#11

TECHNICAL PERSPECTIVE

The Natural-Fit Handrim: Factors Related to Improvement in Symptoms and Function in Wheelchair Users

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Abstract

Background/Objective: People with spinal cord injury (SCI) may spend several decades using a wheelchair as their primary means of mobility. Secondary injury and a decline in independence over time are common with manual wheelchair users who, in turn, may require increased assistance as time passes. The Natural-Fit contoured handrim has been shown to improve symptoms and function in people with SCI who use manual wheelchairs and who have experienced upper extremity pain. The objective of this study was to determine the factors associated with improved symptoms and functions.

Participants: 87 people who purchased the ergonomic wheelchair handrims. Participants were predominately men, with a median age of 51 to 55 years, median level of injury T10 to T12, median time in a wheelchair of 15 years, and they had used the contoured rims for 1 to 2 years.

Methods: This was a mail survey of 217 people who purchased the rims. The survey was mailed out from the manufacturer and was anonymously returned to the physical therapy department of a university. A $10 incentive was offered for returning the survey.

Results: The majority of participants reported improvements in upper extremity symptoms, ease of wheelchair propulsion, and functional status. Longer use of the rims was associated with reported improvement in ease of wheelchair propulsion and reduction in pain in hands and wrists.

Conclusion: If a simple modification of the wheelchair can help bring about significant changes in the users' symptoms and function, this modification should be incorporated by people who use manual wheelchairs before decline in function begins. Proactive intervention may alleviate symptoms, help the person maintain maximal independence, and prolong the length of time the individual remains independent.

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Key Words: Spinal cord injuries; Wheelchair; Handrim; Mobility; Upper extremity pain; Activities of daily life

INTRODUCTION

More than 90% of people with spinal cord injury (SCI) routinely use wheelchairs for mobility and/or activities of daily living (ADLs) (1). The majority of injuries resulting in SCI are sustained by people 16 to 30 years of age; with a life expectancy of 30 to 60 years, this means many decades spent using a wheelchair (2–7). As individuals with SCI age, accumulating more time in the wheelchair, they frequently report a decline in function (2–4,8,9), most often a decreased independence in bathing, dressing, and mobility (9). The change in function occurs at a mean age of 40 years (2), and by 30 years after injury (age range, 46–60 years), most people living with SCI experience a decline from their peak level of independence (4).

Because individuals with SCI are required to use their upper extremities (UEs) for all mobility and functional skills, repeated stress, cumulative trauma, and overuse may lead to a variety of UE pathology. Secondary pathologies include degenerative joint changes (72%) (10), neuropathy, including carpal tunnel syndrome (64%) (11,12), and rotator cuff tears (73%) (13). There is evidence that individuals with SCI age prematurely, with the frequent occurrence of new medical conditions or complications over the years (14). These new conditions can aggravate existing UE pathology (15), often leading to pain, weakness, and eventual decreased independence.

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Nearly 94% of people with SCI reported pain in the UEs at some time, (16) with 70% reporting current UE pain (17,18). The most common site is the shoulder followed by wrists and hands (2,6,19). Pain intensity is most severe during the initiation and performance of wheelchair-related mobility including wheelchair propulsion and transfers (20). Increased age and time since injury are often associated with UE problems and pain, but there are many other potential risk factors including level of injury, increased weight, poor posture, limited range of motion, and decreased physical activity (15,21–23). There is no consensus regarding the role these interrelated factors play in the presence of pain and decreased function. Several studies note a relationship between pain and either time in wheelchair or age (15,18). Gellman et al (12) presents striking evidence that the passage of time is related to UE pain, reporting 52% of a sample of individuals with SCI complaining of pain with transfers during the initial 5 years after onset and 100% complaining by 20 years after onset. Shechtman (22) reported that shoulder pain was associated with age for a wheelchair user group compared with an able-bodied group. Putzke et al (16) noted lower pain levels in younger and older subjects, whereas Salisbury et al (24) noted just the opposite, with lower pain in middle-aged subjects. However, separating age and time spent in a wheelchair is difficult, and several studies noted no relationship between these factors and pain in the UEs. Both Fullerton (23) and Subbarao et al (20) reported that subject's age, level of injury, or time since injury was not statistically significant when comparing groups with and without pain, and Curtis et al (25) found significant results with level of injury but not age or time since injury. Sewatzky et al (26) also found no relationship with age and time in the chair, even when comparing adult wheelchair users who began using their wheelchair as children and those who started as adults. The specific relationships among these factors and UE pain are not clear; it seems that pain in the UEs is most likely a multidimensional process.

Schopp et al (27) reported that pain and fatigue are primary barriers to participating in life activities such as working or being able to leave the home. UE pain is related to disability because it limits activity in work and the community, but initially it is not related to a decline in functioning (15). The pain may not limit the individual's ability to perform activities independently (28), because people with SCI often develop adaptive strategies over time that allow them to compensate for complications and deterioration in function. However, there are still functional costs such as rapid fatigue, loss of endurance, decreased speed or efficiency of movement, and low tolerance for prolonged work or leisure activity (28), which eventually add up to a decline in independence.

Wheelchair Propulsion

Because the wheelchair is required for independence but is associated with UE problems, a vicious cycle often develops. Subbarao et al (20) recommended that alternative methods for wheelchair propulsion be developed for people with SCI to diminish the incidence of chronic upper limb pain, and several studies (29–32) have looked at wheelchair modifications as a way of decreasing or preventing functional declines. A common feature of wheelchairs has been the handrim (also called the pushrim) used to self-propel the wheelchair. The handrim is a round, single-tube made of stainless steel, chrome, or lightweight aluminum, with a 19-mm (3/4") outer rim diameter. These handrims are standard on newly purchased wheelchairs and are sold as replacement rims for older chairs. These handrims have no ergonomic features and were not designed for variations in UE function or to prevent or treat pain associated with UE pathology. Thus, this device was a logical site for modifications that might alleviate UE pain and prolong independent use of a manual wheelchair.

The Natural-Fit Handrim

The Natural-Fit Handrim is an ergonomic contoured handrim brought to the market in 2003 (Three Rivers Holdings LLC, Mesa, AZ). The Natural-Fit is an assembly of two separately coated components, a smooth oval surface for the palm of the hand and a higher friction contoured slot for the thumb. The assembly of these two components creates an ergonomic grip for the hand and provides separate surfaces for propulsion and braking (Figure 1). Because the ergonomic design of the Natural-Fit eliminates the pinch grip required by standard round-tube handrims, it may reduce pressure in the carpal tunnel (less extension of the finger flexors) and relieve UE pain. Moreover, the dual surfaces for propulsion and braking and the larger-diameter, contoured gripping surface should afford greater control when propelling and braking the wheelchair and should require less overall forces and less peak forces during these tasks.

Outcomes

Consistent with these claims, several studies have reported improved outcomes with the use of the Natural-Fit Handrims. Yang et al (33) showed that, after a 2-week period, a Natural-Fit prototype resulted in decreased grip forces on the handrim, without a drop in propulsive power output. Boninger and Dixon (34) found that use of the contoured rims reduced self-reported pain in the hands and wrists of manual wheelchair users. Most recently, Koontz et al (35), in Study 3 of their 2006 paper, reported significant improvement in UE pain and tingling or numbness and the ability to do general functional tasks with extended use of the contoured rims. These results were more pronounced after more prolonged use. Individuals who used the rims for longer than 1 year reporting greater improved function and decrease in pain in hands, wrists, and shoulders (also decrease in shoulder tingling) than those who had used the rims for less than 1 year.

Figure 1. *Design features of the Natural-Fit Handrim.*

However, Koontz et al (35) did not examine their data for factors that may influence the relation between use of the contoured rims and improved outcomes. Moreover, they only examined symptom severity and functional status but did not examine overall satisfaction with the contoured rims. Therefore, this study will expand on the analyses of Study 3 in Koontz et al (35) to further enhance understanding of the outcomes associated with use of an ergonomic handrim.

Once UE symptoms and impairments begin to occur, persons with SCI risk loss of functional independence, progressive pain, and decrease in quality of life. A therapeutic goal therefore is to prevent or minimize the impairments that lead to declining function (2). Accurate assessment, early recognition of potential secondary pathology, and use of preventative measures by health care professionals are ways of providing proactive services for people with SCI. The Natural-Fit contoured rims seem to provide therapeutic benefits to individuals with spinal cord dysfunction and UE symptoms. These benefits may include reductions in UE pain and functional improvements in carrying out activities of daily living. The aim of this research was to determine what particular factors are associated with reported improved symptoms and functions in a sample using the Natural-Fit contoured rims. Specifically, this study will address the following objectives: (a) determine whether there is an impact on wheelchair propulsion when using the contoured rims (ie, is there a change in comfort, efficiency, difficulty, and/or fatigue associated with propelling the wheelchair when using the contoured rims); (b) determine whether the factors of age, time in wheelchair, or time using contoured rims is most related to "satisfaction," a variable created by combining scores for comfort, efficiency, difficulty, and fatigue when using the contoured rims; (c) determine whether there is there a relationship with age, length of time in the wheelchair, or length or time using the contoured rims and the change in wheelchair propulsion, symptoms, or function when using the rims; (d) examine changes in wheelchair propulsion, symptoms, or function according to length of time using the rims.

METHODS

The study was approved by the Human Research Review committee at a large university. A sample of study participants was identified through Three Rivers Holdings. Participants were individuals who had previously purchased the Natural-Fit contoured manual wheelchair handrims. Inclusion criteria for the study included (a) having been a manual wheelchair user for at least 1 year; (b) having used the rims for a minimum of 4 weeks, and (c) an age range of 18 to 99 years. Questionnaires were mailed by Three Rivers Holdings with a $10 incentive offered to all those individuals who returned their surveys to the university on or before the deadline. To maintain anonymity, each questionnaire had a code number at the bottom, which was removed on receipt, and was returned to the company to ensure the mailing of the incentive. The survey was modified from one used previously by Three Rivers, following prior recommendations and a small pilot study. The initial survey questions were modified from the Symptom Severity Scale and functional questions of Levine et al (36). The survey included several sections: demographic information (age, level of injury, time in wheelchair, length of time using the Natural-Fit Handrims, reasons they purchased the rims, whether they were still using the rims, and if not, why did they stop); wheelchair propulsion (subjects were asked whether they noticed any changes in their perception of fatigue, difficulty, efficiency, or comfort when propelling their wheelchair when using the Natural-Fit rims as compared with using their prior rims); function (subjects were asked whether they found it more or less difficult to complete 8 activities of daily living: writing, buttoning of clothes, holding a book while reading, gripping a telephone receiver, opening jars, doing household chores, carrying grocery bags, and bathing and dressing) and symptoms (subjects were asked whether any changes in UE symptoms, including pain, numbness, and tingling, had occurred since using the Natural Fit rims). Questions were broken down into specific anatomical regions, hands, wrists, and shoulders, and subjects could answer N/A if they did not have the symptom.

Statistical Analysis

The sample was analyzed using SPSS 13. Descriptive statistics were used for changes associated with propelling the wheelchair with the contoured rims. Independent *t* tests were used to compare individuals younger than 50 years old (n = 41) with those older than 50 years of age (n = 46) to compare those who had used the wheelchair less than 15 years and those who had used the wheelchair more than 15 years (n = 45) and to compare the group who had used the contoured rims less than 1 year with those who had used them longer than 1 year (n = 45). Analysis of variance (ANOVA) was used to determine when across time category changes occurred. A regression analysis was used with age, length of time in the wheelchair, and length of time using the contoured rims as the variables related to "satisfaction." Satisfaction is a new variable that was created from the sum of scores on comfort, efficiency, fatigue, and difficulty when propelling the wheelchair; results were converted so that a score of 5 is high for all categories, for a maximum "satisfaction" score of 20. A significance level of $P \leq 0.05$ was set a priori.

RESULTS

A total of 217 surveys were mailed to individuals who had purchased the contoured rims. Eight of the 217 surveys were returned by the post office as undeliverable. Ninety-six surveys were returned (46%) by the participants. Nine participants did not meet the inclusion criteria (1 was too young, 6 had used the rims less than 1 month, and 2 had used their wheelchairs less than 1 year). Therefore, the sample consisted of 87 surveys received from participants age 18 and older. Sample size varied by question because of respondents who failed to answer a question or marked it N/A. In these cases, they were dropped from the analysis for that question.

The majority of participants (82%) indicated a level of SCI, with the remaining 18% writing in other spinal cord dysfunction or leaving the question blank. The participants were predominantly men (87.4% men, 12.6% women). The median age category for the sample was 51 to 55 years; the median category for time in the wheelchair was 15 to 20 years, with 65.5% of the sample using the wheelchair longer than 10 years. The median category for level of injury was T10 to T12, and median category for length of time using the contoured rims was 1 to 2 years, with 51.7% (n = 45) using the rims for longer than 1 year.

From 87.4% to 93.1% of participants reported a change in UE pain (lowest percentages for shoulder symptoms, highest for hand symptoms); 71.3% to 73.6% reported a change in numbness, and 70.1% to 75.9% reported a change in tingling since using the contoured rims. The remaining participants either marked N/A for the symptom or left it blank. This indicates that at least 87% of the sample had pain in the UEs, with fewer noting numbness or tingling.

The most common reason why the participants purchased the contoured rims was to increase pushing efficiency (n = 51). The majority of participants indicated more than 1 answer so the numbers do not sum to 100. The remaining reasons in descending order of frequency are to increase comfort while pushing (46), to stop pushing on the tires (33), to reduce wrist and hand pain (32), cleanliness of hands while pushing (26), to reduce shoulder pain (21), to reduce elbow pain (11), and finally for the looks (8).

Seven participants had stopped using the contoured rims. Six of these indicated a change in symptoms, with a wide variation in responses. Most reported that they stopped using the contoured rims because of a decrease in pushing efficiency or lack of reduction of their UE pain.

Change in Propelling the Wheelchair When Using the Contoured Rims Compared With the Prior Rims

Study participants were asked if they noticed a change in comfort, efficiency, fatigue, or difficulty when propelling the wheelchair with the contoured rims. The majority of the participants reported improvement in all 4 conditions. A maximum of 10.3% (9 subjects) reported negative changes in any of the conditions (Table 1).

Relationships Between Age, Time in Wheelchair or Time Using Contoured Rims, and "Satisfaction" When Using the Contoured Rims

The distribution of "satisfaction" is shown in Figure 2, with the majority of scores greater than 15 of 20. A regression analysis was used to determine whether "satisfaction" was related to age, length of time in wheelchair, or length of time using the rims. All variables were entered at once with an overall significance of $P = 0.004$ ($F = 4.725$, adjusted $R^2 = 0.116$). The relationship of "satisfaction" and time with the contoured rims was significant at 0.002 (Table 2).

Relationships With Age, Length of Time in the Wheelchair, and Length of Time Using the Rims and Wheelchair Propulsion, Function, or Symptoms When Using the Rims

Comparing the group older than age 50 years with those younger than age 50 years, the majority of participants reported improvement associated with wheelchair propulsion and in UE symptoms with the *t* test results indicating no significant difference between the 2 groups. Both groups on average reported "somewhat" or "much less difficult" on all functions, with the group greater than 50 years of age reporting more improvement than the group less than 50 years of age (lower scores = improvement) in the following functions: writing [mean, 2.47 ± 0.726 vs 2.88 ± 0.640; $t(84)$-2.78; $p = 0.007$]; buttoning clothing [mean, 2.57 ± 0.661 vs 2.88 ± 0.600; $t(83)$-2.258; $P = 0.027$]; holding a book [mean, 2.6 ± 0.654 vs 2.9 ± 0.583; $t(84)$-2.255; $P = 0.027$]; gripping

Table 1. Participants Reporting a Change Associated With Propelling the Wheelchair With the Contoured Rims Compared With the Prior Rims

		Much Less Score = 1	Somewhat Less Score = 2	About the Same Score = 3	Somewhat More Score = 4	Much More Score = 5	Missing	Mean Score (SD)
Comfort of	Percent	1.1	2.3	2.3	25.3	67.8	1.1	4.58
propelling	N	0	0	1	20	58	1	(0.759)
chair	n	1	2	1	2	1		
Efficiency of	Percent	4.6	5.7	10.3	39.1	39.1	1.1	4.03
propelling	N	3	3	7	34	32	1	(0.861)
chair	n	1	2	2	0	2		
Fatigue with	Percent	33.3	42.5	20.7	2.3	1.1	0	1.95
propelling	N	27	37	15	1	0	0	(1.014)
chair	n	2	0	3	1	1		
Difficulty of	Percent	40.2	39.1	12.6	4.6	3.4	0	1.92
propelling	N	34	32	10	2	2	0	(1.079)
chair	n	1	2	1	2	1		

Sample size varied by question because of respondents who failed to answer a question or marked it N/A. In these cases, they were dropped from the analysis for that question.
N, participants still using the rims; n, participants no longer using the rims; total, 87.

a telephone receiver [mean, 2.56 ± 0.693 vs 2.85 ± 0.654; *t*(84)-2.047; $P = 0.044$]; opening jars [mean, 2.44 ± 0.725 vs 2.78 ± 0.571; *t*(84)-2.373; $P = 0.020$].

Length of Use of Wheelchair. Comparing the group who used the wheelchair less than 15 years with those who used it more than 15 years, the majority of participants in both groups reported improvement of all symptoms and functions, but the only significant difference between the groups was the perception that propelling the wheelchair with contoured rims was more comfortable (higher scores = improvement) for the group who used the wheelchair less than 15 years [mean, 4.76 ± 0.582 vs 4.42 ± 0.866; *t*(84)-2.08; $P = 0.04$].

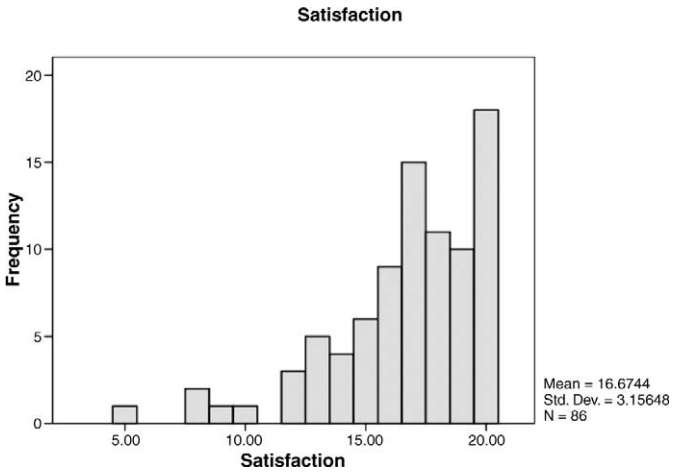

Figure 2. *Distribution of new variable "satisfaction" that was created from the sum of scores on comfort, efficiency, fatigue, and difficulty when propelling the wheelchair; results were converted so that a score of 5 is high for all categories for a maximum "satisfaction" score of 20. Sample size varied by question because of respondents who failed to answer a question or marked it N/A. In these cases, they were dropped from the analysis for that question.*

Length of Time Using the Rims. A significant relationship between length of time using the rims and symptoms and general function was previously reported by Koontz et al (35). To examine the extent to which length of time using the rims had a wider impact, we examined several additional factors including perceptions of propulsion efficiency and difficulty. Specifically, participants using the rims for less than 1 year were compared with those who had used the rims for longer than 1 year. Significant differences were found for the group using the rims longer in the areas of difficulty propelling, with lower scores indicating improvement [mean 1.69 ± 0.733 vs 2.2 ± 1.21; *t*(84)-2.37; $P = 0.02$), and efficiency when propelling, where higher scores indicate improvement [mean 4.30 ± 0.878 vs 3.76 ± 1.22; *t*(83)-2.35; $P = 0.02$].

Differences Across Time Frames Using the Contoured Rims. Because this study and that of Koontz et al (35) found relationships with the length of time using the rims and wheelchair propulsion, symptoms, and functions, an ANOVA was run to determine when across time

Table 2. Regression Coefficients With "Satisfaction" as the Dependent Variable and Age, Time in Wheelchair, and Time Using Contoured Rims as the Predictors

	Standardized β Coefficient	*t*	Significance
Age	0.132	1.244	0.217
Time in wheelchair	−0.197	−1.852	0.068
Time with rims	0.334	3.269	0.002

Table 3. Mean Scores and SDs According to Time Blocks of Use of Contoured Rims for 3 Significant Symptoms on ANOVA

	Time Period for Use of the Contoured Rims						
	2	3	4	5	6	7	Total N, Mean
	1–3 Months	3–6 Months	6–9 Months	9–12 Months	1–2 Years	>2 Years	
Average injury category	T4–T6	L1–L3	T10–T12	T10–T12	T7–T9	T7–T9	T7–T9
Average age category (years)	51–55	46–50	46–50	41–45	51–55	51–55	46–50
Average time in wheelchair category (years)	15–20	15–20	15–20	5–10	10–15	20–25	15–20
Difficulty propelling wheelchair							
N	8	12	12	9	30	15	86
Mean	3.0*†	1.58*	2.5	1.89	1.73†	1.6†	1.93
SD	1.5	0.667	1.45	0.601	0.785	0.632	1.02
Pain in hands							
N	8	9	11	9	29	15	81
Mean	3.25‡	1.89	2.18	1.89	1.79‡	1.67‡	1.99
SD	1.39	0.782	1.25	0.782	0.726	1.05	1.03
Pain in wrist							
N	7	9	11	9	27	15	78
Mean	3.0§	2.0	2.36	1.89	1.96	1.67§	2.05
SD	1.53	0.866	1.21	0.782	0.706	0.724	0.952

*Significant difference at $P = 0.017$.
†Significant difference at $P = 0.013$.
‡Significant difference at $P = 0.004$.
§Signficant difference at $P = 0.024$.
Scores: 1 = much less, 2 = somewhat less, 3 = about the same, 4 = somewhat more, and 5 = much more. Total sample size = 87; however, sample size varied by question because of respondents who failed to answer a question or marked it N/A. In these cases, they were dropped from the analysis for that question.

categories the significant changes occurred. The ANOVA for differences in time using the contoured rims indicated significant differences in 3 factors: difficulty propelling the wheelchair [F(3.941); $P = 0.003$], pain in hands [F(3.474); $P = 0.007$], and pain in wrists [F(2.426); $P = 0.043$]. Post hoc testing determined that the significant differences were between the least and the greatest amounts of time using the rims. Means and SDs for the significant differences are shown in Table 3 (also in Figures 3a through 3c).

DISCUSSION

Each individual with SCI has specific primary impairments and known limitations because of the injury, but any further impairment caused by aging or secondary complications may cause a marked decrease or even total loss of remaining functional independence (37). Mechanical challenges to the UEs from manual wheelchair use affect persons with SCI and may lead to secondary impairments. As the individual ages and spends more time in the wheelchair, common changes seen with normal aging in the UEs are superimposed on the primary and secondary impairments.

The results suggest that a simple wheelchair modification can improve wheelchair propulsion, reduce UE symptoms, and maintain functional activities in individuals with SCI who have UE pain or impairment in the hand or wrist. The vast majority of the people who responded to the survey reported improvement in all areas without a decline in function. Perceived "satisfaction" with wheelchair propulsion when using the rims was reported, with a significant relationship found for decreased difficulty and increased efficiency with increased time using the rims.

Interestingly, older respondents noted an improvement in specific functions, whereas those using the wheelchair less than 15 years found the rims more comfortable than others. The former finding may stem from the fact that the baseline function of older users (presumably lower function) leaves more room for improvement in specific functions. The latter finding may be as a result of the greater "adaptability" of users who have been in a chair less than 15 years (compared with those in chairs more than 15 years); by more quickly adapting, they more quickly perceive greater comfort.

Other than the above isolated differences, there were no other meaningful differences seen in the reported improvement based on age or length of time in the wheelchair. Therefore, it seems that, across age and time in wheelchair groups, the longer the individuals use the contoured rims, the more positive the outcomes,

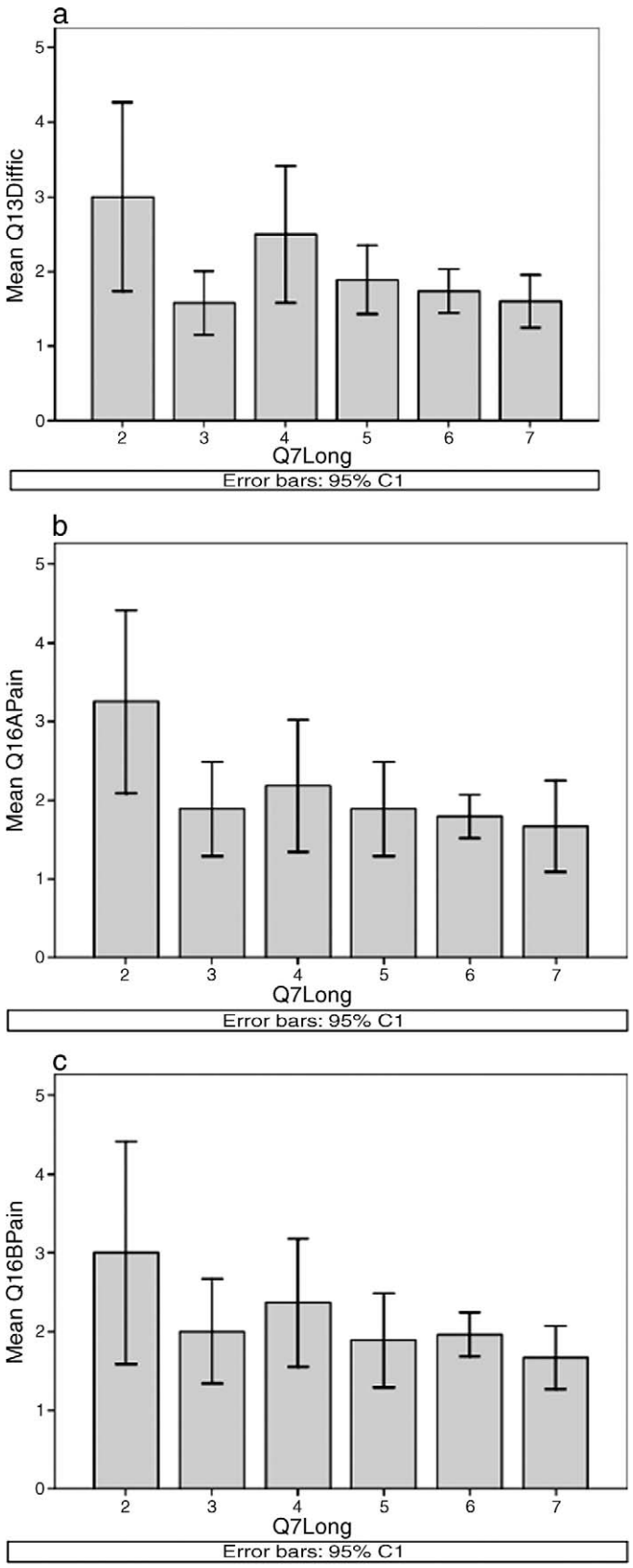

Figure 3. *(a) Change in difficulty propelling wheelchair across time using the contoured rims. (b) Change in pain in hands across time using the contoured rims. (c) Change in pain in wrists across time using the contoured rims.*

including decreases in pain in the wrists and hands. The results are particularly interesting because increased comfort, improved efficiency, and reduced pain are outcomes that may extend the time that one can remain independent.

Extended use of the contoured rims seems to contribute to a decrease in UE symptoms and improved function. Without a radical intervention, subjects with existing symptoms would be expected to get worse with time (5,11,12). The individuals in this study either maintained the same function (most functional activities) or improved (wheelchair propulsion and symptoms). These are important findings for such a simple intervention.

This study was limited to people who had purchased the Natural-Fit contoured handrims to improve their efficiency or comfort or decrease symptoms. Therefore, this sample might not reflect the entire population of wheelchair users with SCI. In addition, there was a less than 50% return rate, and it is not possible to determine whether nonresponders differ from responders. It may be that some people stopped using the rims and did not find it necessary to respond to the survey. This study did not measure the degree of pain or functional limitation, only self-reports of perceived change in these variables. Therefore, it is not possible to quantify changes in pain or functional limitations. This is a cross-sectional study, and therefore, no causal links can be established. Future research should include longitudinal studies of groups using the Natural-Fit contoured rims to determine the presence of causal relationships as suggested by the results in this cross-sectional study. Future research should also try to determine why the rims may not be appropriate for some individuals; 10% or less reported negative changes in wheelchair propulsion when using the contoured rims (Table 1). Additional demographic, activity, and functional information would need to be collected to answer this question.

CONCLUSION

Prior research has shown that increased pain and decreased function with time after SCI are disabling and related to multiple factors. The important relationship noted in this study is between the length of time using the contoured rims and outcomes, suggesting more improvement with longer use. Use of the contoured rims for an extended period has the potential to progressively decrease symptoms, improve function, and may support independence.

Because this simple wheelchair modification results in clinically meaningful improvements in the user's wheelchair propulsion, symptoms, and function, this modification maybe most effective if initiated when function is optimal. Early intervention with handrim modifications may help alleviate or minimize symptoms in persons with SCI and known wrist or hand pain and thereby extend their years of independent function.

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