Patient-Identified Factors That Influence Spasticity in People with Stroke and Multiple Sclerosis Receiving Botulinum Toxin Injection Treatments

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ABSTRACT

Purpose: To describe the nature, extent, and impact of spasticity; determine factors that are perceived to influence its severity; and examine the relationship between time since diagnosis and impact of spasticity on daily activities in people with stroke and multiple sclerosis (MS) who are receiving botulinum toxin injection treatments. **Methods:** After a cross-sectional telephone survey, descriptive statistics and correlations were analyzed separately for the stroke and MS groups. **Results:** A total of 29 people with stroke and 10 with MS were surveyed. Both groups perceived increased spasticity with outdoor cold (69% stroke, 60% MS), muscle fatigue (59% stroke, 80% MS), and mental stress (59% stroke, 90% MS). No statistically significant correlations were found between time since diagnosis and perceived impact of spasticity on function in the stroke ($r = 0.07$, $p = 0.37$) or MS ($r = 0.16$, $p = 0.33$) groups. The MS group experienced bilateral and more severe perception of spasticity in the legs than the stroke group and identified more factors as worsening their spasticity ($p < 0.05$). Severity of leg (but not arm) spasticity was significantly correlated with severity of impact of the following factors in the MS group only: lying on the back ($r = 0.70$, $p < 0.05$), outdoor heat ($r = 0.61$, $p < 0.05$), and morning ($r = 0.59$, $p < 0.05$). **Conclusion:** Intrinsic and extrinsic triggers can influence the perception of spasticity differently depending on individual factors, severity, location (arm vs. leg), and distribution of spasticity (unilateral vs. bilateral). Clinicians can use the findings to better understand, educate, and treat people with stroke and MS.

Key Words: cold temperature; fatigue; muscle spasticity; multiple sclerosis; psychological stress; stroke; botulinum toxins.

RÉSUMÉ

Objet : Décrire la nature, l'étendue et l'effet de la spasticité; déterminer les facteurs qui, croit-on, ont un effet sur sa gravité; examiner le lien entre le temps écoulé depuis le diagnostic et l'effet de la spasticité sur les activités quotidiennes chez des personnes qui avaient subi un accident vasculaire cérébral et chez d'autres qui avaient la sclérose en plaques (SP) et qui reçoivent des traitements par injection de toxine botulique. **Méthodes :** À la suite d'un sondage téléphonique transversal, on a analysé des statistiques descriptives et des corrélations séparément pour les patients qui avaient subi un accident vasculaire cérébral et ceux qui avaient la SP. **Résultats :** Au total, on a sondé 29 personnes victimes d'un accident vasculaire cérébral et 10 autres qui avaient la SP. Les deux groupes ont perçu une spasticité accrue par temps froid à l'extérieur (69 % accident vasculaire cérébral, 60 % SP), de la fatigue musculaire (59 % accident vasculaire cérébral, 80 % SP) et du stress mental (59 % accident vasculaire cérébral, 90 % SP). On n'a constaté aucune corrélation statistiquement significative entre le temps écoulé depuis le diagnostic et l'effet perçu de la spasticité sur le fonctionnement chez les groupes de patients qui avaient subi un accident vasculaire cérébral ($r = 0,07$, $p = 0,37$) ou qui avaient la SP ($r = 0,16$, $p = 0,33$). Les personnes qui avaient la SP avaient une perception bilatérale et plus grave de la spasticité dans les jambes que celles qui avaient subi un accident vasculaire cérébral et elles ont indiqué un plus grand nombre de facteurs qui aggravaient leur spasticité ($p < 0,05$). On a établi une corrélation significative entre la gravité de la spasticité des jambes (mais non des bras) et la gravité de l'effet des facteurs suivants chez les personnes qui avaient la SP seulement: position couchée sur le dos ($r = 0,70$, $p < 0,05$), chaleur à l'extérieur ($r = 0,61$, $p < 0,05$) et l'avant-midi ($r = 0,59$, $p < 0,05$). **Conclusion :** Des facteurs déclencheurs intrinsèques et extrinsèques peuvent avoir un effet sur la perception de la spasticité qui diffère selon les facteurs individuels, la gravité, l'endroit atteint (bras ou jambe) et l'étendue de la spasticité (unilatérale ou bilatérale). Les cliniciens peuvent utiliser les constatations pour mieux comprendre, informer et traiter les personnes qui ont subi un accident vasculaire cérébral et celles qui ont la SP.

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Stroke and multiple sclerosis (MS) are among the most prevalent neurological conditions.^{1,2} In Canada, more than 300,000 people are living with the effects of stroke,¹ and an estimated 55,000–75,000 are currently living with MS.² Both stroke and MS result from an upper motor neuron (UMN) lesion, and they share similar debilitating symptoms such as altered reflexes, increased muscle tone, and spasticity.³

Spasticity, defined as a velocity-dependent increase in muscle resistance, is one of the most commonly reported signs contributing to disability and reduced function.^{4–6} As many as 40% of people with stroke⁴ and as many as 84% of those with MS⁵ experience spasticity, which may also lead to secondary structural changes in muscle tissue such as stiffness or contractures.⁷ The neural and musculotendinous changes in UMN syndromes result in reduced range of motion and decreased function, but the impact of the disease on activities of daily living (ADL) can vary on the basis of the development of coping strategies and recovery or deterioration of function over time.^{5,8–10} In MS, people who have had the disease longer report a higher level of spasticity and greater interference with ADL;⁵ conversely, patient-rated quality of life tends to increase with time in people with stroke.¹¹ Understanding the relationship between length of time since diagnosis and perceived impact of spasticity on ADLs can help guide health care treatment of people living with these conditions.

The severity of spasticity in neurological populations can be influenced by both intrinsic and extrinsic factors. Intrinsic factors include bladder and bowel issues (urinary tract infections [UTIs], full bladder, blocked catheter, constipation), fever, inflammation, fractures, stress (mental stress, anxiety), skin conditions (pressure ulcers, hemorrhoids, scabies), pregnancy, menstrual cycle, splinting and bracing, ingrown nails, pain, and posture.^{12–14} Extrinsic factors include temperature (environmental cold or heat, air conditioning) and time of day.^{12–14} Although avoiding these triggers is often included in spasticity management for various neurological conditions,^{12–14} the evidence to support their influence on spasticity is limited, and the existing literature has focused primarily on the population with spinal cord injury (SCI).^{15–20}

Our study, focusing on a population of people with stroke or MS living in the community, had the following objectives: (1) to describe the distribution (limb and side affected), extent (severity), and impact (effects on ADL) of spasticity; (2) to identify factors perceived to influence severity of spasticity; and (3) to determine whether there is an association between time since diagnosis and the perceived impact of spasticity on ADL.

METHODS

Questionnaire development

For the purpose of this study, we developed a 39-item questionnaire (see Appendix 1). Throughout the questionnaire, *spasticity* was defined as “muscle tightness.”

To measure the severity of spasticity, the questionnaire used an 11-point numeric rating scale (NRS; 0 = no spasticity, 10 = worst imaginable spasticity) that has been found to be correlated with clinical assessments of spasticity in people with MS.^{21,22} To examine the effects of spasticity on ADL, we adopted six items from the Daily Activities subscale of the Patient-Reported Impact of Spasticity Measure (PRISM), which is a reliable and valid tool for measuring quality of life in people with SCI.²³ Participants rate their agreement with each PRISM item on a 5-point scale (0 = never true for me, 4 = very true for me);²³ ratings are summed for a total score ranging from 0 to 24, with a higher score indicating greater impact on ADL.²³ Finally, the questionnaire lists 19 factors identified in the literature as having a perceived impact on spasticity^{12–14} and asks participants to recall their past experience with each factor and rate its influence on their spasticity, using a 7-point scale (1 = a lot better, 7 = a lot worse; see Appendix 1).

Participants and data collection

The target population for our study was community-dwelling adults living with stroke or MS and receiving botulinum toxin injection treatments at the hospital clinic for their spasticity. Eligible participants had to (1) have a diagnosis of stroke or MS, (2) have the ability to communicate in and comprehend English, (3) reside in the community, and (4) be a maximum of 1 month before or 1 week after their botulinum toxin injection to minimize its effect as a confounding factor.²⁴ We excluded those with impaired cognition because it might have limited their ability to understand the questionnaire or recall their experiences with spasticity.

Data collection

Before their hospital appointment, potential participants were mailed an information letter and questionnaire for visual reference during the telephone survey. We then contacted them by phone and invited them to participate in the study; informed consent was received over the phone. Ethics approval was received from the University of Toronto and West Park Healthcare Centre ethics boards.

Data analysis

Data analysis was performed using SPSS 18.0 (IBM Corporation, Armonk, NY), and the patient groups were

Table 1 Demographic and Spasticity Characteristics of Stroke and MS Groups

Variable	Stroke group (<i>n</i> = 29), mean (SD)*	MS group (<i>n</i> = 10), mean (SD)*
Age, y	62.0 (12.9)	59.1 (11.1)
Male, no. (%)	21 (72)	4 (40)
Time since diagnosis, y	4.5 (6.5)†	18.0 (13.2)
Location of spasticity, no. (%)		
Arm only	5 (17.2)	1 (10.0)
Leg only	1 (3.4)	5 (50.0)
Arm and leg	23 (79.3)	4 (40.0)
Side affected, no. (%)		
Dominant side	15 (51.7)	—
Non-dominant side	13 (44.8)	1 (10.0)
Bilateral	1 (3.4)	9 (90.0)
Spasticity severity rating		
Arm	7.0 (2.5)†	5.0 (2.0)
Legs	5.0 (3.0)†	6.9 (1.7)
PRISM score	7.0 (14.0)†	9.8 (6.3)

*Unless otherwise specified.

†Median (inter-quartile range).

MS = multiple sclerosis; PRISM = Patient-Reported Impact of Spasticity Measure.

analyzed separately. The Shapiro–Wilk test of normality was conducted on all variables. Non-normally distributed data are reported below as medians and inter-quartile ranges; normally distributed data, as means and standard deviations. Demographic information and data on disease characteristics for each group are presented as descriptive statistics.

We categorized NRS scores to determine severity of spasticity—mild (1–3), moderate (4–7), and high (8–10)—and grouped results on factors that influence spasticity as better (1–3), no effect (4), and worse (5–7), described as frequencies and percentages. We then compared the average number of factors identified as worsening overall and arm and leg spasticity between stroke and MS groups. The association between severity of perceived spasticity and severity of the impact of factors on perceived spasticity was tested using Pearson's correlation in the stroke group (*n* = 29) and Spearman's correlation in the MS group (*n* = 10), based on normality of the data. The magnitude of the correlation coefficient was interpreted as weak ($r < 0.3$), moderate ($r_s = 0.30$ – 0.7), or strong ($r > 0.7$).²⁵ The threshold for statistical significance was set at $p < 0.05$ for all tests.

RESULTS

Participants

A total of 110 people with stroke (*n* = 88) or MS (*n* = 22) were contacted. Of these, 60 were busy, unreachable, or unwilling to participate; 10 people with stroke and 1 with MS were excluded from the study (be-

cause of communication difficulties). The remaining 39 participants (stroke group *n* = 29, MS group *n* = 10) were recruited and completed the questionnaire. The response rate was 37% for stroke and 48% for MS.

Table 1 lists characteristics of the two groups. In the stroke group, time since onset of stroke ranged from 9 months to 29 years; in the MS group, time since diagnosis ranged from 1 year to 40 years.

Findings on the nature and distribution of spasticity and its perceived impact on ADL are presented in Table 1.

Factors that influence perception of spasticity

We examined the data to determine whether intrinsic and extrinsic factors affected the perceived severity of spasticity, as reported by people with stroke and people with MS. Table 2 presents responses from the stroke group. Muscle fatigue (59% of participants), stress and anxiety (59%), and exposure to outdoor cold (69%) were reported to increase perceived spasticity. The majority of participants with stroke reported no change in the severity of their spasticity as a result of sitting (72%), having a full bladder (69%), or needing to have a bowel movement (69%). Results were mixed regarding how the remaining factors influenced perceived spasticity. Additional factors reported by participants with stroke to worsen their spasticity were difficulty with concentration, dampness, yawning, and stretching. Warm water, cold water, and exercise were listed as factors that improved perceived spasticity.

Table 3 presents responses from the MS group. The majority of the group identified lying supine (50%), outside cold (60%), outside heat (60%), inside cold (70%), stress and anxiety (90%), and muscle fatigue (80%) as exacerbating the severity of perceived spasticity. Time of day also influenced the perception of spasticity for the majority of participants with MS: Morning was reported as exacerbating spasticity by most of the group (80%), followed by night (70%) and afternoon (60%). The majority (70%) reported no change in spasticity when they felt the need to have a bowel movement. There was no clear consensus on how the remaining factors were perceived to affect spasticity. Other factors reported to increase perception of spasticity in the MS group were humidity, atmospheric pressure, and driving over bumps in the road; massage was reported to improve spasticity. Although pain has been reported in the literature to be a trigger for spasticity, none of the participants mentioned it.

Differences between stroke and MS groups

Mean self-perceived arm spasticity (measured via NRS) did not differ significantly between stroke (mean 6 [SD 2]) and MS (5 [SD 2]) groups, but leg spasticity was significantly lower in the stroke group (5 [SD 2]) than in the MS group (7 [SD 2]; $p < 0.01$). The mean number of factors identified as exacerbating perceived spasticity was significantly lower in the stroke group (5 [SD 4]) than in the MS group (9 [SD 2]; $p < 0.001$).

Table 2 Factors Affecting Spasticity in Stroke Group ($n = 29$)

Factor	% of participants				
	Better	No change	Worse	Does not apply	Do not know
Lying on your back	34	55	10	—	—
Sitting	14	72	14	—	—
Changing position	21	55	24	—	—
Outside cold	—	24	69	7	—
Outside heat	31	52	3	7	7
Inside cold	3	55	34	3	3
Full bladder	—	69	31	—	—
Bowel movement	7	69	21	—	3
Stress and anxiety	—	31	59	3	7
Tight clothes	—	38	28	28	7
Muscle fatigue	3	34	59	—	3
Morning	28	41	31	—	—
Afternoon	41	45	10	—	3
Night	21	52	28	—	—
Urinary tract infection	—	14	10	69	7
Skin	—	17	14	69	—
Tight splint ($n = 28$)	14	21	21	43	—
Menstruation	—	3	3	93	—

Table 3 Factors Affecting Spasticity in MS Group ($n = 10$)

Factor	% of participants				
	Better	No change	Worse	Does not apply	Do not know
Lying on your back	—	50	50	—	—
Sitting	20	40	40	—	—
Changing position	30	30	40	—	—
Outside cold	—	40	60	—	—
Outside heat	10	30	60	—	—
Inside cold	20	10	70	—	—
Full bladder	—	50	40	—	10
Bowel movement	—	70	20	—	10
Stress and anxiety	—	10	90	—	—
Tight clothes	—	20	50	30	—
Muscle fatigue	—	10	80	10	—
Morning	20	—	80	—	—
Afternoon	20	20	60	—	—
Night	30	—	70	—	—
Urinary tract infection	—	20	30	50	—
Skin ($n = 9$)	—	56	22	22	—
Tight splint	10	20	—	70	—
Menstruation	—	20	—	80	—

Relationship between severity of spasticity and severity of factors

In the stroke group, severity of arm and leg spasticity were significantly correlated ($r = 0.76$, $p < 0.001$). No significant correlations were found between severity of spasticity (in arms or legs) and severity of the impact of factors on perceived spasticity.

In the MS group, severity of arm and leg spasticity were not significantly correlated ($\rho = -0.11$). Severity of arm spasticity was not significantly correlated with severity of the impact of any of the tested factors, but severity of leg spasticity was significantly correlated with the severity of the impact of lying on the back ($\rho = 0.70$, $p = 0.005$), outdoor heat ($\rho = 0.61$, $p = 0.018$), and morning ($\rho = 0.59$, $p = 0.021$).

Relationship between time since diagnosis and perceived impact on ADL

We found no statistically significant correlations between length of time since diagnosis of stroke or MS and the perceived impact of spasticity on ADL as measured with the Daily Activities subscale of the PRISM ($\rho = 0.07$ for the stroke group; $r = 0.16$ for the MS group).

DISCUSSION

Factors found to increase perceived spasticity for more than 50% of both participants with stroke and those with MS were outdoor cold, muscle fatigue, and stress and anxiety. The MS group also reported that lying supine, outdoor heat, indoor cold, and tight clothing negatively

affected their perception of spasticity. We found no association between time since diagnosis and perceived impact on ADL for either stroke or MS groups.

Although the exact physiologic mechanism is unknown, several possibilities involving both musculotendinous and neural components of UMN syndrome may explain how muscle fatigue, stress or anxiety, and cold can influence perception of spasticity. The effects of muscle fatigue on spasticity may be linked to the increase in muscle stiffness that occurs with the onset of muscle fatigue;²⁶ the decrease in passive range of motion that can result from increased muscle stiffness may be perceived as increased spasticity.²⁶ Similarly, higher anxiety has been shown to correlate with higher level of muscle activation,²⁷ which may be perceived as higher spasticity. It is also worth noting that several participants reported more than one factor that worsened their spasticity; it is possible that two or more factors acting concurrently (e.g., changing position and stress and anxiety) may have a cumulative impact, and this question should be explored in future research.

One possible explanation for the perceived effects of cold involves the increased sensitivity of reflex pathways in people with UMN lesions.²⁶ Specifically, increased muscle spindle activity results in a hyper-excitabile thermoregulatory reflex pathway, which initiates shivering and generates heat to restore body temperature.²⁶ (Note, however, that although this phenomenon has been found in animals, it has yet to be reported in humans.²⁶) In addition, heat loss occurs more rapidly in the extremities because the body tries to keep the internal organs warm when exposed to cold environments.²⁶

Although 50% of our MS sample reported experiencing UTIs, 60% of these identified UTI as increasing their perceived spasticity; increased spasticity has been reported as a clinical sign of UTI in 30% of all UTI occurrences in people with SCI.²⁸ Noxious stimuli, including UTIs, elicit withdrawal reflex responses and increased muscle tone.²⁹ Communication between central and peripheral nervous systems is impaired in people with MS, but the physiologic mechanism of how UTIs affect the perception of spasticity has not been examined.

Other studies have also reported that heat can increase the perception of spasticity in people with MS and that this finding may be related to the Uhthoff's phenomenon (heat intolerance that exacerbates symptoms).^{2,30} In contrast, 31% of people in our stroke group reported an improvement in perceived spasticity with heat. Increase in body temperature has been used to alleviate spasticity, but little research has focused on how environmental temperature affects the perception of spasticity.^{31,32}

Several factors known to exacerbate the perception of spasticity in the SCI population, such as sitting, a full bladder, and the need to have a bowel movement, did not act as triggers for our participants with stroke and

MS. Bowel and bladder distention and pressure sores from prolonged sitting are common triggers of autonomic dysreflexia, a phenomenon characterized by uncontrolled and dangerous autonomic responses to noxious stimuli in people with SCI above the T6 level.^{33,34} Clinicians should keep in mind that environmental factors known to worsen the perception of spasticity in people with SCI may not have the same effect for people with stroke or MS. More work is needed to determine whether the type of underlying neurological condition affects how environmental factors affect perceived spasticity.

We did not find significant correlations between time since diagnosis and effect on ADL in either the stroke or the MS population for two possible reasons. First, because of the cross-sectional design of the study, we could not examine change in spasticity over time, which may influence how length of time since diagnosis affects reported effects of spasticity on ADL. Second, spasticity in the legs has been cited as helpful for both dressing and transferring by providing a stable base.³⁵ The positive effects of spasticity on ADL performance may have masked its detrimental effects and thus lowered participants' PRISM scores.

Differences between stroke and MS groups

Perceived spasticity of the legs (but not the arms) was significantly greater in the MS group than in the stroke group, probably because of the higher number of leg muscles treated for spasticity in the MS group (hip adductors, knee flexors, and ankle plantar flexors) compared with the stroke group (ankle plantar flexors). Because treatment is required for a greater number of leg muscles with spasticity in the MS group, it is likely that the number of muscles with spasticity was greater in the MS group, resulting in the perception of greater leg spasticity than in the stroke group. The number of factors perceived to worsen spasticity was almost 2 times as high in the MS group as in the stroke group. A lot of these factors are routinely encountered during ADL, and cumulative effects of these factors may have contributed to the differences in spasticity severity perception between MS and stroke groups.

Taken together, these findings suggest that spasticity is more severe and more factors worsen spasticity in the MS group. It should be noted, however, that spasticity in the MS group was seen in both legs, thus doubling the impact of the greater number of leg muscles with spasticity noted earlier. Thus, the majority of the difference between the two groups can probably be explained by the bilateral manifestation of leg spasticity experienced by the MS group. We also found differences in the number of people experiencing worsening of factors in the MS and stroke groups (see Tables 2 and 3). Perceptions of the effects of outdoor cold were comparable between groups, but there was a large difference in perceptions of indoor cold: Only 34% of stroke participants reported

that indoor cold worsened their spasticity, compared with 60% of MS participants. This difference may be attributable to the predominant location, severity, and distribution of spasticity between stroke and MS participants: arm (stroke) versus both legs (MS; see Table 1). Legs have a larger surface area than arms; thus, in people with bilateral leg spasticity as seen in the MS group, more surface area is potentially exposed to cold than in people with unilateral arm spasticity. Greater number of leg muscles with spasticity, bilateral leg spasticity, and more surface area for cold exposure can all explain the greater impact of cold in the MS group. The difference in results between outdoor and indoor cold may also be related to clothing and outerwear worn when it is cold outside, which limits cold exposure. The effects of cold need to be tested in future studies using objective clinician-measured spasticity and manipulation of ambient temperature.

We also found differences in perceived worsening of spasticity in response to supine lying between participants with stroke (10%) and those with MS (50%). Although we did not collect data on muscle-specific distribution of spasticity in the extremities, expected spasticity distribution suggests that severity and location of spasticity (arm vs. leg) may help explain this difference. Participants' ratings of the severity of leg spasticity were higher in the MS group than in the stroke group, and although 50% of the MS group reported leg-only spasticity, only 3% of the stroke group did so. In addition, treatment of leg spasticity in people with MS typically includes hip adductors and knee flexors, and arm muscles typically treated for spasticity after stroke include shoulder adductors and elbow flexors. Both shoulder and hip adductors are in natural or shortened positions while lying on the back, but knee flexors may be in a stretched position while lying supine, which may have triggered worsening spasticity in these muscles in the MS group. In contrast, the stroke group is not expected to experience knee flexor spasticity, which likely explains why only 10% of stroke participants identified lying on the back as a factor that increased spasticity. These results may also be tied to the experience of increased spasticity at night for participants with stroke (28%) and MS (70%) because "lying on your back" may coincide with going to bed at night.

Relationship between severity of spasticity and severity of factors

For our stroke participants, perceived severity of spasticity in the arms and legs was positively correlated; this finding was expected because ipsilateral lesion on one side of the brain leads to predominant symptoms on one (contralateral) side of the body. In MS, by contrast, UMN lesions are not uniformly unilateral and, again as expected, we found no association between severity of perceived spasticity in the arms and legs in the MS group. Our findings suggest that severity of leg spasticity in the MS group is positively correlated with severity of

the impact that factors such as lying on the back, outdoor heat, and morning have on worsening spasticity. We found no significant relationships between severity of impact of any of the factors and severity of arm spasticity in the MS group, or between severity of impact of any of the factors and severity of either arm or leg spasticity in the stroke group. Because leg spasticity was more severe in the MS group, severity of leg spasticity appears to be the predominant factor explaining the differences we observed between the MS and stroke groups.

LIMITATIONS

Our study has several limitations. The small number of participants with MS limits generalizability of the results and raises the possibility that outliers or unique disease presentations may have influenced the results. The patient population at the spasticity clinic may also differ from the larger population with these conditions, because people with very mild or very severe spasticity are not often treated at the clinic. Furthermore, because treatment at the spasticity management clinic is targeted toward improving function, which may influence patients' confidence and perceived abilities to complete ADL, participants' perceptions of severity of spasticity and impact of spasticity on ADL may differ from those of people in the community who are not receiving any therapy.

We used participants' perception of spasticity, rather than clinical assessment of spasticity, to understand the impact of environmental factors. Although a previous study has reported that participant-perceived spasticity in people with SCI correlates with clinician-measured spasticity, similar studies have not been performed with people with stroke or MS, and it is possible that some of these factors do not directly influence clinically assessed spasticity.¹⁷ Future studies need to assess the impact of environmental factors specifically on clinical and objective assessment (e.g., stretch reflex latency and amplitude) of spasticity.

Finally, the questionnaire had several limitations. First, the questionnaire's definition of spasticity as "muscle tightness" may have led participants to include effects of muscle hypertonicity and contractures in their answers. Second, the PRISM outcome measure has not been validated in either stroke or MS populations, which may have affected results regarding how participants perceived spasticity to affect their ability to complete ADL. However, we used the PRISM because it is valid in the population with SCI, and no validated measures exist to assess how spasticity affects ADL in the target populations of our study.²³

CONCLUSION

Our study has identified factors that influence perception of spasticity severity and described the extent of functional effects for people with stroke and MS. Spasticity is a common neurological sign experienced by many people with UMN lesions; however, our results suggest

that irrespective of the type of neurological lesion, the severity, location (arm vs. leg), and distribution (unilateral vs. bilateral) of spasticity can shape people's experience differently. Cold, fatigue, and stress and anxiety were identified as increasing perceived spasticity severity for people with stroke and people with MS, but heat appears to differentially affect perceived spasticity severity between those with MS and those with stroke. Therefore, clinicians should consider the location and distribution of spasticity to better understand their patients' experience of spasticity.

Our findings have significant clinical relevance; it is important for clinicians to consider the intrinsic and extrinsic factors that influence spasticity in people with stroke and MS. Improving understanding of spasticity triggers will enable clinicians to better adapt treatment settings to minimize exacerbations of their patients' spasticity. Further knowledge of personal and environmental stressors of spasticity can contribute to patient education, which can aid in patient autonomy and lead to improved self-management of spasticity in these individuals.

KEY MESSAGES

What is already known on this topic

Spasticity is a common neurological sign experienced by people with UMN lesions, including those with stroke and MS. Spasticity can be altered by various factors, but because research on spasticity has largely focused on people with SCI, there is little evidence identifying factors that influence perceived spasticity in populations with stroke and MS.

What this study adds

Applying the factors previously identified as influencing spasticity in the SCI population to the stroke and MS populations, this study found both similarities and differences between neurological populations. The majority of participants with stroke and MS perceived an increase in spasticity with cold, muscle fatigue, and stress or anxiety but reported no change in spasticity with the need to have a bowel movement (identified as a factor that worsens spasticity for people with SCI). The majority of people with stroke also reported no change in spasticity associated with sitting or with a full bladder. It appears that more environmental factors worsen spasticity for people with more severe leg spasticity and people with bilateral spasticity. These findings can help clinicians educate and treat people with stroke and MS more effectively.

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APPENDIX 1: SPASTICITY QUESTIONNAIRE**Demographic**

1. Age: years
2. Gender: Male / Female
3. What is your dominant hand? Right/Left
4. Diagnosis: Stroke/MS
5. Year of diagnosis:
6. When did you start attending the Spasticity Clinic?
7. Are you on any other anti-spasticity treatment? Yes/No
 - a. If yes, which ones?
8. Date of last Botox injection:

Nature and Extent of Spasticity

If 0 is no spasticity and 10 is the worst imaginable spasticity,

9. Currently, do you have spasticity in your upper extremity (includes from your shoulder down to your fingers)? Yes/No
 - a. If yes, is it on your Right, Left, or Both sides?
 - b. How bad is your arm spasticity on a scale of 0–10?
 - c. In the past week, has your spasticity changed (better, worse, or both): Yes/No
10. Currently, do you have spasticity in your lower extremity (includes from your hip down to your toes)? Yes/No
 - a. If yes, is it on your Right, Left, or Both sides?
 - b. How bad is your leg spasticity on a scale of 0–10?
 - c. In the past week, has your spasticity changed (better, worse, or both): Yes/No

IMPACT OF SPASTICITY

Please indicate how well each of the following statements applies to your experience during the past week.

0	1	2	3	4
Never true for me	Rarely true for me	Sometimes true for me	Often true for me	Very true for me

Over the PAST WEEK, my spasticity:

Answer

11. Made grooming (hair, teeth) difficult for me or my attendant/caregiver
12. Made dressing difficult for me or my attendant/caregiver
13. Made personal hygiene (e.g. toileting, cleaning) difficult for me or my attendant/caregiver
14. Made eating or feeding difficult for me or my attendant/caregiver
15. Interfered with my ability to exercise
16. Made transfers hard for me or my attendant/caregiver

Factors That Influence Spasticity

Try to think back in the past when you have encountered these factors and choose from the following options.

1	2	3	4	5	6	7	Does not apply	Do not know
A lot better	Somewhat better	A little better	No change	A little worse	Somewhat worse	A lot worse		

IN GENERAL, how do the following factors affect your spasticity?

Factor	Answer	Factor	Answer
17. Lying on your back		27. Muscle fatigue	
18. Sitting		28. In the morning	
19. Changing your position		29. In the afternoon	
20. Outdoor cold		30. At night	
21. Outdoor heat		31. Bladder infections	
22. Indoor cold (i.e. air conditioning)		32. Skin conditions (rashes, infection, cuts)	
23. A full bladder		33. Tight splinting and bracing	
24. Stress/anxiety		34. During menstrual cycle	
25. Tight fitting clothing		35. Pregnancy	
26. The need to have a bowel movement			

36. Are you taking birth control (oral contraceptives)? Yes / No

37. Are there any other factors that change your spasticity? Yes / No

a. If yes, please indicate up to 3 and rate how they affect you using the previous scale above.

Factor	Answer
i.	
ii.	
iii.	

38. What is the one factor that makes your spasticity the worst:

39. What is the one factor that improves your spasticity the most: