and Objectives

- To estimate the prevalence of Pre-hypertension and Pre-diabetes among people aged 18 to 40 years in the rural field practice area of Madras Medical College, Chennai, Tamil Nadu, 2025
- To determine the factors associated with the prevalence of Pre-hypertension and Pre-diabetes among people aged 18 to 40 years in the rural field practice area of Madras Medical College, Chennai, Tamil Nadu, 2025.

3. Review of Literature

Non-Communicable Diseases (NCDs), also known as lifestyle diseases, are recognised as one of the leading causes of disease burden with substantial contribution to morbidity and mortality globally[11]. The world is currently undergoing an epidemiological transition, in which the burden of disease has shifted from communicable to non-communicable conditions.

The term "epidemiological transition" refers to the gradual shift from a disease burden dominated by acute infectious and nutritional deficiency diseases, typical of underdevelopment, to a predominance of chronic Non-Communicable Diseases (NCDs), characteristic of modernised and developed populations. This transition is a continuous ongoing process, with some diseases declining while others emerge or re-emerge over time[12].

There are two key components of the epidemiological transition:

1. Demographic changes: A shift in population age distribution from younger to older age groups due to declining birth and death rates.
2. Mortality pattern changes: Rising life expectancy and a transition in leading causes of death from infectious diseases to chronic illnesses.

3.1 Factors Driving the Epidemiological Transition

The shift towards NCD dominance in disease burden is primarily influenced by demographic and behavioural changes driven by socioeconomic growth and development. Several key factors contribute to this transition:

- Ageing population: As life expectancy is up, more individuals live into their 50s and 60s, which means they are at risk for chronic diseases for longer.
- Urbanisation and industrialisation: These processes bring lifestyle changes that increase the risk of NCDs.
- Unhealthy lifestyles: Diets high in saturated fats.

3.2 Burden of Hypertension

The Global Report on Hypertension 2023 reveals a major gap in hypertension management, while 54% of adults with hypertension are diagnosed, only 42% receive treatment, and a mere 21% have their blood pressure under control. Furthermore, regional trends indicate that hypertension rates declined in the WHO European region between 1990 and 2019; however, they rose in many Asian countries. In the WHO Southeast Asia Region (covering India), the rates climbed from 29% to 32%[13].

Hypertension is the biggest health risk factor in India, playing a major role in disease burden and mortality. WHO data from 2019 shows that 31% of adults aged 30-79 years had hypertension, which translates to around 188.3 million people[14]. Meanwhile, the NFHS-5 survey (2019-2021) found that 23% of adults aged 15 and above had hypertension[15].

The ICMR-INDIAB-17 study, conducted by the Indian Council of Medical Research (ICMR) between 2008 and 2020, was a national-level cross-sectional population-based study that assessed hypertension prevalence in India. The findings revealed an overall hypertension prevalence of 35.5% (95% CI: 33.8–37.3)[16].

3.3 Burden of Diabetes

According to data published by the NCD Risk Factor Collaboration (NCD-RisC) there are significant global variations in diabetes prevalence, with about 20% of adults aged 18 and older affected in the WHO South-East Asia and Eastern Mediterranean regions. These two regions, along with Africa, also have the lowest coverage for diabetes treatment. Fewer than 4 out of 10 persons with diabetes get diabetes treatment[17].

Based on the ICMR-INDIAB national cross-sectional study, the prevalence of Diabetes is 11.4% and prediabetes is 15.3% of Indian adults (aged 20+), which equates to over 100 million adults in India[16].

3.4 Effects of Hypertension and Diabetes

Undetected and uncontrolled hypertension and diabetes can lead to many health problems. In most cases, damage happens over time. Diabetes and hypertension are closely interlinked because of similar risk factors and vascular processes that lead to structural remodelling, thereby producing microvascular and macrovascular complications[18].

Heart:

Heart disease is the leading cause of death in individuals with hypertension and diabetes. Congestive Heart Failure (CHF), either diastolic heart failure, systolic failure, or a combination of the two, is common among hypertensives. People with hypertension or diabetes end up with Left Ventricular Hypertrophy (LVH), increased atrial size, atherosclerotic coronary artery disease, microvascular disease, cardiac arrhythmias, including atrial fibrillation[19].

Brain:

- Stroke:
  Approximately 85% of strokes are caused by either intracerebral or subarachnoid haemorrhage. The risk of stroke increases steadily with rising blood pressure. Managing hypertension significantly reduces the occurrence of both ischemic and hemorrhagic strokes[20].
- Impaired Cognition and Dementia:
  Hypertension is linked to the accumulation of beta-amyloid, a key pathological factor in dementia. Beyond just blood pressure levels, arterial stiffness and fluctuations in blood pressure between visits may contribute to subclinical small vessel disease and, over time, lead to cognitive decline. Cognitive impairment and dementia associated with hypertension may also result from either a single infarct caused by a blockage in "a strategic" larger artery or from multiple lacunar infarcts due

to the occlusion of small vessels, which can lead to subcortical white matter ischemia[21].

- Hypertensive Encephalopathy:
  This condition occurs when cerebral blood flow autoregulation fails at high blood pressure levels, leading to vasodilation and hyperperfusion. If untreated, hypertensive encephalopathy can rapidly progress to stupor, coma, seizures, and even death within hours[22].

Kidney:

Hypertensive and diabetic nephropathy: Hypertension-related vascular damage in the kidneys primarily affects the preglomerular arterioles, causing ischemic changes in the glomeruli and post- glomerular structures. Glomerular injury can also arise from direct damage to the glomerular capillaries due to hyperperfusion. As this progresses, it eventually causes ischemia and atrophy of the tubules of the kidney[23].

- End-Stage Renal Disease (ESRD): Chronic systemic hypertension causes irreversible damage to the kidneys. Hypertension accounts for 27% of end-stage kidney disease cases, making it the second leading cause of ESRD, following diabetic nephropathy[24].
- Acute Renal Failure: Malignant hypertension creates intense hemodynamic stress, leading to fibrinoid necrosis of small blood vessels, which can result in acute renal failure[25].
- Peripheral arteries: Peripheral Arterial Disease (PAD) in the iliac, femoral, and popliteal arteries are mainly attributed to hypertension. This results from arterial stiffness and vascular remodelling caused by persistently elevated blood pressure[26].

Retina:

Fundoscopic features are used to identify hypertensive and diabetic retinopathy, which typically shows few symptoms[26].

3.5 Factors Associated with Diabetes and Hypertension

High blood pressure is a risk factor for both heart disease and renal disease on its own. It is also a risk factor for diabetes, which has its own set of risk factors. There was a far higher chance of getting diabetes when blood pressure is not under control.

According to the World Health Organisation (WHO), its high prevalence is influenced by a range of contributing factors, including behavioural habits and broader social determinants. The risk factors of hypertension are broadly classified into modifiable and non-modifiable risk factors[27].

Non-modifiable risk factors

- Age
- Sex
- Genetic factors
- Ethnicity

Modifiable risk factors

- Overweight and Obesity
- Excess salt intake
- Less fruit and vegetable intake
- Lack of Physical activity
- Tobacco use
- Alcohol consumption
- Socioeconomic status

Though rapid urbanisation has played a pivotal role in the epidemiological shift, driving changes in daily routines, dietary habits, and lifestyles, rural areas are experiencing a rapid shift, contributing to the surge in NCDs such as diabetes, hypertension, and cardiovascular diseases. In countries that are experiencing an epidemiological transition with deleterious changes in lifestyle and concurrent economic development, prevention of hypertension and diabetes is critical, due to the possibility of significant cardiovascular disease epidemics.

The review of existing literature highlights the growing burden of hypertension and diabetes, particularly in low- and middle-income countries like India. While substantial research has documented the prevalence and complications of these conditions, there is a relative paucity of community-based studies focusing on the preclinical stages, like pre-diabetes and pre-hypertension, especially among younger adults in rural settings. Early identification and modification of risk factors during this age group can significantly reduce long-term health complications and healthcare costs. Therefore, understanding the prevalence and determinants of these pre-disease states in rural young

adults is not only timely but also critical for designing effective preventive strategies and strengthening the NCD component of primary healthcare services.

4. Materials and Methods

A community-based, cross-sectional study was done among people aged 18-40 years who are residents of Medavakkam village, St. Thomas Mount Block in Chengalpattu district, which is a rural field practice area of Madras Medical College, from May 2025 to August 2025. Sample size was calculated based on a study conducted by R M Anjana *et al.,* in which the prevalence of pre-diabetes was 8.3%[10]. With a confidence level of 95%, absolute precision 5%, design effect 1.2, and non- response rate 10%, the sample size was calculated to be 157.

Inclusion criteria

- Persons aged between 18 years and 40 years of both genders who are residents in the Medavakkam Upgraded Primary Health Centre area of St. Thomas Mount Block in Chengalpattu district for more than 6 months.
- Those who give informed consent after understanding the purpose and the procedures involved.

Exclusion criteria

- Pregnant women
- Post-partum women
- Individuals with known diabetes mellitus or hypertension
- Individuals who are severely ill or have disabilities that may interfere with participation in the study.

4.1 Sampling Methodology

A multi-stage sampling technique was employed to select study participants for the study. There are 4 Health Sub-Centres (HSCs) in the Medavakkam block. In the first stage, 1 village was randomly selected from each HSC area using simple random sampling. In the second stage, 1 ward was selected from each village, again by simple random sampling. After boundary mapping, households within each selected ward were chosen using systematic random sampling. Finally, 1 eligible member from each selected household was chosen using the KISH selection method, ensuring unbiased selection within households. A total of 147 participants were selected, 37, 36, 37, and 37 from the respective HSCs.

4.2 Data Collection

Eligible participants were identified and interviewed in-person at their households using a semi- structured questionnaire, which includes the WHO STEP-wise approach for the surveillance of Non- Communicable Disease risk factors study tool[28]. The questionnaire collected information on socio- demographic characteristics (age, sex, marital status, education, occupation, income), tobacco use, alcohol consumption, fruit and vegetable intake, and level of physical activity.

Anthropometric data were collected using standardised protocols:

- Height was measured to the nearest 0.1 cm using a portable stadiometer, with participants standing erect, barefoot, with heels, buttocks, and upper back touching the vertical surface.
- Weight was recorded to the nearest 0.1 kg using a calibrated electronic weighing scale placed on a firm, level surface, with participants barefoot and standing upright.
- Waist circumference was measured to the nearest 0.1 cm at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest.
- Hip circumference was measured at the widest point of the buttocks using a non-stretchable measuring tape.

Blood pressure was measured using a calibrated automatic digital blood pressure monitor (OMRON). Participants were seated comfortably with legs uncrossed and asked to rest for 15 minutes before measurement. The cuff was placed on the left upper arm, with the arm supported at heart level. Three readings were taken at five-minute intervals, and the average of the second and third readings was considered for analysis.

Fasting capillary blood glucose was measured using the ACCU-CHEK Instant S glucometer. Participants were informed the day before and instructed to fast for at least 8 hours overnight. On the day of assessment, participants were asked to confirm their fasting status and capillary blood samples were collected following infection control protocols.

Operational definitions

- Pre-hypertension: Systolic BP 120-139 mmHg or Diastolic BP 80-89 mmHg[28].
- Pre-diabetes: Fasting capillary glucose ≥110 and <126 mg/dL[29].
- Adequate physical activity: 150-300 minutes of moderate-intensity physical activity or 75-150 minutes of vigorous-intensity physical activity[30].
- Abdominal obesity: Waist circumference and waist-hip ratio are used as measures of abdominal obesity. Waist circumference ≥ 94 cm for men and ≥ 80 cm for women. Waist Hip Ratio: >0.90 for men and >0.85 for women[27].
- Fruits and vegetable consumption: One standard serving is equal to 80 grams of vegetables or fruits or one medium piece of fruit (apple, banana, orange, guava, etc.). An adult should consume at least 400 g (i.e. five portions) of fruit and vegetables per day[27].

Data management and analysis

The collected data were entered and cleaned in Microsoft Excel, and statistical analysis was performed using Epi Info version 7.2.6.0. Categorical variables were presented as frequency and proportion, continuous variables were presented as mean and standard deviation if normally distributed and median and interquartile range, if not normally distributed. The prevalence of pre- diabetes and pre-hypertension was estimated and reported as proportions with 95% confidence intervals (95% CI). Statistical tests such as the Chi-square test, Fisher's exact test, and logistic regression were used to find the association between various socio-demographic and behavioural factors and pre-diabetes and pre-hypertension. A p-value of less than 0.05 was considered statistically significant.

Ethical consideration

Permission to conduct the study was obtained from the Institutional Ethics Committee of Madras Medical College, Chennai (IEC: 22062025). Informed written consent was obtained from all participants before data collection. Participants were interviewed in a neutral place in isolation from others, ensuring privacy, and they were informed that the data collected would be kept confidential. Unique identifiers were used to maintain participant anonymity.

5. Results (Including Observations)

A total of 147 individuals aged between 18 and 40 years participated in the study. The median age of the participants was 35 years, and females formed the majority (67.4%). The socio- demographic details of the participants are shown in Table 1.

Out of 147 participants, 21.1% reported having ever used smoking tobacco, with nearly all of them (96.8%) using it daily. Though daily use was minimal, smokeless tobacco use was reported by 8.2% of the participants. Passive smoking exposure was noted in 34%, predominantly at home.

Alcohol consumption was reported by 10.9% of the participants, all of whom had consumed alcohol in the past year, though only 25% had done so in the past month. These findings highlight the presence of substance use behaviours even in a relatively young rural population (Tables 2 and 3).

Even though fruit consumption was reported by 68.7% of the participants, and all individuals consumed vegetables, only 25.9% met the recommended intake of at least five servings of fruits and vegetables per day. With regard to physical activity, vigorous- or moderate-intensity activity, either during work or leisure, was reported only by a small proportion of participants. Walking or cycling for travel was reported by 20.4%. Notably, 78.9% of the participants had sedentary behaviour lasting six or more hours per day. These findings indicate suboptimal dietary patterns and physical inactivity among the study population (Tables 4 and 5).

Based on the Asia Pacific classification of BMI, 36.1% of the participants were obese, and 29.9% were overweight, indicating that nearly two-thirds of the study population had excess body weight. Abdominal obesity, measured by waist circumference, was observed in 29.9% of individuals. Furthermore, 24.5% had a high waist-hip ratio, suggesting central fat distribution. These findings suggest a high burden of overweight and obesity among adults in the study area (Table 6).

Among the 147 study participants, the prevalence of pre-hypertension was 38.8%, while 6.8% and 4.1% were newly diagnosed with Stage I and Stage II hypertension, respectively (Table 7). The prevalence of pre-diabetes was 21.8%, and 1.4% were newly diagnosed with diabetes (Table 8).

Table 1. Socio-demographic characteristics of the study participants (N=147)

Socio-demographic variable	n	Proportion %
Age in years [Median (IQR)]	35 (29-38)	
≤ 20	7	4.76
21-30	33	22.45
31-40	107	72.79
Gender		
Male	48	32.65
Female	99	67.35
Total no. of family members [Median (IQR)]	4 (1-4)	
Total monthly family income (in thousands) [Median (IQR)]	20 (12-25)	
Socio-economic status (According to BJ Prasad scale)		
Class I	30	20.41
Class II	40	27.21
Class III	39	26.53
Class IV	38	25.85
Education		
Graduate	19	12.93
Higher secondary	27	18.37
Secondary	39	26.53
Middle school	31	21.09
Primary school	31	21.09
Occupation		
Semi-profession [a]	14	9.52
Clerical / shop owner	21	14.29
Skilled worker [b]	16	10.88
Unskilled worker [c]	89	60.54
Student	7	4.76
Marital status		
Married	123	83.67
Unmarried	21	16.33

a: Teacher, Advocate, IT employee, Nurse
b: Cook, Driver, Electrician, Plumber
c: Coolie, Construction laborer, House-keeping worker, Homemaker

Table 2. Tobacco usage among the study participants

Characteristics	n	Proportion %
Smoking tobacco		
Ever used tobacco (N=147)	31	21.09
Daily tobacco use (N=31)	30	96.77
Smokeless tobacco		
Ever used smokeless tobacco (N=147)	12	8.16
Daily smokeless tobacco use (N=12)	1	8.33
Passive smoking		
Passive smoking exposure (N=147)	50	34.01
Passive smoking exposure at home (N=50)	49	98
Passive smoking exposure at work (N=50)	23	46

Table 3. Alcohol consumption among the study participants

Characteristics	n	Proportion %
Ever consumed alcohol (N=147)	16	10.88
Alcohol consumption in the past 12 months (N=16)	16	100
Alcohol consumption in the past 1 month (N=16)	4	25

Table 4. Fruit and vegetable consumption among the study participants (N=147)

Characteristics	n	Proportion %
Fruit consumption	101	68.71
Vegetable consumption	147	100
Adequate fruit and vegetable consumption	38	25.85

In the bivariate analysis, pre-hypertension was significantly associated with older age, lower educational status and behavioural factors such as tobacco use, smokeless tobacco use, passive smoking, alcohol consumption, and inadequate physical activity, also showed significant associations. In addition, overweight and obesity based on BMI were linked to a higher prevalence of pre- hypertension. After adjusting for all variables in multivariate analysis, male gender, married status, inadequate physical activity,

Table 5. Physical activity among the study participants (N=147)

Characteristics	n	Proportion %
Vigorous intensity work	9	6.12
Moderate intensity work	14	9.52
Vigorous intensity leisure activity	19	12.93
Moderate intensity leisure activity	19	12.93
Walking (or) bicycle for travel	30	20.41
Sedentary behaviour duration per day		
≥ 6 hours	115	78.91
< 6 hours	32	21.09

Table 6. Anthropometry of the study participants (N=147)

Characteristics	n	Proportion %
Height [Median (IQR)]	161 (154-168)	
Weight [Median (IQR)]	62 (55-78)	
BMI		
Underweight	7	4.76
Normal	43	29.25
Overweight	44	29.93
Obese	53	36.05
Waist circumference		
High	44	29.93
Normal	103	70.07
Hip circumference [Median (IQR)]	101 (97.9-104.4)	
Waist-hip ratio		
High	36	24.49
Normal	111	75.51

Table 7. Prevalence of pre-hypertension and Hypertension among the study participants (N=147)

Blood pressure	n	Proportion	95% CI
Normal	74	50.34	41.98-61.22
Pre-hypertension	57	38.78	30.86-47.15
Newly diagnosed hypertension Grade I	10	6.8	3.31-12.15
Newly diagnosed hypertension Grade II	6	4.08	1.51-8.67

Table 8. Prevalence of pre-diabetes and diabetes among the study participants (N=147)

Blood sugar	n	Proportion	95% CI
Normal	113	76.87	69.21-83.42
Pre-diabetes	32	21.77	15.39-29.32
Newly diagnosed diabetes	2	1.36	0.17-4.83

and obesity remained significantly associated with pre-hypertension (Tables 9 and 10).

In the bivariate analysis, pre-diabetes was more commonly observed among those with lower education levels, lower socioeconomic status, married individuals, and those with exposure to passive smoking. Obesity, high waist circumference, and high waist-hip ratio were also significantly associated. In the multivariate analysis, only high waist circumference remained significantly associated with pre-diabetes, highlighting abdominal obesity as a key predictor in this population (Tables 11 and 12).

6. Discussion

This community-based cross-sectional study assessed the prevalence and associated factors of pre-diabetes and pre-hypertension among individuals aged 18 to 40 years in a rural area of Tamil Nadu.

The prevalence of pre-hypertension in the present study was 38.8%, which is higher than the 29.7% reported for Tamil Nadu in a secondary data analysis of NFHS-5 (2019–21) conducted by Seenappa K *et al.*, which included adults aged 18 to 54 years[31]. Although direct comparison should be made cautiously due to differences in age groups, our findings suggest that early elevations in blood pressure are emerging even among younger adults in rural settings.

The prevalence of pre-diabetes was 21.8%, which is also higher than the 8.3% reported in Tamil Nadu in the ICMR-INDIAB study by Anjana *et al.*[10]. These findings underline the growing burden of metabolic risk in younger populations, likely reflecting ongoing lifestyle and dietary transitions.

In our study, pre-hypertension was significantly associated with male gender, married status, inadequate physical activity, and obesity. These results are in line with findings from previous studies, which have consistently shown higher rates of pre-hypertension

Table 9. Association of socio-demographic factors and pre-hypertension among the study participants (N=131)

Variables		Pre-hypertension		Normal		Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
		n	%	n	%				
Age	≤ 20 (N=7)	0	0	7	100	Ref			
	21-30 (N=30)	14	46.7	16	53.3	-	**.031***	-	.993
	31-40 (N=94)	43	45.7	51	54.3	-	**.019***	-	.991
Gender	Male (N=44)	22	50	22	50	1.49 (0.72-3.08)	.287	**0.09 (0.01-0.93)**	**.043**
	Female (N=87)	35	40.2	52	59.7				
Relationship status	Married (N=109)	44	40.4	65	59.6	0.47 (0.19-1.19)	.106	0.01 (0-99.9)	**<.001***
	Unmarried (N=22)	13	59.1	9	40.9				
SES (BJ Prasad)	Class I (N=29)	9	31	20	69	Ref			
	Class II (N=35)	13	37.1	22	62.9	1.31 (0.46-3.73)	.609	1.94 (0.36-10.66)	.442
	Class III (N=37)	20	54.1	17	45.9	2.61 (0.94-7.24)	.062	2.18 (0.41-11.75)	.363
	Class IV (N=30)	15	50	15	50	2.22 (0.77-6.44)	.138	3.63 (0.58-22.63)	.168
Education	Graduate, Diploma (N=19)	5	26.3	14	73.7	Ref			
	Higher secondary (N=26)	8	30.8	18	69.2	1.24 (0.33-4.65)	.745	3.44 (0.2-59.1)	.395
	Secondary (N=39)	22	56.4	17	43.6	**3.63 (1.09-12.05)**	**.031**	6.17 (0.68-55.88)	.105
	Middle school (N=25)	9	36	16	64	1.58 (0.43-5.82)	.495	6.36 (0.53-76.3)	.144
	Primary school (N=22)	13	59.1	9	40.9	**4.04 (1.07-15.27)**	**.035**	7.99 (0.69-91.46)	.095

Associations were assessed using the Chi-square test; Fisher's Exact test was applied where expected cell counts were <5
A *p* value <0.05 was considered statistically significant
Statistically significant values are indicated in bold

among males[31,32] and individuals with sedentary lifestyles[31,33,34]. Obesity is a well-established risk factor for elevated blood pressure[31–34], and our study reinforces this association in younger adults.

For pre-diabetes, abdominal obesity was found to be the most significant associated factor.

Participants with high waist circumference had significantly higher odds of having pre-diabetes, even after adjusting for other variables. This aligns with evidence from both national and international studies, which highlight central obesity as a stronger predictor of insulin resistance compared to general obesity[35–37].

Table 10. Association of behavioural risk factors and pre-hypertension among the study participants (N=145)

Variables		Pre-hypertension		Normal		Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
		n	%	n	%				
Ever used tobacco	Yes (N=27)	17	63	10	37	**2.72 (1.13-6.53)**	**.022**	3.77 (0.31-45.45)	.296
	No (N=104)	40	38.5	64	61.5				
Ever used smokeless tobacco	Yes (N=10)	8	80	2	20	**5.88 (1.19-28.86)**	**.015**	1.77 (0.12-26.04)	.674
	No (N=121)	49	40.5	72	59.5				
Passive smoking	Yes (N=42)	24	57.1	18	42.9	**2.26 (1.07-4.78)**	**.031**	1.26 (0.38-4.16)	.704
	No (N=89)	33	37.1	56	62.9				
Ever consumed alcohol	Yes (N=16)	12	75	4	25	**4.67 (1.42-15.37)**	**.007**	7.91 (.61-103.55)	.115
	No (N=115)	45	39.1	70	60.9				
Fruit and vegetable consumption	< 5 servings (N=97)	41	42.3	56	57.7	0.82 (0.38-1.81)	.628	0.18 (0.03-1.18)	.051
	≥ 5 servings (N=34)	16	47.1	18	52.9				
Physical activity	Inadequate (N=98)	51	52	47	48	**4.88 (1.85-12.87)**	**<.001**	**9.49 (1.79-50.15)**	**.008**
	Adequate (N=33)	6	18.2	27	81.8				
BMI	Normal (N=38)	11	28.9	27	71.1	Ref			
	Underweight (N=7)	0	0	7	100	-	.102	-	.992
	Overweight (N=40)	20	50	20	50	2.46 (0.96-6.26)	.057	2.69 (0.58-12.47)	.204
	Obese (N=46)	26	56.5	20	43.5	**3.19 (1.28-7.94)**	**.011**	**4 (1.01-16.56)**	**.049**
Waist circumference	High (N=37)	19	51.4	18	48.6	1.56 (0.72-3.34)	.256	0.39 (0.08-1.75)	.221
	Normal (N=94)	38	40.4	56	59.6				
Waist-hip ratio	High (N=33)	18	54.6	15	45.4	1.82 (0.82-4.02)	.139	1.67 (0.37-7.61)	.508
	Normal (N=98)	39	39.8	59	60.2				

Associations were assessed using the Chi-square test
A p value <0.05 was considered statistically significant
Statistically significant values are indicated in bold

The fact that nearly two-thirds of participants were overweight or obese, and nearly 80% reported six or more hours of sedentary behaviour per day, highlights the need for urgent lifestyle interventions. Low intake of fruits and vegetables, along with substance use (tobacco, alcohol), further compounds the risk profile of the participants.

Table 11. Association of socio-demographic factors and pre-diabetes among the study participants (N=145)

Variables		Pre-diabetes		Normal		Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
		n	%	n	%				
Age	≤ 20 (N=7)	0	0	7	100	Ref			
	21-30 (N=32)	1	3.1	31	96.9	-	.636	-	.997
	31-40 (N=106)	31	29.3	75	70.7	-	.093	-	.997
Gender	Male (N=48)	10	20.8	38	79.2	0.9 (0.39-2.09)	.801	1.77 (0-99.9)	.996
	Female (N=97)	22	22.7	75	77.3				
Relationship status	Married (N=121)	32	36.5	89	73.5	-	**.004**	4.93 (0-99.9)	.995
	Unmarried (N=24)	0	0	24	100				
SES (BJ Prasad)	Class I (N=29)	3	10.3	26	89.7	Ref			
	Class II (N=39)	8	20.5	31	79.5	2.24 (0.54-9.31)	.26	0.37 (0.01-14.43)	.595
	Class III (N=39)	13	33.3	26	66.7	4.33 (1.1-17)	**.027**	1.4 (0.05-42.24)	.846
	Class IV (N=38)	8	21.1	30	78.9	2.31 (0.56-9.63)	.241	1.13 (0.04-30.2)	.942
Education	Graduate, Diploma (N=19)	0	0	19	100	Ref			
	Higher secondary (N=26)	0	0	26	100	-	-	2.12 (0-99.9)	.999
	Secondary (N=39)	11	28.2	28	71.8	-	**.01**	1.48 (0-99.9)	.996
	Middle school (N=31)	11	35.5	20	64.5	-	**.003**	3.79 (0-99.9)	.996
	Primary school (N=30)	10	33.3	20	66.7	-	**.005**	5.15 (0-99.9)	.996

Associations were assessed using the Chi-square test
A p value <0.05 was considered statistically significant
Statistically significant values are indicated in bold

This study also brings attention to the changing health landscape in rural India. Traditionally considered protected from urban lifestyle-related diseases, rural communities are now increasingly exposed to risk factors such as poor diet, physical inactivity, and stress. The findings support the need for early NCD screening and health education interventions tailored to young adults in rural areas, even before clinical disease becomes evident.

7. Summary and Conclusion

The study found a high burden of both conditions in this relatively young population, indicating an early onset of Non-Communicable Disease (NCD) risk. The prevalence of pre-hypertension and pre- diabetes is around 38.8% and 21.8%, respectively, among individuals aged 18 to 40 years in a rural area of Tamil

Table 12. Association of behavioural risk factors and pre-diabetes among the study participants (N=145)

Variables		Pre-diabetes		Normal		Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
		n	%	n	%				
Ever used tobacco	Yes (N=31)	7	22.6	24	77.4	1.04 (0.4-2.69)	.938	6.43 (0-99.9)	.996
	No (N=114)	25	21.9	89	78.1				
Ever used smokeless tobacco	Yes (N=12)	2	16.7	10	83.3	0.69 (0.14-3.31)	.637	1.54 (0-99.9)	.994
	No (N=133)	30	22.6	103	77.4				
Passive smoking	Yes (N=49)	18	36.7	31	63.3	**3.4 (1.51-7.66)**	**.002**	1.11 (0.15-8.33)	.919
	No (N=96)	14	14.6	82	85.4				
Ever consumed alcohol	Yes (N=16)	2	12.5	14	87.5	0.47 (0.1-2.19)	.328	4.55 (0-99.9)	.994
	No (N=129)	30	23.3	99	76.7				
Fruit and vegetable consumption	< 5 servings (N=107)	23	21.5	84	78.5	0.88 (0.37-2.14)	.779	1.67 (0.07-38.74)	.751
	≥ 5 servings (N=38)	9	23.7	29	76.3				
Physical activity	Inadequate (N=112)	28	25	84	75	2.42 (0.78-7.48)	.117	0.374 (0.01-13.98)	.595
	Adequate (N=33)	4	12.1	29	87.9				
BMI	Normal (N=43)	5	11.6	38	88.4	Ref			
	Underweight (N=7)	0	0	7	100	-	.341	1.88 (0-99.9)	.999
	Overweight (N=43)	10	11.6	33	88.4	2.3 (0.72-7.42)	.155	0.16 (0.01-6.28)	.326
	Obese (N=52)	17	32.7	32	67.3	**3.69 (1.23-11.07)**	**.015**	0.48 (0.02-10.42)	.64
Waist circumference	High (N=42)	28	66.7	14	33.3	**49.5 (15.09-162.3)**	**<.001**	**217.83 (5.63-8431.9)**	**.004**
	Normal (N=103)	4	3.9	99	96.1				
Waist-hip ratio	High (N=36)	21	58.3	15	41.7	**12.47 (5.02-30.98)**	**<.001**	10.25 (0.64-163.98)	.1
	Normal (N=109)	11	10.1	98	89.9				

Associations were assessed using the Chi-square test
A p value <0.05 was considered statistically significant
Statistically significant values are indicated in bold

Nadu. The study identified male gender, inadequate physical activity, and obesity as key factors associated with pre-hypertension. For pre-diabetes, abdominal obesity emerged as the strongest associated factor.

Limitations

- Self-reported data on behavioural risk factors such as tobacco use, alcohol consumption, and physical activity may be influenced by recall bias or social desirability.
- Since the study was conducted in a single rural field practice area, the results may not be generalizable to other regions or urban populations.

Recommendations

Although population-based screening for non-communicable diseases is already in place for individuals aged 18 years and above, there is a need to ensure better coverage and consistent implementation at the primary care level. Special focus should be given to the identification and management of pre-hypertension and pre-diabetes, which are often missed during routine screenings.

Primary healthcare teams should be trained to recognise and counsel individuals in these early risk stages. Behaviour change communication should emphasise the importance of lifestyle modification even before clinical disease onset. Interventions should include promoting physical activity, a healthy diet, weight management, and tobacco and alcohol cessation. Regular follow-up and monitoring of individuals identified with preconditions can help prevent progression to full-blown NCDs.

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