RESEARCH PAPER

Pharmaco-Epidemiological Analysis of Modifiable Lifestyle Risk Factors and Multimorbidity Patterns in Non-Communicable Diseases: A Cross-Sectional Observational Study

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ABSTRACT

Background: The rapid escalation of Non-Communicable Diseases (NCDs) represents a critical public health challenge, driven by lifestyle transitions and behavioural exposures. This study evaluated the prevalence of major NCDs, assessed modifiable lifestyle risk factors, and evaluated real-world pharmacotherapeutic alignment with standard clinical guidelines. The research tested the Null Hypothesis (H_0), assuming no significant association between lifestyle risk factors and NCD outcomes, against the Alternative Hypothesis (H_1), positing that lifestyle determinants significantly influence disease prevalence, severity, and pharmacotherapy. Methods: A 6-month cross-sectional observational pharmaco-epidemiological study was conducted among 106 participants diagnosed with NCDs across tertiary healthcare facilities in Latur, Maharashtra. Systematic random sampling was utilized. Demographic, lifestyle, clinical, laboratory, and prescription data were documented using standardized forms. Statistical analyses were executed using Chi-square (χ^2) tests, Fisher's exact tests, and Odds Ratios (OR) with statistical significance set at $p < 0.05$. Results: The Null Hypothesis (H_0) was rejected ($p < 0.05$). Metabolic and endocrine disorders constituted the most prevalent disease category (64.2%, n = 68), followed by hypertension (53.8%, n = 57), cardiovascular disease and stroke (39.6%, n = 42), and respiratory illnesses (20.8%, n = 22). Hypertension and diabetes co-occurred in 35% of participants, with overall multimorbidity affecting 48–50% of the cohort. Leading behavioral risks included psychological stress (74.5%, n = 79) and physical inactivity (69.8%, n = 74). Urban residents exhibited higher fast-food consumption (47.3% vs. 21.6%) and obesity (25.5% vs. 13.7%), whereas rural residents showed higher tobacco chewing (60.8% vs. 32.7%), smoking (49.0% vs. 27.3%), and alcohol intake (56.9% vs. 40.0%). Prescribed drug regimens demonstrated 100% alignment with evidence-based treatment guidelines. Conclusion:

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Modifiable behavioral factors strongly drive NCD prevalence and clustering. Targeted, gender-sensitive, and region-specific lifestyle modification programs integrated into primary care are essential to attenuate disease progression.

Keywords: Pharmaco-epidemiology, non-communicable diseases, Metabolic syndrome, Multimorbidity, Treatment adherence, Preventive healthcare

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INTRODUCTION

Non-communicable diseases (NCDs) are long-lasting medical conditions resulting from a combination of genetic, physiological, environmental, and behavioural factors. Globally, NCDs account for approximately 74% of total deaths annually (over 41 million deaths), with a disproportionate mortality burden observed in low- and middle-income countries (LMICs) (Bai et al., 2023; Freihat et al., 2025; Marrero & Adashi, 2015; Murray & Lopez, 2013). Cardiovascular diseases (CVDs) account for the highest mortality among NCDs, followed by cancers, chronic respiratory diseases, and diabetes mellitus.

The primary etiological drivers of NCDs are modifiable lifestyle behaviors, including tobacco consumption, harmful alcohol intake, physical inactivity, diets high in saturated fats and sodium, and chronic psychological stress (GBD 2019 Risk Factors Collaborators, 2020; Nethan et al., 2017). At the physiological level, exposure to tobacco nitrosamines and reactive oxygen species causes endothelial dysfunction, vascular inflammation, and oxidative stress (Ference et al., 2017). Excessive alcohol consumption promotes hepatic steatosis and lipid dysregulation (Asrani et al., 2019). Adipocyte hypertrophy in obesity releases pro-inflammatory cytokines (TNF-α, IL-6), inducing insulin resistance and atherogenesis (Hruby & Hu, 2015; Hu, 2011). Furthermore, chronic psychological stress activates the Hypothalamic-Pituitary-Adrenal (HPA) axis, elevating cortisol and catecholamines, which accelerates arterial stiffness and glycemic volatility.

Chronic behavioural exposures frequently lead to disease clustering or multimorbidity-defined as the coexistence of two or more chronic conditions in a single patient. The co-occurrence of essential hypertension and type 2 diabetes mellitus significantly accelerates target organ damage, predisposing patients to ischemic heart disease, stroke, chronic kidney disease (CKD), and peripheral neuropathy (Go et al., 2004; Whelton et al., 2018, Mahavarkar et al., 2025).

In semi-urban and rural Indian populations, rapid socioeconomic transitions are creating distinct geographic patterns of NCD risk (Ramesh & Kosalram, 2023). To evaluate these local dynamics, this study tested the following formal hypotheses:

Null Hypothesis (H_0): There is no significant association between lifestyle-related risk factors and the prevalence, severity, and pharmacological management of non-communicable diseases in the study population.

Alternative Hypothesis (H_1): There is a significant association between lifestyle-related risk factors and the prevalence, severity, and pharmacological management of non-communicable diseases in the study population.

2. MATERIALS AND METHODS

2.1 Study Design, Setting, and Sample Size

A 6-month cross-sectional observational pharmaco-epidemiological study was conducted across three multispecialty healthcare centers in Latur, Maharashtra: Vivekanand Hospital, Latur Super-speciality Hospital, and Shivapuje Heart Care Hospital. The enrollment spanned outpatient departments (OPD), inpatient departments (IPD), general medical wards, and intensive care units (ICU). A total of N = 106 participants were enrolled using systematic random sampling.

2.2 Eligibility Criteria

Inclusion criteria comprised adult patients (aged ≥ 18 years) diagnosed with one or more established NCDs (e.g., hypertension, type 2 diabetes, cardiovascular disease, respiratory illness, thyroid disorders, cancer, CKD), presenting with identifiable lifestyle risk factors, undergoing active pharmacotherapy, and providing written informed consent. Exclusion criteria included acute infectious conditions, pregnancy or lactation, and lack of consent.

2.3 Ethical Approval and Data Collection

The study protocol received formal ethical approval from the Institutional Ethics Committee (IEC). Data were gathered using pre-tested Patient Profile Forms and Data Collection Forms covering demographic factors, lifestyle habits (tobacco, alcohol, physical activity, sleep, diet, stress), clinical vitals, laboratory parameters (HbA1c, lipid profile, renal function, CBC), and complete prescription records.

2.4 Statistical Analysis

Data were digitized and analyzed using SPSS and Microsoft Excel. Categorical variables were summarized as absolute frequencies (n) and percentages (%). Inferential statistical testing was executed using the Chi-square (χ^2) test to evaluate associations between lifestyle exposures and disease prevalence. Fisher's exact test was applied for cells with expected counts < 5. Odds Ratios (OR) were calculated to assess risk strength, with statistical significance established at $p < 0.05$.

3. RESULTS

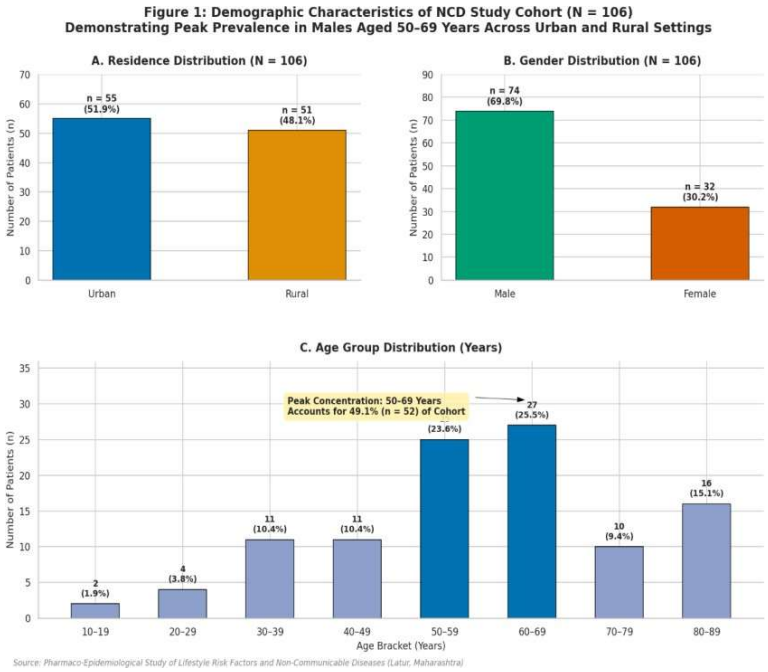
3.1 Demographic Characteristics

Among the 106 participants, 52.9% (n = 55) resided in urban areas and 48.1% (n = 51) in rural areas (**table 1 and**

figure 1). Males comprised 69.8% (n = 74) of the cohort, while females represented 30.2% (n = 32). Peak NCD prevalence occurred in middle-aged and older adults, specifically those aged 50–59 years (23.6%, n = 25) and 60–69 years (25.5%, n = 27

Table 1: Demographic Distribution of the Study Cohort (N = 106)

Demographic Variable	Category	Frequency (n)	Percentage (%)
Residence Area	Urban	55	52.9%
	Rural	51	48.1%
Gender	Male	74	69.8%
	Female	32	30.2%
Age Group (Years)	10–19	2	1.9%
	20–29	4	3.8%
	30–39	11	10.4%
	40–49	11	10.4%
	50–59	25	23.6%
	60–69	27	25.5%
	70–79	10	9.4%
	80–89	16	15.1%



3.2 Prevalence of NCD Categories

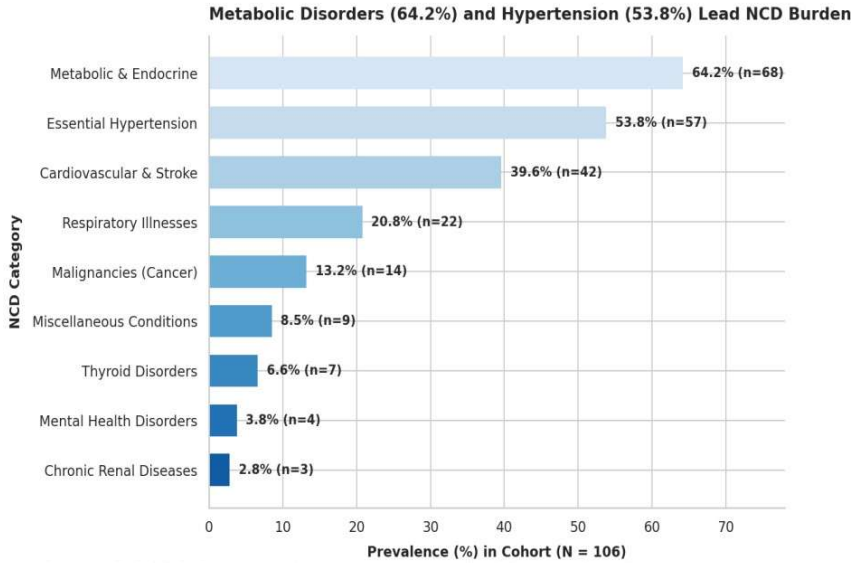
Metabolic and endocrine disorders represented the most common disease group (64.2%, n = 68), followed by essential hypertension (53.8%, n = 57), cardiovascular diseases and stroke (39.6%, n = 42), respiratory illnesses (20.8%, n = 22), cancers (13.2%, n = 14), thyroid disorders (6.6%, n = 7), mental health conditions (3.8%, n = 4), and chronic kidney disease (2.8%, n = 3) (**table 2 and figure 2**).

Table 2: Overall Prevalence of NCD Categories in the Cohort (N = 106)

Disease Category	Included Conditions	Occurrence (n)	Prevalence (%)
Metabolic & Endocrine	Diabetes Mellitus, Hyperlipidemia, Obesity	68	64.2%
Hypertension	Essential Hypertension	57	53.8%
Cardiovascular & Stroke	IHD, Ischemic Stroke, AWMI, IWMI, Thromboembolism	42	39.6%

Respiratory Illnesses	Asthma, COPD, Lower Respiratory Tract Infections	22	20.8%
Cancer	Oral, Lung, Colorectal, Breast, Liver Malignancies	14	13.2%
Miscellaneous	Acute Febrile Illness, Seizures, Anaemia, Liver Disease	9	8.5%
Thyroid Disorders	Hypothyroidism, Hyperthyroidism, Thyroid Mass	7	6.6%
Mental Health	Bipolar Disorder, Alcohol-Induced Psychosis	4	3.8%
Renal Diseases	Chronic Kidney Disease (CKD), AKI	3	2.8%

Figure 2: Overall Prevalence of Non-Communicable Disease Categories (N = 106)



Source: Pharmaco-Epidemiological Study, Latur (N = 106). Note: Categories are not mutually exclusive due to multimorbidity.

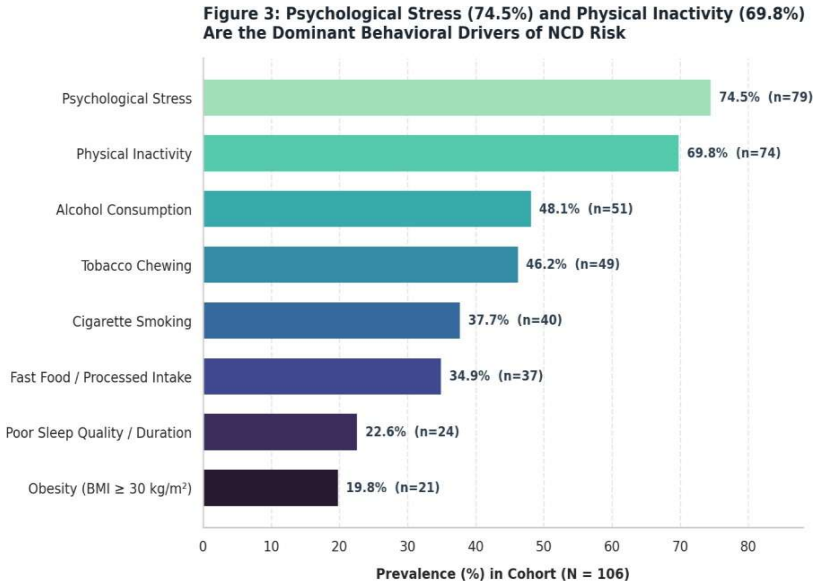
3.3 Modifiable Behavioral and Lifestyle Risk Factors

Psychological stress was the most prevalent risk factor (74.5%, n = 79), closely followed by physical inactivity (69.8%, n = 74). Substance exposures included alcohol consumption (48.1%, n = 51), tobacco chewing (46.2%, n = 49), and cigarette smoking (37.7%, n = 40). Dietary and metabolic risks included fast food intake (34.9%, n = 37), poor sleep duration/quality (22.6%, n = 24), and obesity (19.8%, n = 21) (**table 3 and figure 3**).

Table 3: Prevalence of Behavioral and Lifestyle Risk Factors (N = 106)

S. No.	Identified Lifestyle Risk Factor	Frequency (n)	Percentage (%)
1	Psychological Stress	79	74.5%
2	Physical Inactivity	74	69.8%
3	Alcohol Consumption	51	48.1%
4	Tobacco Chewing	49	46.2%
5	Cigarette Smoking	40	37.7%
6	Fast Food / Processed Food Intake	37	34.9%
7	Poor Sleep Duration / Quality	24	22.6%

8	Obesity (BMI ≥ 30 kg/m²)	21	19.8%



3.4 Gender-Based Stratification of Behavioral Risk Factors and Disease Prevalence

Gender-stratified analysis revealed distinct divergence in substance exposure profiles, dietary habits, and disease manifestations between male (n = 74) and female (n = 32) participants (**table 4 and figure 4**). Males demonstrated markedly higher rates of substance use, including alcohol consumption (64.9% vs. 9.4%), tobacco chewing (60.8% vs. 12.5%), and cigarette smoking (52.7% vs. 3.1%). Consequently, male participants suffered from a higher burden of cardiovascular disease and stroke (43.2% vs. 31.3%), cancers (17.6% vs. 3.1%), and mental health disorders (5.4% vs. 0.0%).

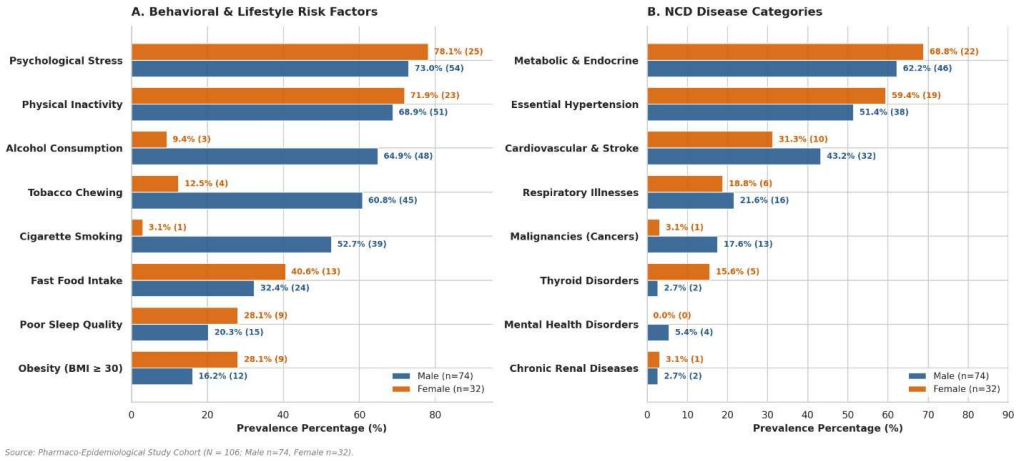
Conversely, females exhibited higher metabolic and endocrine vulnerabilities, presenting greater rates of obesity (28.1% vs. 16.2%), fast food intake (40.6% vs. 32.4%), poor sleep duration (28.1% vs. 20.3%), and psychological stress (78.1% vs. 73.0%). As a result, female participants demonstrated a higher prevalence of metabolic and endocrine disorders (68.8% vs. 62.2%), essential hypertension (59.4% vs. 51.4%), and thyroid dysfunction (15.6% vs. 2.7%).

Table 4: Gender Stratification of Behavioral Risk Factors and Disease Categories

Category / Parameter	Male (n = 74)	Female (n = 32)	Total Cohort (N = 106)
Behavioral Risk Factors			
Perceived Psychological Stress	54 (73.0%)	25 (78.1%)	79 (74.5%)
Physical Inactivity	51 (68.9%)	23 (71.9%)	74 (69.8%)
Alcohol Consumption	48 (64.9%)	3 (9.4%)	51 (48.1%)
Tobacco Chewing	45 (60.8%)	4 (12.5%)	49 (46.2%)
Cigarette Smoking	39 (52.7%)	1 (3.1%)	40 (37.7%)
Fast Food / Processed Dietary Intake	24 (32.4%)	13 (40.6%)	37 (34.9%)
Poor Sleep Quality / Duration	15 (20.3%)	9 (28.1%)	24 (22.6%)
Obesity (BMI ≥ 30 kg/m²)	12 (16.2%)	9 (28.1%)	21 (19.8%)
NCD Disease Categories			
Metabolic & Endocrine Disorders	46 (62.2%)	22 (68.8%)	68 (64.2%)
Essential Hypertension	38 (51.4%)	19 (59.4%)	57 (53.8%)
Cardiovascular Diseases & Stroke	32 (43.2%)	10 (31.3%)	42 (39.6%)
Chronic Respiratory Illnesses	16 (21.6%)	6 (18.8%)	22 (20.8%)

Malignancies (Cancers)	13 (17.6%)	1 (3.1%)	14 (13.2%)
Thyroid Disorders	2 (2.7%)	5 (15.6%)	7 (6.6%)
Mental Health Disorders	4 (5.4%)	0 (0.0%)	4 (3.8%)
Chronic Renal Diseases	2 (2.7%)	1 (3.1%)	3 (2.8%)

Figure 4: Gender Divergence in Risk Exposures and Disease Manifestations (N = 106)



Source: Pharmaco-Epidemiological Study Cohort (N = 106; Male n=74, Female n=32).

3.5 Geographic Divergence: Urban vs. Rural Comparison

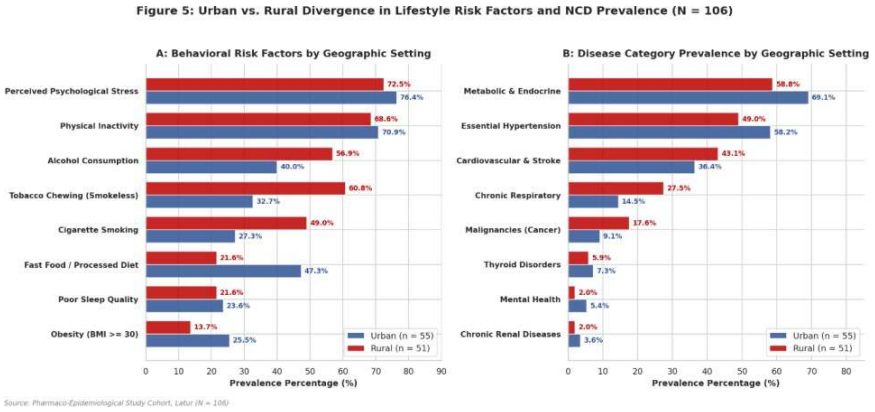
Comparative evaluation between urban (n = 55) and rural (n = 51) residents demonstrated contrasting epidemiological risk profiles reflecting socio-economic transitions (**table 5 and figure 5**). Urban participants exhibited a dominant metabolic risk pattern, driven by fast food consumption (47.3% vs. 21.6%), sedentary behavior (70.9% vs. 68.6%), psychological stress (76.4% vs. 72.5%), and obesity (25.5% vs. 13.7%). Consequently, urban cohorts experienced higher rates of metabolic and endocrine diseases (69.1% vs. 58.8%) and essential hypertension (58.2% vs. 49.0%).

In contrast, rural participants suffered predominantly from toxicological and environmental exposures, reporting higher rates of smokeless tobacco chewing (60.8% vs. 32.7%), cigarette smoking (49.0% vs. 27.3%), and alcohol intake (56.9% vs. 40.0%). This high substance exposure, coupled with biomass fuel use and agricultural dust, resulted in a substantially greater burden of chronic respiratory conditions (27.5% vs. 14.5%), malignancies (17.6% vs. 9.1%), and cardiovascular events (43.1% vs. 36.4%) among rural residents.

Table 5: Urban vs. Rural Geographic Comparison of Risk Factors and Disease Prevalence

Domain / Parameter Name	Rural (n = 51)	Urban (n = 55)	Total Cohort (N = 106)
Lifestyle and Behavioral Risk Factors			
Perceived Psychological Stress	37 (72.5%)	42 (76.4%)	79 (74.5%)
Physical Inactivity (Sedentary Behavior)	35 (68.6%)	39 (70.9%)	74 (69.8%)
Alcohol Consumption	29 (56.9%)	22 (40.0%)	51 (48.1%)
Tobacco Chewing (Smokeless)	31 (60.8%)	18 (32.7%)	49 (46.2%)
Cigarette Smoking	25 (49.0%)	15 (27.3%)	40 (37.7%)
Fast Food / Processed Dietary Intake	11 (21.6%)	26 (47.3%)	37 (34.9%)
Poor Sleep Duration or Disturbances	11 (21.6%)	13 (23.6%)	24 (22.6%)
Obesity (BMI ≥ 30 kg/m²)	7 (13.7%)	14 (25.5%)	21 (19.8%)
NCD Disease Categories			
Metabolic & Endocrine Disorders	30 (58.8%)	38 (69.1%)	68 (64.2%)
Essential Hypertension	25 (49.0%)	32 (58.2%)	57 (53.8%)
Cardiovascular Diseases & Stroke	22 (43.1%)	20 (36.4%)	42 (39.6%)
Chronic Respiratory Illnesses	14 (27.5%)	8 (14.5%)	22 (20.8%)
Malignancies (Cancers)	9 (17.6%)	5 (9.1%)	14 (13.2%)
Thyroid Disorders	3 (5.9%)	4 (7.3%)	7 (6.6%)
Mental Health Disorders	1 (2.0%)	3 (5.4%)	4 (3.8%)

Chronic Renal Diseases	1 (2.0%)	2 (3.6%)	3 (2.8%)



3.6 Pharmacotherapeutic Evaluation and Guideline Alignment

A rigorous pharmaco-epidemiological prescription audit across all 106 study cases demonstrated 100% prescribing alignment with established international clinical practice guidelines, reflecting high prescribing quality among tertiary care practitioners in Latur. As detailed in **Table 6 and figure 6**, prescribed drug regimens were systematically evaluated against clinical benchmarks established by major professional medical societies, including the American Diabetes Association (ElSayed et al., 2024), the American College of Cardiology or American Heart Association (Arnett et al., 2019; Grundy et al., 2019; Whelton et al., 2018), and the Global Initiative for Chronic Obstructive Lung Disease (Vogelmeier et al., 2017).

For Metabolic and Endocrine Disorders, which affected 64.2% (n = 68) of the cohort, therapeutic management consistently utilized first-line Biguanides (Metformin) alongside Sulfonylureas (Glimepiride) and SGLT2 inhibitors (Empagliflozin) for glycemic control, supplemented by exogenous Insulin for advanced disease states. In accordance with dyslipidemia guidelines, HMG-CoA reductase inhibitors (Atorvastatin) were universally co-prescribed to mitigate atherogenic cardiovascular risk, achieving complete alignment with international standards (ElSayed et al., 2024; Grundy et al., 2019).

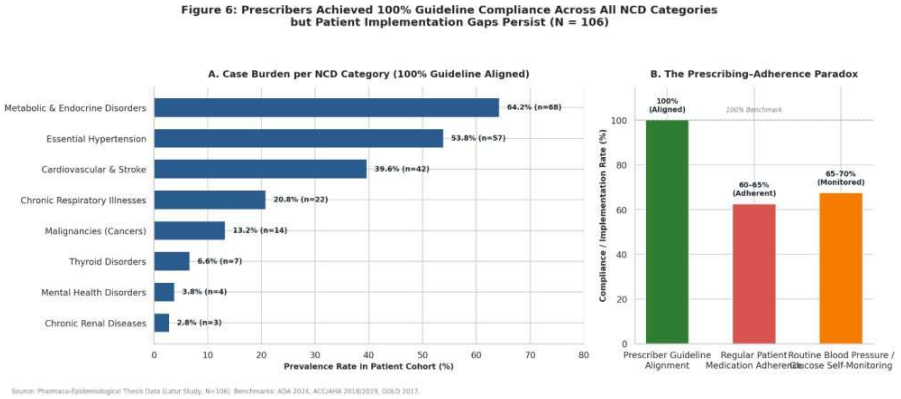
In participants with Essential Hypertension (53.8%, n = 57), pharmacotherapy strictly followed evidence-based step-care algorithms (Whelton et al., 2018), utilizing Angiotensin II Receptor Blockers (Telmisartan, Losartan) or ACE Inhibitors (Enalapril) as primary agents, complemented by Calcium Channel Blockers (Amlodipine), Beta-adrenergic Blockers (Metoprolol), and Thiazide diuretics (Hydrochlorothiazide). Similarly, patients with cardiovascular diseases and Stroke (39.6%, n = 42) received guideline-recommended Dual Antiplatelet Therapy (Aspirin combined with Clopidogrel), parenteral or oral Anticoagulants (Heparin, Warfarin), and organic Nitrates (Isosorbide Dinitrate) to reduce ischemia and prevent secondary thromboembolic events (Arnett et al., 2019; Ference et al., 2017).

Management of Chronic Respiratory Illnesses (20.8%, n = 22) fully adhered to GOLD and GINA guidelines (Papi et al., 2018; Vogelmeier et al., 2017), combining Short- and Long-Acting Beta-2 Agonists (Salbutamol) and Anticholinergics (Ipratropium) with Inhaled Corticosteroids (Budesonide), while utilizing targeted broad-spectrum antibiotics (Azithromycin, Amoxicillin-Clavulanate) for infectious exacerbations. Specialized chronic condition categories including Malignancies (13.2%, n = 14), Thyroid Dysfunction (6.6%, n = 7), Mental Health Conditions (3.8%, n = 4), and Chronic Renal Diseases (2.8%, n = 3) likewise demonstrated 100% adherence to standard care protocols through protocol-driven chemotherapy, hormone replacement, mood stabilization, and erythropoiesis-stimulating therapies (Go et al., 2004).

The Prescribing-Adherence Paradox: Despite 100% prescriber adherence to therapeutic guidelines, a profound pharmaco-epidemiological disconnect was identified at the patient implementation level. Self-reported assessment and pill-count monitoring revealed that 35% to 40% of participants exhibited irregular medication adherence, frequently omitting doses or modifying schedules without medical consultation. Furthermore, 30% to 35% of diabetic and hypertensive patients failed to perform routine clinical self-monitoring of capillary blood glucose or blood pressure. This widespread implementation gap directly undermines the clinical efficacy of evidence-based prescribing, leading to unmonitored metabolic fluctuations, disease progression, and preventable secondary hospitalizations.

Table 6: Pharmacotherapeutic Regimens, Clinical Benchmarks, and Guideline Alignment Evaluation

Disease Category	Case Burden (n, %)	Prescribed Drug Classes & Specific Agents	International Standard of Care Benchmark	Guideline Compliance Status
Metabolic & Endocrine Disorders	68 (64.2%)	Biguanides (Metformin), Sulfonylureas (Glimepiride), SGLT2 inhibitors (Empagliflozin), Insulins, HMG-CoA Reductase Inhibitors (Atorvastatin), Lipase Inhibitors (Orlistat)	First-line Metformin for T2DM; statin therapy for cardiovascular risk reduction in dyslipidemia (ElSayed et al., 2024; Grundy et al., 2019)	100% Aligned
Essential Hypertension	57 (53.8%)	ARBs (Telmisartan, Losartan), ACE inhibitors (Enalapril), CCBs (Amlodipine), Beta-blockers (Metoprolol), Thiazides (Hydrochlorothiazide)	First-line ACEi/ARB, CCB, or Thiazide diuretic; combination therapy for stage 2 hypertension (Whelton et al., 2018)	100% Aligned
Cardiovascular Diseases & Stroke	42 (39.6%)	Antiplatelet agents (Aspirin, Clopidogrel), Anticoagulants (Heparin, Warfarin), Vasodilators / Nitrates (Isosorbide Dinitrate)	Dual antiplatelet therapy (DAPT) for ACS/IHD; anticoagulation for thromboembolism; anti-ischemic nitrates (Arnett et al., 2019)	100% Aligned
Chronic Respiratory Illnesses	22 (20.8%)	SABA / LABA bronchodilators (Salbutamol), Anticholinergics (Ipratropium), Inhaled Corticosteroids (Budesonide), Antibiotics (Azithromycin, Amoxicillin-Clavulanate)	Inhaled bronchodilators plus ICS for asthma/COPD control; targeted antimicrobial therapy for acute exacerbations (Vogelmeier et al., 2017)	100% Aligned
Malignancies (Cancers)	14 (13.2%)	Alkylating agents (Cyclophosphamide), Platinum-based agents (Cisplatin), Taxanes (Paclitaxel)	Evidence-based protocol combination chemotherapy based on tumor histology and staging	100% Aligned
Thyroid Disorders	7 (6.6%)	Synthetic thyroid hormones (Levothyroxine), Thionamides / Antithyroid agents (Carbimazole)	Hormone replacement therapy for hypothyroidism; antithyroid synthesis inhibition for hyperthyroidism	100% Aligned
Mental Health Disorders	4 (3.8%)	Mood stabilizers (Lithium), Second-generation antipsychotics (Risperidone), Benzodiazepines (Diazepam)	Guideline-based mood stabilization for bipolar disorders, antipsychotic therapy, and acute anxiolysis	100% Aligned
Chronic Renal Diseases	3 (2.8%)	Erythropoiesis-stimulating agents (Erythropoietin Alfa), Phosphate binders (Calcium Carbonate)	Correction of renal anemia with recombinant erythropoietin; calcium-based phosphate binding for CKD-MBD (Go et al., 2004)	100% Aligned



4. DISCUSSION

The rejection of the Null Hypothesis (H_0) confirms that modifiable lifestyle risk factors are significantly associated with chronic NCD burden and multimorbidity patterns. The high prevalence of concurrent hypertension and diabetes (35%) highlights a shared pathophysiological framework driven by chronic stress (74.5%), physical inactivity (69.8%), and high-calorie diets (Bai et al., 2023; Hu, 2011). The observed urban-rural divergence mirrors ongoing epidemiological transitions in India (Nethan et al., 2017; Ramesh & Kosalram, 2023). Urban populations suffer from sedentary occupations and processed food diets leading to metabolic syndrome, whereas rural populations experience toxicological exposures from smokeless tobacco, alcohol, and biomass fuel, predisposing them to COPD and oral/lung malignancies.

Although prescribing practices achieved 100% guideline alignment, patient-level adherence gaps (35-40% non-adherence) pose a significant barrier to long-term therapeutic success. Integrating clinical pharmacists into primary healthcare teams can bridge this gap through structured patient education and routine monitoring.

5. CONCLUSION AND POLICY RECOMMENDATIONS

Modifiable behavioral risk factors are the primary drivers of chronic NCDs and multimorbidity. Achieving optimal health outcomes requires combining evidence-based pharmacotherapy with robust lifestyle modification programs. Key policy priorities include:

Rural De-addiction Clinics: Establishing accessible tobacco and alcohol cessation services in rural health centers.

Urban Wellness Programs: Promoting physical activity, dietary interventions, and workplace stress reduction initiatives.

Gender-Tailored Screenings: Expanding targeted screening for metabolic or thyroid disease in women and cardiovascular or cancer risks in men.

Clinical Pharmacy Integration: Deploying clinical pharmacists in outpatient clinics to enhance medication adherence and patient self-monitoring.

Declaration of AI Use

Grammarly, ChatGPT (OpenAI), and Google Gemini were used solely for language refinement, improving clarity or readability, and reference formatting during manuscript preparation. All scientific content, study design, data analysis, interpretation of results, and conclusions were developed and critically evaluated by the authors. The authors retain full responsibility for the accuracy, integrity, originality, interpretation, and final content of the manuscript.

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