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Original Article

Relationship between Sedentary Behavior and Health-Related Quality of Life in Patients on Chronic Hemodialysis

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We explored the relationship between sedentary behavior and the health-related quality of life (HRQOL) in patients on chronic hemodialysis. A total of 60 outpatients, aged 71.1 ± 12.0 years, were enrolled in this cross-sectional study. Sedentary behavior was measured using a tri-accelerometer and HRQOL was evaluated by the Euro-QOL questionnaire (EQ-5D). The relationship between the patients' sedentary behavior and HRQOL was evaluated by simple and multiple correlation analyses. The relative sedentary behavior (%) for total days was 73.7 ± 12.9% and the EQ-5D scores were 0.688 ± 0.233. Relative sedentary behavior (%) was negatively correlated with EQ-5D scores for total days, hemodialysis days and non-hemodialysis days. The relative light-intensity physical activity (LPA) (%) and relative moderately vigorous-intensity physical activity (MVPA) (%) were correlated with EQ-5D scores. Multiple regression showed that the relative sedentary behavior (%) had a clinical impact on EQ-5D scores after adjusting for confounding factors for total, hemodialysis and non-hemodialysis days. Sedentary behavior is closely linked to HRQOL, and reducing sedentary behavior may be beneficial to improve the HRQOL of patients on chronic hemodialysis.

Key words: physical activity, sedentary behavior, health-related quality of life , HRQOL, hemodialysis

The numbers of patients on chronic hemodialysis are dramatically increasing in many countries. In Japan, the average age of individuals beginning hemodialysis was reported to be 69.2 years in 2015 (http://docs.jsdt.or.jp/overview/index.html. accessed on July 21, 2017). Therefore, appropriate management including lifestyle modifications for patients on chronic hemodialysis is urgently required. We have investigated the relationship between physical activity and health-related quality of life (HRQOL) in patients on chronic hemodialysis [1-2]. HRQOL is an individual's or a group's perceived physical and mental health over time (https://www.cdc.gov/hrqol/. accessed on January 17, 2018). In a cross-sectional study, physical activity over 4 metabolic equivalents (METs) • h/week on non-hemodialysis days (days that patients did not undergo hemodialysis) was closely associated with HRQOL [1], and in a longitudinal study, changes in the amount of physical activities (1-3 METs) were weakly and negatively correlated with HRQOL on hemodialysis days, with a 1-year follow-up [2].

However, in general, patients on chronic hemodialysis must lie in the supine position 3×/week for 4 hr each time (http://docs.jsdt.or.jp/overview/index.html, accessed on July 21, 2017). In addition, several studies

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described lower physical activity [3-5] and longer sitting times in patients on chronic hemodialysis [3-7].

Sedentary behavior, which is characterized by ≤1.5 METs of physical activity (http://www.sedentarybehavior.org/. accessed July 7, 2017), has been recognized as an important factor in various diseases [8-13] and mortality [14, 15]. In addition, sedentary behavior has been reported to be negatively related to health independently of physical activity [10, 12]. Few studies have focused on sedentary behavior in patients on chronic hemodialysis [3-7], and the relationship between the sedentary behavior evaluated accurately by a tri-accelerometer and the HRQOL of patients on chronic hemodialysis in Japan has not been examined.

Therefore, in this pilot study, we evaluated sedentary behavior, and its relationship to HRQOL in Japanese patients on chronic hemodialysis.

Patients and Methods

Patients. A total of 60 outpatients (31 men and 29 women) on chronic hemodialysis, among 153 patients, were voluntarily enrolled in this cross-sectional and secondary analysis study. The 60 enrolled patients met the following criteria: (1) they underwent chronic hemodialysis at Innoshima General Hospital, Onomichi, Japan between September 2013 and September 2016; (2) they underwent measurements of their HRQOL and physical activity by a tri-accelerometer as part of a previous study [1, 2, 16]; and (3) they provided written informed consent to participate.

Ethical approval for this study was obtained from the ethics committee at Innoshima General Hospital, Onomichi, Japan (H25-2-27, H26-1-23, H26-12-16, H27-12-25).

Clinical parameters and measurements. The following clinical parameters were evaluated: age, sex, height, body weight, duration of hemodialysis, history of diabetes mellitus, HRQOL, and physical activity including sedentary behavior. Each patient's body mass index (BMI) was calculated as follows: body weight (kg)/[height (m)]^2. In addition, albumin (g/mL), fasting blood glucose (mg/mL), triglyceride (mg/dL), and HDL cholesterol (mg/dL) as blood sample data were evaluated from the patients' clinical records.

The patients' HRQOL was evaluated using the EuroQOL (EQ-5D) Japanese version [17] as described [1, 2, 16]. The descriptive system of the EQ-5D consists of five dimensions: (1) mobility, (2) self-care, (3) usual activities, (4) pain/discomfort, and (5) anxiety/depression. Each dimension has three levels, allowing for 3^5 (*i.e.*, 243) possible health combinations [1].

Physical activity (including sedentary behavior) was measured by a tri-accelerometer (Active style Pro: HJA-350IT, Omron, Kyoto, Japan). This device is one of the most commonly used for measuring sedentary behavior in Japan [18]. Sedentary behavior was defined as energy expenditure at ≤1.5 METs in a sitting or reclining posture. Light-intensity physical activity (LPA) was defined as 1.6-2.9 METs. Moderately vigorous-intensity physical activity (MVPA) defined as ≥3.0 METs. The patient was instructed to wear the tri-accelerometer continuously for 2 weeks on his or her waist throughout the day except while sleeping and bathing, from the time they got up in the morning. The data was recorded in 60-sec epochs. 'Non-wearing time' was defined as a period of ≥60 consecutive minutes of activity intensity <1.0 MET [11]. The wearing time was estimated by subtracting the non-wearing time from the total observation time in a day [11, 19]. In this algorithm, we used the data from ≥600 min of wearing time in a day [11, 20, 21].

One hundred-one patients agreed to wear a tri-accelerometer, and 60 patients wore it for ≥600 min for 7 days including three hemodialysis days and four non-hemodialysis days. We used the data from these 60 patients for the analyses. We defined the days that the patients underwent hemodialysis as the hemodialysis days, and the other days as the non-hemodialysis days. All measurements were performed at the same period.

Statistical analysis. Data are expressed as the mean ± standard deviation (SD). We performed a simple correlation analysis to evaluate the relationship between EQ-5D scores and physical activity, where $p < 0.05$ was considered significant. We performed a multiple regression analysis to adjust for confounding factors. The variance inflation factor (VIF) was calculated for the evaluation of multicollinearity. The statistical analyses were performed using JMP 13.0 software (SAS, Cary, NC, USA).

Results

The clinical profiles of the enrolled 60 patients on chronic hemodialysis are summarized in Table 1: age, 71.1 ± 12.0 years; BMI, 22.1 ± 3.4 kg/m^2; duration of

hemodialysis, 93.2±85.3 months; relative sedentary behavior (%), 73.2±12.9% and EQ-5D score, 0.688±0.233. We evaluated the relationship between EQ-5D scores and physical activity (Table 2). Relative sedentary behavior (%) was negatively correlated with the EQ-5D scores for total days, hemodialysis days and non-hemodialysis days. Relative LPA (%) and relative MVPA (%) were significantly correlated with EQ-5D scores for total days, hemodialysis days and non-hemodialysis days.

We evaluated the factors significantly affecting the EQ-5D scores in patients on chronic hemodialysis by performing a multiple regression analysis (Table 3). We used the EQ-5D score as a dependent variable, and relative sedentary behavior (%), sex, duration of hemodialysis, age, and history of diabetes mellitus as independent variables. The clinical impact of sedentary behavior on the EQ-5D scores was noted for total,

Table 1 Clinical characteristics of patients on hemodialysis

	Mean ± SD	Minimum	Maximum
Men/Women	31/29		
Age (years)	71.1 ± 12.0	41.0	92.0
over 65 years	46 (76.7%)		
Height (cm)	154.9 ± 9.6	133.6	175.6
Body weight (dry weight) (kg)	53.2 ± 10.7	35.3	91.0
Body mass index (kg/m^2)	22.1 ± 3.4	16.5	31.5
Duration of hemodialysis (months)	93.2 ± 85.3	5.0	283.0
History diabetes mellitus (%)	17 (28.3%)		
EQ-5D scores	0.688 ± 0.233	−0.062	1.000
Blood sample			
Albumin (g/mL)	3.7 ± 0.4	2.7	5.2
Fasting blood glucose (mg/dL)	134.5 ± 47.0	82.0	302.0
Triglyceride (mg/dL)	107.0 ± 72.8	29.0	431.0
HDL cholesterol (mg/dL)	56.0 ± 19.0	19.1	108.7
Physical Activity (Total)			
Wear time (min/day)	1,030.3 ± 199.5	693.1	1,425.6
Sedentary behabior (min/day)	772.9 ± 243.0	369.3	1,320.4
LPA (min/day)	244.9 ± 109.8	40.9	482.0
MVPA (min/day)	15.2 ± 15.2	0.7	54.7
Relative sedentary behavior (%)	73.7 ± 12.9	45.9	95.4
Relative LPA (%)	24.8 ± 12.3	0.1	49.2
Relative MVPA (%)	1.6 ± 1.7	0.0	7.0
Physical Activity (Hemodialysis days)			
Wear time (min/day)	1,019.8 ± 212.9	666.0	1,440.0
Sedentary behabior (min/day)	771.4 ± 246.8	258.3	1,331.0
LPA (min/day)	235.8 ± 113.4	53.6	530.3
MVPA (min/day)	15.0 ± 14.4	0.0	47.7
Relative sedentary behavior (%)	74.4 ± 13.2	38.8	94.2
Relative LPA (%)	24.1 ± 12.8	0.1	54.2
Relative MVPA (%)	1.6 ± 1.6	0.0	6.2
Physical Activity (Non-hemodialysis days)			
Wear time (min/day)	1,038.2 ± 214.2	682.8	1,436.8
Sedentary behabior (min/day)	774.1 ± 258.3	360.8	1,312.5
LPA (min/day)	251.7 ± 120.1	31.3	584.0
MVPA (min/day)	15.4 ± 17.2	0.3	65.5
Relative sedentary behavior (%)	73.1 ± 13.7	38.8	96.5
Relative LPA (%)	25.4 ± 13.0	0.1	57.9
Relative MVPA (%)	1.7 ± 2.0	0.0	8.9

LPA: Light intensity Physical Activity, 1.6 METs ≤LPA < 3.0 METs.
MVPA: Moderate-Vigorous intensity Physical Activity, over 3.0 METs.

hemodialysis and non-hemodialysis days.

Discussion

In this cross-sectional study, we first investigated the influence of physical activity (including sedentary behavior) with the use of tri-accelerometers and the HRQOL in patients on chronic hemodialysis, and our analyses revealed that the clinical impact of sedentary behavior on HRQOL is notable.

It was reported that Japanese people engage in longer sitting times compared to other countries as measured by the International Physical Activity Questionnaire (IPAQ) [22]. Anderson *et al.* studied patients on chronic hemodialysis, using self-reported questionnaires, and they reported that sedentary behavior in the patients on chronic hemodialysis was significantly longer than that of kidney disease patients without chronic hemodialysis [7]. In another study using a tri-accelerometer, it was found that patients on chronic hemodialysis spend approx. 70% of their daily life in a sitting and/or supine position [3]. The walking and/or standing time of patients on chronic hemodialysis was reported to be significantly shorter than that of control subjects, especially on hemodialysis days [4]. In the present study, we accurately evaluated physical activity including sedentary behavior by using tri-accelerometers. The percentage of relative sedentary behavior was 73.7 ± 12.9%, and the results obtained in this study will be useful reference data regarding sedentary behavior in patients on chronic hemodialysis.

Balboa-Castillo *et al.* reported that reducing sedentary behavior and increasing physical activity was associated with better HRQOL as evaluated by the Medical Outcome Study Short-Form 36-Item Health Survey (SF-36) in elderly Spanish subjects [23]. A meta-analysis showed that sitting time accounted for 3.8% of the etiology for all-cause mortality independent of physical activity [24]. In Japan, sedentary behavior was reported to be closely associated with mortality, but not with HRQOL, in subjects in a primary industry [25]. Regarding the relationship between sedentary behavior and HRQOL in patients on chronic hemodialysis, O'Hare *et al.* reported that there was a significant relationship between sedentary behavior evaluated by self-reported questionnaire and HRQOL, with a 1-year

Table 2 Simple correlation analysis between EQ-5D scores and physical activity

	r	*p*
Physical Activity (Total days)		
Relative sedentary behavior (%)	−0.349	**0.006**
Relative LPA (%)	0.333	**0.009**
Relative MVPA (%)	0.385	**0.002**
Physical Activity (Hemodialysis days)		
Relative sedentary behavior (%)	−0.283	**0.028**
Relative LPA (%)	0.259	**0.046**
Relative MVPA (%)	0.438	**0.001**
Physical Activity (Non-hemodialysis days)		
Relative sedentary behavior (%)	−0.369	**0.004**
Relative LPA (%)	0.362	**0.005**
Relative MVPA (%)	0.317	**0.014**

Bold values indicated statistically significant ($p < 0.05$).
LPA: Light intensity Physical Activity, 1.6 METs ≤LPA < 3.0 METs
MVPA: Moderate-Vigorous intensity Physical Activity, over 3.0 METs.

Table 3 Relationship between EQ-5D scores and clinical parameters by multiple regression analysis

	Total days			Hemodialysis days			Non-Hemodialysis days		
	β	*p*	VIF	*β*	*p*	VIF	*β*	*p*	VIF
Dependent variable: EQ-5D scores									
Independent variables									
Relative sedentary behavior (%)	−0.414	**0.005**	1.387	−0.311	**0.026**	1.208	−0.455	**0.003**	1.491
Sex (men/women)	−0.203	0.121	1.156	−0.157	0.231	1.108	−0.223	0.090	1.179
Duration of hemodialysis (months)	−0.190	0.140	1.117	−0.210	0.113	1.119	−0.170	0.182	1.122
Age (years)	−0.122	0.345	1.131	−0.176	0.172	1.067	−0.094	0.468	1.172
History diabetes mellitus	0.025	0.852	1.233	−0.030	0.826	1.171	0.054	0.689	1.275
	Adjusted $R^2 = 0.148$, $p = 0.017$			Adjusted $R^2 = 0.1008$, $p = 0.0554$			Adjusted $R^2 = 0.1653$, $p = 0.0107$		

$p < 0.05$ indicated in bold.
VIF: variance inflation factor.

follow-up [6].

In the present study, there was a significant relationship between relative sedentary behavior (%) evaluated by tri-accelerometers and HRQOL evaluated by a multiple regression analysis, even after adjusting for confounding factors. In our previous study, ≥4 METs • h/week on non-hemodialysis days with physical activity was associated with better HRQOL [1]. However, increasing one's physical activity (especially moderate- and/or high-intensity physical activity) is expected to be difficult for patients on chronic hemodialysis in clinical practice. In addition, patients on hemodialysis are getting older (http://docs.jsdt.or.jp/overview/index.html. accessed on July 21, 2017). Taken together, the past and present finding indicate that reducing sedentary behavior may be beneficial to improve the HRQOL of patients on chronic hemodialysis.

There are several potential limitations in this study. First, it was cross-sectional, not longitudinal. Second, the 60 enrolled patients were thought to be more health-conscious than other non-enrolled patients. Third, the small sample size may also make it difficult to establish the causality of the relationship between sedentary behavior and HRQOL. Sedentary behavior, characterized by no muscle activity [27], can induce hyperinsulinemia and/or insulin resistance, resulting in obesity, type 2 diabetes mellitus, and hypertension [27]. In addition, sedentary behavior is related to depression, stress [28], and anxiety [29]. These physical and psychological factors along with sedentary behavior may affect the HRQOL of patients on chronic hemodialysis. Nevertheless, it is reasonable that the reduction of sedentary behavior may increase the HRQOL in patients on chronic hemodialysis. Larger samples and prospective studies are needed to test our present findings.

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