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Research Article

Prevalence and Risk Factors of Metabolic Syndrome Among the Elderly in Darbhanga, North Bihar: A Cross-Sectional Study

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Abstract

Background: The geriatric population in North Bihar is increasingly vulnerable to metabolic syndrome due to biological ageing and limited healthcare access [1, 4]. This study investigates the prevalence of metabolic disorders, specifically type-2 diabetes, hypertension, and obesity, among the elderly in Darbhanga, India.
Methods: A community-based cross-sectional study was conducted on 100 geriatric subjects (aged ≥60 years) recruited from urban and semi-urban clusters in Darbhanga using purposive random sampling. Anthropometric measurements (BMI) [15], clinical blood pressure [16], and biochemical parameters (fasting blood glucose [2] and total serum cholesterol) [11] were assessed. Data were analysed using SPSS version 20.0.
Results: The study revealed a high prevalence of metabolic dysfunctions: hypertension in 45% of subjects, hypercholesterolemia in 38%, hyperglycemia in 32%, and overweight/obesity in 32% [15]. A significant "diagnosis gap" of 25% was identified, where subjects were unaware of their chronic conditions. Significant positive correlations were observed between advancing age, elevated BMI, and metabolic abnormalities ($p<0.05$).
Conclusion: Metabolic syndrome is highly prevalent yet significantly underdiagnosed among the elderly in Darbhanga [4, 8, 12]. The findings underscore an urgent need for targeted geriatric screening programs and public health interventions in North Bihar [14, 17].

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1. INTRODUCTION

The global demographic landscape is undergoing a profound transformation, marked by a rapid increase in life expectancy [14]. In India, this epidemiological transition is particularly pronounced; the geriatric population (aged 60 years and above) is projected to reach approximately 198 million by 2030, constituting nearly 12% of the total population [4, 14]. This demographic shift presents an unprecedented challenge to public health infrastructure, especially in economically developing regions like North Bihar, where geriatric healthcare facilities remain nascent and under-equipped [8, 12].

At the biological level, ageing, or senescence, is a complex, multifactorial process. A primary driver of age-related decline is oxidative stress, as posited by the Free Radical Theory of

Ageing [6]. This theory proposes that the systemic accumulation of reactive oxygen species (ROS) inflicts cumulative oxidative damage to cellular components, including mitochondrial DNA, structural proteins, and membrane lipids. This cellular deterioration serves as the pathophysiological foundation for various age-related metabolic dysfunctions [3].

Clinically, the convergence of oxidative stress, chronic inflammation, and lifestyle factors culminates in metabolic syndrome (MetS) [1, 5]. MetS is a multifaceted clinical construct characterised by a cluster of interconnected metabolic abnormalities, including hypertension, insulin resistance (type-2 diabetes mellitus), dyslipidemia, and abdominal obesity [1, 5]. In the North Bihar region, specific socio-environmental factors such as dietary habits high in carbohydrates and saturated fats, coupled with limited healthcare access, may further exacerbate these risks [8].

This study aims to provide a comprehensive evaluation of these metabolic risk factors among the elderly population in Darbhanga through rigorous analysis of body mass index (BMI) [15], fasting blood glucose (FBG) [2], and serum lipid profiles [11]. A key objective is to quantify the gap in diagnosis and awareness within the community, providing evidence-based recommendations for targeted geriatric interventions [17].

2. MATERIALS AND METHODS

2.1 STUDY DESIGN AND AREA

This study employed a community-based, analytical, cross-sectional design. It was conducted between March 2023 and February 2024 in the Darbhanga district of North Bihar, India (26.152°N, 85.897°E). Both urban (Laheriasarai, Darbhanga city) and semi-urban (Sadar, Hayaghat) clusters were selected to ensure diverse socioeconomic representation of the geriatric population.

2.2 Sample Size and Subject Recruitment

The sample size was calculated using the formula for cross-sectional studies: $n = Z^2pq/d^2$, assuming an expected prevalence of metabolic syndrome of 35% (based on a pilot study [12]), 95% confidence level, and 10% absolute precision. The minimum required sample size was 87; we recruited 100 subjects to account for non-response.

A total of 100 geriatric subjects (54 males, 46 females) aged 60 years and above were recruited using a purposive random sampling technique. Inclusion criteria were: (i) age ≥60 years, (ii) residency in the study area for at least one year, and (iii) willingness to provide informed consent. Exclusion criteria were: (i) diagnosed terminal illnesses (cancer, end-stage renal disease), (ii) bedridden or critically ill individuals, and (iii) unwillingness to participate. Informed written consent was obtained from all participants before inclusion.

2.3 Anthropometric Assessment

Physical parameters were recorded for each subject. Height (in meters) was measured using a stadiometer (Seca 213) with subjects standing barefoot. Weight (in kilograms) was measured using a calibrated digital weighing scale (Omron HN-286) with light clothing. Body mass index (BMI) was calculated as $weight/height^2$ (kg/m^2). Subjects were categorised according to the WHO (2000) classification [15]: underweight (<18.5), normal (18.5–24.9), overweight (25.0–29.9), and obese (≥30.0).

2.4 Clinical Blood Pressure Monitoring

Resting blood pressure was recorded using a calibrated aneroid sphygmomanometer (Omron HEM-7124) on the left arm at heart level after at least 10 minutes of rest in a sitting position. Three readings were taken at 5-minute intervals, and the mean of the last two readings was used for analysis. Hypertension was defined as systolic blood pressure (SBP) ≥140 mmHg and/or diastolic blood pressure (DBP) ≥90 mmHg, or current use of antihypertensive medication [16].

2.5 Biochemical Sample Collection and Analysis

Venous blood samples (5 mL) were collected from each participant after an overnight fast of 8–12 hours. Samples were collected under aseptic conditions in plain vacutainers (BD Vacutainer®). Serum was separated by centrifugation at 3000 rpm for 10 minutes within 2 hours of collection and stored at -20°C until analysis (maximum 7 days).

- **Fasting Blood Glucose (FBG):** Estimated using the glucose oxidase-peroxidase (GOD-POD) method with commercial kits (Erba Mannheim, Germany). Intra-assay CV <3%. Hyperglycemia was defined as FBG ≥126 mg/dL [2].
- **Total Serum Cholesterol:** Estimated using the cholesterol oxidase-peroxidase (CHOD-POD) method with commercial kits (Erba Mannheim, Germany). Intra-assay CV <3%. Hypercholesterolemia was defined as total cholesterol ≥200 mg/dL [11].

All analyses were performed on a semi-autoanalyser (Chem-5X, Erba Mannheim) in a NABL-accredited pathology laboratory (Referral Pathology Lab, Darbhanga).

2.6 Statistical Analysis

Data were entered into Microsoft Excel 2019 and analysed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were expressed as mean ± standard deviation (SD) for continuous variables and as frequencies (percentages) for categorical variables. The Chi-square (χ^2) test was used to compare proportions between groups (e.g., males vs. females, age groups). Pearson's correlation coefficient was calculated to assess relationships between continuous variables. A p-value <0.05 was considered statistically significant.

2.7 Ethical Considerations

The study protocol was approved by the Institutional Ethics Committee of L.N. Mithila University, Darbhanga (Ref No.: LNMU/IEC/2023/12, dated 15.02.2023). All procedures followed the ethical guidelines of the Declaration of Helsinki

(2013 revision) for human research. Participant confidentiality was maintained throughout the study.

3. RESULTS

3.1 Demographic Profile

A total of 100 elderly subjects participated in the study, comprising 54 males (54%) and 46 females (46%). The mean age of the study population was 68.7 ± 6.8 years (range: 60–88 years). The age-gender distribution is presented in Table 1.

Table 1: Age-Gender Distribution of the Study Population (N=100)

Age Group (Years)	Male (n=54)	Female (n=46)	Total (N=100)	Percentage (%)
60 – 65	18	14	32	32%
66 – 70	14	12	26	26%
71 – 75	12	10	22	22%
76 and Above	10	10	20	20%
Total	54 (54%)	46 (46%)	100 (100%)	100%

3.2 Prevalence of Metabolic Abnormalities

The clinical and biochemical profiles of the subjects are summarised in Table 2.

- **Fasting Blood Glucose:** Levels ranged from 80 to 375 mg/dL (mean: 145.2 ± 58.4 mg/dL). Overall, 32% (n=32) of subjects were hyperglycemic (FBG ≥126 mg/dL) [2].
- **Blood Pressure:** Systolic BP ranged from 110 to 190 mmHg (mean: 142.5 ± 18.2 mmHg); diastolic BP ranged from 60 to 110 mmHg (mean: 86.4 ± 10.5 mmHg). 45% (n=45) of subjects had stage-II hypertension.
- **Total Serum Cholesterol:** Levels ranged from 142 to 591 mg/dL (mean: 218.6 ± 52.1 mg/dL). 38% (n=38) had total cholesterol ≥200 mg/dL.
- **Body Mass Index:** Mean BMI was 24.8 ± 3.6 kg/m^2. 32% (n=32) were overweight or obese. Females had a higher prevalence of obesity (39.1%) compared to males (25.9%) ($\chi^2=4.12, p=0.04$).

Table 2: Clinical and Biochemical Profile of the Study Population (N=100)

Parameter	Observed Range	Mean ± SD	Prevalence n (%)	95% CI	p-value (M vs F)
Fasting Blood Glucose [2]	80 – 375 mg/dL	145.2 ± 58.4	32 (32%)	23.1% – 41.9%	0.65
Systolic Blood Pressure [16]	110 – 190 mmHg	142.5 ± 18.2	45 (45%)	35.2% – 55.0%	0.49
Diastolic Blood Pressure [16]	60 – 110 mmHg	86.4 ± 10.5	28 (28%)	19.5% – 37.9%	0.38
Total Serum Cholesterol [11]	142 – 591 mg/dL	218.6 ± 52.1	38 (38%)	28.5% – 48.2%	0.22
Body Mass Index (BMI) [15]	17.2 – 32.5 kg/m^2	24.8 ± 3.6	32 (32%)	23.1% – 41.9%	0.04*

***Note:** $p<0.05$ is statistically significant (Chi-square test).

3.3 The "Diagnosis Gap"

A critical finding of this study was the significant "diagnosis gap":

- Among the 32 subjects identified with hyperglycemia, 10 subjects (31.2%) were unaware of their status.
- Among the 45 subjects with stage-II hypertension, 15 subjects (33.3%) were previously undiagnosed.
- Among the 38 subjects with hypercholesterolemia, 22 subjects (57.9%) were unaware of their condition.
- Overall, approximately 25% of participants with at least one metabolic abnormality were completely unaware before this study [8,12].

Table 3: Diagnosis Gap among Affected Subjects

Condition	Total Affected (n)	Aware	Unaware (New)	Unaware (%)
Hypertension [16]	45	30	15	33.3%
High Blood Sugar [2]	32	22	10	31.2%
High Cholesterol [11]	38	16	22	57.9%
Overall (at least one) [17]	75	56	19	25.3%

3.4 CORRELATION ANALYSIS

- Significant positive correlation between age and SBP ($r = 0.42, p = 0.01$).
- Significant positive correlation between BMI and FBG ($r = 0.38, p = 0.02$).
- Significant positive correlation between BMI and total cholesterol ($r = 0.31, p = 0.04$).

4. DISCUSSION

The present study provides crucial insights into the burden of metabolic syndrome among the geriatric population of Darbhanga, North Bihar. The clinical data reveal a disproportionately high prevalence of hyperglycemia (32%), hypertension (45%), and hypercholesterolemia (38%). These findings are consistent with the observations of Prasad and Singh [12], but the severity of undiagnosed cases (25% diagnosis gap) is higher than the national averages reported in the LASI study [7].

The observed metabolic derangements can be contextualised within the framework of the Free Radical Theory of Ageing [6]. Systemic accumulation of ROS likely triggers mitochondrial DNA damage [3]. This oxidative stress impairs cellular capacity for glucose and lipid metabolism, leading to insulin resistance and dyslipidemia [5]. The high cholesterol levels (up to 591 mg/dL) serve as a potential marker for vascular inflammation and atherosclerosis [5, 9].

The significant "diagnosis gap" corroborates the observations of Kumar and Jha [8] regarding the "double burden" of health issues in North Bihar. The high gap for hypercholesterolemia (57.9%) reflects its silent nature, placing the elderly at high risk for stroke and myocardial infarction [17]. The association with BMI, particularly in females ($p=0.04$), points toward the role of nutritional transition and decreased physical activity [10].

5. CONCLUSION AND RECOMMENDATIONS

This study demonstrates a high prevalence of undiagnosed and poorly managed metabolic syndrome among the elderly in Darbhanga [4, 8, 12]. The findings support the hypothesis that

ageing, oxidative stress, and lifestyle factors [3, 6] increase the risk of chronic conditions.

RECOMMENDATIONS:

1. **Routine Screening:** Implement mandatory annual screening for BP, FBG, and lipids for those aged ≥60 under NPHCE [14].
2. **Antioxidant-Rich Diets:** Promote consumption of local foods like makhana and amla [3, 6].
3. **Infrastructure:** Establish functional geriatric clinics at district hospitals [8].
4. **Awareness:** Conduct programs in Maithili and Hindi about "silent" killers [17].

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