THE ROLE OF PHYSICAL ACTIVITY IN MODERATING HEALTH-RELATED QUALITY-OF-LIFE IN PERSONS WITH DISABILITY: ANALYSIS OF THE 2003 BEHAVIORAL RISK FACTOR SURVEILLANCE SYSTEM DATA

by

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CERTIFICATE OF APPROVAL

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ABSTRACT

Background: Physical activity has been shown to be an efficacious mechanism for improving a wide range of physiological, psychological and social characteristics. However, for a variety of reasons, people with disabilities have generally been neglected for physical activity interventions to enhance their health-related quality of life (HRQOL).

Purpose: To investigate the association between physical activity status and health-related quality of life in person with disabilities.

Methods: A secondary data analysis of the 2003 Behavioral Risk Factor Surveillance System (BRFSS) utilizing structural equation modeling (SEM) and multiple regression techniques was used to characterize the moderating effects of physical activity on health-related quality of life in 45,142 persons self-classified as having a disability according to BRFSS measures. Multiple regression was used to assess the relationship between physical activity, level of disability and HRQOL measures of physical unhealthy days, mental unhealthy days and days of limited activity.

Results: The SEM indicated that there was a significant relationship between persons with disabilities who are sedentary and a lower level of HRQOL. However, this relationship was not significant for those who were physically active. Moreover, persons with disabilities who were physically active had significantly better HRQOL profiles and this difference persisted across all levels of disability, after adjusting for age, sex, ethnicity, education, employment and income.

Conclusion: Persons with disabilities can be physically active, even if they are significantly limited and in poor health. The results of this study indicate that being

physically active, rather than disability status per se, is associated with better HRQOL profiles, especially the number of days that a person's normal activities are curtailed because of poor health. The results of this study support previous research indicating the benefits of physical activity and highlight the need for greater emphasis to be given to developing, and implementing, functionally appropriate physical activity interventions for persons with disabilities to enhance their HRQOL and meet the goals of Healthy People 2010.

TITLE:

The role of physical activity in moderating health-related quality-of-life in persons with disabilities: Analysis of the 2003 Behavioral Risk factor Surveillance System data.

RESEARCH QUESTIONS:

Is physical activity associated with better health-related quality-of-life in persons with disabilities and does the association differ across levels of disability?

SPECIFIC AIMS:

Using data from the 2003 Behavioral Risk Factor Surveillance System that included self-reported levels of disability, physical activity, and health-related quality-of-life, the following specific aims were pursued:

Primary Aim: to examine the structural relationship between disability, health-related quality-of-life (HRQOL) and physical activity (see Figure 1).

Hypothesis: it was hypothesized that disability would have a negative "main" effect on HRQOL, that is, more poor health days, but that people with disabilities who are physically active would have a higher level of HRQOL. Therefore, it was further hypothesized that the interaction between disability and physical activity would make the disability-HRQOL relationship weaker in the physical activity group.

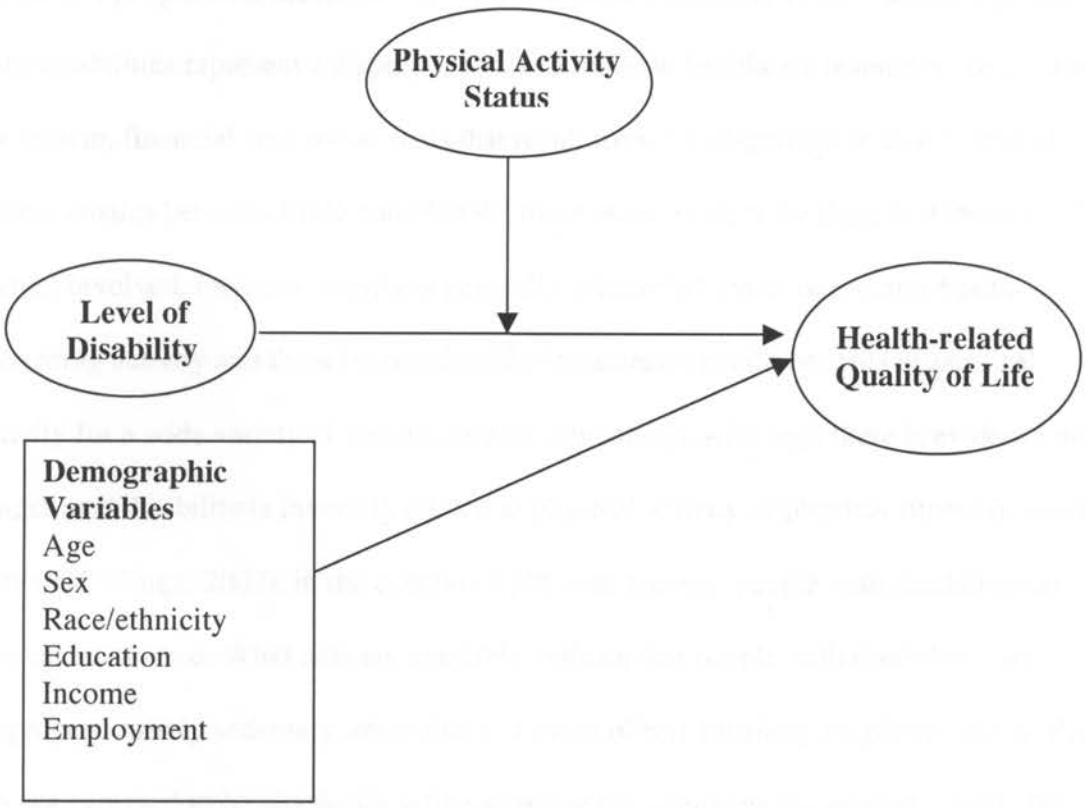
To further delineate the relationship between disability, physical activity, and HRQOL, two secondary aims were proposed. The secondary aims of the study were:

Secondary Aim 1: to examine whether there were significant differences in the mean number of unhealthy days for each HRQOL indicator (physical unhealthy days, mental

unhealthy days, and days of limited activity) according to level of disability at each level of self-described health status.

Hypothesis: it was hypothesized that people with a lesser degree of disability would have significantly fewer poor health days than those with a greater degree of disability in each health status level.

Figure 1. Basic Model



Secondary Aim 2: to examine whether there were significant differences in the mean number of unhealthy days for each HRQOL indicator between those who were physically active and those who were not in each level of disability.

Hypothesis: it was hypothesized that for each level of disability, those who were physically active would have significantly fewer poor health days for each HRQOL indicator than those who were sedentary.

INTRODUCTION

People with disabilities are a rapidly increasing, yet understudied, population. Preliminary evidence suggests there are substantial discrepancies between the health profiles of people with disabilities (PWD) and those without (PWOD), and that people with disabilities represent a disproportionate burden on healthcare resources. To improve the human, financial, and social costs that result from the disparities in health-related characteristics between PWD and PWOD, more work needs to be done to understand the factors involved. Physical activity is generally acknowledged to be a major health-enhancing activity and there is considerable literature on health benefits of physical activity for a wide variety of conditions and populations. Although there is evidence that "functional disability is inversely related to physical activity or physical fitness in various domains" (Singh, 2002), in the context of physical activity, people with disabilities are also under-studied. What data are available indicate that people with disabilities are disproportionately sedentary, often due to a cycle of self-fulfilling prophesy, that is, PWD are not expected to be physically active so many fail to engage in physical activity for health or recreation purposes. Conversely, they may be less than optimally active because of limitations related to their disability. The extent to which poor health indicators in PWD are related to lack of physical activity is unclear. Recently, work by Brown and colleagues (2003, 2005) indicated that physical activity may have an ameliorating effect on specific health-related quality of life indicators, such as the number of days a person

feels physically or mentally unhealthy, in PWD as well as the general population. The present study was intended to gain further insight into the association of physical activity to health-related quality of life in PWD.

Background and Significance

Alleviating the personal, social, and financial burdens associated with disability is an important public health issue. Recent estimates for the prevalence of persons with disabilities in the USA range from 13%-33%, representing up to 90 million people (Andresen et al., 1999; Kinne, Patrick & Doyle, 2004; MMWR4931, 2000). The wide range of estimates is tied to the difficulty of applying a clear and encompassing definition of disability. Traditionally, disability has been conceived as congenital defects (blind, deaf, CP), or acquired impairment (paraplegia, quadriplegia). However, current definitions also encompass any condition that interferes with the individual's capacity to freely engage in life activities (e.g., obesity, age-related declines in function, psychological barriers).

Despite the difficulty of concisely delineating the state of disability, it is evident that the prevalence is growing and that persons with disabilities present a disproportionate burden on the healthcare system, particularly in terms of secondary conditions. For example, a study of Washington state respondents to the 2001 Behavioral Risk Factor Surveillance System (BRFSS) found that significantly more persons with disabilities reported one or more secondary conditions than for those without disability (87% vs. 49%) (Kinne, Patrick & Doyle, 2004). Although persons with disabilities appear overall to have poorer health than those without, they are benefiting from medical and health improvements and are living longer. However, this also presents a significant

public health concern in that the presentation and duration (thus, the public health burden) of secondary conditions is likely to increase (Cooper et al., 1999). Therefore, there is a pressing need to understand the nature and characteristics of health disparities and risks associated with disability.

Unfortunately, despite the status of people with disabilities as an at-risk group, public health researchers have traditionally paid little attention to their health needs (Lollar, 2002; Rimmer, 1999). For example, as recently as February 2004, in a review of populations at risk for no leisure-time physical activity (a known significant risk factor for a variety of health deficits) in the context of Healthy People 2010 goals, the Centers for Disease Control and Prevention (CDC) analyzed leisure-time physical activity from 14 years of BRFSS data for women, older adults, and racial/ethnic minorities but made no mention of people with disabilities (MMWR534, 2004). However, more interest in, and commitment to, the health status of people with disabilities is emerging. For example, people with disabilities are specified for the first time in the national health goal of Healthy People 2010 to eliminate health disparities among different segments of the population (Lollar, 2002; MMWR4931, 2000).

If the goal is to be met more research is needed to characterize the health-related impact of disability. Preliminary work by Drum, Horner-Johnson and Krahn (n.d.) indicates significant discrepancies between the functional health status of people with disabilities and those without, even within the same self-reported level of health. A better understanding of the nature of these differences will enable the development of effective intervention strategies to increase functional ability and maintain independence of persons with disabilities, reduce the occurrence of secondary conditions (e.g., obesity,

hypertension, pressure sores), enhance their overall quality of life and decrease their draw/burden on health resources (Rimmer, 1999).

Physical Activity and Health

The value of physical activity as a significant health-enhancing activity is generally acknowledged. It is first in the list of Leading Health Indicators targeted as Priorities for Action in Healthy People 2010 (the overall purpose of which is to "increase the quality and years of healthy life and to eliminate health disparities" (Healthy People, 2010) and is a featured component of 2005 Dietary Guidelines for Americans from the US Departments of Agriculture, and Health and Human Services. There is considerable literature on health benefits of physical activity for a wide variety of conditions and populations. For example, using 2001 Behavioral Risk Factor Surveillance System (BRFSS) data, Brown et al. (2003) examined the relationship between recommended levels of physical activity and health-related quality of life (HRQOL) to determine whether physical activity was "associated with better HRQOL and perceived health status" and found that "the proportion of adults reporting 14 or more unhealthy days (physical or mental) was significantly lower among those who attained recommended levels of physical activity than physically inactive adults for all age, racial/ethnic, and sex groups" (p. 520).

Physical Activity and Disabilities

These benefits seem to be applicable to persons with disabilities. For example, Brown and colleagues (2003) found the risk of having 14 or more physical or mental unhealthy days in the preceding month was approximately 50% lower for PWD who met recommended levels of physical activity than for those who did not. In addition,

Radowski and Mor (1992) found that for older adults with one or more Instrumental Activities of Daily Living (IADL) impairments, walking was associated with lower mortality. However, for a variety of reasons, including the nature of the disability, social constraints and self-imposed barriers, people with disabilities are more likely to be sedentary than those without disabilities (Taylor, Baranowski & Young, 1998). Data from the 1997 National Health Interview Survey indicated that 56% of persons with disabilities over the age of 18 years engaged in no leisure-time physical activity (compared to 36% of the general population) and only 23% had even 20 minutes of moderate activity at least three times per week (compared to 33% of the general population) (Healthy People 2010, 2000). Although specific interventions have produced good results on a limited basis there is little understanding of the relationship between physical activity and disability in the general population, especially for differing levels of disability. From a consensus conference "to identify research priorities for physical activity and health among people with disabilities" involving experts from "engineering, epidemiology, medicine, nutrition, exercise physiology, and psychology [as well as] participants in the 1996 Paralympic Congress" it was concluded that "exercise must be studied from the perspective of disease prevention" but that "greater emphasis must be placed on determining . . . the benefits of exercise among people with disabilities" because the current "dearth of research on the exercise and activity patterns of persons with disabilities . . . makes it difficult for public health officials to set policy guidelines for this segment of the population" (Cooper et al., 1999).

Health-related Quality of Life

The lack of a consistent and appropriate population-based surveillance of good health lead the CDC to incorporate questions to assess health-related quality of life (HRQOL) in the BRFSS in 1993 (MMWR4320, 1994). These measures were considered necessary because they could identify "dysfunction and disability not reflected by standard measures of morbidity and mortality" (MMWR4411, 1995, p. 195), and personal perceptions of health and well-being had been shown to reliably predict loss of function, morbidity and mortality. The current HRQOL questions were derived from an initial set of 14 items which were developed from the need for a "brief, yet valid, set of measures". The CDC, in conjunction with several other agencies, analyzed HRQOL data from non-institutionalized persons in the United States, Canada, Sweden and Puerto Rico and determined that the HRQOL-4 measures had good construct validity. Further testing indicated acceptable criterion validity with the Medical Outcomes Survey Short Form (SF-36), as well as concurrent validity based on reported health conditions, physical exams and other measures in a sample of older Canadians. Moreover, additional studies indicated the measures had acceptable test-retest reliability and good internal consistency (Moriarty, Zack & Kobau, 2003). Finally, although the HRQOL-4 was designed as a generic method of identifying, monitoring and promoting the physical and mental health of the population at large, it has been effective in highlighting "subsets that experience more persistent HRQOL deficits". Of particular interest was the conclusion of Verbrugge and colleagues (1999) who found the number of activity-limited days to be a valid global indicator of disability in the general population.

METHODS

Data Source

This study was a secondary data analysis of the Behavioral Risk Factor Surveillance System (BRFSS) using result from the 2003 collection. The BRFSS, an annual, random-digit dialing survey of non-institutionalized adults aged 18 years and older in the 50 US states and four protectorates, has been described as a snapshot of the health of the nation. It consists of three parts: a) core questions, b) optional modules, and c) state added questions. Information concerning physical activity and HRQOL is derived from BRFSS core questions, while disability data come from an optional module. Physical activity is measured by a number of questions, such as "In a usual week, do you do moderate activities for at least 10 minutes at a time, such as brisk walking, bicycling, vacuuming, gardening, or anything else that causes small increases in breathing or heart rate?" Data from these questions can be used to calculate total number of minutes per week a respondent is engaged in moderate and/or vigorous physical activity, or to categorize respondents as having no activity (sedentary), insufficient activity to meet recommended guidelines, or meeting guidelines. HRQOL is captured by four questions: a) "Would you say your general health is: excellent, very good, good, fair or poor?"; b) "Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?"; c) "Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?"; and d) "During the past 30 days, for about how many days did poor physical or mental health keep you from doing your usual activities, such as self-care, work, or recreation?"

Disability is characterized by two questions: a) "Are you limited in any activities because of physical, mental, or emotional problems?" and b) "Do you now have any health problem that requires you to use special equipment, such as a cane, wheelchair, a special bed, or a special telephone?"

Disability is usually a global measure incorporating anyone who answers "yes" to either of the identifier questions. However, it is possible to conceptualize three levels of disability (from least disadvantaged to most disadvantaged) from these two questions, that is: a) not disabled but use an assistive device, b) disabled but do not use an assistive device, and c) disabled and use an assistive device. This distinction is important because, to date, BRFSS analyses of disability have treated persons with disabilities as a homogeneous population and important information related to disabilities and health characteristics is lost in the process. Similarly, physical activity data are generally reduced to three classifications: no physical activity; activity insufficient to meet recommended guidelines, and activity sufficient to meet recommended guidelines. However, the number of people with disabilities who are capable of meeting recommended guidelines is more limited than for the general population and policies based on the "recommended level" criterion may be unreasonable and misleading for people with disabilities. In fact, the threshold for physical and psychological benefits of activity for people with disabilities is generally lower than for people without disabilities. Thus, rather than combining no activity and insufficient activity in analysis, it is more realistic to compare no activity to a combined grouping of insufficient activity and sufficient activity to understand the relationship between disability, physical activity and HRQOL in Secondary Aim 2.

Analysis

Preliminary Analysis

Prior to the main analyses, demographic information of the study sample was fully documented. All outcome data were checked for out-of-range values. Missing values or nonresponse to survey items were either recoded or removed. Finally, the distributions of outcome variables were examined to ensure that they met the assumptions of the statistical tests employed.

Main Analysis

Given the BRFSS complex sampling design, the analyses used sample weights to account for differential probabilities of selection into the sample, nonresponse, and noncoverage. All statistical inferences were based on a significance level of P (two-tailed) $\leq .05$. M*plus* software (Muthén & Muthén, 1998-2004) was used in evaluating the primary study aim. SUDAAN software (Research Triangle Institute, 2004) was used to evaluate hypotheses in the secondary aims because "biased point estimates, inappropriate standard errors and confidence intervals, and misleading tests of significance can result from using standard statistical software packages to analyze sample survey data" (Brogan, 1998, p. 4167). Brogan argues that characteristics of complex survey designs such as BRFSS, including unequal probability of selection of observations, clustering of observations, stratification, and nonresponse and other adjustments, are not incorporated into standard statistical packages (p. 4167). The following describes the data analyses specific to each of the study aims.

Primary Aim: to examine the structural relationship between disability, physical activity and HRQOL.

Hypothesis: it was hypothesized that physical activity would be associated with better HRQOL (i.e., lower scores), and disability positively associated with poor HRQOL. However, it was further hypothesized that the interaction between disability and physical activity would make the disability-HRQOL relationship weaker in the physical activity group.

Data Analyses. The stated hypotheses were evaluated within a latent variable and multisample framework. Specifically, the latent variable of disability was defined by two indicators (activity limitation due to health problems, health problems requiring special equipment), and the latent variable of HRQOL was defined by four indicators (physical unhealthy days, mental unhealthy days, days of limited activity, and health status). "Poor health" indicators are used in this analysis as the measure of HRQOL for BRFSS are the number of days in the previous month the respondent experienced poor physical health, mental health or limited activity. As poor health is an unusual event in the general population, it is easier and more accurate for people to remember these events than to estimate the number of "normal" days. Physical activity was operationalized as a categorical variable and the relationship between disability and HRQOL was examined at the *a priori* determined levels of the interacting variable – physical activity defined as "no activity, physically active." The interaction effect was determined by using the chi-square difference test. Demographic variables of age, sex, race, education, employment, and income were included as control variables in the model testing.

Secondary Aim 1: to examine whether there were significant differences in the mean number of unhealthy days for each health-related quality-of-life (HRQOL) indicator

(physical unhealthy days, mental unhealthy days, and days of limited activity) according to level of disability at each level of self-described health status.

Hypothesis: it was hypothesized that people with a lesser degree of disability would have significantly fewer poor health days than those with a greater degree of disability in each health status level.

Data Analyses. The two independent variables of health status and disability were treated as categorical and the dependent variables of HRQOL indicators were continuous. Based on previous research and preliminary analysis, health status was collapsed into three categories: Excellent/very good, good, fair/poor. Disability had three categories as described previously: least affected ("use equip"), disabled but without assistive devices ("disabled"), and most affected (disabled with devices; "UE&D"). Analysis of variance was used to determine whether the three levels of disability differed on mean HRQOL indicators (all continuous variables) within each health status level, adjusting for age, sex, race, education, employment and income.

Secondary Aim 2: to examine whether there were significant differences in the mean number of unhealthy days for each HRQOL indicator between those who were physically active and those who were not in each level of disability.

Hypothesis: it was hypothesized that for each level of disability those who were physically active would have significantly fewer poor health days for each HRQOL indicator than those who were sedentary.

Data analyses. The independent variable of disability was operationalized as described under Secondary Aim 1. Physical activity was a categorical variable with two categories: no activity, activity. Analysis of variance was used to determine whether the two levels of

physical activity differed on mean HRQOL indicators (all continuous variables) within each level of disability, adjusting for age, sex, race, education, employment and income.

RESULTS

There were 264,684 respondents for the 2003 BRFSS. Of these, 219,542 were excluded for: (a) having no activity limitation due to health problems (responding 2 on the QLACTLM2 question) and requiring no special equipment (responding 2 on the USEEQUIP question), (b) missing data, (d) answering "Do not know/Not sure" to relevant questions, or (d) refusal to answer the survey questions. Therefore, in the present study, data were analyzed for 45,142 persons with complete information for all study variables. Demographic information on the sample is detailed in Table 1. Of the 219,542 excluded respondents, 198,741 answered "no" to both disability questions (i.e., had no limitations), 4,895 had missing data or were not asked either disability question, and 1,509 refused to answer or answered "don't know/not sure" to one of the disability questions. A further 14,397 who answered "yes" to at least one of the disability questions had missing data, refused to answer or answered "don't know/not sure" on at least one of the variables of interest in the study, producing the final sample of 45,142. Demographic details of the non-selected population with comparison to the selected sample as well as the number of respondents in the non-selected sample for each variable are presented in Appendix A (Table A).

Of the 45,142 persons in the final sample, 3019 (7%) were classified in the theoretically least disabled group (Use equip: no for QLACTLM2; yes for USEEQUIP); 31, 809 (70.5%) were in the middle group (Disabled: yes for QLACTLM2; no for USEEQUIP), and 10,314 (22.5%) were in the proposed most disabled group (UE&D: yes for QLACTLM2; yes for USEEQUIP). A summary table of the number of respondents

for disability level by health status by activity status is also presented in Appendix A (Table B).

Table 1. Description of Measurement Variables Considered in the Study (N = 45,142)

Variable	Value	Description	Proportion in sample
Age	1	Aged between 18 and 59	62.8
	2	Aged between 60 and over	37.2
Sex	1	Male	39.3
	2	Female	60.7
White vs. other	1	White	80.9
	0	Other	19.1
Black	1	Black	7.0
	0	Other	93.0
Hispanic	1	Hispanic	6.1
	0	Other	93.9
Income	1	Less than $20,000	34.3
	0	Over $20,000	65.7
Education	1	Less than high school	14.1
	0	High school or higher	85.9
Employment	1	Not employed	59.8
	0	Employed	40.2
Health	1	Excellent or very good	26.9
	2	Good	31.0
	3	Fair or poor	42.1
Poor physical health days	1	Yes	63.6
	0	No	36.4
Poor mental health days	1	Yes	47.3
	0	No	52.7
Limited activity days	1	Yes	46.3
	0	No	53.7
Disabled (Activies limited)	1	Yes	93.3
- (QLACTLM2)	0	No	6.7
Use equipment	1	Yes	29.5
- (USEEQUIP)	0	No	70.5
Physical activity status	1	Active	75.2
	2	Sedentary	24.8

Cross-Tabulation of HRQOL indicators by Disability and Physical Activity Status

Initial descriptive analyses examined whether levels of disability differed on mean HRQOL indicators within each level of physical activity status. Table 2 (Appendix B)

presents mean estimates of HRQOL indicators by physical activity status and disability categories. Inspection of physical activity status differences within each disability category indicated that active and sedentary groups differed significantly within all three categories of disability on all dependent measures of HRQOL indicators. Pairwise contrasts indicated that, with the exception of poor mental days, where there was no difference between active and sedentary ($p = .60$) for the use equip group, the physically active group had significantly fewer mean days in each of the three dependent unhealthy days measures compared to the sedentary group ($p < .001$) as well as better average health status. Details of these results are presented in Table 3 (Appendix B).

Primary Aim

Structural Equation Model

The Relationship between Disability, Physical Activity Status, and HRQOL

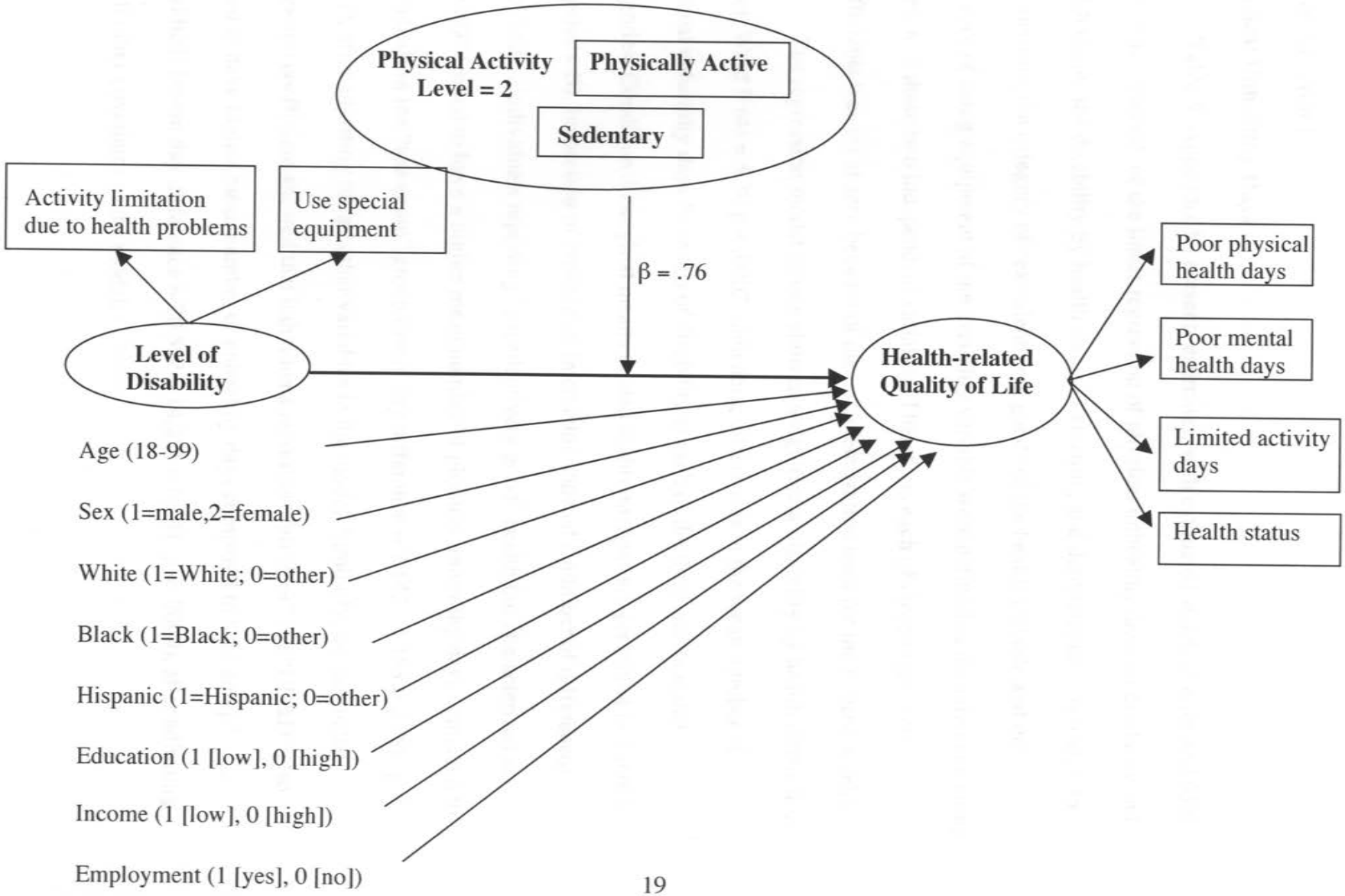
The model shown in Figure 2 resulted in a chi-square value of 1310.19 with 54 degrees of freedom, $p < .001$. Given the known sensitivity of the traditional chi-square test of model fit to sample sizes, it was decided that the use of Root Mean Square Error of Approximation (RMSEA), an index for a "close"-fitting model, was more appropriate to judge the overall model fit. The model had a RMSEA value of .03, indicating the specified model fit the empirical data well. Inspection of factor loadings for the measurement of HRQOL and disability latent constructs indicated that all loadings were statistically significant ($p < .001$) suggesting that the observed measures adequately defined their respective latent constructs.

Parameter estimates are displayed in Table 4 (Appendix B). With respect to the primary aim of the study, the results indicated a non-significant path coefficient between

disability and HRQOL for the physical activity group, unstandardized beta weight b = 21.53, $p > .05$ ($\beta = .72$, where β signifies the standardized estimate); but a statistically significant path coefficient for the sedentary group, $b = 27.98$, $p < .02$ ($\beta = .80$), respectively. The difference in disability and HRQOL was tested by comparing the resulting model to a null model in which the path parameters were constrained to be equal. The test showed a significant chi-square difference with one degree of freedom, $\chi^2_{(1)} = 24.41$, $p < .001$, resulting in rejection of the null model, indicating that the strength of the disability-HRQOL relationship varied according to the physical activity status. This finding suggests that the status of HRQOL for people with disabilities may be related to their activity status rather than their disability status, adjusted for demographic variables. In the physically active group, 68% of variance in HRQOL was accounted for by the combination of the independent variables in the model whereas 76% of variance was accounted for in the sedentary group.

With respect to covariates in relation to disability, all demographic variables were found to be significantly related to the latent variable of disability. Specifically, younger adults, women, low levels of income and education, and unemployment were associated with disability. No particular race/ethnicity was related to disability.

Figure 2. Expanded Model with Operational Indicators that Define Latent Variables.



Secondary Aim 1

Physical Unhealthy Days

Table 5 (Appendix B) presents estimates, with estimated standard error and 95% confidence interval, of the linear regression of physical unhealthy days on disability and health status, the disability by health status interaction, and demographic covariates. In this analysis, the category of "excellent/very good" of the health variable and the category of using equipment of the disability variable were defined as the reference group for each of these two independent variables. Therefore, each of these regression coefficients was set at zero because of the parameterization used for the reference cells.

The regression model testing showed a significant disability by health interaction effect, Wald F (4) = 5.39 $p < .0002$, indicating differences in the mean number of physical unhealthy days by levels of disability at each of the three health status categories. Conditional marginal means related to this analysis are presented in Table 6 (Appendix B). Inspection of cross-level interaction showed a number of differences. Specifically, individuals reporting "excellent/very good" health but characterized as "UE&D" tended to have a higher mean number of physical unhealthy days compared to individuals in the "use equip" group (mean day difference = 7.143 - 4.155 = 2.988, $p < .0001$), after adjusting for all other variables in the model. Similarly, the estimated regression coefficient showed that individuals reporting "fair/poor" but "UE&D" also tended to have higher mean number of unhealthy days compared to "use equip" individuals (mean day difference = 20.592 – 14.251 = 6.341, $p < .0009$), after adjusting for all other covariates in the model.

Specific cross-level contrasts were made to further examine mean differences on the levels of one independent variable (e.g., health) while holding constant for the other independent variable (e.g., disability) at a selected level. These contrasts were designed to test the null hypothesis that the regression coefficients specified in these contrasts were zero, conditional on all other variables in the model. Details of these tests results are presented in Table 7 (Appendix B).

Thus, when holding health status constant at each level, several between group differences emerged. Results showed that, for those reporting "excellent/very good" health, the "use equip" group was significantly different (fewer poor physical health days) from the UE&D group ($p < .0001$), and that the disabled group was significantly different from the UE&D group ($p < .0001$). The same patterns of results were observed when health status was held constant at the category of "Fair/poor" health. However, for "good health", there were significant differences between all three disability groups (see Figure 3: top panel). When considering disability status, for individuals classified as "use equip," there was a significant difference between "excellent/very good" health and "fair/poor" health groups, $p < .0001$; and between "good" health and "fair/poor" health groups, $p < .0001$. Results also showed that for those classified in the "disabled" and "UE&D" categories, significant differences in mean unhealthy days existed among the three health status groups. Specifically, for the category of "disabled" or "UE&D," a significant difference was observed between "excellent/very good" health and "good" health groups; between "excellent/very good" health and "fair/poor" health groups; and between "good" health and "fair/poor" health groups on the dependent measure of physical unhealthy days (see Figure 4: top panel).

Mental Unhealthy Days

Table 8 (Appendix B) presents estimates from the regression analyses for the outcome variable of mental unhealthy days. The results based on mean mental unhealthy days adjusted for demographic covariates are presented in Table 9 (Appendix B). Results from contrasts are presented in Table 10 (Appendix B).

Results indicated a significant health status by disability interaction, Wald F (4) = 5.359, $p < .001$. Following the significant interaction effect, simple main effects analysis was conducted and parameter estimates are presented on the bottom portion of Table 8. Results indicated that, among individuals who reported excellent/very good health, there were no statistically significant differences on mental unhealthy days between the disabled group (marginal mean = 3.91) and the reference group of use equip (marginal mean = 4.21), $p = .71$; or between the UE&D group (marginal mean = 4.57) and the reference group, $p = .70$. For the remaining two health status categories, some differences among the three disability groups were observed. Results showed that, among individuals who reported good health, there was a significant difference on mental unhealthy days between the disabled group (marginal mean = 6.07) and the use equip group (marginal mean = 4.57), $p = .003$. There was, however, no significant difference between the UE&D group (marginal mean = 5.49) and the reference group, $p = .16$, on this measure. In contrast, among those reporting fair/poor health, mental unhealthy days was found to be different across the three disability groups, with the UE&D group having the highest mean of poor mental health days (marginal mean = 10.45) compared to the reference group (marginal mean = 6.58) ($p < .001$), followed by the disabled group (marginal mean = 9.56) as compared to the use equip group, $p = .001$.

Follow-up simple comparisons between levels of health status at each level of disability, and between levels of disability at each level of health status were made (see Figures 3 & 4: middle panel). Tests results are presented in Table 10. For disability, there were significant differences for the categories of disabled and UE&D with respect to each of the health status comparison groups. For the category of use equip, the difference was found on the comparisons between "excellent/very good" vs. "fair/poor", and between "good vs. fair/poor." However, no difference was evident between "excellent/very good" vs. "good" for this group.

Limited Activity Days

Table 11 (Appendix B) presents estimates from the regression analyses for the dependent variable of limited activity days. The mean limited activity days adjusted for demographic covariates are presented in Table 12 (Appendix B). Results from cross-level pairwise contrasts are presented in Table 13 (Appendix B).

Results indicated a significant health status by disability interaction, Wald F (4) = 14.03, $p < .001$. Following the significant interaction effect, simple main effects analysis was conducted and parameter estimates are presented on the bottom portion of Table 11. Estimates from conditional marginal means are presented in Table 12. Results indicated that, among individuals who reported excellent/very good health, there was a statistically significant difference on limited activity days between the disabled group (marginal mean = 2.902) and the reference group of use equip (marginal mean = 2.288), $p = .02$; and between the UE&D group (marginal mean = 5.058) and the use equip group, $p < .0001$. For the remaining two health status categories, results showed that, among individuals who reported fair/poor health, there was a significant difference on limited activity days

between the disabled group (marginal mean = 15.684) and the use equip group (marginal mean = 8.077), $p < .0001$.

Follow-up simple comparisons between levels of disability at each level of health status, and between levels of health status at each level of disability were made. Details of these tests results are presented in Table 13. At each level of health status, within-level differences on limited activity days were observed across three categories of disability (see bottom portion of Table 13). For example, at each level of health status (i.e., excellent/very good, good, fair/poor), each level of disability was shown to be different from each other on the report of limited activity days (see Figure 3: bottom panel). Similarly, significant differences were found across health status within each level of disability (see Figure 4: bottom panel).

Figure 3. HRQOL Indicators (mean days) by Disability and Health Status (* = p <.05)

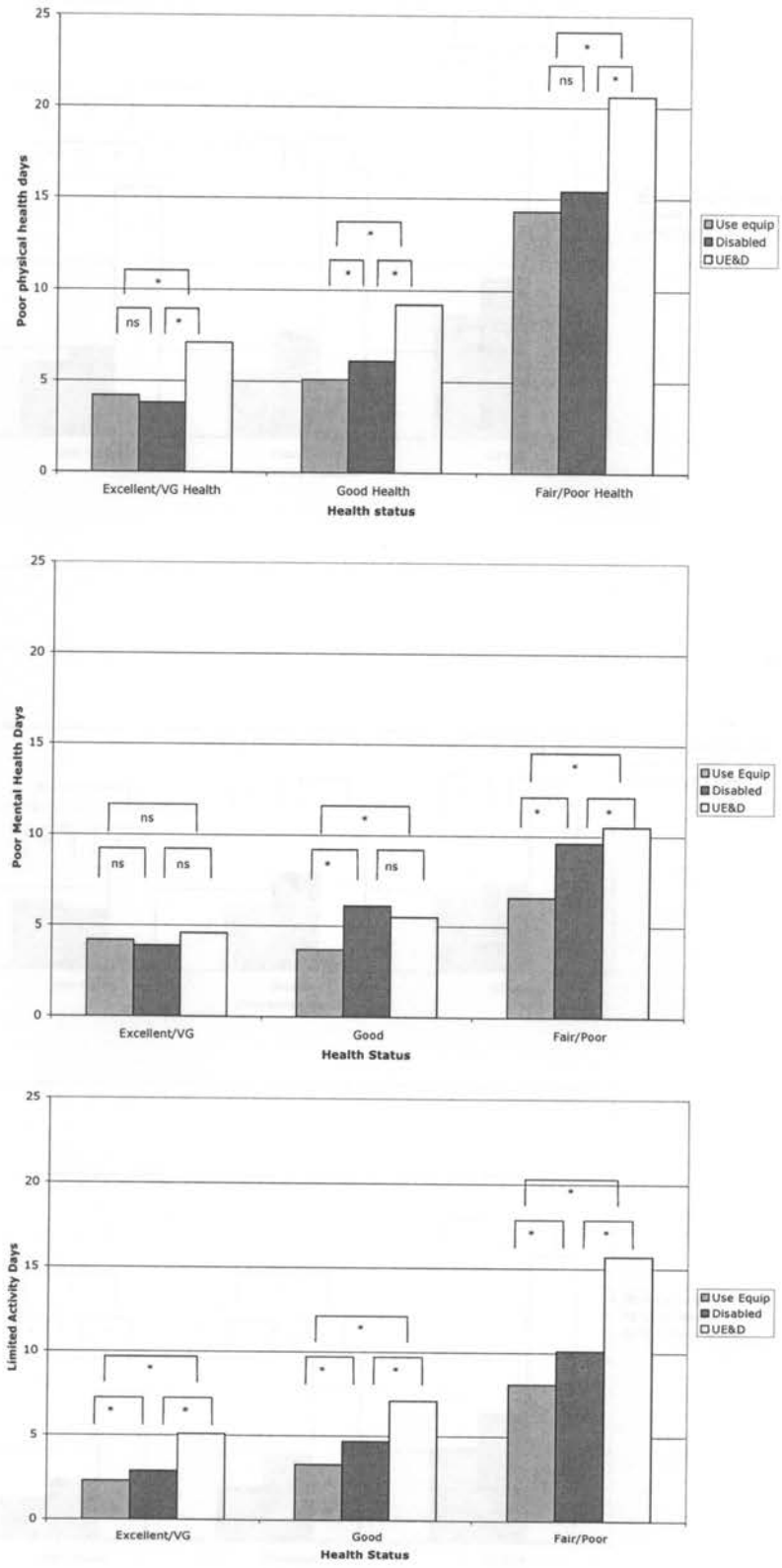
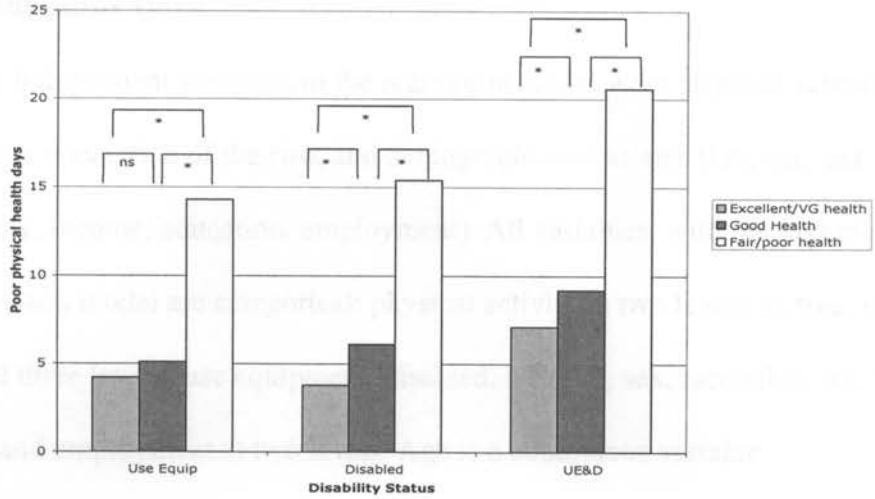
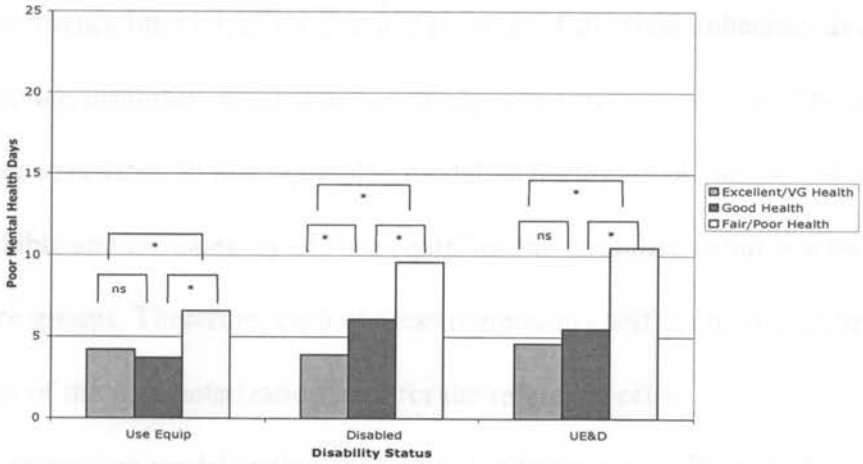
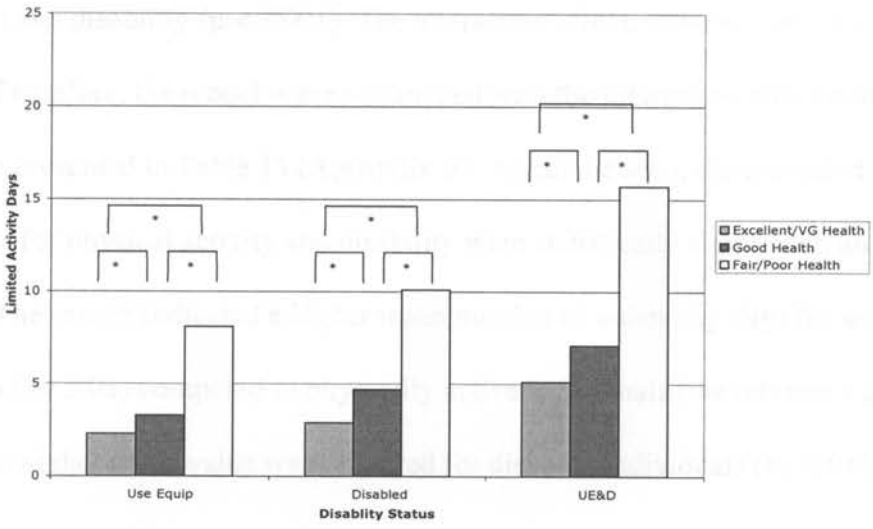


Figure 4. HRQOL Indicators (mean days) by Health Status and Disability (* = $p < .05$)







Secondary Aim 2

Physical Unhealthy Days

The independent variables in the regression model were physical activity, disability, the interaction of the two, and demographic covariates (i.e., age, sex, race/ethnicity, income, education, employment). All variables, with the exception of age, in the regression model are categorical: physical activity at two levels (active, sedentary), disability at three levels (use equipment, disabled, UE&D), sex, race/ethnicity, income, education, and employment at two levels. Age is a continuous variable.

Table 14 (Appendix B) presents model estimates, with estimated standard error and 95% confidence interval, of the linear regression of physical unhealthy days on physical activity, disability, the interaction of physical activity and disability, and demographic covariates. In this regression model, the category of "active" of the physical activity variable and the category of "use equip" of the disability variable were defined as the reference groups. Therefore, each of these regression coefficients was defined to be zero because of the parameterization used for the reference cells.

The regression model testing showed a significant main effect of physical activity ($p < .0001$) and disability ($p < .0001$). The interaction effect, however, was not significant ($p = .12$). Therefore, the model was re-estimated with the interaction effect removed. Results are presented in Table 15 (Appendix B). As can be seen, the estimated regression coefficients for physical activity and disability were statistically significant, all positive in direction. The results indicated a higher mean number of unhealthy days for sedentary individuals (by 5.03) compared to physically active individuals (the reference group). Similarly, a higher mean value was observed for disabled individuals (by 2.01) and for

UE&D individuals (by 7.44), compared to those in the use equip (the reference group). The conditional marginal means of physical unhealthy days, with estimated standard error, after adjusting for demographic covariates are presented in Table 16 (Appendix B). No specific contrasts were made because of the non-interaction between physical activity and disability.

Mental Unhealthy Days

Table 17 (Appendix B) presents model estimates, with estimated standard error and 95% confidence interval, of the linear regression of mental unhealthy days on physical activity, disability, the interaction of physical activity and disability, and demographic covariates.

The regression model testing showed a significant physical activity by disability interaction ($p = .02$), indicating differences in the mean number of mental unhealthy days by levels of disability at each of the two physical activity categories. An examination of cross-level interaction showed that sedentary individuals in both the disabled and UE&D groups tended to have a higher mean number of mental unhealthy days (mean day difference = 8.498 – 4.837 = 3.661 for sedentary disabled individuals; mean day difference = 9.188 – 4.837 = 4.351 for sedentary UE&D individuals) compared to use equip sedentary individuals, after adjusting for all other variables in the model (Table 18; Appendix B)).

Follow-up contrasts are presented in Table 19 (Appendix B). Results indicated that for disabled or UE&D individuals, those reporting no activity were significantly different on their mean number of mental unhealthy days compared to those reporting being active ($p < .001$) (see Figure 5: top panel). When levels of physical activity were

considered, for physically active individuals, there was a difference between use equip and disabled individuals on mean mental unhealthy days ($p < .001$) and between use equip and UE&D participants but not between disabled and UE&D groups. This difference was also evident for those reporting no physical activity ($p < .001$) (see Figure 6: top panel).

Limited Activity Days

Table 20 (Appendix B) presents model estimates, with estimated standard error and 95% confidence interval, of the linear regression of limited activity days on physical activity, disability, the interaction of physical activity and disability, and demographic covariates.

The regression model testing showed a significant physical activity by disability interaction ($p < .0001$), indicating differences in the mean number of limited activity days by levels of disability at each of the two physical activity categories. An examination of cross-level interaction showed that sedentary individuals in both disabled and UE&D groups tended to have a higher mean number of limited activity days (mean day difference = 3.523, $p = .03$, for sedentary disabled individuals; mean day difference = 9.39, $p < .0001$ for sedentary UE&D individuals) compared to use equip sedentary individuals, after adjusting for all other variables in the model (see Table 21; Appendix B).

Specific contrasts are presented in Table 22 (Appendix B). Results indicated a statistical difference between physically active and sedentary individuals at each level of disability ($p < .01$) (see Figure 5: bottom panel). In general, the results indicated that sedentary individuals had a higher mean number of limited activity days compared to

physically active individuals, although the difference varied by levels of disability. When levels of physical activity were considered, there was a significant difference in the mean number of limited activity days between all disability groups, both for those who were active and those who were sedentary (see Figure 6: bottom panel).

Figure 5. HRQOL Indicators (mean days) by Disability Level and Activity Status (* = $p < .05$)

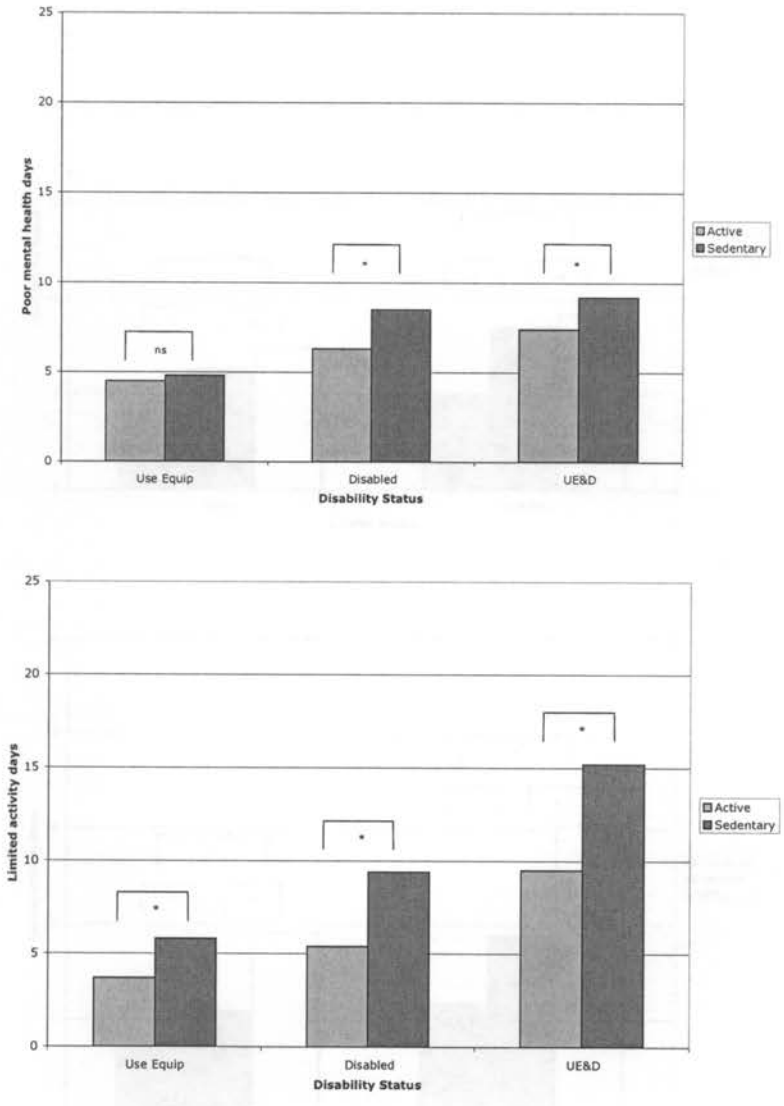
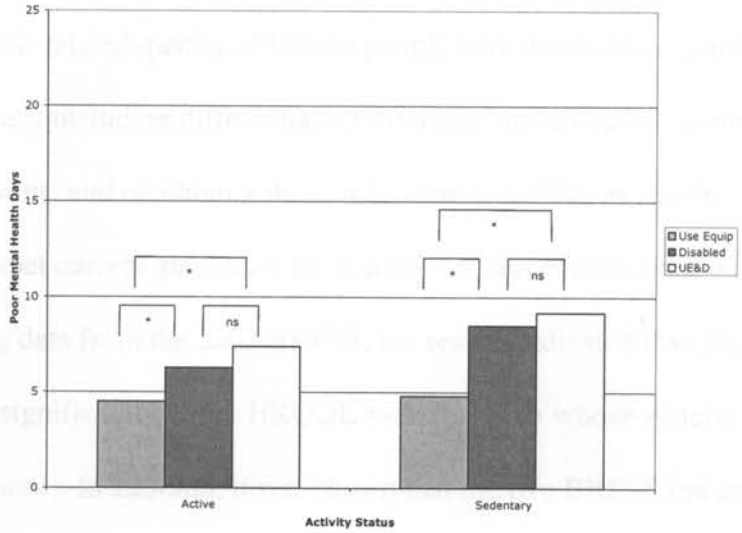
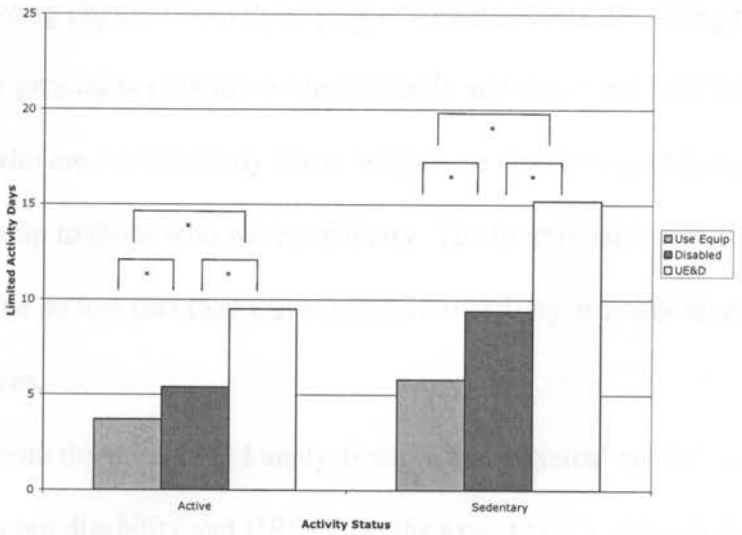


Figure 6. HRQOL Indicators (mean days) by Activity Status and Disability Level (* = p <. 05)





DISCUSSION

This study was designed to gain insight into the relationship between physical activity and health-related quality of life for people with disabilities by utilizing several unique approaches, including differentiating disability into three categories based on two indicators questions, and combining those who were identified as insufficiently active with those who met current guidelines for activity for comparison with those who were sedentary. Using data from the 2003 BRFSS, the results indicated that physical activity is associated with significantly better HRQOL even for those whose general health is less than ideal (fair/poor). In addition, it was shown that the two BRFSS indicator questions for disability can be effectively partitioned to identify three distinct levels of disability. Finally, categorizing physical activity in people with disability according to the guidelines of the general population is unreasonable and it is more meaningful to combine those who are insufficiently active with those who met guidelines and compare the combined group to those who were sedentary. The functional levels of people with disabilities may be so low that they can benefit from activity at lower levels than people without disabilities.

Results from the initial SEM analysis show that physical activity moderates the relationship between disability and HRQOL to the extent that it appears that physical activity rather than disability status is more strongly associated with HRQOL. This finding, in concert with previous research on the benefits of physicall activity, strengthens the argument for improving physical activity opportunities for people with disabilities. Considerable research across multiple populations has shown that well devised and judiciously applied exercise or physical activity interventions can improve

multiple physiological, psychological and social parameters. Unfortunately, people with disabilities have not been consistently targeted on a broad scale. The results of this study may prompt more effort and provide additional support for the targeting of people with disabilities in the goals of Healthy People 2010. It indicates that poor HRQOL may not be an inevitable consequence of disability but rather an ameliorable characteristic. This is important because it reinforces the concept that people with disabilities have the capacity to improve their quality of life.

Furthermore, results indicate that people with disabilities are heterogeneous with respect to HRQOL, and that the heterogeneity can be captured by using the two BRFSS disability identifiers to form three distinct groups. Although the magnitude of the differences across the groups varied by the specific HRQOL indicator, there was a clear pattern demonstrating that those identified as "UE" (use equip; conceptually the most functional) had better profiles than either "disabled" or "UE-D" (the latter being conceptually the least functional). Similarly, the "disabled" group fared significantly better than the "UE-D" group. These findings have two implications: a) although all people with disabilities need additional resources, support and well-designed interventions to engage them in physical activity, the specific type(s) of resource and intervention should vary, i.e., be specific to the abilities of the group, for the greatest efficacy, and b) the BRFSS disability questions can be considered a very useful, and highly desirable, global measure of disability as they have now been shown to satisfy the major criteria proposed by Verbrugge and colleagues (1999) of having "high descriptive and analytic value," capturing both short- and long-term disability, and doing so parsimoniously. Moreover, it has been shown in the present study that global disability is,

indeed, distinct from self-rated health. Although questions related to specific disabling conditions should be added to the BRFSS (such as those presently included for arthritis or diabetes), the capacity of the currently used two general disability questions to identify three distinct groups, as demonstrated in this paper, provides policy-makers and others involved in improving the health-status of persons with disabilities a much clearer picture of the nature and scope of the problem.

Although research on physical activity and HRQOL of people with disabilities has been lacking, recent work by Brown et al. (2003) and Brown et al. (2005) indicated that physical activity can influence HRQOL in this population. The present study combines and extends this work. For example, Brown and colleagues (2003), in the first study to "examine the relationship between currently recommended levels of moderate or vigorous physical activity and HRQOL" (p. 523), were principally interested in this relationship in the general population. Nonetheless, in their secondary analysis, they found that the odds of 14 or more physical or mental unhealthy days was 0.47 for people with disabilities who met the guidelines compared to those who were sedentary. However, they used the usual formulation of people with disabilities as a homogeneous entity, dichotomized physical activity into meeting guidelines or sedentary groups, and used a dichotomized approach to only two of the HRQOL indicators (14 or more physical and mental unhealthy days). Brown et al. (2005) advanced this work by specifically comparing physical activity status of people with and without disabilities but only for the population over age 50 years. In addition, although they provided information on the number of persons with disabilities who were in the three disabilities categories utilized in the present study (use equip, disabled, UE&D), they did not use these categories in

their analyses, nor did they use HRQOL measures as outcomes variables, except for health status. Finally, although they argued that people with disabilities can be active, even if at insufficient levels, they did not combine those identified as insufficiently active with those meeting guidelines but used the three separate physical activity groupings (inactive, insufficiently active, recommended) for their analyses. In general, their findings indicated that the odds of having poor general health were significantly higher for people with disabilities who were sedentary compared to those who were meeting activity guidelines.

The present study supports the general conclusions of Brown et al. (2003) and Brown et al. (2005). However, it also found that the association was not consistent across HRQOL items. For example, disability class does not seem to be related to mental unhealthy days to the extent that it is for physical unhealthy days, implying that although people with disabilities may suffer physically, their psychological well-being is not as adversely affected. More importantly, identifying the functional consequences of disability rather than just the health problems (Verbrugge et al., 1999) is necessary for ensuring appropriate interventions. Thus, the findings of this study that the mean number of limited activity days differed significantly between disability groups irrespective of health status and that those who were physically active had significantly fewer limited activity days across all three disability groups indicates that physical activity interventions could produce significant improvements in real-life terms for people with disabilities by reducing the number of days in which they are unable to engage in regular life activities.

In sum, physical activity is apparently strongly associated with better HRQOL profiles in people with disabilities, even in the most severely affected group. Coupled with the results of previous intervention studies, the findings of this study support the need to design and implement well-structured physical activity interventions taking into account the specific functional characteristics of the participants and not approaching them as a homogeneous group. People with disabilities are an at-risk group and ameliorating the risk requires particular emphasis in accordance with Healthy People 2010 objectives.

Limitations

The results of this study must be considered in light of a number of limitations. First, although the BRFSS is designed to produce a valid nationally representative sample, it excludes certain classes of participants, including those under the age of 18, those who are institutionalized, and those who do not have a telephone. As many persons with disabilities, particularly severe disabilities, are not community dwellers but rather cared for in specialized facilities, BRFSS may underestimate the prevalence of disability and the distribution of its characteristics. Second, the data collected are cross-sectional in nature and, as such, cannot be used to establish causal relationships. Thus, it is not possible with these data to determine whether physical activity *per se* is responsible for the improved HRQOL profiles of PWD or whether better HRQOL characteristics allowed PWD to be more physically active. Third, all measures in the BRFSS are self-report, including the amount of physical activity and being disabled, making the data subject to recall bias and/or Hawthorne effect. Fourth, as noted previously, the mechanism for classifying a participant as disabled is broad and does not provide any

insight into the specific nature of the disability (orthopedic, neurologic, cardiovascular, congenital, acquired, etc.). In addition, the duration of the disability is not known.

Recommendations for future research

Despite the limitations identified in the current study, the results provide the basis for further pursuing the question of the influence of physical activity on HRQOL in persons with disabilities. Although the current BRFSS modules have been shown to provide very useful information, for future studies to significantly advance our understanding, several changes are recommended for the BRFSS: a) the disability module (or the core questions) needs to be expanded with more precise indicators so better interventions can be planned, and b) the physical activity module must be expanded.

Beyond these changes, researchers must develop, and test the efficacy of, appropriate physical activity interventions for person with disabilities. These interventions must be designed specifically based on the characteristics of the particular group in question, not the standardized needs of the general population or even the "general" population with disabilities. This approach is analogous to the development of cardiac rehabilitation programs for post-myocardial infarct patients rather than utilizing a general physical conditioning protocol.

Finally, it is important to continue research to identify the source of discrepancies in HRQOL between PWD and PWOD. Although physical activity is clearly shown to be associated with better HRQOL profiles in PWD, it does not appear to be the whole answer and, as the US population ages and a greater proportion become subject to age-related disabilities, identifying the causes and finding effective means to diminish the

differences will have profound effects on national healthcare costs and individual quality of life.

REFERENCES

Andresen, E. M., Fitch, C. A., McLendon, P. M., & Meyers, A. R. (2000). Reliability and validity of disability questions for US Census 2000. *American Journal of Public Health, 90*(8), 1297-1299.

Andresen, E. M., Prince-Caldwell, A., Akinci, F., Brownson, C. A., Hagglund, K., Jackson-Thompson, J., & Crocker, R. (1999). The Missouri Disability Epidemiology and Health Project. *American Journal of Preventive Medicine, 16*(3 suppl), 63-71.

Bloom, Y., Figgs, L. W., Baker, E. A., Dugbatey, K., Stanwyck, C. A., & Brownson, R. C. (2000). Data uses, benefits, and barriers for the Behavioral Risk Factors Surveillance System: A qualitative study of users. *Journal of Public Health Management and Practice, 6*(1), 78-86.

Brogan, D. (1998). Pitfalls of using standard statistical software packages for sample survey data. In P. Armitage & T. Colton (Eds.), *Encyclopedia of biostatistics* (pp. 4167-4174). New York: Wiley.

Brown, D. W., Balluz, L. S., Heath, G. W., Moriarty, D. G., Ford, E. S., Giles, W. H., Mokdad, A. H. (2003). Associations between recommended levels of physical activity and health-related quality of life. Findings from the 2001 Behavioral Risk factor Surveillance System (BRFSS) survey. *Preventive Medicine, 37*(5), 520-528.

Brown, D. W., Brown, D. R., Heath, G. W., Balluz, L., Giles, W. H., Ford, E. S., & Mokhad, A. H. (2004). Associations between physical activity dose and health-related quality of life. *Medicine and Science in Sports and Exercise, 36*(5), 890-896.

Brown, D. R., Yore, M. M., Ham, S., Macera, C. (2005). Physical activity among adults ≥ 50 yrs with and without disabilities, BRFSS 2001. *Medicine and Science in Sports and Exercise, 37*(4), 620-629.

Brownson, R. C., Jones, D. A., Pratt, M., Blanton, C., & Heath, G. W. (2000). Measuring physical activity with the Behavioral Risk Factor Surveillance System. *Medicine and Science in Sports and Exercise, 32*(11), 1913-1918.

Carlson, J. E., Ostir, G. V., Black, S. A., Markides, K S., Rudkin, L., & Goodwin, J. S. (1999). Disability in older adults. 2: Physical activity as prevention. *Behavioral Medicine, 24*(4), 157-168.

Compton, D. M., Eisenman, P. A., & Henderson, H. L. (1989), Exercise and fitness for persons with disabilities. *Sports Medicine, 7*(3), 150-162.

Cooper, R. A., Quatrano, L. A., Axelson, P. W., Harlan, W., Stineman, M., Franklin, B., Krause, J. S., Bach, J., Chambers, H., Chao, E. Y., Alexander, M., & Painter, P. (1999). Research on physical activity and health among peole with disabilities: A consensus statement. *Journal of Rehabilitation Research and Development, 36*(2), 142-154.

Drum, C., Horner-Johnson, W., & Krahn, G. (n.d). Behavioral Risk Factor Surveillance System Project – Health status and disability. Unpublished analysis. Children's Development and Research Center, Oregon Health & Sciences University.

Figgs, L. W., Bloom, Y., Dugbatey, K., Stanwyck, C. A., Nelson, D. E., & Brownson, R. C. (2000). Uses of Behavioral Risk Factor Surveillance System data, 1993-1997. *American Journal of Public Health, 90*(5), 774-776.

Ford, E. S., Moriarty, D. G., Zack, M. M., Mokdad, A. H., & Chapman, D. P. (2001). Self-reported body mass index and health-related quality of life: Findings from the Behavioral Risk Factor Surveillance System. *Obesity Research, 9*(1), 21-31.

Heath, G. W., & Fentem, P. H. (1997). Physical activity among persons with disabilities – A public health perspective. *Exercise and Sports Science Reviews, 25*, 195-234.

Jette, A. M. (2003). Assessing disability in studies on physical activity. *American Journal of Preventive Medicine, 25*(3, suppl. 2), 122-128.

Jia, H., Muenning, P., Lubetkin, E. I., & Gold, M. R. (2004). Predicting geographical variations in behavioral risk factors: An analysis of physical and mental health days. *Journal of Epidemiology and Community Health, 58*(2), 150-155.

Kinne, S., Patrick, D. L., & Doyle, D. L. (2004). Prevalence of secondary conditions among people with disabilities. *American Journal of Public Health, 94*(3), 443-445.

Lollar, D. J. (2002). Public health and disability: Emerging opportunities. *Public Health Reports, 117*(2), 131-136.

MMWR534. (2004). Prevalence of no leisure-time physical activity – 35 states and the District of Columbia, 1988-2002. *Morbidity and Mortality Weekly Report, 53*(4), 82-86.

MMWR5221. (2003). Public health and aging: Projected prevalence of self-reported arthritis or chronic joint symptoms among persons aged >65 years – United States, 2005-2030. *Morbidity and Mortality Weekly Report, 52*(21), 489-491.

MMWR5232. (2003). Prevalence of physical activity, including lifestyle activities among adults – United States, 2000-2001. *Morbidity and Mortality Weekly Report, 52*(32), 764-769.

MMWR4931. (2000). State-specific prevalence of disability among adults – 11 states and the District of Columbia, 1998. *Morbidity and Mortality Weekly Report, 49*(31), 711-714.

MMWR4411. (1995). Health-related quality of life measures – United States, 1993. *Morbidity and Mortality Weekly Report, 44*(11), 195-200.

MMWR4320. (1994). Quality of life as a new public health measure – Behavioral Risk Factor Surveillance System, 1993. *Morbidity and Mortality Weekly Report, 43*(20), 375-380.

MMWR424. (1993). Behavioral Risk Factor Surveillance, 1991: Monitoring progress toward the nation's year 2000 health objectives. *Morbidity and Mortality Weekly Report CDC Surveillance, 42*(SS-4), 1-21.

Moriarty, D. G., Zack, M. M., & Kobau, R. (2003). The Centers of Disease Control and Prevention's Healthy Days Measures – Population tracking of perceived physical and mental health over time. *Health and Quality of Life Outcomes, 1*(1), 37 (open access: www.hqlo.com/content/1/1/37)

Nelson, D. E., Holtzman, D., Bolen, J., Stanwyck, C. A., & Mack, K. A. (2001). Reliability and validity of measures from the Behavioral Risk Factor Surveillance System (BRFSS). *Sozial-und Praventivmedizin, 46* (Supplement 1), S3-S42.

Partridge, C., Johnston, M., & Morris, L. (1996). Disability and health: Perceptions of a sample of elderly people. *Physiotherapy Research International, 1*(1), 17-29.

Rakowski, W., & Mor, V. (1992). The association of physical activity with mortality among older adults in the Longitudinal Study of Aging (1984-1988). *Journal of Gerontology, 47*(4), M122-129.

Rimmer, J. H. (1999). Health promotion for people with disabilities: The emerging paradigm shift from disability prevention to prevention of secondary conditions. *Physical Therapy, 79*(5), 495-502.

Rimmer, J. H., Braddock, D., & Pitetti, K. H. (1996). Research on physical activity and disability: An emerging national priority. *Medicine and Science in Sports and Exercise, 28*(8), 1366-1372.

Rimmer, J. H., Rubin, S. S., Braddock, D., & Hedman, G. (1999). Physical activity patterns of African-American women with physical disabilities. *Medicine and Science in Sports and Exercise, 31*(4), 613-618.

Siegel, P. Z., Frazier, E. L., Mariolis, P., Brackbill, R. M., Smith, C. (1993). Behavioral Risk Factor Surveillance, 1991: Monitoring progress toward the nation's year 2000 health objectives. *MMWR CDC Surveillance Summary, 42*(4), 1-21.

Singh, M. A. (2002). Exercise to prevent and treat functional disability. Clinics in *Geriatric Medicine, 18*(3), 431-462, vi-vii.

Strath, S. J., Bassett, D. R., Ham, S. A., & Swartz, A. M. (2003). Assessment of physical activity by telephone interview versus objective monitoring. *Medicine and Science in Sports and Exercise, 35*(12), 2112-2118.

Stutts, W. C. (2002). Physical activity determinants in adults. Perceived benefits, barriers, and self efficacy. *AAOHN Journal, 50*(11), 499-507.

Taylor, W. C., Baranowski, T., & Young, D. R. (1998). Physical activity interventions in low-income, ethnic minority, and populations with disability. *American Journal of Preventive Medicine, 15*(4), 334-343.

U.S. Department of Health & Human Services. (2000). Healthy People 2010 – Leading health indicators: Priorities for action. Washington, DC: Government Printing Office. Accessed at: www.healthypeople.gov/publications

U.S. Department of Health & Human Services. (2000). Healthy People 2010 – Section 22: Physical activity and fitness.

Ueda, S., & Okawa, Y. (2003). The subjective dimension of functioning and disability: What is it and what is it for? *Disability and Rehabilitation, 25*(11-12), 596-601.

van der Ploeg, H. P., van der Beek, A. J., van der Woude, L. H., & van Mechelen, W. (2004). Physical activity for people with a disability: A conceptual model. *Sports Medicine, 34*(10), 639-649.

Verbrugge, L., Merrill, S., & Liu, X. (1999). Measuring disability with parsimony. *Disability and Rehabilitation, 21*(5), 295-306.

Washburn, R. A., Heath, G. W., & Jackson, A. W. (2001). Reliability and validity issues concerning large-scale surveillance of physical activity. *Research Quarterly for Exercise and Sport, 71*(2 suppl.), S104-113.

APPENDIX A

Table A. Demographic details of the non-selected population with comparisons to selected population

Table B. Summary table of number of respondents for disability level by health status by activity status

Table A. Demographic details of non-selected population and comparison to selected population

Variable	Description	Sample N = 45,142	Non-selected N = 20,801	Non-selected N per Variable
Age	Aged 18 - 59	62.8	50.5	20,331
	Aged 60 and over	37.2	49.5	
Sex	Male	39.3	34.3	20,801
	Female	60.7	65.7	
White vs. other	White	80.9	75.2	20.029
	Other	19.1		
Black	Black	7.0	8.9	
	Other	93.0		
Hispanic	Hispanic	6.1	6.5	
	Other	93.9		
Income	Less than $20,000	34.3	38.0	10,684
	Over $20,000	65.7	62.0	
Education	Less than high school	14.1	20.8	20,554
	High school or higher	85.9	79.2	
Employment	Not employed	59.8	68.4	20,516
	Employed	40.2	31.6	
Health	Excellent -very good	26.9	27.3	
	Good	31.0	29.6	20,452
	Fair or poor	42.1	43.1	
Poor physical health days	Yes	63.6	45.0	18,137
	No	36.4	55.0	
Poor mental health days	Yes	47.3	36.8	18,747
	No	52.7	63.2	
Limited activity days	Yes	46.3	35.7	19,081
	No	53.7	64.3	
Physical activity status	Active	75.2	63.4	14,287
	Sedentary	24.8	36.6	

Table B. Summary table of sample for disability level by health status by activity status

Count

			DISABILITY LEVEL			
			Use equip	Disabled	UE&D	Total
Active	Health Status	Excellent/VG	731	9014	976	10721
		Good	759	9074	1660	11493
		Fair/Poor	583	7842	3297	11722
	Total		2073	25930	5933	33936
Sedentary	Health Status	Excellent/VG	196	884	338	1418
		Good	276	1546	700	2522
		Fair/Poor	474	3449	3343	7266
	Total		946	5879	4381	11206

APPENDIX B

Tables 2-22

Table 2. Mean Estimates on Health-Related Quality of Life Indicators by Physical Activity Status and Disability Categories

	Physical Activity Status					
	Active			Sedentary		
	Disability Status					
	Use Equip.	Disabled	UE&D	Use Equip.	Disabled	UE&D
HRQOL						
Poor Physical Days						
Mean (SE)	5.968 (.368)	7.505 (.1243)	13.715 (.312)	11.013 (.718)	13.224 (.350)	20.099 (.334)
Confidence interval	5.247 - 6.689	7.261 - 7.748	13.105 -14.326	9.607 - 12.419	12.537 - 13.911	19.445 - 20.753
Poor Mental Days						
Mean (SE)	3.405 (0.447)	6.395 (0.116)	7.366 (0.263)	3.753 (0.482)	8.589 (0.318)	9.295 (0.357)
Confidence interval	2.529 - 4.280	6.168 -6.621	6.851 - 7.88	2.809 - 4.697	7.966 - 9.212	8.595 - 9.995
Limited Activity Days						
Mean (SE)	3.015 (.278)	5.103(.110)	9.982 (.304)	6.003 (.729)	9.637 (.319)	16.310 (.396)
Confidence interval	2.471 - 3.560	4.887 - 5.319	9.385 - 10.58	4.574 - 7.431	9.012 - 10.263	15.534 - 17.085
Health Status						
Mean (SE)	2.873 (0.048)	2.915 (0.013)	3.545 (0.028)	3.460 (0.066)	3.633 (0.028)	4.074 (0.029)
Confidence interval	2.778 - 2.968	2.889 - 2.941	3.490 - 3.600	3.331 - 3.590	3.578 - 3.688	4.016 - 4.132

Note. For the health status measure, lower scores indicate better health.

Table 3. Physical Activity Status Differences within Each Disability Category

	Difference in mean between active and sedentary	Standard error	T - value	P value
Poor Physical Days				
Use Equip.	-5.045	0.806	-6.256	< 0.0001
Disabled	-5.720	0.372	15.388	< 0.001
UE&D	-6.384	0.456	-13.991	< 0.0001
Poor Mental Days				
Use Equip.	-0.349	0.657	-0.531	0.596
Disabled	-2.195	0.339	-6.483	< 0.0001
UE&D	-1.929	0.444	-4.345	< 0.0001
Activity Limited Days				
Use Equip.	-2.987	0.780	-3.830	0.0001
Disabled	-4.534	0.338	-13.412	< 0.0001
UE&D	-6.328	0.499	-12.675	< 0.0001
Health Status				
Use Equip.	-0.588	0.082	-7.170	< 0.0001
Disabled	-0.718	0.031	-23.015	< 0.0001
UE&D	-0.529	0.041	-13.001	< 0.0001

Table 4. Parameter Estimates for the Disability and HRQOL Model

Relationship	Unstandardized estimate (*b*)	Standard error	Standardized estimate (β)	T value	95% Confidence Interval
Physically Active					
Disability - HRQOL	21.53	11.11	.72	1.94	.24 - 43.30
Sedentary					
Disability - HRQOL	27.98	11.55	.80	2.44	5.34 - 50.61
Covariates					
Age (18-99 years)	-.05	.005	-.09	-8.82	-.06 - -.04
Sex (1=male; 2=female)	.39	.15	.02	2.53	.09 - .69
Race/ethnicity (1=White, 0 =other)	-1.07	.33	-.06	-3.20	-1.72 - -.41
Race/ethnicity (1=Black, 0 =other)	-1.16	.42	-.05	-2.75	-1.99 - -.33
Race/ethnicity (1=Hispanic, 0 =other)	-1.47	.48	-.05	-3.08	-2.40 - -.54
Income (1= <$20,000; 0= >$20,000)	3.019	.19	.17	15.91	2.65 – 3.39
Education (1= < HS; 0= >HS)	1.49	.23	.07	6.54	1.04 - 1.94
Employment (1=no; 0=yes)	4.75	.21	.23	22.77	4.34 - 5.16

Table 5. Regression Model Parameter Estimates for Physical Unhealthy Days

Effect	Beta	SE	95% CI	T value	P value
Constant	8.034	0.804	6.458 - 9.611	9.989	< 0.0001
Health					
1 (excellent/very good)	0.0 (referent)	0.0	0.0		
2 (good)	0.882	0.701	-0.493 - 2.257	1.258	0.2085
3 (fair/poor)	10.096	0.823	8.483 - 11.709	12.2700	< 0.0001
Disability					
1 (use equip)	0.0 (referent)	0.0	0.0		
2 (disabled)	-0.339	0.496	-1.311 - 0.634	-0.683	0.495
3 (UE&D)	2.988	0.705	1.605 - 4.370	4.236	< 0.0001
Age in years	-0.054	0.007	-0.066 - -0.041	-8.084	< 0.0001
Sex	0.280	0.192	-0.097 - 0.657	1.456	0.145
White	-0.592	0.452	-1.477 - -0.293	1.311	0.190
Black	-1.977	0.561	-3.076 - -0.878	3.525	0.0004
Hispanic	1.762	0.630	-2.996 - -0.528	-2.799	0.005
Income	0.767	0.238	0.301 - 1.238	3.226	0.001
Education	0.277	0.318	-0.346 - 0.900	0.870	0.384
Employment	-2.465	0.221	-2.898 - -2.032	11.164	< 0.0001
Health by Disability					
Excellent/very good, Use equip.	0.0 (referent)	0.0	0.0		
Excellent/very good, Disabled	0.0 (referent)	0.0	0.0		
Excellent/very good, UE&D	0.0 (referent)	0.0	0.0		
Good, Use equip.	0.0 (referent)	0.0	0.0		
Good, Disabled	1.449	0.740	-0.002 - 2.899	1.957	0.0504
Good, UE&D	1.162	1.019	-0.835 - 3.159	1.141	0.2539
Fair/poor, Use equip.	0.0 (referent)	0.0	0.0		
Fair/poor, Disabled	1.505	0.864	-0.188 - 3.198	1.742	0.0815
Fair/poor, UE&D	3.354	1.009	1.377 - 5.331	3.325	0.0009

Table 6. Conditional Marginal Means of Physical Unhealthy Days by Health and Disability

Health by Disability	Marginal Mean	SE	T value	P value
Excellent/very good, Use equip.	4.155	0.470	8.842	< 0.0001
Excellent/very good, Disabled	3.816	0.159	24.076	< 0.0001
Excellent/very good, UE&D	7.143	0.528	13.520	< 0.0001
Good, Use equip.	5.037	0.526	9.586	< 0.0001
Good, Disabled	6.147	0.192	32.105	< 0.0001
Good, UE&D	9.187	0.519	17.687	< 0.0001
Fair/poor, Use equip.	14.251	0.678	21.030	< 0.0001
Fair/poor, Disabled	15.417	0.217	71.047	< 0.0001
Fair/poor, UE&D	20.592	0.267	77.274	< 0.0001

Table 7. Contrasts for Physical Unhealthy Days

Contrast	Wald F value	P value
Effect of Health Conditional on Disability		
Excellent/very good vs. Good, when Disability = Use equip.	1.582	0.209
Excellent/very good vs. Good, when Disability = Disabled	88.607	< 0.0001
Excellent/very good vs. Good, when Disability = UE&D	7.636	0.006
Good vs. Fair/poor, when Disability = Use equip.	117.641	< 0.0001
Good vs. Fair/poor, when Disability = Disabled	1016.366	< 0.0001
Good vs. Fair/poor, when Disability = UE&D	387.928	< 0.0001
Excellent/very good vs. Fair/poor, when Disability = Use equip.	150.554	< 0.0001
Excellent/very good vs. Fair/poor, when Disability = Disabled	1781.366	< 0.0001
Excellent/very good vs. Fair/poor, when Disability = UE&D	509.199	< 0.0001
Effect of Disability Conditional on Health		
Use equip. vs. Disabled, when Health = Excellent/very good	.466	0.495
Use equip. vs. Disabled, when Health = Good	3.938	0.047
Use equip. vs. Disabled, when Health = Fair/poor	2.686	0.101
Disabled vs. UE&D when Health = Excellent/very good	36.931	< 0.0001
Disabled vs. UE&D when Health = Good	30.403	< 0.0001
Disabled vs. UE&D when Health = Fair/poor	234.002	< 0.0001
Use equip. vs. UE&D, when Health = Excellent/very good	17.942	< 0.0001
Use equip. vs. UE&D, when Health = Good	32.139	< 0.0001
Use equip. vs. UE&D, when Health = Fair/poor	77.157	< 0.0001

Note. All contrasts were conducted with one degree of freedom.

Table 8. Regression Model Parameter Estimates for Mental Unhealthy Days

Effect	Beta	SE	95% CI	T value	P value
Constant	11.807	1.088	9.675 - 3.940	10.853	< 0.0001
Health					
1 (excellent/very good)	0.0 (referent)	0.0	0.0		
2 (good)	-0.486	0.875	-2.202 - -1.230	0.555	0.579
3 (fair/poor)	2.366	0.957	0.490 - 4.241	2.473	0.013
Disability					
1 (use equip)	0.0 (referent)	0.0	0.0		
2 (disabled)	-0.304	0.825	-1.920 - 1.313	-0.368	0.713
3 (UE&D)	0.358	0.896	-1.399 - 2.115	0.340	0.690
Age in years	-0.165	0.006	-0.177 - -0.153	27.323	0.0000
Sex	1.162	0.177	0.815 1.508	6.5681	0.0000
White	-0.663	0.435	-1.515 - 0.189	-1.526	0.1271
Black	-0.823	0.563	-1.927 - 0.281	-1.462	0.144
Hispanic	-1.456	0.576	-2.584 - -0.328	-2.530	0.0114
Income	2.163	0.235	1.702 - 9.194	2.624	< 0.0001
Education	0.723	0.311	0.113 1.333	2.322	0.0202
Employment	-2.137	0.213	-2.555 - -1.720	10.033	< 0.0001
Health by Disability					
Excellent/very good, Use equip.	0.0 (referent)	0.0	0.0		
Excellent/very good, Disabled	0.0 (referent)	0.0	0.0		
Excellent/very good, UE&D	0.0 (referent)	0.0	0.0		
Good, Use equip.	0.0 (referent)	0.0	0.0		
Good, Disabled	2.650	0.903	0.879 - 4.421	2.933	0.0034
Good, UE&D	1.409	1.018	-0.586 - 3.405	1.384	0.1663
Fair/poor, Use equip.	0.0 (referent)	0.0	0.0		
Fair/poor, Disabled	3.282	0.992	1.338 - 5.225	3.302	0.0009
Fair/poor, UE&D	3.513	1.073	1.410 - 5.616	3.274	0.0011

Table 9. Conditional Marginal Means of Mental Unhealthy Days by Health and Disability

Health by Disability	Marginal Mean	SE	T value	P value
Excellent/very good, Use equip.	4.213	0.807	5.219	< 0.0001
Excellent/very good, Disabled	3.909	0.156	25.061	< 0.0001
Excellent/very good, UE&D	4.571	0.386	11.847	< 0.0001
Good, Use equip.	3.727	0.361	10.311	< 0.0001
Good, Disabled	6.073	0.173	35.206	< 0.0001
Good, UE&D	5.494	0.342	16.089	< 0.0001
Fair/poor, Use equip.	6.579	0.522	12.602	< 0.0001
Fair/poor, Disabled	9.557	0.206	46.319	< 0.0001
Fair/poor, UE&D	10.450	0.278	37.593	< 0.0001

Table 10. Contrasts for Mental Unhealthy Days

Contrast	Wald F value	P value
Effect of Health Conditional on Disability		
Excellent/very good vs. Good, when Disability = Use equip.	0.309	0.579
Excellent/very good vs. Good, when Disability = Disabled	90.550	< 0.0001
Excellent/very good vs. Good, when Disability = UE&D	3.263	0.07
Good vs. Fair/poor, when Disability = Use equip.	21.089	< 0.0001
Good vs. Fair/poor, when Disability = Disabled	160.672	< 0.0001
Good vs. Fair/poor, when Disability = UE&D	129.936	< 0.0001
Excellent/very good vs. Fair/poor, when Disability = Use equip.	6.113	0.013
Excellent/very good vs. Fair/poor, when Disability = Disabled	448.749	< 0.0001
Excellent/very good vs. Fair/poor, when Disability = UE&D	154.618	< 0.0001
Effect of Disability Conditional on Health		
Use equip. vs. Disabled, when Health = Excellent/very good	0.136	0.713
Use equip. vs. Disabled, when Health = Good	34.804	< 0.0001
Use equip. vs. Disabled, when Health = Fair/poor	28.550	< 0.000
Disabled vs. UE&D when Health = Excellent/very good	2.503	0.114
Disabled vs. UE&D when Health = Good	2.315	0.128
Disabled vs. UE&D when Health = Fair/poor	6.830	0.009
Use equip. vs. UE&D, when Health = Excellent/very good	0.160	0.69
Use equip. vs. UE&D, when Health = Good	13.107	0.0003
Use equip. vs. UE&D, when Health = Fair/poor	44.533	< 0.0001

Note. All contrasts were conducted with one degree of freedom.

Table 11. Regression Model Parameter Estimates for Limited Activity Days

Effect	Beta	SE	95% CI	T value	P value
Constant	9.812	0.642	8.555 - 11.069	15.294	< 0.0001
Health					
1 (excellent/very good)	0.0 (referent)	0.0	0.0		
2 (good)	0.961	0.485	0.010 - 1.912	1.981	0.048
3 (fair/poor)	5.789	0.743	4.334 - 7.245	7.797	< 0.0001
Disability					
1 (use equip)	0.0 (referent)	0.0	0.0		
2 (disabled)	0.614	0.277	0.072 - 1.156	2.220	0.0264
3 (UE&D)	2.770	0.489	1.811 - 3.728	5.661	0.0000
Age in years	-0.103	0.006	-0.115 - -0.092	17.684	0.0000
Sex	-0.348	0.178	-0.696 - 0.000	1.960	0.05
White	-0.356	0.384	-1.109 - 0.398	0.926	0.355
Black	-0.498	0.505	-1.4874 0.491	0.987	0.323
Hispanic	-1.193	0.575	-2.321 - -0.065	2.073	0.038
Income	1.246	0.226	0.802 - 1.689	5.503	< 0.0001
Education	0.375	0.312	0.235 - 0.986	1.205	0.228
Employment	-4.027	0.204	-4.428 - -3.627	19.709	< 0.0001
Health by Disability					
Excellent/very good, Use equip.	0.0 (referent)	0.0	0.0		
Excellent/very good, Disabled	0.0 (referent)	0.0	0.0		
Excellent/very good, UE&D	0.0 (referent)	0.0	0.0		
Good, Use equip.	0.0 (referent)	0.0	0.0		
Good, Disabled	0.795	0.524	-0.232 - 1.822	1.518	0.129
Good, UE&D	1.093	0.781	-0.437 - 2.623	1.400	0.162
Fair/poor, Use equip.	0.0 (referent)	0.0	0.0		
Fair/poor, Disabled	1.407	0.782	-0.125 - 2.940	1.800	0.072
Fair/poor, UE&D	4.837	0.902	3.069 - 6.605	5.360	< 0.0001

Table 12. Conditional Marginal Means of Limited Activity Days by Health and Disability

Health by Disability	Marginal Mean	SE	T value	P value
Excellent/very good, Use equip.	2.288	0.245	9.324	< 0.0001
Excellent/very good, Disabled	2.902	0.137	21.121	< 0.0001
Excellent/very good, UE&D	5.058	0.430	11.772	< 0.0001
Good, Use equip.	3.249	0.426	7.628	< 0.0001
Good, Disabled	4.658	0.162	28.70	< 0.0001
Good, UE&D	7.111	0.442	16.081	< 0.0001
Fair/poor, Use equip.	8.077	0.703	11.491	< 0.0001
Fair/poor, Disabled	10.099	0.207	48.838	< 0.0001
Fair/poor, UE&D	15.684	0.294	53.367	< 0.0001

Table 13. Contrasts for Limited Activity Days

Contrast	Wald F value	P value
Effect of Health Conditional on Disability		
Excellent/very good vs. Good, when Disability = Use equip.	3.925	0.048
Excellent/very good vs. Good, when Disability = Disabled	74.077	< 0.0001
Excellent/very good vs. Good, when Disability = UE&D	11.176	< 0.0001
Good vs. Fair/poor, when Disability = Use equip.	35.029	< 0.0001
Good vs. Fair/poor, when Disability = Disabled	413.857	< 0.0001
Good vs. Fair/poor, when Disability = UE&D	264.565	< 0.0001
Excellent/very good vs. Fair/poor, when Disability = Use equip.	60.797	< 0.0001
Excellent/very good vs. Fair/poor, when Disability = Disabled	812.516	< 0.0001
Excellent/very good vs. Fair/poor, when Disability = UE&D	410.879	< 0.0001
Effect of Disability Conditional on Health		
Use equip. vs. Disabled, when Health = Excellent/very good	4.929	0.026
Use equip. vs. Disabled, when Health = Good	9.604	0.002
Use equip. vs. Disabled, when Health = Fair/poor	7.572	0.0059
Disabled vs. UE&D when Health = Excellent/very good	23.176	< 0.0001
Disabled vs. UE&D when Health = Good	27.204	< 0.0001
Disabled vs. UE&D when Health = Fair/poor	244.416	< 0.0001
Use equip. vs. UE&D, when Health = Excellent/very good	32.042	< 0.0001
Use equip. vs. UE&D, when Health = Good	40.552	< 0.0001
Use equip. vs. UE&D, when Health = Fair/poor	100.740	< 0.0001

Note. All contrasts were conducted with one degree of freedom.

Table 14. Regression Model Parameter Estimates for Physical Unhealthy Days (with Physical Activity by Disability interaction)

Effect	Beta	SE	95% CI	T value	P value
Constant	9.848	0.818	8.245 - 11.451	12.040	0.0000
Physical Activity					
1 (active)	0 (referent)	0	0	0	
2 (sedentary)	3.7068	0.811	2.117 - 5.297	4.569	0.0000
Disability					
1 (use equip)	0 (referent)	0	0	0	
2 (disabled)	1.618	0.421	0.793 - 2.444	3.842	0.0001
3 (UE&D)	6.808	0.497	5.834 - 7.783	13.696	0.0000
Age in years	-0.040	0.007	-0.055 - -0.026	-5.526	0.0000
Sex	0.288	0.206	-0.116 - 0.691	1.396	0.1628
White	-1.007	0.469	-1.926 - -0.088	-2.147	0.0318
Black	-2.172	0.595	-3.338 - -1.007	3.654	0.0003
Hispanic	-1.511	0.646	-2.777 - -0.244	2.337	0.0194
Income	2.179	0.263	1.664 - 2.694	8.294	0.0000
Education	1.323	0.344	0.648 - 1.997	3.843	0.0001
Employment	-3.962	0.244	-4.441 - -3.484	-6.237	0.0000
Physical Activity by Disability					
Active, Use equip.	0 (referent)	0	0	0	
Active, Disabled	0 (referent)	0	0	0	
Active, UE&D	0 (referent)	0	0	0	
Sedentary, Use equip.	0 (referent)	0	0	0	
Sedentary, Disabled	1.230	0.889	-0.512 - 2.971	1.384	0.166
Sedentary, UE&D	1.854	0.925	0.041 - 3.667	2.005	0.045

Table 15. Regression Model Parameter Estimates for Physical Unhealthy Days (without Physical Activity by Disability interaction effect)

Effect	Beta	SE	95% CI	T value	P value
Constant	9.450	0.807	7.868 - 11.032	11.708	0.0000
Physical Activity					
1 (active)	0 (referent)	0	0	0	
2 (sedentary)	5.032	0.290	4.465 - 5.600	17.383	0.0000
Disability					
1 (use equip)	0 (referent)	0	0	0	
2 (disabled)	2.011	0.379	1.268 - 2.753	5.305	0.0000
3 (UE&D)	7.437	0.419	6.617 - 8.258	17.761	0.0000
Age in years	-0.041	0.007	0.055 - -0.026	-5.587	0.0000
Sex	0.290	0.206	0.114 - 0.693	1.405	0.1599
White	-0.997	0.470	-1.918 - -0.076	-2.121	0.0339
Black	-2.176	0.595	3.341 - -1.011	-3.660	0.0003
Hispanic	-1.508	0.647	-2.775 - -0.240	-2.331	0.0197
Income	2.177	0.263	1.662 - 2.693	8.275	0.0000
Education	1.304	0.344	0.630 - 1.978	3.792	0.0001
Employment	-3.961	0.244	-4.439 - -3.482	-16.218	0.0000

Table 16. Conditional Marginal Means of Physical Unhealthy Days by Physical Activity and Disability

Variable	Marginal Mean	SE	T value	P value
Physical Activity				
Active	8.959	0.114	78.437	0.0000
Sedentary	13.991	0.255	54.969	0.0000
Disability				
Use equip.	7.069	0.356	19.855	0.0000
Disabled	9.079	0.123	74.063	0.0000
UE&D	14.506	0.239	60.714	0.0000

Table 17. Regression Model Parameter Estimates for Mental Unhealthy Days

Effect	Beta	SE	95% CI	T value	P value
Constant	11.885	0.831	10.256 - 13.514	14.296	0.0000
Physical Activity					
1 (active)	0 (referent)	0	0	0	
2 (sedentary)	0.295	0.637	-0.954 - 1.544	0.462	0.6439
Disability					
1 (use equip)	0 (referent)	0	0	0	
2 (disabled)	1.746	0.466	0.832 - 2.659	3.745	0.0002
3 (UE&D)	2.894	0.513	1.890 - 3.899	5.646	0.0000
Age in years	-0.157	0.006	-0.170 - -0.145	-24.740	0.0000
Sex	1.182	0.182	0.825 - 1.537	6.498	0.0000
White	-0.864	0.445	-1.736 - 0.008	-1.943	0.0521
Black	-0.895	0.570	-2.012 - 0.221	-1.572	0.1160
Hispanic	-1.385	0.596	-2.554 - -.217	-2.324	0.0201
Income	2.815	0.242	2.340 - 3.289	11.637	0.0000
Education	1.189	0.317	0.567- 1.811	3.748	0.0002
Employment	-2.830	0.220	-3.262 - -2.399	12.86	0.0000
Physical Activity by Disability					
Active, Use equip.	0 (referent)	0	0	0	
Active, Disabled	0 (referent)	0	0	0	
Active, UE&D	0 (referent)	0	0	0	
Sedentary, Use equip.	0 (referent)	0	0	0	
Sedentary, Disabled	1.915	0.704	0.536 - 3.294	2.722	0.0065
Sedentary, UE&D	1.456	0.756	0.026 - -2.938	1.926	0.0542

Table 18. Conditional Marginal Means of Mental Unhealthy Days by Physical Activity and Disability

Physical Activity by Disability	Marginal Mean	SE	T value	P value
Active, Use equip.	4.543	0.451	10.064	0.0000
Active, Disabled	6.288	0.114	55.300	0.0000
Active, UE&D	7.437	0.255	29.125	0.0000
Sedentary, Use equip.	4.837	0.467	10.370	0.0000
Sedentary, Disabled	8.498	0.290	29.287	0.0000
Sedentary, UE&D	9.188	0.333	27.567	0.0000

Table 19. Contrasts for Mental Unhealthy Days

Contrast	Wald F value	P value
Effect of Physical Activity Conditional on Disability		
Active vs. Sedentary, when Disability = Use equip.	0.214	0.6439
Active vs. Sedentary, when Disability = Disabled	8.690	0.0000
Active vs. Sedentary, when Disability = UE&D	17.959	0.0000
Effect of Disability Conditional on Physical Activity		
Use equip. vs. Disabled, when Physical Activity = Active	14.024	0.0002
Disabled vs. UE&D, when Physical Activity = Active	2.510	0.1131
Use equip. vs. UE&D, when Physical Activity = Active	31.882	0.0000
Use equip. vs. Disabled, when Physical Activity = Sedentary	46.217	0.0000
Disabled vs. UE&D, when Physical Activity = Sedentary	2.510	0.1131
Use equip. vs. UE&D, when Physical Activity = Sedentary	31.882	0.0000

Note. All contrasts were made with one degree of freedom.

Table 20. Regression Model Parameter Estimates for Limited Activity Days

Effect	Beta	SE	95% CI	T value	P value
Constant	11.260	0.706	9.876 - 12.644	15.942	0.0000
Physical Activity					
1 (active)	0 (referent)	0	0	0	
2 (sedentary)	2.117	0.765	0.618 - 3.615	2.769	0.0056
Disability					
1 (use equip)	0 (referent)	0	0	0	
2 (disabled)	1.671	0.321	1.041 - 2.300	5.198	0.0000
3 (UE&D)	5.772	0.411	4.968 - 6.577	14.058	0.0000
Age in years	-0.098	0.006	-0.111 - -0.086	-15.550	0.0000
Sex	-0.351	0.186	-0.717 - 0.014	1.885	0.0595
White	-0.634	0.412	-1.441 - 0.173	-1.540	0.1235
Black	-0.757	0.525	-1.786 - 0.272	-1.442	0.1493
Hispanic	-1.093	0.614	-2.297 - 0.111	-1.779	0.0753
Income	2.094	0.240	1.623 - 2.564	8.726	0.0000
Education	0.927	0.316	0.308 - 1.546	2.935	0.0033
Employment	-4.938	0.218	-5.365 - -4.511	22.661	0.0000
Physical Activity by Disability					
Active, Use equip.	0 (referent)	0	0	0	
Active, Disabled	0 (referent)	0	0	0	
Active, UE&D	0 (referent)	0	0	0	
Sedentary, Use equip.	0 (referent)	0	0	0	
Sedentary, Disabled	1.852	0.828	0.231 - 3.474	2.239	0.0252
Sedentary, UE&D	3.618	0.899	1.855 - 5.381	4.023	0.0001

Table 21. Conditional Marginal Means of Limited Activity Days by Physical Activity and Disability

Physical Activity by Disability	Marginal Mean	SE	T value	P value
Active, Use equip.	3.714	0.299	12.427	0.0000
Active, Disabled	5.385	0.115	46.842	0.0000
Active, UE&D	9.486	0.290	32.700	0.0000
Sedentary, Use equip.	5.831	0.710	8.217	0.0000
Sedentary, Disabled	9.354	0.299	31.246	0.0000
Sedentary, UE&D	15.221	0.384	39.599	0.0000

Table 22. Contrasts for Limited Activity Days

Contrast	Wald F value	P value
Effect of Physical Activity Conditional on Disability		
Active vs. Sedentary, when Disability = Use equip.	7.666	0.0056
Active vs. Sedentary, when Disability = Disabled	146.587	0.0000
Active vs. Sedentary, when Disability = UE&D	145.262	0.0000
Effect of Disability Conditional on Physical Activity		
Use equip. vs. Disabled, when Physical Activity = Active	27.021	0.0000
Disabled vs. UE&D, when Physical Activity = Active	149.725	0.0000
Use equip. vs. UE&D, when Physical Activity = Active	197.618	0.0000
Use equip. vs. Disabled, when Physical Activity = Sedentary	21.191	0.0000
Disabled vs. UE&D, when Physical Activity = Sedentary	149.725	0.0000
Use equip. vs. UE&D, when Physical Activity = Sedentary	197.618	0.0000

Note. All contrasts were made with one degree of freedom.