Health-Related Quality of Life in Active Persons with Spinal Cord Injury

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Abstract This study aims at identifying how sports activity status, level of residual function, and independence in activities of daily living (ADL) affect the health-related quality of life (HRQOL) of persons with spinal cord injury (PSCI) who regularly participate in sports activities. Eighty-one male PSCI (21 persons with tetraplegia and 60 persons with paraplegia) who regularly participated in sports activities (wheelchair basketball or wheelchair twin basketball) were included in the present study. They were evaluated in terms of their characteristics, sports activity status, independence in ADL (Spinal Cord Independence Measure [SCIM]), and HRQOL (Medical Outcomes Study Short Form-36 [SF-36]). The age was a significant explanatory variable for physical functioning, role physical, and physical component summary ($P < 0.05$). On the other hand, the level of residual function was a significant explanatory variable for general health, vitality, mental health, and mental component summary ($P < 0.05$). The physical aspects of HRQOL of PSCI who regularly participate in sports activities were mainly affected by age, whereas the mental aspects were affected by the level of residual function.

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Introduction

Population life expectancy has increased thanks to medical technology advancement. Life style has therefore become an important factor which affects mortality in persons with spinal cord injury (PSCI) as well as healthy individuals. In view of this, helping PSCI maintain high levels of physical fitness and have a healthy and good quality of life is an important research target.

Previous studies have demonstrated that PSCI who engage in sports and physical activities show improved physical fitness¹⁻⁵⁾, experience psychological benefits⁵⁻⁸⁾, and have a good health-related QOL (HRQOL)^{5,9,10)}. It has also been shown that HRQOL improvement associated with physical exercise diminishes once physical exercise is stopped¹¹⁾. In other words, regular sports activity is key to maintaining and improving the benefits derived from physical exercise. On the other hand, there is little information on the association between sports activity status and HRQOL in PSCI. The present research, therefore, focuses on the HRQOL of PSCI.

There are several factors that should be taken into account when studying the HRQOL of PSCI. One of them, in particular, is the extent of injury (or the level of lesion, i.e., complete or incomplete injury), which is known as a

factor that specifically affects HRQOL in PSCI. However, other studies claim that the extent of injury has nothing to do with HRQOL¹²⁾. Yet, other studies claim that the extent of injury is particularly correlated with the physical component summary (PCS) subscale of HRQOL¹³⁻¹⁶⁾. Kreuter et al.¹⁷⁾ studied the association between HRQOL and the extent of injury in Australian and Swedish participants and reported that while a significant association was observed in Australian participants, no significant association was observed in Swedish participants. Thus, there is no conclusive evidence as to the association between HRQOL and the extent of injury. One of the reasons for this is that residual function varies even among individuals with a similar extent of injury. In order to have a more precise picture of the possible association between HRQOL and the extent of injury, it is necessary to have a measure that can accurately reflect and categorize the residual function as well as the extent of injury of PSCI.

Wheelchair basketball (WCB) is a sport designed for PSCI, in particular, persons with paraplegia. There is also a form of WCB that is available for persons with tetraplegia, which is called a wheelchair twin basketball (WCTB). WCTB was born in Japan in 1980¹⁸⁾. A classification system is used in the competitions to maintain equality between players and fairness between teams¹⁹⁾.

The classification is determined comprehensively, based not only on the extent of injury but also on the trunk motion range and the stability of the trunk while seated on a wheelchair, as well as on body balance maintained while making basic basketball moves. Based on this classification, each player is given 1.0 to 4.5 playing points. Low playing points mean high degree of disability, and high playing points mean low degree of disability. In order to maintain equality and fairness, an upper limit is set for the total playing points that can be earned by each player on the court during a game. Playing points are believed to reflect the residual function of players, which cannot be estimated merely by the extent of injury. At present, residual function is believed to be a better measure of HRQOL than the circumstance of injury. In view of these facts, the present study focused on playing points awarded to classify players in WCB and WCTB.

Independence in activities of daily living (ADL) is also an important factor in considering HRQOL in PSCI. The Barthel index and Functional Independence Measure (FIM) are the frequently used measures to evaluate ADL. However, both of them are comprehensive measures that can be used regardless of illnesses, and some point out that they do not fully address the functional outcomes that are important to PSCI²⁰⁾. On the other hand, the Spinal Cord Independence Measure (SCIM) is known as the ADL measure specific to spinal cord injury²¹⁾. It can be used not only on persons with trauma-related SCI but also on persons with nontraumatic SCI. Furthermore, it can be used on persons with paraplegia and tetraplegia as well. Thus, the SCIM is an optimum measure for investigating the performance of ADL in PSCI.

The present study was carried out to identify how sports activity status, level of residual function, and ADL may be associated with HRQOL in WCB and WCTB players.

Methods

Participants Participants in this study were 81 male PSCI. Of them, 60 were WCB players (persons with paraplegia) and 21 were WCTB players (persons with tetraplegia). The level of lesion was C4 or lower. The Demographic data of the participants are summarized in Table 1. The group of individuals of the present study included WCB and WCTB players who participated in two games held in the Western Japan area and members of two teams from Chugoku and Tohoku regions of Japan who consented to participate in this study. Because relatively few participants regularly played WCTB, all persons with tetraplegia who played WCTB were classified as Group I ($n = 21$). WCB players, on the other hand, were classified into Group II, Group III, and Group IV according to the playing points assigned to each player, and based on the classification manual issued by the International Wheelchair Basketball Federation¹⁹⁾. The playing points assignment was determined comprehensively, based not only on

the extent of injury but also on the trunk motion range and the stability of the trunk while seated on a wheelchair, as well as on body balance maintained while making basic basketball moves. Low playing points mean high degree of disability, and high playing points mean low degree of disability. The playing points of an individual player reflect the level of his residual function. In the present study, individuals with playing points equivalent to 1.0 or 1.5 were assigned to Group II ($n = 23$), those with playing points equivalent to 2.0 or 2.5 were assigned to Group III ($n = 22$), and those with playing points of over 3.0 were assigned to Group IV ($n = 15$). Thus, Group I had the lowest level of residual function and Group IV had the highest level of residual function. The present study has been approved by Hiroshima University Graduate School of Integrated Arts and Sciences Ethics Committee.

Surveyed items and survey methods The survey was carried out using an anonymous self-administered questionnaire that was designed to identify the participants' basic behaviors as well as their sports activity status, ADL, and HRQOL. In principle, the investigator went to the practice/competition sites, where they informed the prospective participants (or team leaders) of the purpose of the study, and, if a participant gave written informed consent to participate in the present study, handed out the

Table 1. Demographic data of subjects

Variable	n	%
Age		
Less than 30 years	28	34
30 to 39 years	35	43
Over 40 years	19	23
Marital status		
Married	29	35
Single	53	65
Occupation		
Student	7	9
Employed	55	67
Non-employed	20	24
Number of years since injury		
Less than 13 years	39	48
Over 13 years	35	43
No response	7	9
Level of residual function		
I	21	26
II	23	28
III	22	27
IV	15	18
Number of years of playing experience		
Less than 10 years	39	48
Over 10 years	41	50
No response	2	2
Practice frequency per week		
Less than three times	52	63
Over three times	30	37
Practice time		
Less than three hours	40	49
Over three hours	42	51
ADL score		
Less than 65	36	44
Over 65	39	48
No response	7	9

questionnaire and asked them to complete it. For participants who were unable to write due to their disability, someone else was asked to write for them (but not read for them), or an electronic version of the questionnaire was sent as an e-mail attachment so that the questionnaire can be completed using the personal computer.

Questions related to the participants' behaviors and sports activity status include: age, occupation, marital status, level of lesion, month and year of injury, number of years of playing experience, playing points, practice frequency per week, and practice time.

For the evaluation of ADL, the Japanese version of SCIM²⁰⁾ was used. The reliability and validity of SCIM have been verified in previous studies²⁰⁻²²⁾. A self-administered ADL questionnaire was distributed to participants. The upper section of the questionnaire clearly stated that participants were expected to complete the questionnaire by themselves by consulting with family members and primary carers whenever possible. The SCIM consists of the following three domains: self-care (score range 0-20), respiration and sphincter management (score range 0-40), and mobility (score range 0-40). The total score would be in the range from 0 to 100 points. Higher SCIM scores indicate greater independence in ADL.

The Japanese version (v2) of the Medical Outcomes Study Short Form (SF36) was used for the evaluation of HRQOL. The SF-36 is the world's most popular questionnaire for measuring health status, and is used widely in research targeting not only healthy individuals but also the elderly and people with disabilities. The use of SF-36 was approved by the NPO Institute for Health Outcomes & Process Evaluation Research.

The form SF-36 includes the following eight subscales: physical functioning (PF), role physical (RP), bodily pain (BP), social functioning (SF), general health (GH), vitality (VT), role emotional (RE), and mental health (MH). Furthermore, based on the eight subscale scores, physical component summary (PCS) and mental component summary (MCS) scores were calculated to estimate the physical and mental health of the participants. Estimating not only the eight subscale scores but also PCS and MCS

allows a more comprehensive evaluation of HRQOL.

Statistical analysis The eight SF-36 subscales were rescored using norm-based scoring, in which the general Japanese population has a mean of 50²³⁾. SPSS12.0J for windows was used for the statistical analysis. A non-paired t test was used to compare the HRQOL scores of the participants in terms of their sports activity status and ADL score. A one-way analysis of variance was used to compare the HRQOL scores of the participants in terms of their level of residual function. If a significant difference was found, multiple comparison was performed using the Scheffe's method of multiple comparison. The relation among sports activity status, ADL score, level of residual function, and HRQOL scores was analyzed by Spearman's correlation coefficient. Multiple regression analysis was applied to examine the factors that affect HRQOL scores. The level of residual function was expressed by continuous variables ranging from I (low level) to IV (high level). The significance level was set at 5%.

Results

Table 2 shows the SF-36 subscale scores and summary scores (HRQOL scores) corresponding to individuals with different sports activity status and ADL score. Participants who practiced basketball over three times a week had a significantly higher GH score than those who practiced less than three times a week ($P<0.05$).

Figure 1 shows the national mean as well as the HRQOL scores of the participants by the level of residual function. All groups scored significantly lower than the national mean on PF and PCS ($P<0.01$). On the other hand, Group IV scored significantly higher than the national mean on GH ($P<0.05$), and Groups II, III, and IV scored significantly higher than the national mean on MCS ($P<0.01$). Inter-group comparison revealed that GH and VT scores increased with the level of residual function, with Group IV scoring significantly higher than Group I on these subscales ($P<0.05$).

A correlation matrix was produced to examine how sports activity status, ADL score, and level of residual

Table 2. SF-36 subscale scores and summary scores for individuals with different sports activity status and ADL scores

		n	PF	RP	BP	GH	VT	SF	RE	MH	PCS	MCS
Number of years of playing experience	Less than 10 years	34	19.1±13.2	47.0±9.3	48.6±12.1	50.0±9.0	51.0±10.4	49.9±9.5	51.1±9.4	50.4±9.6	35.1±11.2	56.7±9.8
	Over 10 years	39	17.8±12.5	45.3±14.8	50.2±11.9	51.9±11.5	52.0±12.5	51.0±8.6	49.5±12.3	51.2±13.0	33.2±11.1	59.0±11.1
Practice frequency	Less than three times	50	16.9±13.0	46.8±10.9	49.7±11.9	48.2±10.1	50.0±11.7	50.3±8.6	51.2±10.5	50.5±12.0	34.5±10.4	56.5±10.7
	Over three times	25	21.0±12.3	45.5±15.2	48.6±12.2	55.5±9.9	53.4±11.0	51.0±9.7	48.7±11.8	51.3±10.2	33.8±12.5	59.8±10.0
Practice time	Less than three hours	39	17.3±11.9	47.8±9.7	50.6±11.8	51.5±11.1	51.8±10.7	49.8±9.0	51.2±9.0	51.6±11.1	34.7±9.6	58.3±10.8
	Over three hours	36	19.3±13.8	44.8±14.8	47.9±12.0	49.8±10.1	50.4±12.5	51.3±8.9	49.5±12.8	49.9±11.7	33.9±12.6	56.9±10.4
ADL score	Less than 65	33	16.9±11.7	47.0±12.1	51.6±12.1	51.4±11.6	51.2±13.4	51.5±9.0	50.8±11.9	50.2±14.0	34.7±10.6	58.0±12.8
	Over 65	35	18.3±12.7	46.4±12.4	48.4±11.1	49.6±10.0	50.9±10.5	50.0±9.1	49.6±10.4	51.2±9.2	33.8±11.2	57.3±8.9

Note. PF: physical functioning, RP: role physical, BP: bodily pain, GH: general health, VT: vitality, SF: social functioning, RE: role emotional, MH: mental health, PCS: physical component summary, MCS: mental component summary

* $p<0.05$

function may be correlated with each other (see Table 3). This table shows that the number of years of playing experience is negatively correlated with practice frequency and practice time. It also shows that practice frequency and ADL score are positively correlated with the level of residual function, but that practice time is negatively correlated with the level of residual function.

Another correlation matrix was produced to examine how sports activity status, ADL score, and level of residual function may be correlated with HRQOL scores (see Table 4), which shows that practice frequency is positively correlated with GH, and that the level of residual function is positively correlated with PF, GH, VT, and MCS.

Table 5 presents the results of multiple regression

analysis performed using a forced entry method, in which HRQOL scores were the dependent variables, and age, sports activity status, ADL score, and the level of residual function were the independent variables. The analysis performed using the SF-36 physical subscale scores and PCS score as the dependent variables (upper section of Table 5) revealed the contribution rate of PF to be 15.5%, RP 8.4%, BP 3.9%, GH 17.8%, and PCS 10.3%. Age was a significant explanatory variable for PF, RP, and PCS ($P<0.05$), whereas the level of residual function was a significant explanatory variable for GH ($P<0.05$). The analysis carried out using the SF-36 mental subscale scores and MCS as the dependent variables (lower section of Table 5) revealed the contribution rate of VT to be 16.5%, SF 4.1%, RE 8.8%, MH 10.0%, and MCS 12.2%. The level of residual function was a significant explanatory variable for VT, MH, and MCS ($P<0.05$).

Discussion

Participants scored significantly lower than the national mean on PF and PCS while their MCS scores were at or above the national mean. Similar findings have been reported by previous studies which compared persons with tetraplegia and persons with paraplegia and concluded that a significant difference was observed between the two groups on PF and PCS¹⁴⁻¹⁶. In contrast, in the present study it could be observed that PSCI in the tetraplegia group and paraplegia group, both regularly engaged in sports activities, had similar scores on PF and PCS.

The analysis of the association between the level of residual function and sports activity status showed that the

Fig 1. SF-36 subscale scores and summary scores for individuals with different levels of residual function

Note. PF: physical functioning, RP: role physical, BP: bodily pain, GH: general health, VT: vitality, SF: social functioning, RE: role emotional, MH: mental health, PCS: physical component summary, MCS: mental component summary
Broken line: National mean, Inter-group comparison: * $P<0.05$, Comparison against the reference value: # $P<0.05$, ## $P<0.01$

Table 3. Correlation matrix of sports activity status, ADL scores, and level of residual function

	Number of years of playing experience	Practice frequency	Practice time	ADL score	Level of residual function
Number of years of playing experience	-	-0.232*	-0.233*	0.001	-0.067
Practice frequency		-	-0.176	-0.009	0.491**
Practice time			-	0.039	-0.242*
ADL score				-	0.246*
Level of residual function					-

* $P<0.05$, ** $P<0.01$

Table 4. Sports activity status/ ADL score/ level of residual function vs. SF-36 subscale scores and summary scores

	PF	RP	BP	GH	VT	SF	RE	MH	PCS	MCS
Number of years of playing experience	-0.026	0.080	0.031	0.106	0.037	0.058	0.030	0.045	-0.035	0.044
Practice frequency	0.167	0.024	-0.039	0.338**	0.183	0.027	-0.070	0.005	0.025	0.166
Practice time	0.037	-0.071	-0.136	-0.145	-0.136	0.113	-0.002	-0.057	-0.050	-0.120
ADL score	0.203	0.015	-0.091	-0.018	0.021	-0.082	-0.133	0.097	0.068	-0.029
Level of residual function	0.246*	-0.039	-0.001	0.340**	0.297*	-0.089	-0.038	0.177	0.023	0.263*

Note. PF: physical functioning, RP: role physical, BP: bodily pain, GH: general health, VT: vitality, SF: social functioning, RE: role emotional, MH: mental health, PCS: physical component summary, MCS: mental component summary

* $p<0.05$, ** $p<0.01$

Table 5. Multiple regression analysis performed using SF-36 subscale scores and summary scores as dependent variables

	PF			RP			BP			GH			PCS		
	B	β	t	B	β	t	B	β	t	B	β	t	B	β	t
Age	-6.130	-0.379	-2.369*	-5.435	-0.320	-1.924*	-2.635	-0.163	-0.955	-1.970	-0.135	-0.858	-5.665	-0.377	-2.288*
Number of years of playing experience	0.269	0.164	1.051	0.181	0.106	0.648	0.069	0.042	0.254	0.363	0.247	1.597	0.155	0.102	0.635
Practice frequency	1.229	0.109	0.758	-0.415	-0.035	-0.235	-1.204	-0.107	-0.696	1.358	0.134	0.945	-0.166	-0.016	-0.107
Practice time	0.561	0.042	0.331	-1.923	-0.138	-1.039	-1.376	-0.104	-0.761	-0.322	-0.027	-0.214	-1.094	-0.089	-0.674
ADL score	0.059	0.057	0.434	-0.034	-0.031	-0.226	-0.125	-0.119	-0.855	-0.145	-0.154	-1.197	-0.019	-0.020	-0.145
Level of residual function	1.025	0.088	0.588	0.040	0.003	0.021	1.049	0.090	0.564	3.243	0.309	2.097*	-0.740	-0.068	-0.444
Multiple correlation coefficient(R2)	0.394(0.155)			0.290(0.084)			0.197(0.039)			0.422(0.178)			0.321(0.103)		
F value	0.12			0.888			0.391			2.093			1.108		
	VT			SF			RE			MH			MCS		
	B	β	t	B	β	t	B	β	t	B	β	t	B	β	t
Age	-3.573	-0.221	-1.388	-2.775	-0.219	-1.287	-4.213	-0.270	-1.627	-3.655	-0.225	-1.361	-1.819	-0.121	-0.741
Number of years of playing experience	0.272	0.167	1.071	0.250	0.196	1.173	0.092	0.058	0.359	0.206	0.126	0.778	0.253	0.166	1.041
Practice frequency	0.471	0.042	0.292	0.118	0.013	0.087	-1.866	-0.172	-1.151	-1.586	-0.140	-0.943	-0.313	-0.030	-0.204
Practice time	-1.066	-0.080	-0.632	0.224	0.022	0.159	-1.356	-0.106	-0.799	-0.158	-0.012	-0.090	-0.297	-0.024	-0.185
ADL score	-0.182	-0.173	-1.336	-0.033	-0.041	-0.291	-0.215	-0.213	-1.570	-0.110	-0.105	-0.777	-0.169	-0.174	-1.308
Level of residual function	3.701	0.317	2.134*	-0.911	-0.100	-0.627	1.094	0.098	0.628	3.648	0.311	2.017*	3.698	0.341	2.238*
Multiple correlation coefficient(R2)	0.406(0.165)			0.203(0.041)			0.296(0.088)			0.316(0.100)			0.349(0.122)		
F value	1.91			0.414			0.931			1.076			1.344		

Note. PF: physical functioning, RP: role physical, BP: bodily pain, GH: general health, VT: vitality, SF: social functioning, RE: role emotional, MH: mental health, PCS: physical component summary, MCS: mental component summary, B: unstandardized coefficients, β : standardized coefficients, t: t value, * $P < 0.05$, ** $P < 0.01$

level of residual function was positively correlated with practice frequency, and negatively correlated with practice time. Individuals with low level of residual function are more likely than those with a high level of residual function to require assistance from staff or carers to access the practice/competition sites, to make necessary preparations, and to ensure safety, in order to be able to participate in sports activities. In particular, for Group I individuals to play WCTB, they need to have 1.2-m baskets, the same basketballs as those used by healthy basketball players and the same court and baskets as those used in WCB¹⁸⁾. In other words, it is hard for them to practice WCTB in gymnasiums that do not have these facilities. For this reason, individuals with a low level of residual function tend to practice less often, for which they compensate by long practice.

The analysis of HRQOL scores in terms of practice status showed no differences in the scores by the length of practice time. On the other hand, participants who practiced basketball over three times a week had a significantly higher GH score than those who practiced less than three times a week. Furthermore, although a significant positive correlation was found between practice frequency and GH, the result of multiple regression analysis revealed that practice frequency is not a significant explanatory variable for all subscales including GH. From these results, it seems that HRQOL is not dependent on the length of practice time and practice frequency.

No differences in HRQOL scores were observed between individuals with low and high ADL scores, and therefore no association was found between ADL and HRQOL scores. In addition, ADL score was not a significant explanatory variable for HRQOL scores. This finding is in agreement with results from a study conducted

by Tominaga et al.²⁴⁾ targeting persons with chronic SCI. Nomura²⁵⁾ reported that individuals with chronic SCI may suffer from impairments in basic functions required to perform ADL but, compared to what is medically expected, they often have greater independence in ADL. This is because they usually develop a compensatory mechanism and also learn to augment their physical ability by using assistive and self help devices. Thus, independence in ADL has little impact on the HRQOL of persons with chronic SCI, regardless of whether or not they play sports.

The results from multiple regression analysis performed using HRQOL scores as dependent variables showed that the level of residual function was a significant explanatory variable for GH, VT, MH, and MCS. Furthermore, age was a significant explanatory variable for PF, RP, and PCS. Previous studies have confirmed that age is a factor that affects SF-36 subscale scores^{14,23)}. On the other hand, many of the previous studies that explored the relationship between the extent of injury and HRQOL have concluded that the extent of injury is especially correlated with the physical aspects of HRQOL¹³⁻¹⁶⁾. However, the findings from the present study are not in agreement with these previous results. The main reason for this is the fact that the present study included only individuals who regularly engaged in sports activities. Moreover, the level of residual function was assessed taking into consideration the extent of injury, and was found to have a significant correlation with practice frequency, practice time, and ADL score. Results from the present study might therefore reflect more detailed information compared to that derived from previous research. Another difference also lies in that the present study adopted stringent inclusion criteria to eliminate the effect of the different types of sports played (individual and team sports). The present

study also revealed that the physical aspects of HRQOL in PSCI who regularly participated in sports activities were affected by age, whereas the mental aspects of HRQOL were affected by the level of residual function.

As to the methodology followed in the present study, it must be taken into account that it has some inherent limitations. Firstly, only WCB and WCTB players were included. Secondly, the evaluation of ADL was not objective. Thirdly, causal relations could not be established on account of the fact that this was a cross-sectional study. This means, in turn, that a longitudinal study must be carried out in the future.

Conclusion

Results from the present study suggest that sports activity status, including the number of years in WCB/WCTB, frequency of participation, and practice time, does not affect HRQOL in PSCI who regularly engage in sports activities. Independence in ADL has no impact on the HRQOL of persons with chronic SCI, regardless of whether or not they regularly participate in sports activities. The physical aspects of HRQOL in PSCI who regularly participate in sports activities were affected particularly by age, whereas the mental aspects of it were affected by the level of residual function.

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