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ASSOCIATION BETWEEN SPASTICITY AND PAIN INTENSITY IN MULTIPLE SCLEROSIS PATIENTS

Original Research

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ABSTRACT

Background: Multiple sclerosis (MS) is a chronic autoimmune disorder affecting the central nervous system, leading to neurodegeneration, disability, and a range of debilitating symptoms. Among these, spasticity and pain are highly prevalent, significantly impacting patients' quality of life. Spasticity, characterized by involuntary muscle stiffness and spasms, often exacerbates pain, further limiting mobility and daily activities. Understanding the relationship between these symptoms is crucial for improving symptom management and optimizing therapeutic interventions for individuals living with MS.

Objective: This study aimed to assess the association between spasticity and pain intensity in individuals diagnosed with multiple sclerosis.

Methods: A cross-sectional study was conducted over six months at multiple tertiary care hospitals, including the University of Lahore Teaching Hospital, Jinnah Hospital, Services Hospital, and Central Park Teaching Hospital. A total of 171 MS patients were recruited using a non-probability purposive sampling technique. Spasticity was measured using the Modified Ashworth Scale (MAS), while pain intensity was assessed using the Visual Analogue Scale (VAS). The association between spasticity and pain was evaluated using the Chi-Square test, with statistical significance set at $p<0.05$. Data analysis was performed using SPSS version 20, and demographic details, as well as symptom severity, were analyzed through descriptive and inferential statistics.

Results: The study included 171 MS patients, with a mean age of 31.44±7.979 years. Among them, 103 (60.2%) were female, and 68 (39.8%) were male. Spasticity was observed in varying degrees: mild (24.0%), moderate (38.0%), and severe (38.0%). Pain intensity assessment revealed that 21 (12.3%) patients had no pain, 53 (31.0%) experienced mild pain, 56 (32.7%) reported moderate pain, and 41 (24.0%) had severe pain. The Chi-Square test demonstrated a statistically significant association between spasticity and pain ($p=0.000$), confirming that increased spasticity levels correlated with heightened pain intensity in MS patients.

Conclusion: The study established a strong association between spasticity and pain intensity in multiple sclerosis patients, emphasizing the need for comprehensive symptom management. Patients with higher spasticity levels were more likely to experience severe pain, highlighting the importance of integrated treatment approaches. Targeted interventions combining pharmacological management, physiotherapy, and rehabilitative strategies are essential to improving the quality of life in individuals with MS.

Keywords: Multiple sclerosis, Pain, Pain measurement, Spasticity, Spasticity management, Symptom assessment, Visual Analogue Scale.

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INTRODUCTION

Multiple sclerosis (MS) is a chronic autoimmune disorder characterized by the immune system erroneously attacking the protective myelin sheath surrounding nerve fibers in the central nervous system (CNS), leading to neurodegeneration and functional impairment (1). This demyelination disrupts nerve signal transmission, resulting in a wide array of neurological symptoms that affect physical, sensory, and cognitive functions. Among the numerous debilitating manifestations of MS, pain is a predominant and complex symptom that significantly impacts the quality of life of affected individuals. According to the International Association for the Study of Pain (IASP), pain is a subjective and distressing experience linked to actual or potential tissue injury and is modulated by various psychological and physiological factors (2). In MS, pain presents in multiple forms, including neuropathic pain arising from demyelination-induced nerve damage, musculoskeletal pain associated with abnormal postures and muscle weakness, and pain resulting from spasticity and tonic muscle spasms (3). This variability complicates diagnosis and management, necessitating an individualized approach to treatment. Additionally, pain perception is influenced by methodological disparities in research, such as differences in classification criteria, variations in study populations, and inconsistencies in assessment tools, which have led to significant heterogeneity in reported prevalence rates and treatment outcomes (4).

Despite advancements in disease-modifying therapies, MS remains an incurable condition that progressively leads to disability in most patients, emphasizing the need for symptom management strategies that enhance quality of life (5). Historically, research efforts have focused primarily on pharmacological interventions targeting disease progression rather than the symptomatic burden of MS, particularly pain and spasticity, which are often overlooked in clinical management (6). The interplay between spasticity and pain in MS is of particular interest, as spasticity—a condition marked by muscle stiffness and involuntary contractions—can exacerbate pain symptoms, further contributing to functional impairment and psychological distress (7). Individuals with chronic upper motor neuron syndrome (UMNS), commonly seen in MS, frequently experience hypertonicity, characterized by increased resistance to passive movement. This hypertonicity can significantly limit mobility, interfere with daily activities, and reduce the efficacy of rehabilitative interventions (8). However, despite its clinical significance, the management of hypertonicity remains suboptimal due to inconsistencies in healthcare providers' understanding of its pathophysiology and the multifaceted nature of symptom presentation (9).

MS is recognized as a global health concern, affecting individuals across different geographical regions and ethnic backgrounds. It is characterized not only by progressive demyelination but also by chronic neuroinflammation and axonal damage, contributing to widespread disability and social burden (10). Effective management of MS-related symptoms requires a multifaceted approach integrating both pharmacological and non-pharmacological interventions. While pharmacological therapies such as disease-modifying agents, immunomodulators, and symptomatic treatments play a crucial role in disease management, non-pharmacological strategies—including physiotherapy, rehabilitation programs, and lifestyle modifications—are equally essential in maintaining functional independence and improving overall well-being (11). Understanding the heterogeneity of MS and its clinical subtypes, including relapsing-remitting MS (RRMS), primary progressive MS (PPMS), and clinically isolated syndrome (CIS), is fundamental to tailoring treatment approaches that address the unique needs of patients (12). Moreover, pain management in MS requires distinguishing between nociceptive and neuropathic pain, as each subtype necessitates distinct therapeutic strategies. Nociceptive pain, often managed with non-steroidal anti-inflammatory drugs (NSAIDs) or opioids, differs in its etiology from neuropathic pain, which is typically treated with anticonvulsants or antidepressants (13). Addressing pain and spasticity comprehensively is imperative in optimizing clinical outcomes and enhancing the quality of life of individuals with MS.

Beyond its physical manifestations, MS imposes significant psychosocial challenges, particularly for women, who may encounter difficulties in forming and maintaining intimate relationships, navigating marital dynamics, and coping with the emotional toll of chronic illness (14). These psychosocial aspects further underscore the need for holistic care strategies that encompass psychological support, patient education, and targeted interventions to improve social integration and mental well-being. Given the substantial burden posed by spasticity and pain in MS, there is a pressing need to explore their interrelationship and its implications for disease management. The rationale of this study was to address this gap by quantifying the association between spasticity and pain intensity in MS patients, facilitating resource allocation, raising public awareness, and prioritizing research efforts. Identifying high-risk subpopulations enables early intervention and personalized treatment strategies, ultimately contributing to enhanced patient care. Furthermore, this research

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evaluates the effectiveness of existing therapies, paving the way for novel treatment approaches and addressing unmet needs in symptom management. By elucidating the complex interplay between spasticity and pain, this study aims to inform clinical practice and improve the quality of life of individuals living with MS (15,16,17)

METHODS

A cross-sectional study was conducted to evaluate the association between spasticity and pain intensity in individuals diagnosed with multiple sclerosis (MS). The study was carried out in multiple tertiary care hospitals, including the University of Lahore Teaching Hospital, Jinnah Hospital, Services Hospital, and Central Park Teaching Hospital. The research was completed within six months following the approval of the synopsis. A total of 171 MS patients were recruited through a non-probability purposive sampling technique, ensuring that individuals meeting the eligibility criteria were included in the study.

Participants were selected based on predefined inclusion and exclusion criteria. Eligible individuals had a confirmed diagnosis of MS by a neurologist and were between the ages of 18 and 45 years (Łabuz-Roszak et al., 2019). Additionally, they were required to have a stable neurological status for at least three months before enrollment, possess the ability to provide informed consent, and effectively communicate in the language of the study. Patients with a history of other neurological disorders, such as stroke, Parkinson's disease, or traumatic brain injury, were excluded to minimize potential confounding variables. Other exclusion criteria included severe medical conditions that could interfere with participation, current pregnancy or breastfeeding, and simultaneous participation in another research study that could affect the results.

Ethical approval was obtained from the institutional review board before initiating data collection. Informed consent was directly obtained from each participant before their enrollment in the study. Hospital management provided authorization to conduct the research within their institutions, but participation was strictly voluntary, and confidentiality was maintained throughout the study. To ensure unbiased results, data collection followed a structured approach, with all information stored securely to prevent unauthorized access or data loss.

The study population included both male and female MS patients, ensuring a representative sample for analysis. Standardized measurement tools were used to assess the study variables. Pain intensity was evaluated using the Visual Analogue Scale (VAS), a widely recognized tool for quantifying subjective pain perception. Spasticity levels were assessed using the Modified Ashworth Scale (MAS), which is commonly used in clinical research to measure muscle resistance to passive movement. These validated tools ensured the reliability of the findings and allowed for precise comparisons between participants.

Data analysis was conducted using SPSS (version 20). Categorical variables were analyzed using frequency and percentage distributions, while continuous variables were summarized using mean and standard deviation calculations. Graphical representations, including bar charts and pie charts, were used to illustrate qualitative data, while histograms were utilized to depict quantitative variables. The Chi-Square test was performed to assess the association between spasticity and pain, with statistical significance set at $p<0.05$.

A structured approach was taken to consider potential confounding variables such as disease duration, medication use, and comorbid conditions, as these factors could influence the severity of spasticity and pain in multiple sclerosis patients. While data on these variables were not explicitly collected for statistical adjustment, efforts were made to maintain sample homogeneity by including only patients with a stable neurological status for at least three months before enrollment. This criterion helped minimize fluctuations in symptoms due to recent disease progression or medication changes. Additionally, individuals with severe medical conditions that could impact study outcomes were excluded to reduce variability. However, it is acknowledged that the absence of direct adjustments for these factors remains a limitation of the study. Future research should incorporate a more detailed assessment of disease duration, specific treatment regimens, and associated comorbidities to provide a more comprehensive understanding of their impact on pain and spasticity. A longitudinal study design could further enhance the findings by capturing symptom progression over time and evaluating the long-term effects of therapeutic interventions.

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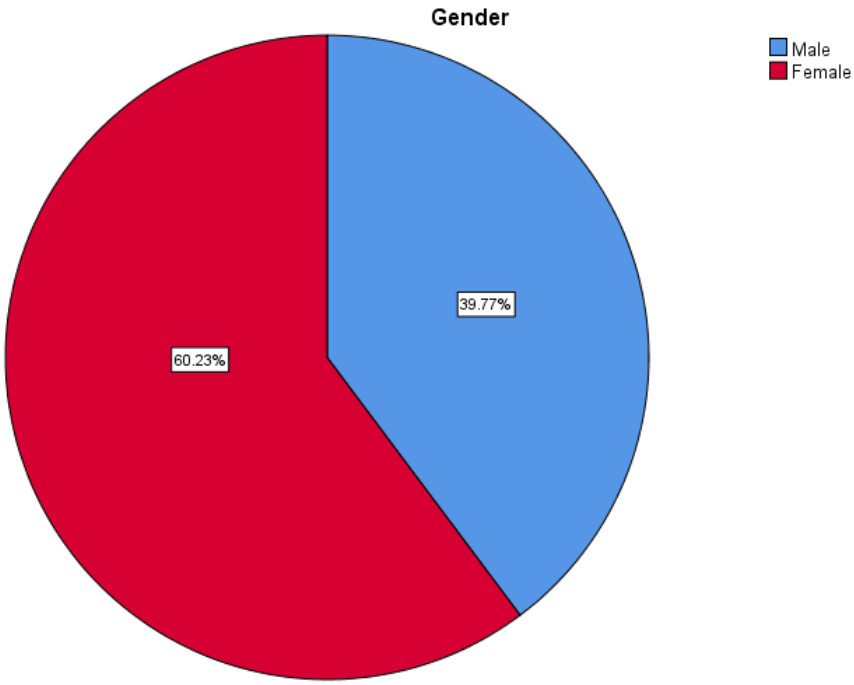
RESULTS



The descriptive analysis of the study population revealed that the mean age of patients diagnosed with multiple sclerosis was 31.44±7.979 years, with an age range of 18 to 45 years. The gender distribution showed that out of 171 participants, 68 (39.8%) were male, while 103 (60.2%) were female, indicating a higher prevalence of MS among females in this study population.

An assessment of spasticity in key muscle groups, including the biceps brachii, hamstrings, and gastrocnemius, demonstrated that 41 (24.0%) patients exhibited mild spasticity, while a larger proportion of the cohort had either moderate or severe spasticity, with 65 (38.0%) patients in each category. These findings indicate that the majority of MS patients experienced a significant degree of muscle stiffness and hypertonicity, potentially contributing to mobility impairments and pain-related complications.

Pain distribution was analyzed across multiple anatomical regions, including the thighs, calves, feet, arms, hands, fingers, lower back, and neck. Among the participants, 21 (12.3%) reported no pain, whereas 53 (31.0%) experienced mild pain, 56 (32.7%) reported moderate pain, and 41 (24.0%) suffered from severe pain. These results suggest that a substantial proportion of MS patients endure varying levels of pain, with nearly one-fourth of the cohort experiencing severe discomfort, highlighting the burden of pain as a prominent symptom in this population.

To examine the association between spasticity and pain, a Chi-Square test was performed. The analysis revealed a statistically significant relationship between these two variables, as indicated by an asymptotic significance (2-sided) value of ($p<0.05$). This finding suggests that increased levels of spasticity were associated with higher pain intensity among MS patients, reinforcing the interconnection between these symptoms and emphasizing the need for targeted management strategies to alleviate both spasticity and pain.

Table 1: Descriptive statistics of Age

Mean	31.44
Std. Deviation	7.979
Minimum	18
Maximum	45

The dataset has a mean value of 31.44, indicating the central tendency of the data. The standard deviation of 7.979 suggests a moderate spread around the mean, reflecting variability in the dataset. The minimum value recorded is 18, while the maximum value is 45, highlighting the range of the data. This distribution suggests that most values are clustered around the mean with some variation, spanning from the lowest to the highest observed values.

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Table 2: Descriptive statistics of Spasticity in Biceps Brachi, Hamstrings, Gastrocnemius

Variable	Frequency	Percent
Mild Spasticity	41	24.0
Moderate Spasticity	65	38.0
Severe Spasticity	65	38.0
Total	171	100.0

The data represents the distribution of spasticity severity among 171 individuals. Mild spasticity was observed in 41 cases (24.0%), while both moderate and severe spasticity were equally prevalent, each occurring in 65 cases (38.0%). This indicates that a significant proportion of individuals experienced moderate to severe spasticity, with mild cases being less frequent. The total sample size accounts for 100% of the observed cases.

Table 3: Descriptive statistics of Having pain in Thighs, calves, and feet, Arms, hands, fingers, Lower Back, Neck

Variable	**Frequency**	**Percent**
No Pain	21	12.3
Mild Pain	53	31.0
Moderate Pain	56	32.7
Severe Pain	41	24.0
Total	171	100.0

The data presents the distribution of pain severity among 171 individuals. A minority of participants, 21 (12.3%), reported no pain, while the majority experienced varying levels of pain. Mild pain was observed in 53 individuals (31.0%), moderate pain in 56 (32.7%), and severe pain in 41 (24.0%). This indicates that most individuals experienced some degree of pain, with moderate pain being the most common, followed closely by mild and severe pain. The total sample accounts for 100% of the cases.

Figure 2: Graphical representation for Chi Square in Spasticity and Pain

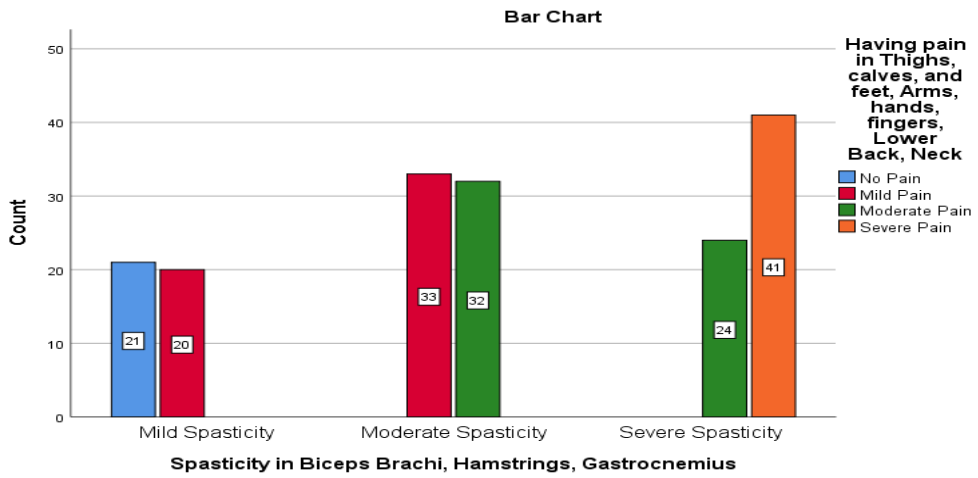

Figure 1Graphic Representation of Chi Square in Spasticity and Pain

The Chi-Square test was conducted to assess the association between spasticity and pain in multiple sclerosis patients. The analysis revealed statistically significant differences between the two variables, as indicated by an asymptotic significance (2-sided) value of ($p<0.05$). These results confirm that variations in spasticity levels are significantly associated with differences in pain intensity, highlighting the interplay between these symptoms in individuals with multiple sclerosis.

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DISCUSSION

The findings of this study demonstrated a significant association between spasticity and pain intensity in individuals with multiple sclerosis (MS), reinforcing the necessity for integrated symptom management strategies. Among the 171 participants, the mean age was 31.44±7.979 years, with a higher prevalence of female patients (60.2%) compared to males (39.8%). Spasticity levels varied, with 24.0% of patients experiencing mild spasticity, while moderate and severe spasticity were observed in 38.0% of participants each. Pain assessment revealed that 12.3% of participants reported no pain, whereas the majority experienced varying degrees of pain, including mild (31.0%), moderate (32.7%), and severe pain (24.0%). The statistically significant association between spasticity and pain ($p=0.000$) underscores the clinical importance of addressing these symptoms concurrently to improve the quality of life in MS patients. These findings align with previous studies that highlight the high prevalence of pain in MS patients. Kasap et al. reported that 62% of MS patients experienced pain, with neuropathic pain affecting 29.03% of individuals, and demonstrated a significant association between pain severity and reduced quality of life ($p<0.001$), increased fatigue ($p=0.002$), and negative mood disturbances ($p<0.001$) (18). The current study corroborates these findings, as a substantial proportion of participants experienced moderate to severe pain, likely contributing to functional limitations and psychological distress. However, a noteworthy concern is that a limited proportion of individuals with MS receive appropriate treatment for their symptoms, indicating gaps in pain management and the need for more comprehensive therapeutic interventions.

Spasticity has been identified as a significant contributor to physical dysfunction in MS, particularly in weight-bearing muscles essential for mobility. Alghamdi et al. examined the impact of spasticity on daily activities and reported that while muscle rigidity itself did not pose substantial difficulty, symptoms such as tightness (32.9%) and stiffness due to prolonged immobility (36.7%) led to considerable discomfort (19). Their findings indicated that over 30% of MS patients reported a negative impact of spasticity on walking ability and stair-climbing capacity, highlighting the mobility challenges associated with the condition. Similarly, Rizzo et al. emphasized that spasticity significantly affects daily function, with 41% of patients requiring treatment intervention (20). These findings are consistent with the present study, which found a high prevalence of moderate to severe spasticity, potentially limiting functional independence. Furthermore, the implications suggest that addressing spasticity through pharmacological and rehabilitative measures may significantly enhance patient mobility and overall well-being. The psychological impact of spasticity should also not be overlooked, as irritation (30.4%) and anxiety (29.4%) have been reported among patients, indicating a broader spectrum of MS-related distress beyond physical impairment (21).

Mobility impairment in MS is strongly linked to spasticity severity, particularly in lower limb muscles involved in gait stability and balance. Norbye et al. reported a strong correlation between spasticity levels in the ankle plantar flexors and knee extensors and reduced walking distance ($\rho = -.69$, $p < .001$ and $\rho = -.45$, $p = .012$, respectively) (22). Their study also found a significant association between spasticity severity in key lower limb muscles and impaired balance ($\rho = -.69$, $p < .001$ for plantar flexors; $\rho = -.52$, $p = .003$ for knee extensors; and $\rho = -.5$, $p = .005$ for hip adductors). The present study supports these findings, as spasticity was prevalent in muscles essential for posture and movement, potentially exacerbating mobility limitations and increasing fall risk in MS patients. Additionally, Flachenecker et al. noted that spasticity severity directly correlates with diminished quality of life, emphasizing that both pain and mobility impairment contribute to increased dependency and reduced physical activity (23). Given these findings, effective management of spasticity is crucial in minimizing disability progression and optimizing patient autonomy. Rehabilitation approaches, including physiotherapy and neuromuscular interventions, have shown promise in improving function in patients with spasticity-associated pain and disability (24).

The strengths of this study include its robust sample size and comprehensive assessment of both pain and spasticity using validated tools such as the Visual Analogue Scale (VAS) and the Modified Ashworth Scale (MAS). The inclusion of a diverse study population from multiple hospital settings enhances the generalizability of the findings. However, certain limitations must be acknowledged. The study did not account for confounding variables such as disease duration, medication use, or concurrent comorbidities, all of which could influence pain and spasticity severity. Additionally, the cross-sectional design precludes the establishment of causality, limiting the ability to determine whether spasticity directly exacerbates pain or vice versa. Longitudinal studies assessing the progression of these symptoms over time would provide further insights into their interrelationship and response to different therapeutic interventions. In conclusion, the study provides valuable insights into the significant association between spasticity and pain in MS patients, reinforcing the necessity for integrated therapeutic approaches. The high prevalence of moderate to severe pain and spasticity underscores the need for personalized interventions, including pharmacological management, physiotherapy, and psychological support, to mitigate symptom burden and enhance overall quality of life. Addressing the interplay between these symptoms is essential for improving functional

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outcomes and promoting long-term well-being in individuals with MS. Future research should focus on evaluating the effectiveness of multimodal interventions in managing spasticity-related pain and its impact on disability progression.

CONCLUSION

The study established a significant association between spasticity and pain intensity in individuals with multiple sclerosis, highlighting the impact of increased muscle stiffness on discomfort experienced in various body regions. Patients with higher levels of spasticity were more likely to report heightened pain, reinforcing the need for comprehensive management strategies that address both symptoms simultaneously. These findings emphasize the importance of integrating targeted interventions, including pharmacological treatments, physiotherapy, and rehabilitative approaches, to improve overall quality of life. By recognizing the interplay between spasticity and pain, this research underscores the necessity of personalized treatment plans that prioritize symptom relief and functional well-being in individuals living with multiple sclerosis.

AUTHOR CONTRIBUTIONS

Author	Contribution
Ammar Kazim	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Arsh-E-Mah Nawaz*	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Ali Kazim	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Qurat Ul Ain	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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