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Comparative analysis of mortality and morbidity in the elderly population across major ethnic groups in North Kashmir, Jammu & Kashmir

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Abstract
This study investigates mortality and morbidity patterns across four ethnic groups in North Kashmir: Kashmiris, Hanjis, Dards, and Gujjars, focusing on health disparities among the elderly. Cardiovascular diseases were the leading cause of mortality, with 25.7% of Kashmiris, 22.5% of Hanjis, 25.9% of Dards, and 26.7% of Gujjars affected. Chronic conditions such as arthritis, hypertension, and chronic renal diseases were notably prevalent, especially among Gujjars (12.55%) and Hanji (6.85%) populations. The Elbow Method analysis revealed four disease clusters, emphasizing Diabetes, Cardiovascular Diseases, Chronic Renal Diseases, and Chronic Respiratory Diseases. These findings highlight the growing burden of non-communicable diseases (NCDs) and underline the need for targeted healthcare interventions to address chronic conditions, improve healthcare access, and reduce health disparities in North Kashmir.

Keywords: North Kashmir, mortality, morbidity, ethnic groups, cardiovascular diseases

Introduction
The elderly population is a critical demographic in any society, especially in the context of public health. Mortality and morbidity rates among older adults are not only indicators of overall population health but also reflect the effectiveness of healthcare systems and social support structures. Studying these rates in the elderly provides essential insights into the healthcare needs of this vulnerable group, allowing policymakers to devise more targeted health interventions and allocate resources more efficiently. Additionally, understanding the factors that influence mortality and morbidity, such as chronic diseases, disabilities, and access to healthcare, is crucial for improving the quality of life and ensuring the dignity of older individuals [1, 2]. Chronic diseases, which are prevalent in older adults, often lead to a higher burden of morbidity, resulting in significant economic and social costs [3]. The relationship between morbidity and mortality in the elderly is multifaceted, as higher morbidity often correlates with higher mortality risks. Moreover, aging societies worldwide are witnessing an increasing prevalence of non-communicable diseases (NCDs) such as cardiovascular diseases, diabetes, and cancer, which significantly impact the elderly population's health [4]. In this context, it is essential to examine how these factors influence morbidity and mortality, as this will contribute to the broader understanding of aging-related health issues.

The demographic profile of North Kashmir, Jammu & Kashmir, is characterized by a diverse ethnic population, which is experiencing a significant shift towards an aging society. The elderly population in this region has grown substantially due to improvements in life expectancy and reductions in infant mortality rates over recent decades [5]. However, this growth is accompanied by increasing concerns over the health challenges faced by the elderly, which are compounded by regional and ethnic disparities in healthcare access and social conditions. According to the Census of India 2011, the population of elderly individuals (aged 60 and above) in Jammu & Kashmir accounted for 7.5% of the total population, with a notable concentration in rural areas like North Kashmir [6].

This proportion is expected to rise sharply in the coming decades due to demographic transitions such as declining fertility rates and increased life expectancy. In such a context, the elderly in North Kashmir often face unique challenges, including inadequate healthcare infrastructure, lack of specialized geriatric care, and socio-economic barriers such as poverty, illiteracy, and limited access to health services [7]. Moreover, the mountainous terrain and the remote location of many villages in North Kashmir make it difficult to establish and maintain robust healthcare facilities, which exacerbates the health conditions of the elderly [8]. Understanding how these geographical and socio-economic factors influence mortality and morbidity rates among the elderly in this region is essential for identifying intervention strategies to improve their well-being.

North Kashmir is home to a diverse ethnic composition, including ethnic groups such as Kashmiris, Hanjis, Dards, and Gujjars. These groups differ in their cultural practices and experience varying socio-economic status, educational attainment, and access to healthcare, all of which contribute to disparities in health outcomes [18]. The role of ethnicity in health outcomes is well-documented, as cultural, genetic, and environmental factors significantly influence the health conditions and healthcare utilization patterns of different ethnic groups [9, 10]. Kashmiris, the predominant ethnic group in the region, have distinct social and cultural practices, including dietary habits and religious practices, that may affect their health outcomes. On the other hand, Hanjis, who are an ethnic minority group traditionally engaged in boat-based occupations, face particular challenges in terms of economic opportunities and healthcare access, potentially leading to poorer health outcomes compared to the Kashmiris [11]. Similarly, the Dards, an ethnic group with a unique language and cultural heritage, and the Gujjars, known for their nomadic lifestyle, also face distinct health challenges influenced by their socio-economic conditions and access to health services [12].

Ethnic differences in health outcomes are not just a function of cultural practices but are also linked to systemic inequities in healthcare delivery. For example, studies have shown that ethnic minorities often experience lower levels of healthcare access, lower quality of care, and poorer health outcomes compared to the majority population [13]. In North Kashmir, where ethnic groups are geographically and socially segregated, it is crucial to assess how these disparities manifest in the health outcomes of the elderly population. Factors such as differences in healthcare access, educational attainment, and socio-economic status can lead to significant variations in morbidity and mortality rates across these ethnic groups [14, 21, 22]. By examining these ethnic disparities in health outcomes, this study aims to contribute to the existing body of knowledge on the intersection of ethnicity, aging, and health in rural and ethnically diverse regions of India. This research will also provide valuable insights into how healthcare systems can be improved to address the specific needs of elderly populations from different ethnic backgrounds in North Kashmir.

The primary objectives of this research are to compare the mortality and morbidity rates among different ethnic groups in North Kashmir and to explore the underlying factors that contribute to these differences. By examining ethnic groups such as Kashmiris, Hanji, Dards, and Gujjars, this study aims to highlight variations in health outcomes based on ethnicity, while considering potential influences like socio-economic conditions, healthcare access, and cultural practices. The research seeks to answer critical questions about how mortality and morbidity rates vary across these ethnic groups in North Kashmir and what the underlying factors—such as differences in healthcare access, socio-economic status, and lifestyle practices—are that contribute to these disparities. Understanding these dynamics is essential for improving healthcare policies and interventions that cater to the diverse needs of elderly populations in the region [15].

Methodology

This study employs a cross-sectional research design aimed at analyzing mortality and morbidity patterns among different ethnic groups in the North Kashmir region. The data for this research were collected through a field survey conducted across the study area. This design allows for the examination of the prevalence and distribution of health outcomes in the target Population at a Specific Point in Time.

Study Area

The study was conducted in North Kashmir, situated between latitudes 34° 16' and 34° 40' North, and longitudes 73° 45' and 75° 35' East. The region spans an area of approximately 8320 square kilometers, with elevations ranging from 1060 meters to 5200 meters above sea level. North Kashmir is bordered by the Greater Himalayas to the north and the Kashmir Valley to the south. The North Kashmir Range serves as a natural water divide between the Jhelum River in Kashmir Valley and the Kishenganga River in Gurez Valley [17]. The geographical features and cultural diversity of the region make it an ideal location for studying ethnic variations in health patterns.

Sample Selection

The sampling method used in this study was stratified random sampling, which was chosen to ensure that the sample accurately represented the ethnic diversity of the population in North Kashmir. The population was divided into four distinct ethnic groups: Dard, Gujjar, Hanji, and Kashmiri. Stratified sampling ensures that each group is adequately represented in the final sample, providing a more comprehensive understanding of health patterns across these groups. Proportional allocation was used to determine the sample size for each ethnic group, ensuring that the proportion of individuals from each group in the study mirrored their presence in the general population.

A total of 848 households were selected for the survey, including 351 Kashmiri, 165 Hanji, 170 Dard, and 162 Gujjar families. The sample consisted of 3,121 individuals, with the following ethnic breakdown: 1,437 Kashmiris, 509 Hanji, 575 Dards, and 600 Gujjars. To determine the sample size, the study used Taro Yamane's formula (1967), a statistical method designed to calculate sample sizes for a given margin of error, ensuring that the sample was large enough to produce statistically significant results.

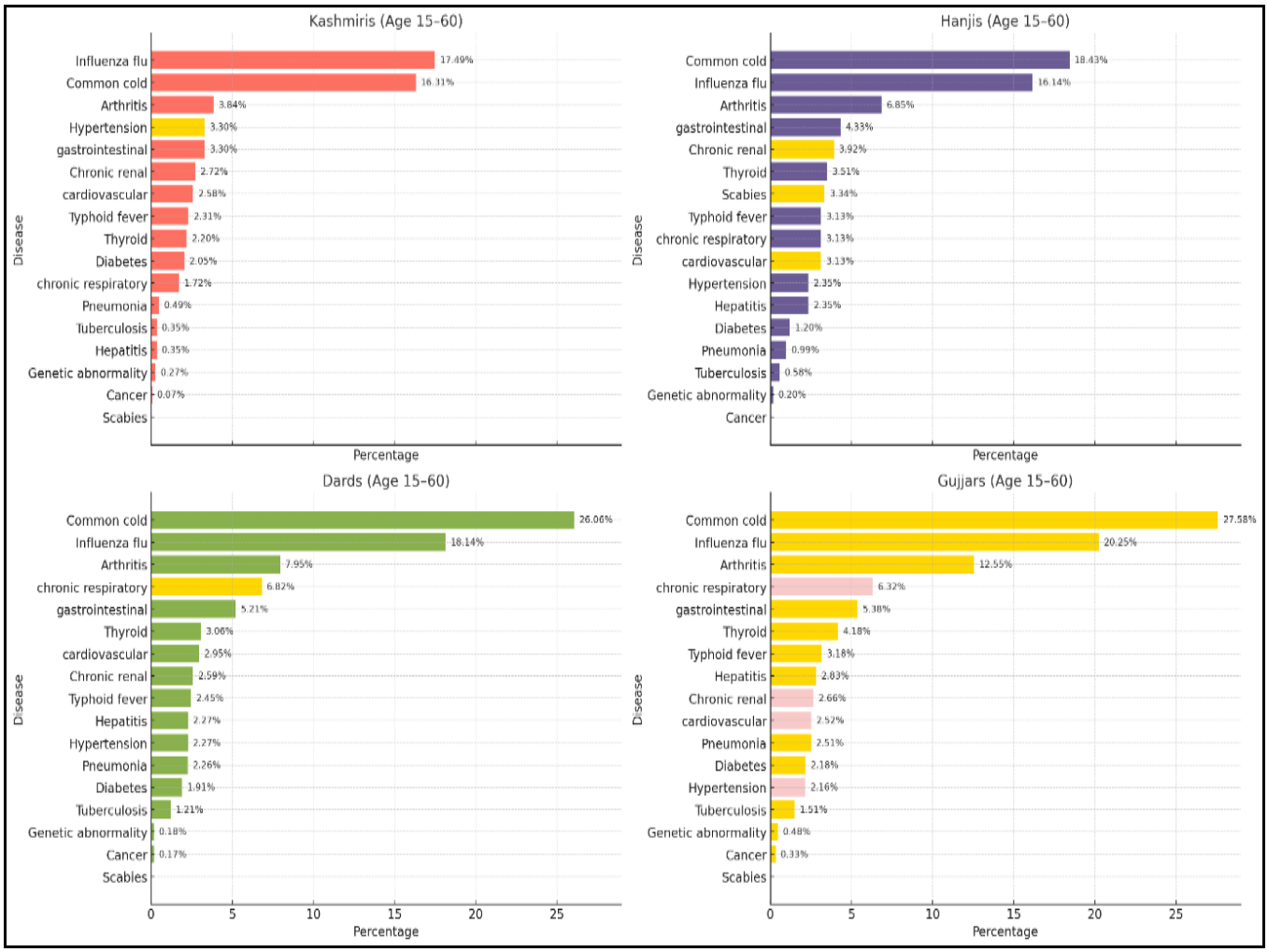
The primary data collection tool was a structured questionnaire, which was designed to capture a wide range of information related to both socioeconomic and health-related indicators. The health data specifically focused on mortality and morbidity patterns within the sampled households. The survey was conducted across three districts

in North Kashmir: Bandipora, Baramulla, and Kupwara. These areas were selected to ensure that a broad cross-section of North Kashmir's population was represented in the study. The data obtained were analyzed to identify patterns of health outcomes and to assess the impact of ethnicity, age, gender, and socioeconomic factors on health disparities.

Statistical Methods

The Elbow Method is a popular technique for determining the optimal number of clusters (K) in K-means clustering. By plotting the inertia (sum of squared distances between data points and their cluster centers) against different values of K, the "elbow" point can be identified where the inertia starts decreasing at a slower rate [16, 25, 26]. This point suggests the optimal number of clusters, balancing the trade-off between the number of clusters and the variance explained. The method is widely used due to its simplicity and effectiveness in finding a suitable K without overfitting the model [27, 28].

Results

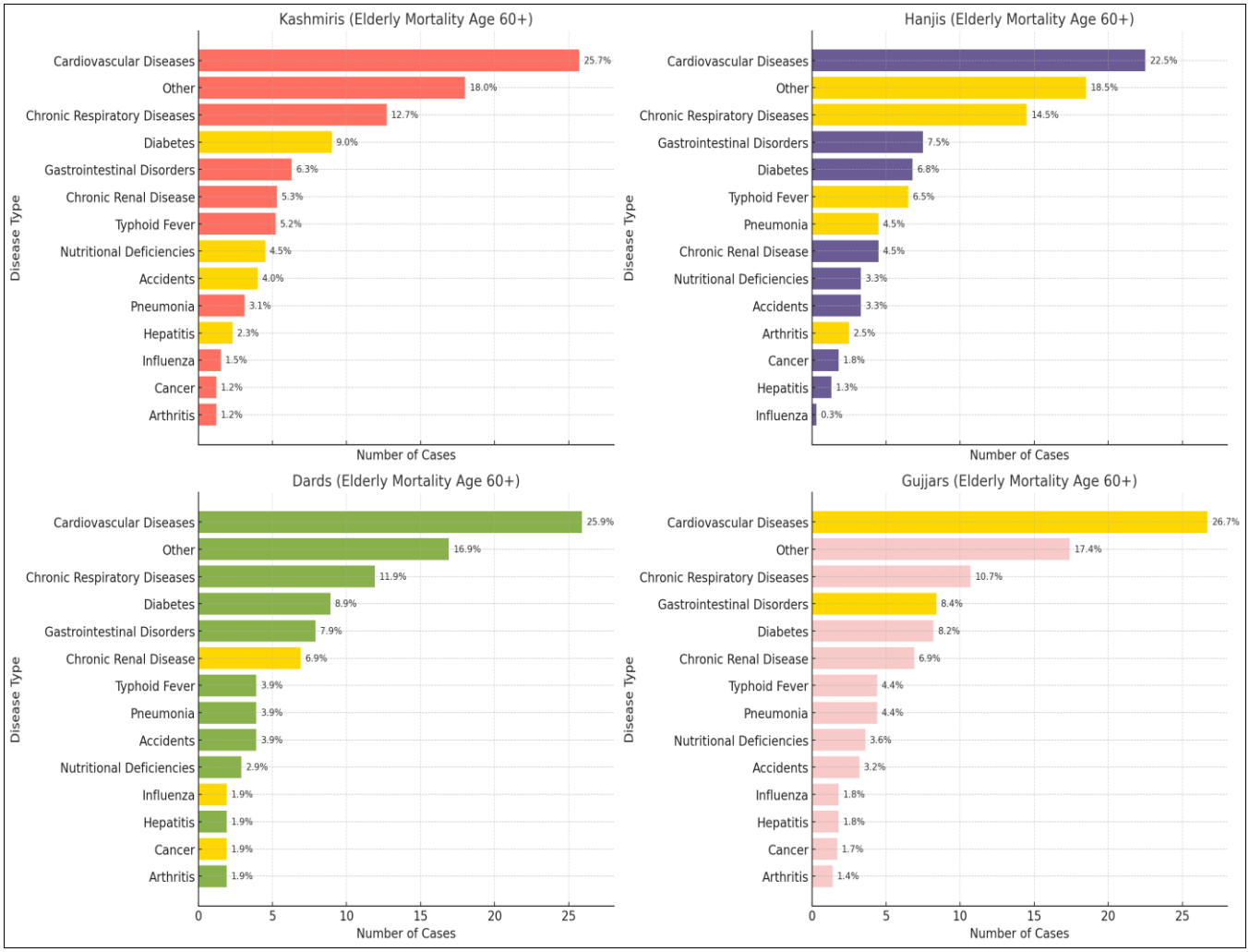


Source: 2021 field survey

Fig 1: Patterns of Morbidity

The data from the health survey highlights that respiratory diseases like common cold and influenza flu are the most prevalent across all ethnic groups in North Kashmir, with significant percentages observed in Kashmiris (37.49%), Hanji (18.43%), Dards (26.06%), and Gujjars (27.58%). These findings suggest a high incidence of respiratory infections in the region, which may be influenced by climatic or environmental factors. Additionally, arthritis is notably common among the Gujjars (12.55%) and Hanji (6.85%) populations, while gastrointestinal diseases are more prevalent among Kashmiris (3.30%) and Hanji (5.63%), indicating health concerns related to digestive issues. Chronic renal diseases also appear in all groups, especially among Kashmiris (2.72%) and Hanji (3.92%), underlining the importance of addressing long-term health conditions in the region.

In addition to infectious diseases and chronic conditions, non-communicable diseases (NCDs) such as hypertension (3.64% in Kashmiris, 2.16% in Gujjars) and cardiovascular diseases are observed across all ethnic groups. This suggests a growing concern for lifestyle-related health issues. The presence of thyroid disorders (notably in Gujjars at 4.18%) and scabies (seen in Hanji at 3.34%) highlights specific regional health challenges. Overall, these findings indicate that while respiratory infections are the primary health burden, there is a significant need to focus on managing chronic diseases and improving healthcare access across the diverse ethnic groups in North Kashmir. Public health interventions should aim at both prevention and management of these diseases, especially NCDs and chronic conditions.



Source: 2021 field survey

Fig 2: Patterns of Mortality

The data presented in these charts reveal the leading causes of elderly mortality (age 60+) among the four ethnic groups in North Kashmir. Cardiovascular diseases are the primary cause of death in all groups, with Kashmiris experiencing 25.7%, Hanji at 22.5%, Dards at 25.9%, and Gujjars at 26.7%. This trend indicates a significant burden of heart-related diseases in the elderly population across these ethnic groups. Chronic respiratory diseases are the second most common cause of mortality, particularly in Kashmiris (12.7%), Dards (11.9%), and Gujjars (10.7%), highlighting respiratory issues as a key health concern in the region. Other common causes include diabetes and gastrointestinal disorders, which are prevalent in all ethnic groups, suggesting the presence of metabolic and digestive health issues that affect the elderly.

The remaining causes of elderly mortality, such as nutritional deficiencies, chronic renal disease, and typhoid fever, show varying trends across the groups. Nutritional deficiencies are notably higher in Kashmiris (4.5%) and Dards (2.9%), indicating potential dietary or socioeconomic factors influencing health outcomes. Typhoid fever is observed more in Kashmiris (5.2%) and Hanji (6.5%), reflecting regional variations in infectious diseases. Additionally, other conditions like cancer, hepatitis, and influenza are less prevalent but still contribute to the mortality figures. Overall, cardiovascular and respiratory diseases dominate the causes of death in elderly populations, while other chronic and infectious diseases also play significant roles in different ethnic groups

Statistical analysis

Based on the Elbow Method chart, which suggests that 4 clusters may be the optimal number, the analysis indicates that dividing the morbidity data into four clusters helps capture distinct patterns of disease burdens across the population. The inertia curve shows a steady decrease in the sum of squared distances between data points and their assigned cluster centers, but after K=2, the curve continues to decrease more gradually. This suggests that while the jump from K=1 to K=2 is significant, further refinement into 3 or 4 clusters can still provide meaningful divisions in the data.

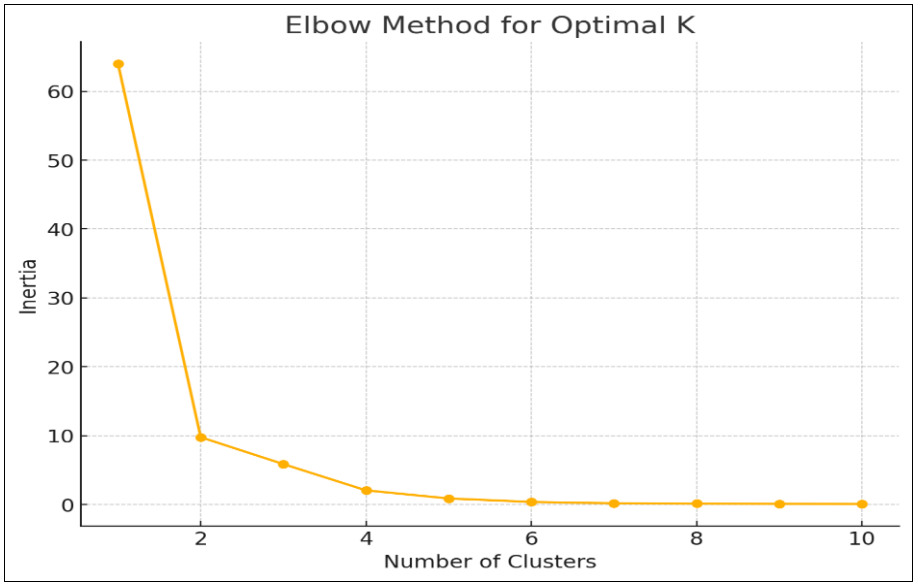


Fig 3: Morbidity Elbow Method

Table 1: Patterns of Morbidity Cluster Analysis

Cluster	Diseases
0	Arthritis, Hypertension, Gastrointestinal
1	Chronic Renal, Cardiovascular, Typhoid Fever, Thyroid, Diabetes, Chronic Respiratory, Pneumonia, Tuberculosis, Hepatitis, Cancer, Scabies
2	Influenza Flu
3	Common Cold

The cluster analysis of diseases across the four ethnic groups in North Kashmir reveals distinct groupings based on disease prevalence and mortality. Cluster 0 includes conditions like Arthritis, Hypertension, and Gastrointestinal disorders, which are prevalent across all ethnic groups but are generally less fatal. These diseases are often chronic, lifestyle-related, or associated with aging, impacting the quality of life without causing immediate mortality. Cluster 1, a larger and more diverse group, encompasses severe diseases such as Chronic Renal Disease, Cardiovascular conditions, Typhoid Fever, Thyroid problems, Diabetes, Chronic Respiratory diseases, Pneumonia, Tuberculosis, Hepatitis, Cancer, and Scabies. Many of these conditions are directly linked to higher mortality rates, particularly among the elderly.

Cluster 2 stands apart with Influenza Flu, a contagious respiratory disease that, while not typically fatal, can lead to high morbidity, especially in older populations. Its separation from chronic conditions reflects its seasonal nature and potential for widespread short-term health disruptions. Cluster 3 includes the Common Cold, a mild illness that, while highly prevalent, does not lead to severe morbidity or mortality. This cluster represents diseases that are more transient or related to environmental factors. Together, these clusters provide valuable insights into how diseases impact elderly populations across ethnic groups, helping prioritize healthcare resources and address the unique health challenges faced by these communities.

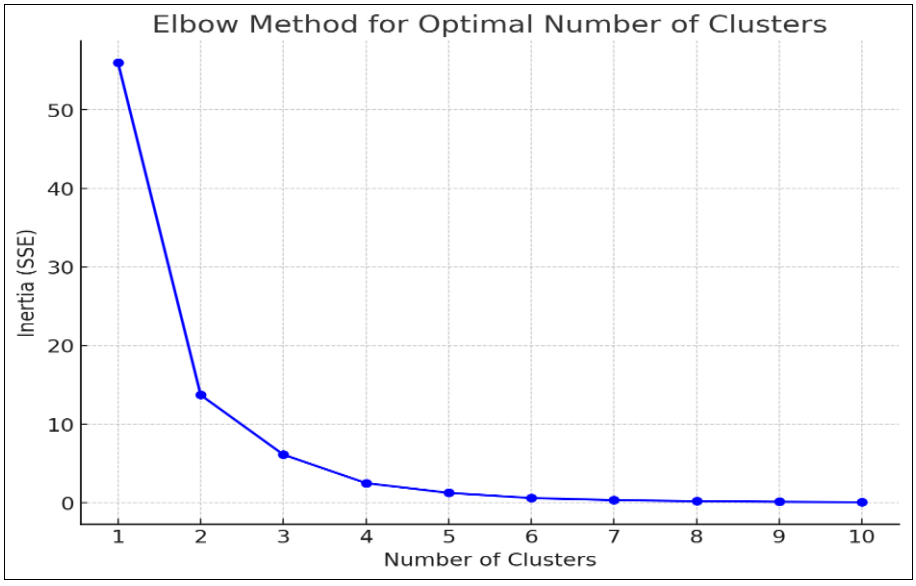


Fig 4: Mortality Elbow Method

Table 2: Patterns of Mortality Cluster Analysis

Cluster	Diseases
0	Diabetes, Gastrointestinal Disorders, Chronic Renal Disease, Typhoid Fever
1	Cardiovascular Diseases
2	Nutritional Deficiencies, Accidents, Pneumonia, Influenza, Hepatitis, Cancer, Arthritis
3	Other, Chronic Respiratory Diseases

From figure 4, the Elbow Method plot indicates that the optimal number of clusters for the data is around 4. The plot shows a sharp decrease in inertia as the number of clusters increases from 1 to 2, and then a more gradual reduction as more clusters are added. This suggests that after 4 clusters, the improvement in clustering results diminishes significantly. The 4 clusters are therefore the most appropriate choice for representing the underlying patterns in the data, as they balance between minimising inertia and ensuring meaningful differentiation of the data points. This number of clusters will provide a good representation of the variations in disease prevalence across the ethnic groups while avoiding overfitting the model.

From Table 2, the mortality clustering analysis reveals significant groupings of diseases across the four ethnic groups in North Kashmir, providing insights for targeted public health interventions. Cluster 0 includes chronic conditions such as Diabetes, Gastrointestinal Disorders, Chronic Renal Disease, and Typhoid Fever. These diseases are associated with long-term health risks like kidney failure, digestive issues, and blood sugar imbalances, particularly prevalent among the elderly. The combination of chronic and infectious diseases in this cluster increases mortality risk, especially in resource-limited areas with inadequate healthcare access. Cluster 1 focuses on Cardiovascular Diseases, including heart disease, hypertension, and stroke, which are leading causes of death in elderly populations. The high mortality rate from these diseases highlights the need for lifestyle-based prevention and treatment strategies, particularly focusing on diet, exercise, and hypertension management.

Cluster 2 encompasses a mix of chronic, infectious, and preventable diseases, including Nutritional Deficiencies, Accidents, Pneumonia, Influenza, Hepatitis, Cancer, and Arthritis. These conditions significantly affect the elderly, with pneumonia and influenza contributing to respiratory infections and cancer and arthritis impacting long-term quality of life. Finally, Cluster 3 groups Other and Chronic Respiratory Diseases, such as COPD and asthma, which may not be immediately fatal but contribute to reduced life expectancy and worsen other health conditions. The analysis underscores the importance of differentiated healthcare strategies addressing both chronic diseases like cardiovascular conditions and preventable causes like nutritional deficiencies and accidents. Improving access to quality healthcare is crucial for managing these conditions effectively and reducing mortality rates across the region.

Discussion

The results of the cluster analysis and mortality analysis highlight the complex and multifaceted nature of health challenges faced by the elderly populations in North Kashmir, specifically across the four ethnic groups: Kashmiris, Hanjis, Dards, and Gujjars. The disease clustering reveals distinct patterns of health burdens, with respiratory diseases like common cold and influenza flu being the most prevalent, especially in the younger population. However, in the elderly population, cardiovascular diseases dominate as the leading cause of death across all groups, followed by chronic respiratory diseases, diabetes, and gastrointestinal disorders. The mortality clustering of these diseases underscores the importance of chronic and non-communicable diseases (NCDs), particularly in older adults, while also recognizing the significant role infectious diseases, such as pneumonia and influenza, play in mortality.

Comparing these findings with existing literature [19, 20], it aligns with global trends where cardiovascular diseases are consistently the leading cause of mortality in aging populations due to their association with lifestyle factors such as diet, physical activity, and smoking. Similarly, chronic respiratory diseases and diabetes have been shown to contribute significantly to health complications and mortality in older adults. The higher prevalence of arthritis, gastrointestinal disorders, and nutritional deficiencies in these groups can be attributed to factors such as poor diet, lack of physical activity, and socioeconomic conditions that limit access to healthcare [23, 24]. The fact that influenza and typhoid fever appear more prominently in some ethnic groups may point to regional or environmental factors, such as exposure to poor sanitation or climate conditions, contributing to higher susceptibility.

Possible Reasons for Variations in Health Outcomes:

Several factors likely explain the variations in health outcomes observed across the ethnic groups. Genetic factors could play a role in the predisposition of certain diseases like cardiovascular disease and diabetes, which are known to have hereditary components. Additionally, lifestyle factors such as diet, physical activity levels, and smoking are likely to vary across ethnic groups, influencing the prevalence of chronic conditions like hypertension, diabetes, and gastrointestinal disorders. For example, some groups may have dietary patterns that are higher in fats or lower in fruits and vegetables, contributing to higher rates of metabolic disorders.

Healthcare disparities also play a significant role in the variations seen in health outcomes. Differences in access to healthcare facilities, availability of preventive services, and socioeconomic status can influence the diagnosis, treatment, and management of diseases like cancer, cardiovascular diseases, and respiratory conditions. Ethnic groups with limited access to healthcare resources or lower health literacy may face higher mortality rates due to delayed diagnoses or inadequate management of chronic diseases. In addition, regional environmental factors, such as air pollution or sanitation levels, could contribute to the higher incidence of respiratory infections and infectious diseases in certain ethnic groups, as seen with the higher rates of influenza and typhoid fever in Kashmiris and Hanjis.

These factors underline the importance of targeted public health interventions that address both genetic and environmental factors, improve healthcare access, and promote healthy lifestyle changes across all ethnic groups in

the region.

Implications for Policy and Healthcare Planning: Improving healthcare for the elderly in North Kashmir requires a multi-faceted approach that addresses both chronic diseases and infectious conditions. With diseases like cardiovascular diseases, diabetes, and chronic respiratory issues being prevalent, specialized programs should be introduced to focus on the prevention, early detection, and management of these conditions. Public health initiatives should aim to improve vaccination rates for respiratory diseases like influenza and pneumonia, and better manage chronic respiratory diseases such as COPD. Furthermore, mobile healthcare units and telemedicine services could be deployed to reach remote populations, providing elderly individuals in rural areas with access to specialized care. Nutritional deficiencies should also be addressed with targeted food programs, while efforts to improve sanitation and hygiene would help reduce the spread of infectious diseases like typhoid fever and respiratory infections. Such measures would mitigate the health burden on the elderly and ensure that they have the resources needed to maintain a better quality of life.

Policy recommendations should focus on equitable healthcare access and reducing socioeconomic disparities. Building more healthcare facilities in underserved areas and improving affordability through social welfare programs would ensure that elderly populations, particularly those from lower socioeconomic backgrounds, can access necessary treatments. Culturally sensitive health interventions tailored to specific ethnic groups are also critical in addressing health disparities. Moreover, enhancing community-based healthcare programs and increasing disease surveillance would help monitor health trends and ensure resources are directed where most needed. The development of national NCD prevention policies, alongside preventive measures such as regular screenings and lifestyle change programs, can help reduce the impact of chronic conditions on the elderly. By implementing these strategies, North Kashmir can improve the health outcomes for its elderly population and reduce the disparities between different ethnic groups.

Conclusion

The comparative analysis of mortality and morbidity rates across the four ethnic groups in North Kashmir reveals key insights into the health challenges faced by the elderly population. Cardiovascular diseases are the leading cause of death in all ethnic groups, with significant mortality attributed to chronic respiratory diseases and diabetes. Respiratory infections, including common cold and influenza, emerge as highly prevalent, especially in Kashmiris, indicating environmental or seasonal factors contributing to these health issues. Additionally, nutritional deficiencies and gastrointestinal disorders present a considerable health burden, particularly in certain ethnic groups like Kashmiris and Dards.

The cluster analysis further underscores these findings by grouping diseases based on their prevalence and severity. Diseases such as arthritis, hypertension, and gastrointestinal disorders form one cluster, highlighting more chronic conditions, while conditions like cardiovascular diseases, chronic renal diseases, and cancer form another, pointing to more serious and life-threatening illnesses. The analysis emphasizes the growing concern of non-communicable diseases (NCDs), along with the need for targeted interventions, especially in managing chronic diseases and improving healthcare access across different ethnic groups. This comprehensive understanding of morbidity and mortality patterns can help inform public health strategies and policy decisions.

Conflict of Interest
Not available

Financial Support
Not available

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