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Sana Ghous
Chandka Medical College Hospital, Larkana

Anjlee Shankar
Chandka Medical College Hospital, Larkana

Abdul Qadir Baloch
Chandka Medical College Hospital, Larkana

Dipanty Khastoori
Dow University Of Health Sciences Karachi

Tahira Maqsood
Chandka Medical College Hospital, Larkana

See next page for additional authors

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Authors

Sana Ghous, Anjlee Shankar, Abdul Qadir Baloch, Dipanty Khastoori, Tahira Maqsood, and Alam Ibrahim Siddiqui

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AGE-STRATIFIED MOSAIC OF NEUROPATHIES: A COMPREHENSIVE ANALYSIS OF THE PREVALENCE AND PATTERNS IN DIFFERENT AGE GROUPS

Sana Ghous[1], Anjlee Shankar [1], Abdul Qadir Baloch[1], Dipanty Khastoori[2], Tahira Maqsood[1], Alam Ibrahim Siddiqui[1]
[1].Chandka Medical Collage Hospital Larkana
[2].Dow University Of Health Sciences Karachi

Corresponding author:* Sana Ghous** *Department of Neurology, Chandka Medical College Hospital, Larkana* ***Email: *sana_shk13@yahoo.com*

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ABSTRACT

Background and Objective:
Neuropathies pose significant challenges in diagnosis and management due to their heterogeneous etiologies, varied clinical presentations, and differential prevalence across age groups. The objective of this study was to analyze the distribution of neuropathies among patients in various age brackets, highlighting prevalent neuropathic types and their clinical implications.

Methods:
From September 18, 2018 to September 17, 2019, 405 patients from Neurology Ward of Chandka Medical College Hospital in Larkana were included in this retrospective cross-sectional comprehensive analysis. Nerve conduction studies (NCS) of these patients were conducted in the electrophysiology department. The study cohort was stratified into age groups, allowing us to compare the frequency and NCS findings of various neuropathies. Statistical analysis using SPSS 23 was performed to ascertain the prevalence and distribution of specific neuropathies across different age brackets.

Results:
In the younger age group below 20 years, a prominent prevalence of neuropathies linked to hereditary factors was notable. Contrastingly, within the 20-40 age stratum, distinctive distribution patterns were observed, showcasing prevalent occurrences of Acute Inflammatory Demyelinating Polyneuropathy (AIDP) and those induced by trauma. Similarly, in the 40-60 and above 60 age cohorts, unique prevalence profiles emerged, spotlighting Chronic Inflammatory Demyelinating Polyneuropathy (CIDP) and neuropathies associated with diabetes and malignancies as most common.

Conclusion:
The findings of this study shed light on the age-related distribution of neuropathies and the corresponding NCS profiles. Such insights can aid in improving the diagnosis and management of neuropathies based on age, ensuring more tailored and effective healthcare strategies.

Key words: Neuropathy, Peripheral nervous system, Age groups, Nerve conduction studies

INTRODUCTION

Neuropathy, a diverse spectrum of disorders affecting the peripheral nervous system, presents a significant clinical challenge due to its multifaceted etiologies and varied clinical manifestations.[1] The term "neuropathy" refers to the dysfunction or damage of one or more peripheral nerves, leading to a wide array of symptoms such as pain, tingling, numbness, muscle weakness, atrophy and autonomic dysfunction. Peripheral neuropathies are one of the most prevalent neurological conditions observed at an annual incidence of 77 cases per 100,000 individuals. Their prevalence spans between one to 12% across all age cohorts and notably elevates to approximately 30% among elderly. In recent years, it has become more common in Asia, particularly in the third world countries like Pakistan. In Pakistan current prevalence of

neuropathy is not accurately known. Literature shows that there is substantial variation in epidemiology, risk factors and etiology of neuropathies.[2]

Neuropathy is a condition that leaves many crippled and disabled leading to dependency. The causes of neuropathy are also diverse, not just limited to diabetes mellitus, autoimmune diseases, infectious agents, hereditary factors, traumatic injuries, and exposure to toxins or medications. The impact of age-related changes on the peripheral nervous system is profound, influencing the prevalence and presentation of neuropathic conditions across different age groups.

The distribution of neuropathy across distinct age groups reflects the complex interplay between age-related physiological changes, cumulative exposures to risk factors, and genetic predispositions. Understanding the age-specific patterns of neuropathy prevalence and type is crucial for tailoring diagnostic and therapeutic strategies to effectively address the diverse needs of patients across the lifespan.[3]

On the basis of etiology neuropathy is divided into following types,

Hereditary Neuropathies: Hereditary neuropathies encompass a group of nerve disorders resulting from genetic mutations.[4] Conditions such as Charcot-Marie-Tooth disease and familial amyloid neuropathy are inherited disorders characterized by progressive nerve damage and neuropathic symptoms.

Inflammatory Neuropathies: Inflammatory neuropathies refer to a spectrum of nerve disorders triggered by immune-mediated mechanisms.[5] Inflammatory disorders, such as AIDP, CIDP, rheumatoid arthritis, lupus, polyarteritis nodosa, Wegener's granulomatosis, and sarcoidosis, contribute to neuropathic manifestations through immune-related mechanisms.

Traumatic Neuropathies: Traumatic neuropathies arise from physical nerve injury or compression following trauma.[6] These injuries, including accidents or sports-related trauma, lead to nerve damage or compression neuropathies like carpal tunnel syndrome (CTS). Symptoms typically manifest according to the affected nerve's distribution and site of injury.

Toxin-Related Neuropathies: Toxin-related neuropathies encompass nerve disorders resulting from exposure to specific toxins present in the environment or through occupational hazards.[7]

Drug-Induced Neuropathies: Drug-induced neuropathies arise as a consequence of certain medications or therapeutic agents.[8] Specific drugs, like Anti-tuberculosis therapy (ATT) and various chemotherapy agents, are known to induce nerve damage, resulting in neuropathic symptoms.

Nutritional Neuropathies: Nutritional neuropathies are nerve disorders caused by deficiencies or imbalances in essential nutrients and vitamins, vital for nerve function.[9] These deficiencies, often stemming from inadequate dietary intake or malabsorption, lead to subsequent neuropathic symptoms.

Infectious Neuropathies: Infectious neuropathies arise from certain infections and can present as post-infectious complications, such as post-diphtheritic neuropathy, where nerve damage occurs as a consequence of the infection.

Metabolic Neuropathies: Metabolic neuropathies encompass nerve disorders resulting from systemic metabolic derangements.[10] Such as hyperglycemia-induced nerve damage in diabetic polyneuropathy.

Vascular Neuropathies: Vascular neuropathies refer to nerve disorders resulting from compromised blood flow to the nerves, leading to nerve damage and subsequent neuropathic symptoms.[11]

Malignancy-Associated Neuropathies:
Malignancy-associated neuropathies arise from certain cancers affecting the nervous system.[12] These neuropathies may result from direct nerve infiltration by the tumor, immune-mediated responses against the malignancy or cancer chemotherapy, leading to neuropathic symptoms.

Endocrine Neuropathies: Endocrine neuropathies stem from hormonal imbalances affecting nerve function. Conditions such as diabetes mellitus and thyroid disorders can lead to endocrine-related nerve damage, resulting in neuropathic symptoms.

In this study, we delve into neuropathic distribution across distinct age groups, aiming to elucidate the prevalence and patterns of specific neuropathy

subtypes in patients below 20, 20-40, 40-60, and above 60 years of age. Through this comprehensive examination, we aspire to inform and empower healthcare professionals in their efforts to recognize and manage neuropathic conditions within the context of age-specific considerations, ultimately enhancing the delivery of personalized and effective care across the age continuum.

METHODS

This was a retrospective cross-sectional analysis of patient record, spanning different age groups, who presented to Neurology department of Chandka Medical College Hospital Larkana, over a one-year period from September 18, 2018, to September 17, 2019. Nerve conduction studies (NCS) was performed using NEUROWERK machine. Consecutive sampling of patients was done who satisfied the inclusion criteria.

Inclusion Criteria: Patients exhibiting symptoms such as limb weakness, numbness, tingling, atrophy, and other neurologic complaints focusing on specific neuropathy subtypes, such as diabetic neuropathy, hereditary neuropathies, autoimmune, traumatic and toxic neuropathies were included.

Exclusion Criteria: Patients with concurrent neurologic conditions confounding neuropathy diagnosis were excluded.

We gathered demographic details, symptoms profiles, and NCS outcomes from patient records. The extracted data were synthesized to generate age-specific prevalence rates of distinct neuropathy subtypes across four age groups, namely below 20, 20-40, 40-60, and above 60 years of age. Statistical analysis of data was performed using SPSS version 23.

The study protocol adhered to ethical standards and received approval from the institutional review board.

RESULTS

The NCS analysis included a total of 405 patients, fulfilling the inclusion/exclusion criteria, with age range of 5-80 years. They were categorized into four distinct age groups: below 20, 20-40, 40-60, and above 60 to determine etiology, pattern and prevalence of age related neuropathies. There were 32, 96, 175, and 102 patients respectively in the groups. As per gender distribution, majority of the patients were males with 53% (n=215), and females with 47% (n=190),

Out of thirty-two patients in age group below 20 years, hereditary causes like Charcot Marie Tooth Disease (CMTs) were most prevalent, followed by inflammatory causes like GBS. Traumatic, infectious, and metabolic causes of neuropathies were also reported (Figure 1).

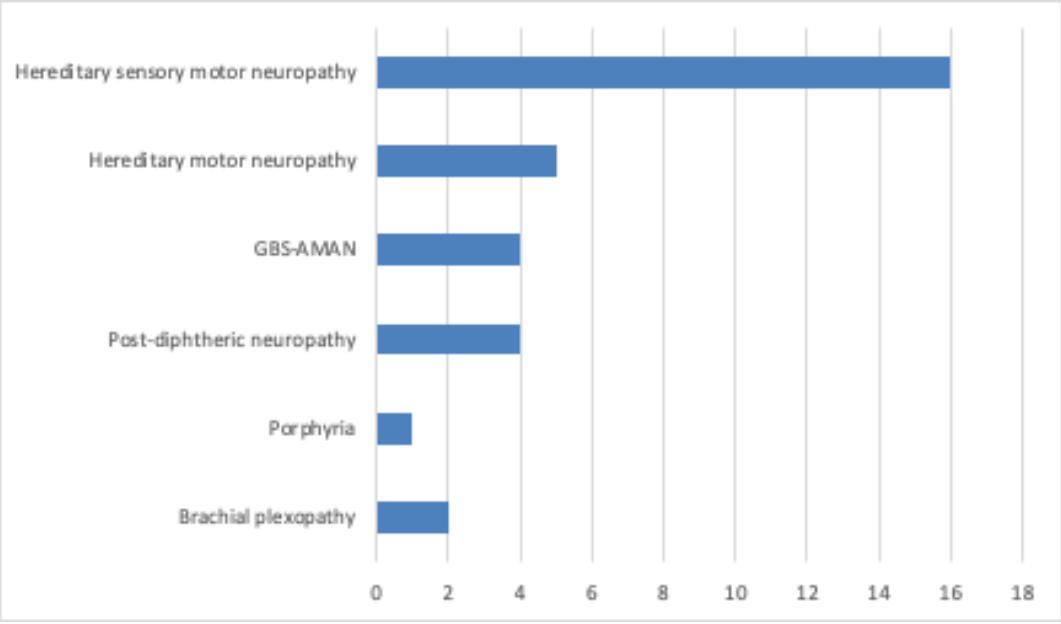

Figure 1: Etiologies of neuropathy in below-20 years age group

In the age bracket between 20 and 40, involving 102 patients, the predominant conditions observed were inflammatory conditions such as Guillain-Barré syndrome (GBS), trauma-related issues, and a variety of other ailments, including hypothyroidism. The most frequent condition found was acute inflammatory demyelinating polyneuropathy (AIDP), followed by the acute motor axonal neuropathy (AMAN) variant. Among cases related to trauma, radial nerve palsy was the most prevalent. Isoniazid-induced neuropathy stood out as the most common drug-induced cause, while vitamin B12 deficiency was notably frequent in cases related to nutrition. In terms of infectious causes, leprosy and diphtheria were identified as common factors. Additionally, among metabolic causes, hypothyroidism emerged as the most prevalent condition (Figure 2).

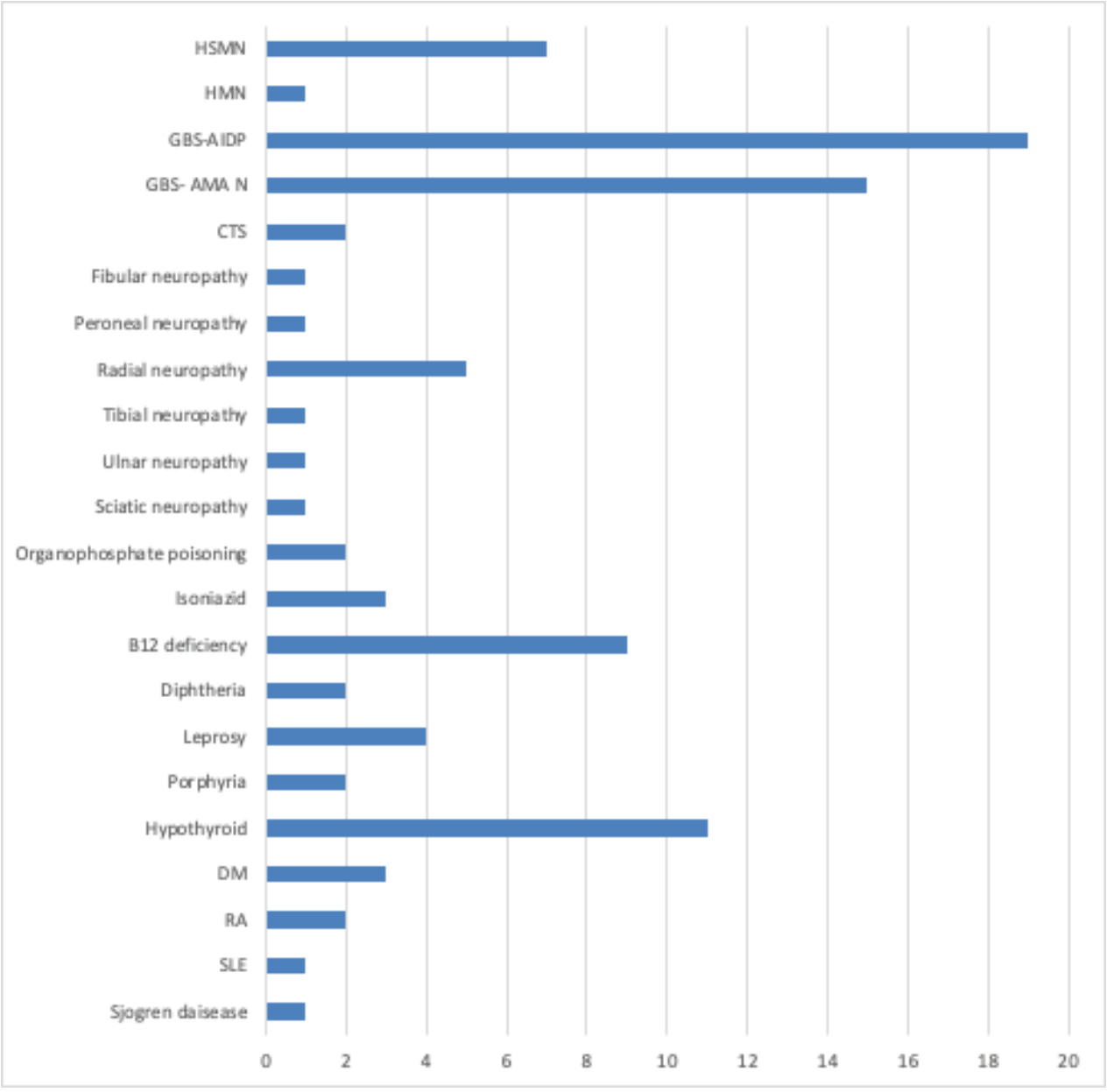

Figure 2: Etiologies of neuropathy in 20-40 years age group

The 40-60 age group displayed a higher prevalence of inflammatory, metabolic, traumatic, toxin and drug-related conditions, as well as malignancies and endocrine disorders. Chronic immune demyelinating polyneuropathy (CIDP), being most common in inflammatory causes. In metabolic causes diabetic polyneuropathy was the most common followed by hypothyroidism and uremia. Among paraneoplastic causes, Carcinoma of lung was most common followed by carcinoma breast. Drug related neuropathy causes include isoniazid and chemothraphy drugs. Inflammatory causes include RA, SLE, PAN, Wegener's granulomatosis and sarcoidosis (Figure 3).

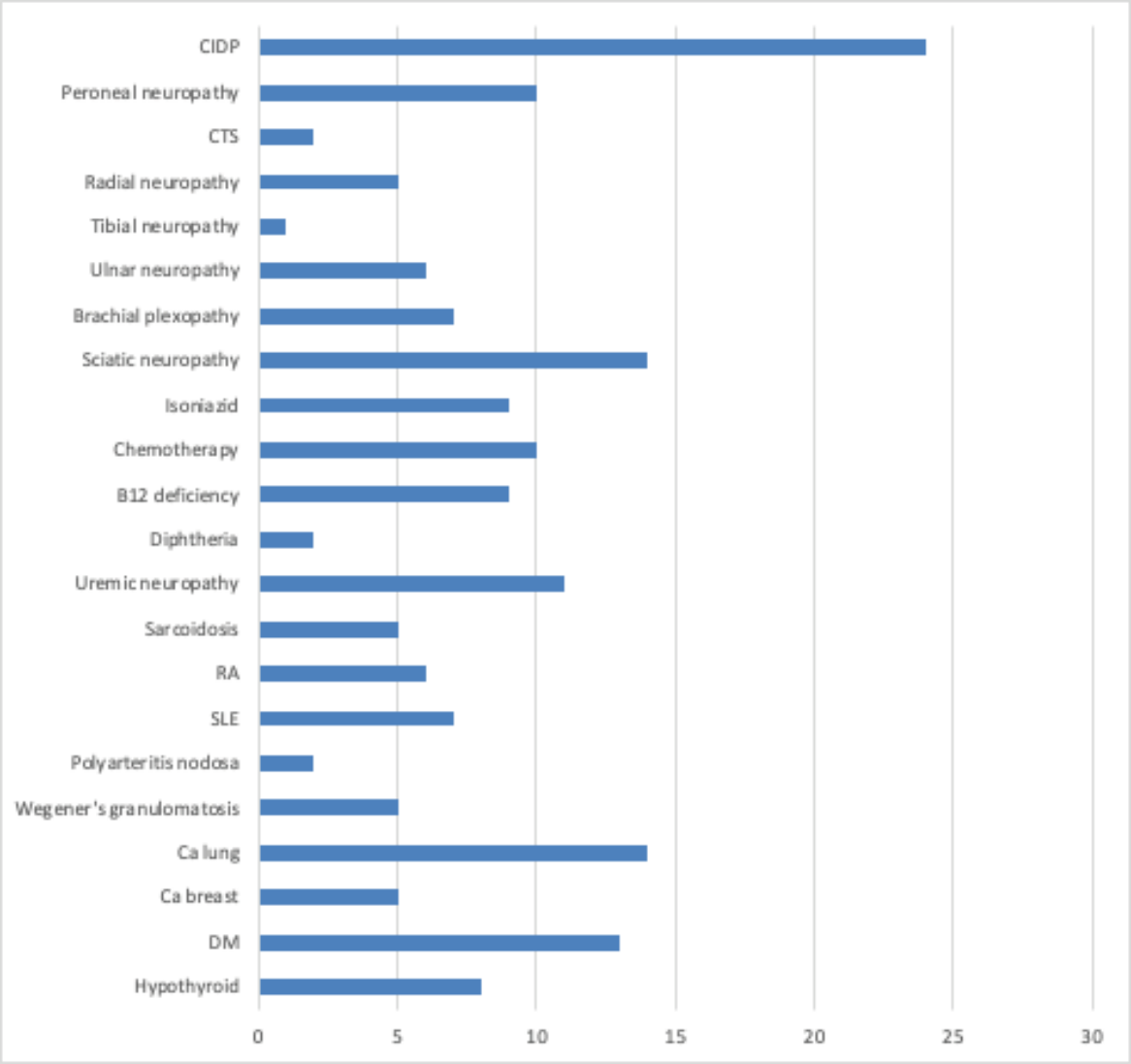

Figure 3: Etiologies of neuropathy in 40-60 years age group

Among the 102 patients aged above 60 years, metabolic etiologies, such as diabetes, hypothyroidism, and uremia constituted the predominant neuropathic causes. Inflammatory conditions, encompassing Chronic Immune Demyelinating Polyneuropathy (CIDP) and systemic disorders like sarcoidosis were also evident. Malignancies, particularly lung and colon carcinoma were reported and cases attributed to drug-induced neuropathies like isoniazid and cancer chemotherapy were also observed. A few Instances of radiculopathy and plexopathy were also documented. Conversely, infectious and hereditary conditions seemed to be sparse (Figure 4).

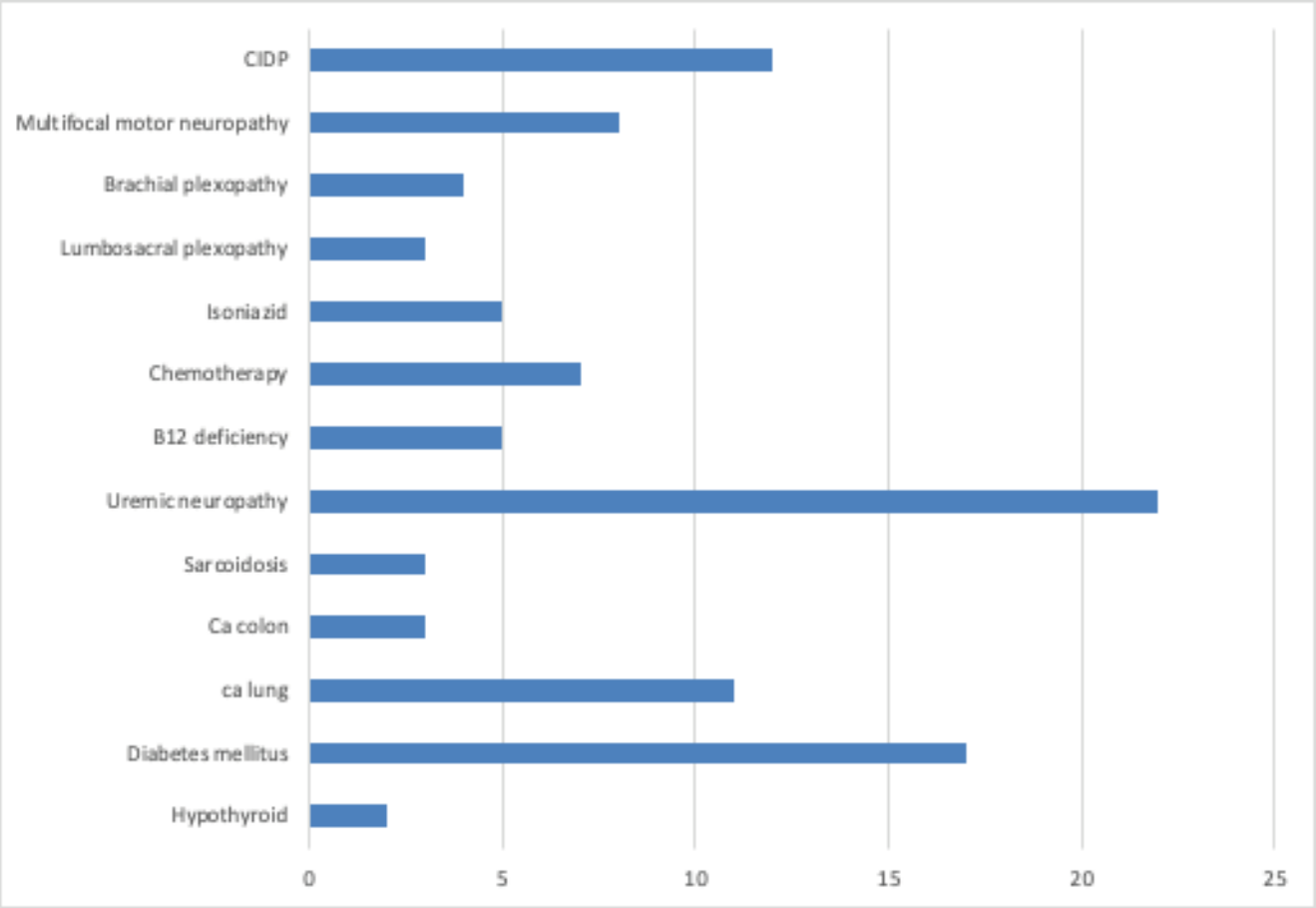

Figure 4: Etiologies of neuropathy in above-60 years age group

DISCUSSION

Neuropathy denotes dysfunction within the nervous system, specifically affecting the peripheral nerves, leading to impaired sensory, motor, or autonomic functions. Neuropathies arise from diverse etiological factors, categorized broadly into various types, including metabolic, inflammatory, traumatic, toxin/drug-related, infectious, hereditary, and malignancy-associated neuropathies.

The age-related spectrum of neuropathies exhibits distinct patterns across different age cohorts, delineating a diverse landscape of underlying etiologies. Younger patients, in particular, tend to manifest a higher prevalence of hereditary sensory motor neuropathy, acute inflammatory demyelinating polyneuropathy (AIDP) and trauma-induced neuropathies. AIDP, a subtype of Guillain-Barré syndrome (GBS), is observed more frequently among younger individuals, highlighting the acute and immune-mediated nature of this neuropathic condition. Furthermore, traumatic neuropathies, often resulting from accidents or sports-related injuries, demonstrate a heightened occurrence in the younger age groups.

In contrast, middle-aged individuals exhibit a distinct prevalence pattern, characterized notably by drug-induced neuropathies like isoniazid neuropathy. The increased incidence of drug-related neuropathies in this age bracket reflects exposure to medications such as isoniazid used in tuberculosis treatment. Additionally, diabetic neuropathy emerges prominently in the middle-aged population, showcasing an alarming trend of rising diabetes prevalence in this demographic. The increasing incidence of diabetic neuropathy among middle-aged individuals warrants heightened attention due to the escalating burden of diabetes in this age group. Moreover, while diabetic neuropathy is conventionally associated with older age, its emergence in the middle-aged and even younger populations indicates a concerning trend of earlier onset and increased prevalence. This phenomenon underscores the evolving landscape of neuropathies, especially the concerning rise in metabolic disorders

like diabetes in younger and middle-aged individuals, posing challenges in disease management and healthcare strategies.

Comparative analysis of neuropathy prevalence among distinct age brackets reveals notable similarities. Notably, our findings demonstrate a higher prevalence of metabolic causes, prominently represented by diabetes mellitus, hypothyroidism, and uremia, among the older age groups, supporting existing literature on age-related trends in neuropathy etiologies.[13] The pronounced occurrence of these metabolic factors in elderly cohorts aligns with the progressive nature of these conditions, reflecting the cumulative impact of prolonged metabolic dysregulation on nerve health. Conversely, our study elucidates a contrasting pattern regarding inflammatory etiologies within the older population. Inflammatory neuropathies, such as Chronic Inflammatory Demyelinating Polyneuropathy (CIDP) and systemic disorders like sarcoidosis, appear to exhibit heightened prevalence among the elderly, mirroring trends observed in established literature.[14]

This observed discrepancy in prevalence, with inflammatory causes assuming greater prominence in older age brackets, establishes the complex interplay between immune-mediated mechanisms and age-related susceptibility to certain neuropathic conditions.

Understanding the age-related prevalence of specific neuropathies can aid healthcare professionals in early detection, diagnosis, and targeted intervention. For instance, the higher prevalence of hereditary neuropathies in the age group below 20 years highlights the importance of genetic screening and counseling for young patients and their families.[15] Furthermore, the peak in inflammatory and immune-related conditions during middle age underscores the need for age-specific approaches to managing acute, autoimmune and chronic inflammatory disorders.[16] The increase in malignancies and endocrine disorders in the 40-60 age group emphasizes the significance of age-appropriate cancer screening and metabolic health management.[17]

Understanding these age-related nuances in neuropathy etiologies is crucial for developing targeted interventions aimed at mitigating the growing burden of neuropathic conditions in diverse age cohorts.

Limitations:

Sample Size and Selection Bias: One of the primary limitations of this study pertains to the sample size, which might not fully represent the entire population. The study's reliance on a specific demographic or geographical location could introduce selection bias, limiting the generalizability of findings to broader populations.

Retrospective Nature and Data Quality: The retrospective design of this study might be prone to inherent limitations associated with data collection and accuracy. Reliance on medical records and retrospective data collection methods might introduce variability in the quality and completeness of the information available, impacting the study's robustness. Despite its contributions, this study is subject to several limitations that should be considered while interpreting the results. Addressing these limitations in future research endeavors could enhance the validity and applicability of findings, providing a more comprehensive understanding of neuropathies across diverse populations and settings.

CONCLUSION

This comprehensive investigation offers valuable insights into the landscape of neuropathies across a varied patient population, demonstrating a clear age-related distribution of neuropathies. Hereditary neuropathies such as CMTs predominated in the younger age group, while Inflammatory neuropathy, particularly chronic inflammatory demyelinating polyneuropathy (CIDP), were prominent in the 20-40 and 40-60 age groups, indicating a potential peak in immune-related disorders during middle age. Traumatic neuropathy demonstrated a consistent presence across all age groups, albeit with a gradual decrease in prevalence with age. The prevalence of drug-related and toxin-related neuropathies increased in the 40-60 age group, reflecting a potential impact of lifestyle and environmental factors during this stage of life. Additionally, the increased prevalence of malignancies and endocrine disorders in the 40-60 age group suggests the influence of age-related physiological changes and long-term exposure to environmental factors on the development of neuropathies.

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Authors' contribution:
Sana Ghous; data collection, data analysis, manuscript writing, manuscript review
Anjlee Shankar ; concept, data collection, data analysis, manuscript writing, manuscript review
Abdul Qadir Baloch; data collection, data analysis, manuscript writing, manuscript review
Dipanty Khastoori ; concept, data collection, manuscript writing
Tahira Maqsood; concept, manuscript revision
Alam Ibrahim Siddiqui; concept, manuscript revision

All the authors have approved the final version to be published and agree to be accountable for all aspects of the work.

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