

## Seasonal Variations in Outdoor Activities in Adults With Spasticity

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Received: May 20, 2015 Revised: June 10, 2015

Accepted: June 16, 2015

Published online: September 1, 2015

service barriers reduced the duration of outdoor activities regardless of season.

**CONCLUSIONS:** Particular emphasis should be placed on management of spasticity, education, and advocacy for individuals with spasticity to enhance outdoor activity engagement during the winter.

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**Key words:** Muscle spasticity, Cold temperature; Hot temperature; Activities of daily living; Leisure activities; Seasonal variation

Wijekoon S, Tran-Nguyen KM, Ismail F, Boulias C, Phadke CP. Seasonal Variations in Outdoor Activities in Adults With Spasticity. *International Journal of Neurology Research* 2015; 1(3): 163-168 Available from: URL: <http://www.ghrnet.org/index.php/ijnr/article/view/1220>

### ABSTRACT

**BACKGROUND:** Spasticity can worsen in winter and result in additional functional impairment.

**OBJECTIVE:** This study examined the perceived differences in, and barriers to duration and types of outdoor activities performed in winter and summer in adults with spasticity.

**METHODS:** Thirty adults with spasticity completed a phone questionnaire, which explored the types and durations of outdoor activities between summer and winter. Data were analyzed quantitatively and qualitatively.

**RESULTS:** Time spent outdoors was four times greater in summer ( $p < 0.01$ ) with participants reporting spending an average of 227 minutes/day, compared to 62 minutes/day in winter. Duration of life-enhancing activities in winter was reduced. The amount of time spent outdoors in winter was negatively correlated with upper extremity spasticity ( $r = -0.39$ ,  $p < 0.05$ ). Furthermore, social, structural, and

### INTRODUCTION

Spasticity is a clinical sign of upper motor neuron (UMN) lesion, resulting in “intermittent or sustained involuntary muscle activation”<sup>[1]</sup>. Spasticity can vary from mild muscle stiffness to severe, painful, and involuntary muscle spasms<sup>[2]</sup>. Spasticity affects at least 35% of people post-stroke<sup>[3]</sup>, 80% of people with multiple sclerosis (MS)<sup>[4]</sup>, 65-78% of individuals with spinal cord injury (SCI)<sup>[5]</sup>, and 80% of people with cerebral palsy (CP)<sup>[6]</sup>; however, the prevalence of spasticity among individuals with traumatic brain injury (TBI) remains undocumented<sup>[7]</sup>.

Spasticity has been reported to worsen in extreme cold conditions in persons with SCI resulting in difficulties with outdoor mobility<sup>[8]</sup>. Although the exact mechanism of increased spasticity in cold temperatures remains untested, an increase in sensitivity of muscle spindles in response to cold weather reported in animal studies<sup>[9]</sup> may offer a possible explanation. Another possible mechanism may be related to hyperexcitability following UMN lesions. The generalized

increase in reflex excitability may also amplify the thermoregulatory reflex pathways<sup>[9]</sup>, underlying the shivering response that generates heat and restores body temperature<sup>[10]</sup>.

Spasticity along with other signs of UMN lesions diminishes the individual's capacity to engage in self-care, productivity, and leisure occupations<sup>[11]</sup>. Spasticity in upper extremity (UE) and lower extremity (LE) compromises several outdoor activities such as ambulation, transferring, propulsion of a wheelchair<sup>[12]</sup>, gait aid manipulation, and vehicle operation. Outdoor activities are known to be limited in winter in healthy control population<sup>[13]</sup> and UMN lesions such as SCI impose further limitations in outdoor activities<sup>[14]</sup>. McColl *et al* (2002) found that weather restricts mobility for Canadians with SCI more than American and British comparison groups, presumably because of greater seasonal variability of temperatures in Canada. The additional effect of cold weather can worsen the functional impact of spasticity resulting in additional limitations in outdoor activities. It is important to study these differences because patients with spasticity may be more susceptible to weather related impact on outdoor activities. Studying the differences in duration and types of outdoor activities, as well as barriers to outdoor activities, in winter and summer conditions is particularly important in regions with drastically different seasonal temperatures such as Canada.

We hypothesized that (1) duration of outdoor activity will be lower in winter compared to summer, with less variety of outdoor activities performed in winter; (2) higher spasticity severity levels experienced in winter will result in less time spent outdoors; and (3) the environmental and resource barriers identified by individuals with spasticity will further limit outdoor activities.

## METHODS

### Study design

A mixed methods design was adopted to capture the differences in duration and types of outdoor activities in summer and winter conditions in adults with spasticity. A previous study<sup>[15]</sup> used objective means to quantify seasonal variations in physical activity; however, a subjective account would allow for a better understanding of the perceived challenges influencing seasonal differences in outdoor activity levels. A cross-sectional method was used due to feasibility, resource availability, and time constraints.

The variables under investigation were operationally defined as the types and durations (minutes per day) of outdoor activities in summer and winter. Qualitative forms of data (types of outdoor activities and participant descriptions of challenges to outdoor activity participation) along with quantitative forms of data (duration of activities and perceived spasticity severity) were used to minimize researcher bias and understand the subjective voices of participants<sup>[16,17]</sup>.

### Participants

Ethical approval for the study was obtained from the hospital and university research ethics boards. A convenience sample of 30 community-dwelling adults with spasticity attending an outpatient spasticity clinic in Ontario, a province in Canada with a large difference in weather between summer and winter, was recruited. Participants were mailed study recruitment packages outlining the purpose, nature, and procedure of the study, as well as the questionnaire (see Appendix 1).

Participants were included if they met the following inclusion criteria: (a) 18 years of age or older; (b) spasticity in either/both

UE and LE; (c) community dwelling residents of Ontario; and (d) experienced both summer and winter conditions following a diagnosis of spasticity. Participants were excluded from our study if: they (a) had inadequate means of communication over the phone; and (b) inability to answer simple questions (yes/no) as determined by the treating clinician.

### Data collection – Measures

We used a 15-item questionnaire developed by the primary investigators for the purpose of this study (see Appendix 1). Questions included items adapted from the *Neighborhood Environment Walkability Survey* (NEWS)<sup>[18]</sup>, a reliable and validated 98-item self-report questionnaire measuring residents' perceptions of neighborhood characteristics. Specifically, the "The stores, facilities, and other things in your neighborhood" subscale from the NEWS questionnaire was adapted to capture types and duration of participation (minutes/day) of outdoor activities in summer and winter. Participants were asked to select the types of outdoor activities they engage in from a list of predetermined categories: grocery shopping, shopping, banking, library/post office, restaurant, salon/barber, recreational and 'other'. In the 'other' category of activities, participants were asked to describe activities that did not fit into the categories provided. Participants were asked to report factors influencing the outdoor activity participation in summer and winter in addition to those mentioned in the questionnaire. Additionally, our questionnaire captured the subjective functional challenges experienced by participants living with spasticity, and its possible influence on the types and durations of outdoor activities in winter and summer (see Appendix 1).

A questionnaire was the most suitable method of data collection because it provided a multitude of questions measuring the stated quantitative and qualitative variables<sup>[19]</sup>. The questionnaire employed close-ended questions as well as open ended questions. The close ended questions, in which response categories were provided, were used to reduce ambiguity and aid statistical analysis<sup>[19]</sup>, while open-ended questions provided in-depth participant views, attitudes and suggestions allowing the researchers to probe and develop new insights<sup>[19]</sup> into outdoor activity participation of participants.

To measure the severity of spasticity, the questionnaire used an 11-point numeric rating scale (NRS; 0 = no spasticity, 10 = worst possible spasticity) that has been found to be correlated with clinical assessments of spasticity in people with UMN lesions<sup>[20-22]</sup>.

### Procedure

Primary researchers explained the purpose of the study and obtained and documented verbal consent. Participants were informed that they could withdraw from the study at any point. The questionnaire took up to 30 minutes to complete and was administered over the phone. Participants were encouraged to follow along using their copy of the questionnaire, and participant responses were documented. Data was collected over a two month period.

### Data analysis

**Quantitative analysis:** Participants were asked to approximate the average duration of total outdoor activity on a typical summer and winter day. Differences in duration of outdoor activities between summer and winter were compared using a parametric paired *t*-test. Pearson's correlation was used to assess relationship between UE and LE spasticity severity and duration of outdoor activities in winter and summer. Statistically significant findings were defined at  $p < 0.05$ . All data analysis was completed using the IBM SPSS version 20

(Statistical Package for Social Sciences, IBM Corporation, New York, NY) and Microsoft Excel add-on (XL Toolbox © 2008-2011 Daniel Kraus, Würzburg, Germany).

**Qualitative analysis:** The two primary researchers analyzed participant responses to the open ended questions regarding types of and barriers to outdoor activities using an inductive content-analysis approach<sup>[23]</sup>. Participant responses about types of and barriers to outdoor activities were coded based on key concepts, clustered into themes which were then refined into meaningful patterns of participants' engagement. Outdoor activity categories on our questionnaire were thematically analyzed into life-maintenance needs (medical visits, grocery shopping, shopping, employment, and banking) and life-enhancing needs (salon/barber, restaurants and 'other' activities – recreational, social, and cultural).

## RESULTS

### Participants

Participants ( $n=30$ ): thirteen stroke, 8 SCI, 5 TBI, and 4 MS. A summary of participant demographics can be found in table 1.

### Durations of outdoor activities

Participants reported spending an average time ( $\pm$ SD) of  $227 \pm 180$  minutes outdoors on a summer day, which is equivalent to 16% of a 24-hour day. Participant responses ranged from 10 – 600 minutes. The average time spent outdoors on a winter day was  $62 \pm 57$  minutes, with participant responses ranging from 0-180 minutes. This is equivalent to 4% of a 24-hour day. Thus, time spent outdoors on a summer day was four times the duration of time spent outdoors on a winter day which was statistically significant,  $p < 0.01$  (degrees of freedom 29), as determined by a t-test. Average seasonal temperatures in winter were  $4.8 \pm 6.8^\circ\text{C}$  (high) and  $-3.3 \pm 5.8^\circ\text{C}$  (low) and in summer were  $26.8 \pm 4.4^\circ\text{C}$  (high) and  $16.4 \pm 3.7^\circ\text{C}$  (low). (Environment Canada, 2011)

### Types of outdoor activities

More participants reported engaging in life-enhancing activities in summer (70%) than in winter (40%); particularly 'other' activities. Participant responses in the 'other' activities category tended to be activities that were leisurely including escape activities such as going to the park and reading outdoors; cultural activities such as attending church; social activities such as spending time with family or friends or volunteering.

### Duration by types of outdoor activities

The average duration of outdoor activities (Figure 1) was similar for most categories of outdoor activities between summer and winter. The biggest difference in average duration was found in the 'other' category of outdoor activities (90 minutes/day in summer; 20 minutes/day in winter).

### Relationship between spasticity and duration of outdoor activities in winter

Sixty-one percent of participants reported that their spasticity increased in winter compared to summer, contributing to less time spent outdoors in winter. Although the average self-reported UE and LE spasticity was similar (see table 1), UE spasticity severity was found to be negatively correlated with the amount of time spent outdoors in winter (Pearson's  $r = -0.39$ ,  $p = 0.016$ ) (See figure 2). LE spasticity was not correlated with time spent outdoor in winter,  $r = 0.030$  ( $p = 0.437$ ).

Characteristic	Count	Mean $\pm$ SD	Range
Participants (N)	30		
Gender (n)			
Females	10		
Males	20		
Assistive device (n)			
Walkers <sup>1</sup>	11		
Non-walkers <sup>1</sup>	19		
Spasticity (n)			
Arms	25		
Legs	24		
Both	19		
Age (years)		56 $\pm$ 16	25-87
Duration of impairment (years)		8 $\pm$ 7	1-27
Spasticity severity – Arms		5 $\pm$ 3	0-10 <sup>2</sup>
Spasticity severity – Legs		5 $\pm$ 3	0-10 <sup>2</sup>

\* Walkers - those who ambulate with a walker, cane, or independently and non-walkers - those using a power/ manual wheelchair, or scooter for mobility. <sup>2</sup>0=no spasticity, 10=cannot move limb

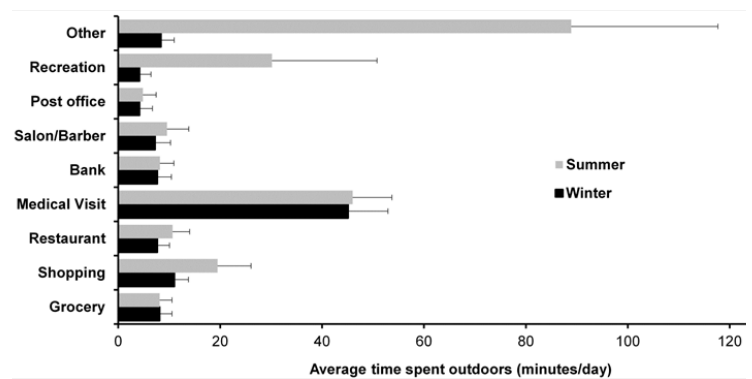


Figure 1 Types and duration of outdoor activities of participants with spasticity in winter and summer Standard error is represented as horizontal lines attached to each column.

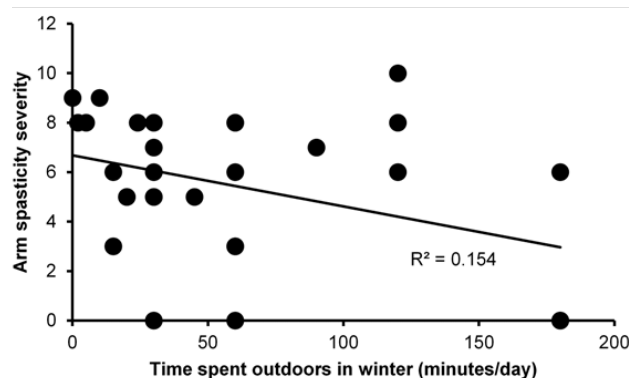


Figure 2 Negative correlation between severity of arm spasticity and the amount of time spent outdoors in winter ( $r = -0.39$ ,  $p = 0.016$ ).

### Extrinsic barriers to outdoor activity engagement

An extrinsic barrier is a theme that emerged from participants discussing challenges to outdoor activity engagement. Based on participant responses, social, structural, service, and seasonal barriers were identified as the four major categories hindering outdoor activity participation.

Respondents identified social challenges such as the unavailability of caregiver for assistance with outdoor mobility or transportation in winter. This finding was supported by our quantitative analysis which revealed that 43% of participants required assistance of another

individual in winter, compared to 33% in summer. Additionally, structural barriers such as unavailability of ramps or sidewalks were also reported to be an impediment to outdoor activity participation.

While both social and structural barriers remained relatively consistent throughout both seasons, participants reported that extreme temperature, snowfall, accumulated snow, and slippery icy surfaces hindered outdoor mobility in winter. These reported seasonal difficulties are captured in two representative statements below:

(1) Participant # 22: "I avoid going outside when it's snowy and icy unless I absolutely have to...in that case I try to limit it to one day a week. Summer is my get out of jail free card."

(2) Participant # 9: "I need to wait until a path has been cleared before I can get through. Chunks of ice and snow on sidewalks is a hazard. I broke the frame of my chair hitting a chunk of ice. The salt rusts parts of my wheelchair."

Additionally, participants reported challenges to accessing public transportation services. Participants used multiple transportation services in both summer and winter since mobility method varied depending on the proximity and travel time to the destination, as well as the seasonal conditions. Forty percent of participants reported using public transportation to a local destination when weather conditions were poor. Seventy three percent reported taking a public door-to-door accessible transit service provided by the city for persons with physical disabilities, 76% walked or used wheelchair/scooter, and 63% were transported by car; these modes of transportation were unaffected by weather. Therefore, mode of transportation depended on environmental conditions and locale. These challenges expressed by participants in winter may have adversely contributed to the duration of time spent on outdoor activities. Furthermore, many participants had inadequate information about resources available to them— such as online banking and web-based grocery services.

## DISCUSSION

### Durations and types of outdoor activities

The main finding of our study was that the time spent outdoors was 4 times less in winter than in summer in persons with spasticity. Merchant *et al* (2007) found that in the winter 64% of the non-neurological population was inactive compared to 49% in summer. Thus, the seasonal differences in activity levels appear to be greater amongst participants with spasticity compared to non-neurological healthy population. These differences in outdoor activities may be related to perceived spasticity levels because of significant negative correlation between arm spasticity and time spent outdoors. In addition to factors that influence inactivity amongst the non-neurological population, such as adverse weather conditions, individuals with spasticity may face additional physiological and environmental obstacles.

The necessity and pertinence of activities was a theme that emerged from participants' prioritizing life-maintenance activities over life-enhancing activities. Interestingly, the time spent on life-maintenance outdoor activities did not vary significantly between the two seasons suggesting that these activities were prioritized and completed regardless of the difficulties that these individuals faced during colder temperatures.

Additionally, longer duration of time was spent participating in leisure-time (life-enhancing) outdoor activities in summer. Merchant *et al* (2007) found that leisure-time activity was 86% more likely to occur in summer than in winter in a non-neurological population. Similarly, Perrier *et al* (2012) found that individuals with SCI, much

like the general population, were less likely to report engaging in leisure-type activity during winter. Therefore, our findings are supported by previous literature showing that leisure activity is prioritized when weather conditions are favorable.

Our findings are also in agreement with Carp (1988), who highlighted the motivations of individuals to satisfy life-maintenance needs<sup>[24]</sup> such as nourishment, clothing, medical care, before meeting life-enhancing needs, such as social interaction, recreation (leisure-type activities), and religious experience. Although life-enhancing needs tend to be devalued, they are essential to achieve acceptable quality of life, allowing individuals to build social relationships, experience positive emotions, and acquire additional skills and knowledge<sup>[25]</sup>.

### Relationship between spasticity severity/location and outdoor activities

Similar to Shirado *et al*<sup>[8]</sup> (1995), spasticity was reported to be worse in winter in our study. Anecdotal reports also indicate that children who experienced recurrent strokes also demonstrated increased spasticity due to cold weather<sup>[26]</sup>. Additionally, external stimuli such as a cold breeze<sup>[27]</sup> or air conditioning<sup>[28]</sup> have also been found to trigger spasticity. Thus, our findings are congruent with past studies.

The present study found that high UE spasticity was related to decreased time spent outdoors in winter. The relationship between UE spasticity and decreased time spent outdoors can be explained by the requirement of upper extremities for ambulation with or without a mobility device<sup>[29]</sup>. Majority of participants in our study sample relied on seated mobility devices, indicating that LE function was not the main contributor towards ambulation. Those with higher UE spasticity severity would have difficulties operating their mobility device with their hands and that can explain restriction of outdoor mobility in winter. Additionally, UE dysfunction has been correlated with loss in quality of life, which has been associated with limitations in the domains of self-care, mobility and other meaningful activities<sup>[30]</sup>. A relationship between leg spasticity and time spent outdoors in winter may not have manifested due to fewer participants (38%) relying on locomotion involving LE muscle activation. Future studies should further assess the individual contribution of UE and LE spasticity on time spent outdoors using multiple regression models.

### Limitations

This study employed subjective (rather than objective) measures to determine the duration of outdoor activities. The perception of spasticity may be influenced by pain, personal interpretations, and coping strategies<sup>[28]</sup>. Additionally, participants may overestimate or underestimate true activity levels, thus compromising the validity and reliability of results. While a cross-sectional method was appropriate because subjective measurements were used, it was not ideal as perceived types and duration of physical activity were not measured in summer and in winter each. Phone surveys were done in winter months and since patients were asked to recollect their perceptions from the past summer the summer perceptions (but not winter perceptions) may have been affected by recall bias. Additionally, this study did not explore the frequency at which activities were performed during the two seasons. Although, participants may spend similar durations of time completing life-maintenance activities during the winter and summer, these activities may have been completed less frequently in winter than in summer.

Objective measures (such as a timer or step monitors), in combination with self-report would be optimal for comparison of

winter and summer outdoor activities. Although elements of the questionnaire were validated (NEWS categories and spasticity assessment), the questionnaire in its entirety was not validated. Future studies should examine the relationship between LE spasticity and duration of outdoor activity, employ objective and subjective measures, and explore both duration and frequency of outdoor activities in winter and summer.

## CONCLUSIONS

This pilot study revealed that adults with spasticity spent less time engaging in life-enhancing needs in winter compared to summer. Spasticity, more specifically UE spasticity, may be the main contributing factor accounting for the reduced duration of outdoor activity observed between the seasons. The contribution of spasticity compared to other signs of UMN lesions such as impaired motor control and muscle weakness remains to be studied. While social and structural barriers were present throughout both seasons, seasonal barriers specifically hindered participation in winter outdoor activities. Further exploration of seasonal and functional outdoor needs of adults with spasticity will inform best practice of care for adults with spasticity, particularly in North America and other countries close to the Polar regions where seasonal changes are drastic.

## ACKNOWLEDGMENTS

We would like to thank the West Park Foundation, all of our participants for their time, and the staff at the Comprehensive Spasticity Management Clinic in West Park Healthcare Centre. We would also like to thank the School of Graduate Studies at the University of Toronto for a travel grant to share our findings at the 2013 Annual Conference of the Canadian Association of Occupational Therapists, held in Victoria, BC.

## CONFLICT OF INTERESTS

The authors have no conflicts of interest to declare.

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**Appendix 1: Outdoor Activities in Winter and Summer Questionnaire**

Date:                      Subject#:                      Time since stroke (years):                      Age:                      Weak side:

- 1) Where is your spasticity?    Arm    Legs    Both    Not Applicable  
 2) How much is your spasticity (muscle tightness) on a scale of 0 - 10 (0= no spasticity and 10=you cannot move your limb)? \_\_\_\_\_  
 3) Do you use devices to help you move around?                      Wheelchair    Walker    Cane    None  
 4) Do you have other conditions that limit your mobility outside? \_\_\_\_\_

WINTER	SUMMER
7) Do you go out of your home in winter?    Yes                      No	7) Do you go out of your home in summer?    Yes                      No
8) If you answered 'No', why don't you go outside in winter? Difficult to move outside Too cold No need to go out Fear of falling Other: _____	8) If you answered 'No', why don't you go outside in summer? Difficult to move outside Too hot No need to go out Fear of falling Other: _____
9) How much time do you spend outside in winter? _____(Minutes/day); _____(Days/week)	9) How much time do you spend outside in summer? _____(Minutes/day); _____(Days/week)
10) Do you need assistance moving outside in winter? Independent Need walker Need cane Need another person	10) Do you need assistance moving outside in summer/fall? Independent Need walker Need cane Need another person
11) Does your spasticity (muscle stiffness) change when you go outside in winter? Increase    Decrease    No Change	11) Does your spasticity (muscle stiffness) change when you go outside in summer? Increase    Decrease    No Change
12) How do you manage your spasticity when you have to go out in winter? _____	12) How do you manage your spasticity when you have to go out in summer? _____
13) What are your main problems when you go outside in winter? _____	13) What are your main problems when you go outside in summer? _____
14) What is the purpose of going outside in winter? (Check all that apply) Grocery Shopping Restaurant Medical Visit Bank Salon/Barber Post-office/Library Recreational activities	14) What is the purpose of going outside in summer? (Check all that apply) Grocery Shopping Restaurant Medical Visit Bank Salon/Barber Post-office/Library Recreational activities
15) What is your mode of transportation for the above activities in winter? Street Car Subway Train Bus Taxi Car Walk Other: _____	15) What is your mode of transportation for the above activities in summer? Street Car Subway Train Bus Taxi Car Walk Other: _____