

**Examination of the Effect of an Ergonomic Wheelchair Handrim  
on Upper Extremity Pain in Manual Wheelchair Users**

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**ABSTRACT**

Manual wheelchair users commonly experience pain in their hands and wrists associated with the repetitive stress of wheelchair propulsion. The objective of this research was to examine the effect of an ergonomic wheelchair handrim as an intervention designed to reduce pain in the hands and wrists. Forty-six manual wheelchair users who replaced their standard handrim with the ergonomic handrim (EH) were surveyed. Average duration of use of the EH was 25 weeks. The survey results strongly confirmed that using the EH led to a reduction in pain. When asked to compare propelling with the EH to propelling with their prior handrims, 85% of the respondents reported less pain in their hands and 80% reported less pain in their wrists. This self-report data clearly demonstrates that the ergonomic wheelchair handrim reduced perceived upper extremity pain in manual wheelchair users.

Keywords: Ergonomic Intervention, Wheelchair Handrims, Carpal Tunnel Syndrome

**BACKGROUND**

Carpal Tunnel Syndrome (CTS) is an upper extremity disorder commonly experienced by manual wheelchair users as a result of the repetitive stress of daily wheelchair propulsion (1-3). The implementation of ergonomic modifications for the management and treatment of CTS is widely advocated in the scientific literature that has examined CTS (4-7). If ergonomic modifications are not made and CTS is left untreated, it will worsen and eventually force surgery and/or the transition to a power wheelchair.

The Natural-Fit is an ergonomic wheelchair handrim brought to market in 2003. 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 (See Figure 1).

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Insert Figure 1 Here

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Because the ergonomic design is intended to reduce stress on the hands, wrists, and arms through improved propulsion and braking efficiency, reduced activation of the finger flexors, and reduced pressure on the carpal tunnel, it is hypothesized that it will reduce the pain typically associated with CTS. The objective of this research is to test this latter hypothesis: The ergonomic handrim will reduce upper-extremity pain in the hands and wrists of manual wheelchair users.

**METHODS**

To test this hypothesis, surveys were mailed to ninety wheelchair users who had purchased and were using the Natural-Fit, the ergonomic handrim (EH) tested in this research, for a minimum of 2 weeks. These were male and female manual wheelchair users who replaced their standard handrim with the EH. Surveys were mailed in late June, 2004 and respondents were requested to return the survey by July 12, 2004. In return for completing and mailing back the survey, respondents were entered into a

drawing to win one of three cash prizes, \$150, \$75, and \$25. To insure anonymity, they were told in a cover letter:

“Your responses to the survey will be completely anonymous. Please do not put your name on the survey. However, to insure your entry into the drawing for the cash prizes, each person has been assigned a code number (which is on the bottom of the second page of the survey). This code number will be removed from the survey upon receipt and placed separately in the drawing – leaving the survey without any identification.”

We received 46 surveys in return (37 males and 9 females), a 51% response rate. Even with the incentive of the drawing, this is an unusually high response rate. Average duration of use of the Natural-Fit was 25 weeks, with a range of 2 to 64 weeks, and with 85% of respondents at 10 weeks or more.

Questions (See Table 1 below) in the 2-page survey were on 5-point scales and were asked in the context of comparing end-users’ propulsion experience with the EH to their experience with their prior standard handrims. Specifically, respondents read that the purpose of this survey was to assess their “comfort, fatigue and pain before and after” using the EH.

## RESULTS

The results of the survey are summarized in *Table 1*. The results strongly confirmed that using the EH lead to a reduction in pain. When asked to compare propelling with the EH to propelling with their prior handrims, 85% of respondents reported less pain in their hands with the EH than with their prior handrims, 80% reported less pain in their wrists, 66% reported less pain in their shoulders, and 85% of respondents reported feeling less fatigue.

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Insert Table 1 Here

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In addition to the questions contained in *Table 1*, the results from two other questions are noteworthy. In response to a question on whether the Natural-Fit was better or worse than a standard wheelchair handrim, 93% of the respondents said it was better (80% said “much better” and 13% said “somewhat better”). In another question, end-users were asked: “If someone were to offer you money to switch back from Natural-Fit Handrims to standard wheelchair handrims, how much money would it take?” Response options ranged from \$1 up to \$500 (by \$100 increments) and an option, “I would never switch back.” The most common response was this latter option: 76% of respondents said they would never switch back. Another 11% said they would switch back for \$500, and just 13% said they would switch back for less than \$500.

Taken together, these results are compelling. They suggest that using the Natural-Fit will help to facilitate outcomes for wheelchair users that will serve to 1) Reduce pain in the upper extremities, particularly pain associated with CTS, 2) Enhance quality of life, 3) Avoid medical costs associated with the surgical treatment of CTS, and 4) Extend ability to remain in a manual wheelchair, which also avoids costs associated with the prescription of a power wheelchair.

## DISCUSSION

There are some alternative explanations for these results. Because the survey is not based on a random sample, one may argue that only those with favorable opinions decided to respond. Or perhaps end-users thought they might have a better chance to win the drawing if they responded favorably. While these are important alternative explanations, it is unlikely that they can account for these results. First,

offering the drawing as incentive should reduce the likelihood that only those who are satisfied with the handrim would respond. Second, because responses were clearly made to be anonymous, it is unlikely that respondents thought that they had to be “positive to win”. Third, not all responses were positive: Respondents showed clear discrimination among the questions. For example, one question asked whether using the Natural-Fit made other activities of daily living easier, activities that don’t involve propulsion such as writing, bathing, and dressing. Here the modal response was “About the Same” with a mean (3.46) just slightly leaning toward “easier” perhaps because there is a spill over effect of having your hands, wrists, and shoulders less stressed during propulsion. Thus, the validity of these results is high.

While it is important to complement this self-report data with objective measures of impairment, the self-report data is a meaningful and highly significant indicator of the positive outcome that using an ergonomic handrim can have on the pain associated with CTS. As a testament to the importance of self-report data, Katz and colleagues (8) note that, “Self-administered symptom severity and functional status scales are much more responsive to clinical improvement than measures of neuromuscular impairment and should serve as primary outcomes in clinical studies of therapy for carpal tunnel syndrome.”

### CONCLUSION

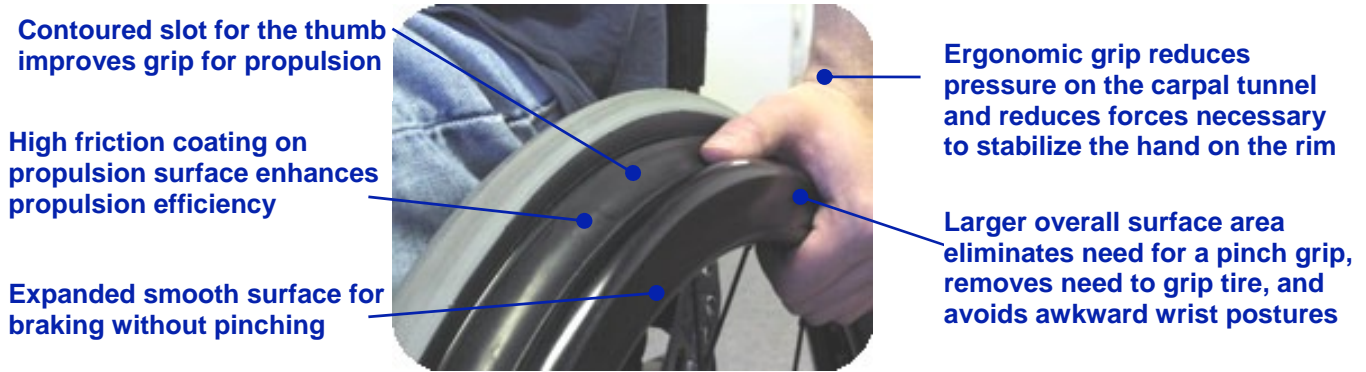
The responses to this survey were based on extensive use with the Natural-Fit EH, in most cases over 2½ months and with an average duration of use of 6 months. These results indicate extremely high levels of satisfaction with the EH, and a decided unwillingness to switch back to a standard handrim. Most importantly, self-reports of end-users indicated reductions in pain in the hands and wrists when propelling with the EH. This is a clear testament to the treatment benefits of the EH.

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**Figure 1: Design Features of the Natural-Fit**



**Table 1: Effect of an Ergonomic Handrim on Upper Extremity Pain - Responses to End-User Survey (n=46)**

Question and Percent (%) for Each Option and Overall Mean	Much Less	Somewhat Less	About the Same	Somewhat More	Much More	Mean (1=less 5=more)
Is propelling more or less <b>comfortable</b> ...	2.2	2.2	0.0	26.1	69.6	4.59
Is propelling more or less <b>fatiguing</b> ...	52.2	32.6	8.7	6.5	0.0	1.69
Is propelling more or less <b>difficult</b> ...	60.9	30.4	4.3	4.3	0.0	1.52
More or less <b>pain</b> in your hands...	60.9	23.9	13.0	0.0	2.2	1.59
More or less <b>pain</b> in your wrists...	52.2	28.3	17.4	0.0	2.2	1.72
More or less <b>pain</b> in your shoulders...	29.5	36.4	29.5	4.5	0.0	2.09
More or less <b>numbness</b> in your hands...	42.9	35.7	21.4	0.0	0.0	1.78
More or less <b>numbness</b> in your wrists...	38.1	23.8	38.1	0.0	0.0	2.00
More or less <b>numbness</b> in your shoulders...	33.3	19.0	47.6	0.0	0.0	2.14
More or less <b>tingling</b> in your hands...	46.3	34.1	19.5	0.0	0.0	1.73
More or less <b>tingling</b> in your wrists...	41.5	22.0	36.6	0.0	0.0	1.95
More or less <b>tingling</b> in your shoulders...	29.3	24.4	43.9	2.4	0.0	2.19
Ease of <b>other</b> ADLs (more or less easy)	2.2	4.3	50.0	32.6	10.9	3.46
<b>Opinion</b> of the Natural-Fit (more or less favorable)	4.3	0.0	0.0	17.4	78.3	4.91