Research Report

Use of Prolonged Standing for Individuals With Spinal Cord Injuries

Background and Purpose. Prolonged standing in people with spinal cord injuries (SCIs) has the potential to affect a number of health-related areas such as reflex activity, joint range of motion, or well-being. The purpose of this study was to document the patterns of use of prolonged standing and their perceived effects in subjects with SCIs. Subjects. The subjects were 152 adults with SCIs (103 male, 49 female; mean age=34 years, SD=8, range=18–55) who returned mailed survey questionnaires. Methods. A 17-item self-report survey questionnaire was sent to the 463 members of a provincial spinal cord support organization. Results. Survey responses for 26 of the 152 respondents were eliminated from the analysis because they had minimal effects from their injuries and did not need prolonged standing as an extra activity. Of the 126 remaining respondents, 38 respondents (30%) reported that they engaged in prolonged standing for an average of 40 minutes per session, 3 to 4 times a week, as a method to improve or maintain their health. The perceived benefits included improvements in several health-related areas such as well-being, circulation, skin integrity, reflex activity, bowel and bladder function, digestion, sleep, pain, and fatigue. The most common reason that prevented the respondents from standing was the cost of equipment to enable standing. Discussion and Conclusion. Considering the many reported benefits of standing, this activity may be useful for people with SCI. This study identified a number of body systems and functions that may need to be investigated if clinical trials of prolonged standing in people with SCI are undertaken. [Eng JJ, Levins SM, Townson AF, et al. Use of prolonged standing for individuals with spinal cord injuries. *Phys Ther.* 2001;81:1392–1399.]

Key Words: *Spinal cord injury, Standing, Weight bearing.*

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More than 900 Canadians sustain a spinal cord injury (SCI) each year.[1] The effects of these injuries are far-reaching, and, in addition to their psychological effects, they can affect the functioning of the cardiovascular, respiratory, musculoskeletal, urinary, and integumentary systems. The majority of people with SCI experience complications such as pressure sores, urinary tract infections, contractures, and spasticity (increased resistance to passive movement or increased reflex activity).[2,5]

Over the past 4 decades, prolonged standing has been investigated as an activity with possible benefits for people with SCI.[6–9] Although prolonged standing may affect many health-related areas such as reflex activity, skin integrity, bowel and bladder function, joint range of motion, and well-being, conclusive evidence of the effects of a standing program has not been documented. For example, only 3 studies with small sample sizes have examined the effects of passive standing on reflex activity in people with SCI. The results, however, were mixed. Odeen and Knutsson[10] reported that spasticity was reduced in 9 subjects with SCI following a single 30-minute session on a tilt table in a near-vertical position, as evident by a reduction of resistance (measured by a force transducer) during passive movement induced by a torque motor. Bohannon[11] evaluated the effect of a 30-minute session on a near-vertical tilt table for a single male subject over 5 nonconsecutive days and reported an immediate reduction of spasticity, as evident by scores on the modified Ashworth scale and pendulum test, but no carryover effects into the next day. In contrast, Kunkel et al[9] found that 3 men with SCI did not show differences in tendon reflexes, H-reflexes, or resistance to passive movement (using a 0–5 scale) while standing

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passively in a standing frame for 45 minutes twice daily for 5 months.

Repeated episodes of standing have been shown to reduce orthostatic hypotension in people with acute SCI[12]; however, less is known about cardiovascular or circulatory adaptations that might result from standing in people with long-standing SCI. Ragnarsson et al[13] reported that the glomerular filtration rate approached normal values in people with quadriplegia when they were in an upright standing position, but not in the supine position. We believe this suggests that standing may benefit renal function. One of the well-documented effects of standing is the reduction of hypercalciuria with the use of a tilt table or during ambulation.[14,15] Although hypercalciuria is associated with an increased risk for developing urinary calculi and infection,[16–18] the effect of a standing program on urinary tract function has not been established.

In addition to the physical effects resulting from prolonged standing, improvements in well-being have been reported by people with SCI.[7,9,19,20] Kunkel et al[9] found that the majority of their subjects enjoyed standing and continued to stand for prolonged periods months after their study was completed, despite findings of only modest physical improvements.

Benefits from prolonged standing have been reported in small samples of people with SCI,[9–11] but many other relevant areas have not been examined. Anecdotal reports of improvements in pain, sleep function, and skin integrity are common. Although some potential for benefits from prolonged standing have been known for many years,[6,10] the extent of practice of this activity among people with SCI is unknown. Furthermore, no guidelines exist concerning the frequency and duration of the sessions that are required to achieve the benefits of standing.

The purpose of our study was to survey people with SCI to: (1) document the extent to which prolonged standing is undertaken in this population, (2) compare the characteristics of people who engage in prolonged standing with those who do not, (3) summarize the methods (eg, standing frame, brace) and the frequency and duration of activity used for prolonged standing, and (4) summarize their reports of the perceived benefits and negative effects of prolonged standing.

Method

The study consisted of a cross-sectional survey sent to all people with SCI (N=463) who were members of the British Columbia Paraplegic Association, a provincial support organization for people who had SCIs and who were at least 1 year postinjury. Subjects with extremely high-level lesions (ie, C1-C2) were excluded because the need for respiratory assistance would minimize their ability to stand for prolonged periods of time.

Survey questionnaires were mailed to recipients with a cover letter that outlined the purpose of the study, ensured confidentiality, and provided contact information. A stamped, self-addressed envelope was also included, and recipients were asked to return their completed anonymous survey questionnaire within 4 weeks.

The investigator-developed instrument contained 17 self-report items designed to elicit information in 3 major categories: demographics, utilization of prolonged standing, and the perceived benefits and negative effects of prolonged standing. The survey instrument was developed from a series of focus groups involving 4 clinicians who work with people with SCI (2 physical therapists, 1 occupational therapist, and 1 physician with a specialty in physical medicine) and one rehabilitation researcher. A pilot test of the survey was performed, using people with SCI who had previously been patients at a local rehabilitation center. They completed the survey and critiqued the survey instrument for clarity and content validity as relevant to the 4 aims stated in the purpose of the study. The survey instrument was modified in response to this feedback.

Demographic data (date and spinal level of injury, age, and sex) were reported by the respondents by filling in blanks and by responding to closed-ended questions (eg, "State your date of injury–month/year; circle your corresponding level of injury: Cervical–neck: C2 C3 . . ."). The American Spinal Injury Association impairment scale (ASIA) rating (A to E)[21] was requested to categorize respondents with complete (ASIA A) or incomplete (ASIA B, C, D) injuries. Because some subjects might not be aware of their ASIA classification, respondents were also asked whether they had control of or feeling around the bladder or bowel. An injury was classified as complete if the person did not have control of or feeling around the bladder or bowel. This classification is a modification of the definition of a complete injury developed by Waters et al[22] (ie, absence of sensory and motor function in the lowest sacral segment), but we tested this question on 30 people with SCI and found their responses to be in agreement with their documented ASIA classifications (thus, responses of no control of or feeling around the bladder or bowel corresponded to ASIA A, and all other responses corresponded to ASIA B, C, or D).

Fill-in-the-blank questions and closed-ended questions were used to determine whether the respondents participated in prolonged standing (type of standing device,

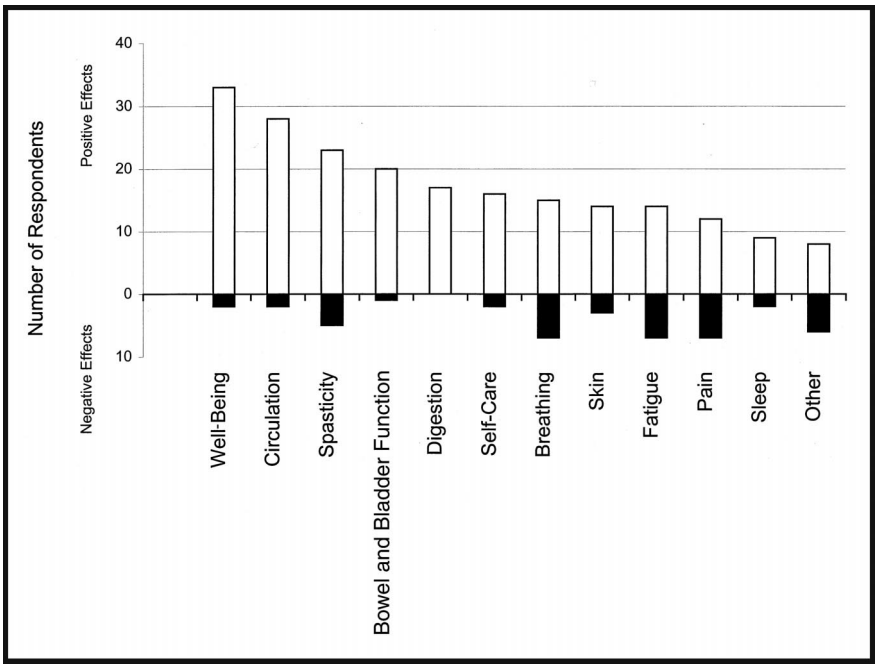

Figure.
Perceived benefits and negative effects from prolonged standing reported by respondents who stood (n=38).

Table 1.
Perceived Barriers to Participating in Standing Activities[a]

	Respondents Who Do Not Stand	
	n	%
Too expensive	29	33
Time constraints	25	28
Unaware of the necessary assistive device	23	26
Lack of assistance	16	18
Space constraints	16	18
Other	9	10

[a] Respondents could have indicated more than one barrier.

Table 2.
Comparison of the Survey Respondents With the Population With Spinal Cord Injuries (SCIs)

	Survey Group (N=152)	Population With SCIs
Mean age at injury (y)	26 (SD=8, range=8–48)	16–30 (most prevalent range)[a]
Male (%)	68	80[a]
Percentage of subjects with complete injury[b]	53	50[c]
Percentage of subjects with paraplegia[d]	54	50[a]

[a] Canadian population.[1]
[b] Complete versus incomplete injury.
[c] American population[21] because Canadian statistic not available.
[d] Subjects with paraplegia versus subjects with quadriplegia.

history, duration, and frequency of use) and in other physical activities such as wheelchair sports and handcycle use (eg, "Describe your average usage of the standing device: Number of days per week____, Number of sessions per day____, Number of minutes per day_____"). Dichotomous responses (yes/no) were requested to document perceived benefits to health (eg, well-being, self-care) as a result of the standing. A separate question was used to document any perceived negative effects. The health-related areas queried (an "other" category was also listed) are documented in the Figure. Dichotomous responses (yes/no) were requested to document the barriers or reasons why subjects did not stand or had discontinued standing. The potential barriers that were identified are provided in Table 1.

The responses were entered into a database (Microsoft Access 97*) and were evaluated first in aggregate to determine the general demographics of the respondents. Injury type was categorized as paraplegic (thoracic/lumbar injuries) or quadriplegic (cervical injuries) for the analysis. Because only 2 respondents to the survey were aware of their ASIA classification, complete versus incomplete injuries were classified from the answer to the question on about the bowel or bladder.

For the purpose of our survey, criteria were established to define prolonged standing. Respondents were considered to be standing for prolonged periods of time if: (1) they required the use of an assistive device (eg, standing frame, walker) to reach and maintain a standing position (therefore not independent in standing), (2) their standing lasted longer than 20 minutes per day, and (3) the standing was undertaken to acquire health benefits. A minimum duration of 20 minutes was selected because standing protocols ranging from 20 to 45 minutes[9–11,15] have resulted in some health benefits. Subjects who engaged in prolonged standing were further subdivided into those individuals participating in active standing or passive standing. *Active standing* was defined as involving muscular effort on the part of the participant to come to and maintain the standing position (eg, using crutches and braces). *Passive standing* was defined as standing that depended on a device to bring the participant to a standing position and to hold them passively in that position (eg, using a standing frame).

* Microsoft Corp, One Microsoft Way, Redmond, WA 98052-6399.

The level of physical activity was defined as "regular involvement" (versus "nonregular involvement") if the respondent reported being involved in a physical activity at least once per week (eg, wheelchair sports, handcycle, bicycle, seated aerobics, swimming).

Descriptive analyses (ie, means, standard deviations, frequency counts) were used to summarize the data. When it was possible to provide multiple answers to a question, each answer given was analyzed as a separate entity. Respondents were then separated into (1) people who participated in prolonged standing and (2) people who did not participate in prolonged standing. The chi-square statistic for categorical variables and *t* tests for continuous variables were used to compare the 2 groups using an alpha level of .05.

Results

One hundred fifty-two survey questionnaires were returned, resulting in a return rate of 33%. The aggregate data closely matched the characteristics of the population with SCI[1,23] (Tab. 2). Twenty-six of the 153 respondents reported minimal effects from their injuries (eg, they were fully ambulatory, their job involved regular standing) and had no need for prolonged standing as an extra activity. The data for these 26 respondents were removed from further analysis, and the remaining sample consisted of 126 respondents who had the potential to benefit from prolonged standing.

Of these 126 respondents, 38 (30%) reported that they engaged in prolonged standing as a method to improve or maintain their health. The respondents who engaged in regular prolonged standing and those who did not are compared in Table 3. Differences between the 2 groups were found for level of activity, level of injury, and duration of injury. More of the respondents who stood had paraplegia than had quadriplegia and engaged in regular physical activity compared with the respondents who did not stand. There was no age difference between the 2 groups, but the respondents who did not stand had had their injury for a longer time.

Respondents who did not engage in prolonged standing reported a number of reasons that prevented their standing (Tab. 1). One third of this group (n=29) stated that they felt the assistive device required to stand was too expensive. More than one quarter of this group (n=23) reported that they were unaware of any device that could help them stand or they said that time constraints prevented their participation in a standing program (n=25). Less than one fifth of the respondents who did not stand reported lack of assistance or space as a limiting factor (n=16 each). Similar proportions of people with quadriplegia (n=8) and paraplegia (n=8) stated that a lack of assistance was a reason that prevented them from participating in standing. Only 3 respondents (3%) felt that they did not have enough motivation or energy to undertake a regular standing program.

Parameters of Use for Prolonged Standing

Of the 38 respondents who engaged in prolonged standing, 17 (45%) used an active method to stand (eg, combination of walker and leg braces), and 20 (53%) used a passive method to stand (eg, standing frame). One respondent used both methods. Respondents had participated in a standing program over a span of 55±54 months (mean ± SD) and their routine program consisted of standing 40±29 minutes per session, 1±0.5 sessions per day, for 3.8±2.4 days per week.

Perceived Effects of Prolonged Standing

Numerous perceived benefits, but very few perceived negative effects, were reported as a result of prolonged standing (Figure). Half of the respondents reported that they experienced at least 6 of the benefits. The most prevalent benefit was a feeling of well-being reported by 33 (87%) of the respondents who stood, whereas more than half of the respondents who stood reported improvements in circulation (n=28), reflex activity (n=23), and bowel and bladder function (n=20). The most prevalent comments regarding circulation were reports of reduced swelling in the legs and feet (n=16). The most prevalent comments regarding spasticity were reports of reduced muscle spasms (n=9). More than one third of the respondents who stood reported improvements in self-care (n=16), digestion (n=17), breathing (n=15), skin integrity (n=14), and fatigue (n=14). Approximately one quarter of the respondents who stood reported improvements in sleep (n=9) and decreased pain (n=12). The psychological benefits were characterized by comments of the respondents such as "my standing frame is the most valuable of my exercise tools . . . it feels so wonderful to get vertical," "it feels great to look others in the eyes," and "it allows me to see things from a different view." Respondents reported that it took 6.4±8.5 days (mean ± SD) to for them to first perceive benefits, and they believed the benefits lasted 1.4±0.7 days.

Although 16 (42%) of the 38 respondents who stood reported some negative effects from prolonged standing (Figure), the majority of these respondents (12/16, 75%) reported only 1 or 2 negative effects. Seven (18%) of the 38 respondents who stood reported an increase in pain, and approximately 10% reported increased fatigue (n=7), breathing difficulties (n=7), or spasticity (n=5) as a negative effect. Only one respondent who stood reported dizziness as a problem.

Table 3.
Comparison of Respondents Who Stand With Respondents Who Do Not Stand

	Respondents Who Stand (n=38)	Respondents Who Do Not Stand (n=88)
Current mean age (y)	34 (SD=7, range=18–55)	34 (SD=9, range=18–54)
Mean duration of injury (mo)	93 (SD=55, range=12–221)[a]	116 (SD=63, range=12–312)
Male (%)	76	62
Percentage of subjects with paraplegia[b]	69[a]	49
Percentage of subjects with an active lifestyle[c]	74[a]	51
Percentage of subjects with a complete injury[d]	55	66

[a] Significant difference between the 2 groups at $P<.05$.
[b] Subjects with paraplegia versus subjects with quadriplegia.
[c] Active lifestyle is defined as regular physical activity at least once per week.
[d] Subjects with a complete injury versus subjects with an incomplete injury.

Discussion and Conclusion

The demographic data for the respondents are similar to the demographic data for the overall population with SCI in Canada, except for a slightly higher percentage of female respondents. Although the literature lacks conclusive scientific evidence on the benefits of prolonged standing, this survey demonstrated that a number of people with SCI are standing on a regular basis and that they are reporting numerous perceived benefits from their participation.

Participating in a regular standing program is not without its difficulties for people with more involved injuries. The finding that proportionally more respondents who did not stand have quadriplegia (versus paraplegia) and led sedentary lifestyles compared with the respondents who stood suggests that physical or medical barriers exist for those whose lack of mobility makes it more difficult for them to stand (eg, assistance required for transfers in and out of a standing frame). This is unfortunate, because people with higher spinal cord lesions are more prone to complications such as urinary tract infections, spasticity, and contractures[2,24,25] and because they may potentially reap benefits from standing. There may be a need to address this group's special requirements for a standing device that is physically easy to use.

The perceived benefits reported by more than half of the respondents who stood suggest that prolonged standing may provide health improvements. The reported improvements in physical health included many different systems and functions.

Although it has long been documented that there is a loss of bone density in people with spinal cord injuries,[26,27] an examination of the effects of standing on bone density was beyond the scope of our study, which examined perceived effects of standing. Controversy exists about the mechanisms behind the osteoporosis and whether weight-bearing activities could halt the bone loss. Recent studies have indicated that the osteoporosis observed in people with SCI may not be the direct result of disuse[28–30] and, consequently, may be less likely to be affected by muscular activity or weight bearing.

The following discussion focuses on the 2 more commonly reported benefits (bowel and bladder function, and well-being) that were experienced by over half of the respondents who stood. It is possible that improvements in one area may have had effects on another area. For example, increased spasticity (as reported or measured by spasms, clonus, resistance to passive movement, or increased deep tendon reflex magnitude) has been shown to affect mobility and sleep and is often associated with limited joint range of motion and pain.[2,31]

Urinary tract infections are the most frequent medical complication in people with SCI following hospital discharge[2]; we believe, therefore, that in future studies investigators may want to determine whether the reported perceived improvements in bladder function following a prolonged standing program are associated with reduced urinary tract infections. We recommend that in future studies investigators also examine the relationship between urinary tract infections and standing programs. Improved renal and urinary function following ambulation and weight bearing in people with SCI have been demonstrated by a reduced incidence and recurrence rate of calculi.[16,17] Hypercalciuria, which begins shortly after an SCI, promotes formation of calculi in both the bladder and kidneys[17,26,32,33] and is a major contributing factor in the development of urinary tract infections.

A majority of the respondents who stood reported an improvement in their feelings of well-being. We believe the psychological benefits, as indicated by the comments of many respondents, are important. Some researchers have found that people with SCI have a lower perceived quality of life[34] and greater chance of depression.[25,35]

When we interpreted our results, we were aware that both the sample size and the nonresponse rate found in this survey are limitations. Are the 152 observations adequate to overcome sampling error (ie, variation about the true value from chance samples differing from the whole population)? Fowler[36] found that sampling error is reduced as sample sizes increase to 150, but after that point, there are only modest gains from increasing sample size. Second, do the characteristics of the sample represent the population the sample was intended to represent? Except for sex, the sample of this survey matched known Canadian statistics for age, level of injury, and type of injury.[1] In addition, no differences were found in the amount of standing between males and females. There may be other variables, which were not examined in the survey (eg, educational level, socioeconomic level), that may have differed between our sample and the sample from the national statistics, which could contribute to nonresponse bias.

Because the survey questionnaire was distributed to members of a support organization, it is possible that these individuals were more interested in their continuing care and in pursuing activities such as standing that may benefit their health. Furthermore, the perceived benefits of prolonged standing may have been overestimated, because people who have had positive experiences with standing may be more willing to share their experiences and more likely to respond than those who did not have positive experiences.

Another limitation of our method is that self-reports were used to document benefits and negative effects, but the magnitude of these effects was not measured. For example, does a self-reported benefit in bladder function as a result of standing translate into fewer urinary tract infections? Self-reports can also have a tendency to elicit honest, but positively biased, responses (self-deceptive enhancement).[37] It is also conceivable that respondents who persisted with prolonged standing are more likely to experience positive effects, otherwise they would discontinue the activity, or that they felt a need to justify their continued standing. However, only 2 respondents stated that they had discontinued a standing program; their reasons for discontinuation involved a lack of assistance to get into the standing posture and not because of negative effects.

Although no published guidelines exist for the prescription of standing, the average respondent stood once per day for 40 minutes 4 days per week using either a standing frame or a combination of braces with an assistive device such as a walker. The reported benefits from prolonged standing occurred relatively quickly (within a week), but were fairly transient (lasting only 1 day). This amount of standing activity, however, was reported to be sufficient to achieve some of the benefits, such as reduced reflex activity and improved well-being, that have been documented in the literature.[10,11,15]

The cost of equipment to enable standing was the most frequently cited deterrent that prevented respondents from engaging in standing. In addition, a lack of knowledge of the potential perceived benefits of standing and of the equipment required to undertake standing activities were also common factors.

Considering the many perceived benefits of standing, this activity may be useful for people with SCI. It is rare that a relatively simple intervention has the potential for such diverse benefits for all systems of the body. Improved access to appropriate equipment and increased education regarding the use of prolonged standing could increase the number of people with SCI who will stand for prolonged periods, but, in our study, we measured only perceived benefits, not actual benefits. As a result, further research is needed to determine the effects of prolonged standing in people with SCI.

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