KMJ THE KITAKANTO MEDICAL JOURNAL 2017 ; 67 : 291～298

Original

Health-related Quality of Life and Potential Barriers to Adequate Nutrition among Japanese Hemodialysis Patients

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Abstract

Background and aims: Malnutrition is common in hemodialysis (HD) patients, which is known to reduce their health-related quality of life (QOL). Potential barriers to adequate nutrition can affect a patient's nutritional status, although whether they also affect the patient's QOL remains unclear. This study investigated the associations between several potential barriers and QOL among HD patients. **Methods:** This cross-sectional study included 36 Japanese patients receiving HD for ≥ 3 months. The patients completed structured questionnaires regarding any potential barriers to adequate nutrition. Clinical parameters were evaluated during monthly check-ups. **Results:** The presence of ≥ 1 potential barrier significantly associated with decreased scores in the *effect of kidney disease, burden of kidney disease, cognitive function, quality of social interaction,* and *mental health* subscales in the Kidney Disease Quality of Life Short Form. Poor knowledge was the most common potential barrier to adequate nutrition. However, difficulty chewing was significantly associated with the greatest number of decreased QOL subscale scores, even after adjustment for age, suggesting that this barrier has the greatest direct effect on QOL. **Conclusions:** The presence of ≥ 1 potential barrier significantly associated with reduced QOL, indicating the importance of evaluating potential barriers to adequate nutrition. Further study is necessary to investigate the possibility that assessment and managing potential barriers improve QOL of patients receiving HD.

Article Information

Key words:
health-related quality of life,
hemodialysis,
kidney disease,
potential barriers,
quality of life

Publication history:
Received: June 29, 2017
Revised: October 20, 2017
Accepted: October 26, 2017

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Introduction

Recent advances in hemodialysis (HD) therapy have contributed to a better prognosis in patients receiving HD, although HD is still associated with significant mental and physical burdens on the patients.[1] Unfortunately, it is difficult to manage the health of patients receiving HD, and they have an increased risk of malnutrition, owing to their dietary restrictions and other comorbid conditions. In turn, malnutrition is associated with increased mortality among patients receiving HD.[2–5]

Additionally, it is also well known that frequent and long-term HD treatment impairs the health-related quality of life (QOL) of the patients. It has been reported that the QOL of patients with kidney disease was lower than that of the general population.[6–8] Reductions in QOL are associated not only with inconveniences in the patient's daily life, but also with the risk of impairment of their physical condition in the future. According to Mapes et al., lower QOL is strongly related with the risk of serious conditions such as death and hospitalization.[7] Therefore, it is necessary to consider how to best maintain or improve the QOL in patients undergoing HD.

Further, while the serum albumin levels are usually used to assess a patient's nutritional status, according to previous studies, assessment of QOL has also recently emerged as a useful tool for predicting mortality.[7,9] These studies showed that such an assessment was a more sensitive tool for identifying patients with

an increased risk of death and hospitalization among patients receiving HD than serum albumin. However, as patients receiving HD are usually at risk of impairment of their QOL, it is important to avoid such impairments in the QOL as soon as possible, ideally before starting HD.

The concept of "potential barriers" to adequate nutrition was first proposed by Sehgal et al.,[10] the authors defined "potential barriers" to adequate nutrition in patients receiving HD as barriers that the patients possess themselves.[10,11] In this concept, patients may experience individual potential barriers to accessing adequate nutrition, such as "poor knowledge," "poor appetite," "difficulty chewing," "difficulty swallowing," and "gastrointestinal symptoms." For example, complex dietary restrictions may cause poor knowledge, inadequate dialysis dose may reduce appetite, and difficulty chewing/swallowing or gastrointestinal symptoms may lead to reduced food intake. All of these potential barriers may in turn cause malnutrition. Furthermore, low albumin levels have been reported to be significantly associated with poor knowledge, and a low protein catabolic rate is reportedly associated with poor appetite in patients receiving HD.[10] Because these potential barriers are modifiable, it is possible to improve the patients' nutritional status; for example, personalized nutrition interventions based on patient-specific barriers have been demonstrated to improve the albumin levels in patients receiving HD.[12]

Thus, personalized assessments of potential barriers may help maintain adequate nutrition and prevent malnutrition. Moreover, if the potential barriers are also associated with the QOL, their assessment could help maintain QOL and prevent malnutrition or hospitalization in patients receiving HD. However, to date, few studies have investigated whether these potential barriers are related to the QOL in this patient population. Therefore, the present study aimed to investigate whether the presence of potential barriers to adequate nutrition is related to QOL among patients receiving HD.

Methods

This was a single-center observational study that included patients who received HD in January 2015 at the HD center of a general hospital in Gunma Prefecture, Japan. The study's design was approved by the Internal Review Boards of the study hospital and Gunma University. All patients provided written informed consent to participate in the study.

The inclusion criteria of this study were as follows: (1) patients who had received HD therapy at the outpatient department for ≥ 3 months, (2) patients who could perform their activities of daily living independently, and (3) patients without cognitive problems. The exclusion criteria were as follows: (1) patients who had started HD therapy within 3 months prior to this study and (2) patients who had an acute illness, infectious disease, malignancy, or depression. One hundred and three patients who fulfilled inclusion criteria were invited in this study and given verbal and written explanation. Finally 40 patients had agreed to participate in this study and provided written informed consent. Among the 40 patients who had provided written informed consents, 1 patient did not fulfill the inclusion criteria, 1 patient did not complete the questionnaires, and 2 patients withdrew their consent after the data collection. Consequently, 36 patients were included in the final analyses. The reason why 63 patients did not participate remained unclear because participation was voluntary.

Two questionnaires "Kidney Disease Quality of Life Short Form" and "Assessment of Potential Barrier" were distributed to the patients before or after their HD therapy. The patients were required to answer these questionnaire at home, however, some answers were obtained by interviews on demand by the patients.

Kidney Disease Quality of Life Short Form

The Kidney Disease Quality of Life Short Form (KDQOL-SF) is an instrument for evaluating QOL among patients with kidney disease.[13] The Japanese version of the KDQOL-SF was developed and validated by Green et al.[14] This tool uses both generic and kidney disease-specific instruments, with the generic instrument being based on the 36-Item Short Form Health Survey. The generic instrument has eight subscales (*physical function, role functioning physical, bodily pain, general health perception, vitality, social functioning, role functioning emotional*, and *mental health*), and typically provides lower scores in patients with kidney disease than in the general population.[13] The kidney disease-specific instrument also has eight subscales: *symptoms/problems, effect of kidney disease, burden of kidney disease, work status, cognitive function, quality of social interaction, sexual functioning*, and *sleep*.[15,16] Each subscale is scored between 0 and 100, with higher scores indicating better QOL.[17] We excluded sexual function from the present study because of the poor response rate.

Potential barriers

The concept of potential barriers to adequate nutrition was first proposed by Sehgal et al.[10] Potential barriers are modifiable, although they are also independently associated with clinical nutritional status.[10] For the present study, we considered six potential barriers: (1) poor nutritional knowledge, (2) poor appetite, (3) difficulty chewing, (4) difficulty swallowing, (5) gastrointestinal symptoms, and (6) need help with preparing meals. However, we excluded (6) need help with preparing meals from the present study because only one patient had answered "Yes". The patients were asked to complete a structured questionnaire regarding their potential barriers.

To evaluate nutritional knowledge, the patients were shown a list of 20 common foods (adjusted to

reflect Japanese food culture) and asked to identify foods with high protein content, such as meat, fish, eggs, and soy beans. Patients who provided >4 incorrect answers were classified as having "poor nutritional knowledge." We also asked the patients to rate their overall appetite on a 5-point Likert scale (very good, good, fair, poor, and very poor), as well as whether 12 common high-protein foods helped maintain their appetite. Patients who reported having a fair/poor overall appetite or a fair/poor appetite for ≥ 4 specific foods were classified as having a "poor appetite." The patients were also asked to rate their difficulty chewing or swallowing using a 4-point Likert scale (never, rarely, sometimes, and always), and responses of always or sometimes were defined as having "difficulty chewing" or "difficulty swallowing." Patients with self-reported heartburn or nausea were defined as having "gastrointestinal symptoms."

Clinical parameters

The present study evaluated the following clinical parameters: cardiothoracic ratio, serum albumin levels, blood urea nitrogen levels, potassium levels, phosphate levels, hemoglobin levels, and systolic blood pressure before HD therapy. These data were collected cross-sectionally at the patients' first health check-up after their inclusion in the study.

Statistical analysis

All statistical analyses were performed using PASW software (version 18; IBM, Tokyo, Japan). Data were expressed as the number (%) or median (interquartile range). Differences were evaluated using the Mann-Whitney U-test, and were considered statistically significant at a p-value of <0.05.

Results

Table 1 shows the patients' demographic characteristics. The median patient age was 63.0 years, and 77.8% of the patients were male. Approximately 40% of cause of end-stage renal disease was diabetes (n=15, 41.7%). 19.4% of the patients had an education level of no more than junior high school. The median duration of HD was 5.9 years. Table 2 shows main responsibility for preparing meals by gender. Sixty seven point nine percent of males did not prepare their meals, whereas every female prepared their own meals.

Tables 3 and 4 show the numbers of patients who had potential barriers, with 83.3% of the patients having ≥ 1 barrier and 50% of these patients having multiple barriers. The most common potential barrier was "poor knowledge" (47.2%), followed by "poor appetite" (33.3%), "gastrointestinal symptoms" (27.8%), "difficulty chewing" (25.0%), and "difficulty swallowing" (5.6%). Table 5 shows the relationships between the patients' demographic characteristics, clinical parameters, and presence or absence of potential barriers. Although protein nutrition was commonly quantified using serum albumin levels, no relationship was observed between the absence or presence of potential barriers and any clinical parameters, including the serum albumin level.

Table 6 shows the median and interquartile KDQOL scores according to the presence or absence of potential barriers. The presence of ≥ 1 barrier was significantly associated with decreased scores in the 6 subscales, *symptoms/problems* (p=0.016), *effect of kidney disease* (p=0.009), *burden of kidney disease* (p=0.013), *cognitive function* (p=0.048), *quality of social interaction* (p=0.005), and *mental health* (p=0.024). Table 7 shows the relationships among the patients' demographic characteristics, albumin levels, and each potential barriers. The patients' sex, primary disease, HD duration, and albumin levels were not associated with any potential barriers. On the other hand, advanced age was significantly associated with

Table 1 Patient demographic characteristics

n=36

Characteristic	n (%), or Median (IQR)
Age in Years	63.0 (57.0–67.0)
Male Gender	28 (77.8)
Education Junior high school or less	7 (19.4)
High school graduate	15 (41.7)
Some college or college graduate	14 (38.9)
Causes of ESRD Non-Diabetic	21 (58.3)
Diabetic	15 (41.7)
Duration of HD therapy (Years)	5.9 (2.7–10.2)

Values given median (IQR) except n (%)
Note: ESRD=End Stage Renal Disease, HD=Hemodialysis

Table 2 Main responsibility for preparing meals by gender

Gender	Responsibility	n (%)
Male (n=28)	Self	9 (32.1)
	Other	19 (67.9)
Female (n=8)	Self	8 (100.0)
	Other	0 (0.0)

Table 3 Number of patients by number of potential barriers

n (%)

Number of potential barriers	
0	6 (16.7)
1	15 (41.6)
2	11 (30.6)
3	3 (8.3)
4	1 (2.8)
5	0 (0.0)
Total	36 (100.0)

Table 4 Number of patients by potential barriers

n=36

Potential barriers	n (%)
Poor knowledge	17 (47.2)
Poor appetite	12 (33.3)
Difficulty chewing	9 (25.0)
Difficulty swallowing	2 (5.6)
Gastrointestinal symptoms	10 (27.8)

Table 5 Relationship patient demographic characteristics, clinical parameters and presence or absence of potential barriers

Characteristics	absent	present	p-Value
Number (%)	6 (16.7)	30 (83.3)	
Age in years	67.0 (61.3–74.8)	63.0 (57.0–67.0)	0.143
Male gender n (%)*1	4 (66.7)	24 (80.0)	0.403
Causes of ESRD n (%)*1			0.185
Non-Diabetic	5 (13.9)	16 (44.4)	
Diabetic	1 (2.8)	14 (38.9)	
Duration of HD (Years)	5.2 (2.2–15.2)	5.7 (3.1–10.2)	0.799
Cardiothoracic ratio (%)	46.7 (43.5–49.4)	46.5 (44.2–49.2)	0.965
Albumin (g/dl)	4.1 (3.8–4.1)	3.9 (3.7–4.3)	0.815
Blood urea nitrogen (mg/dl)	63.9 (59.2–71.4)	62.6 (49.4–68.8)	0.567
Potassium (mEq/l)	5.0 (4.7–5.4)	4.8 (4.5–5.1)	0.233
Phosphate (mEq/l)	5.2 (4.3–6.2)	4.6 (4.0–5.8)	0.497
Hemoglobin (g/dL)	10.6 (10.2–12.3)	10.9 (10.4–11.4)	0.949
Systolic blood pressure before HD (mmHg)	160.5 (149.5–168.0)	158.5 (146.5–169.8)	0.949

Values given median (IQR) Mann-Whitney's U test *1 : χ^2 test

Table 6 Quality of life score by presence or absence of potential barriers

Quality of life domain	absent	present	p-Value
Kidney Disease Quality of Life			
Symptoms/problems	91.9 (83.9–96.3)	83.3 (69.3–85.4)	0.016*
Effect of kidney disease	93.8 (71.9–95.3)	67.2 (50.0–81.3)	0.009**
Burden of kidney disease	46.9 (37.5–68.8)	25.0 (12.5–37.5)	0.013*
Work status	50.0 (37.5–100.0)	50.0 (0.0–100.0)	0.821
Cognitive function	100.0 (93.3–100.0)	90.0 (73.3–100)	0.048*
Quality of social interaction	100.0 (100.0–100.0)	86.7 (73.3–100.0)	0.005**
Sleep	63.8 (51.9–90.0)	65.0 (49.4–72.5)	0.782
Short Form Health Survey (SF-36)			
Physical functioning	90.0 (72.5–96.3)	77.5 (60.0–90.0)	0.230
Role functioning physical	100.0 (56.3–100.0)	50.0 (0.0–100.0)	0.245
Bodily pain	90.0 (52.5–100.0)	67.5 (46.9–90.0)	0.185
General health perceptions	50.0 (33.8–82.5)	40.0 (23.8–45.0)	0.069
Vitality	82.5 (51.3–96.3)	52.5 (38.8–71.3)	0.097
Social functioning	100.0 (71.9–100.0)	87.5 (75.0–100.0)	0.423
Role functioning emotional	100.0 (25.0–100.0)	100.0 (0.0–100.0)	0.528
Mental health	94.0 (74.0–100.0)	70.0 (55.0–81.0)	0.024*

Values given median (IQR) Mann-Whitney's U test: $^*p<0.05$, $^{**}p<0.01$

difficulty chewing (p=0.042).

Table 8 shows the median and interquartile KDQOL scores according to the potential barriers. Poor nutritional knowledge, poor appetite, and difficulty swallowing were not associated with any KDQOL subscale scores, although difficulty chewing was significantly associated with decreases in the following KDQOL subscale scores: *effect of kidney disease* (p=0.016), *role functioning physical* (p=0.011), *bodily pain* (p=0.010), *social functioning* (p=0.018), *role functioning emotional* (p=0.004), and *mental health* (p=0.020). Further, gastrointestinal symptoms were significantly associated with decreased *quality of social interaction* (p=0.001) and *sleep* (p=0.040) scores.

Although difficulty chewing was significantly associated with the greatest number of decreased KDQOL subscale scores, age might have affected these associations, because difficulty chewing was significantly associated with age. There was also no significant relationship between serum albumin level and any demographic characteristics even limited patients with difficulty chewing over 60 age. Only one patient with difficulty chewing was aged<60 years; thus, we only compared demographic characteristics among ≥ 60-year-old patients according to their chewing difficulty (Table 9). We did not detect any significant differences between demographic characteristics except age or serum albumin levels and age. Table 10 shows the KDQOL scores among ≥ 60-year-old patients according to their chewing difficulty. Among these patients, difficulty chewing was significantly associated with decreases in the *role functioning physical* (p=0.020), *bodily pain* (p=0.006), and *role functioning emotional* (p=0.019) scores. Thus, difficulty chewing affected the KDQOL, even after adjusting for age.

Table 7 Patient characteristics by potential barriers

Potential barrier	Poor knowledge			Poor appetite			Difficulty chewing			Difficulty swallowing			Gastrointestinal symptoms		
Demographic data	absent (n=19)	present (n=17)	p-Value	absent (n=24)	present (n=12)	p-Value	absent (n=27)	present (n= 9)	p-Value	absent (n=)	present (n= 2)	p-Value	absent (n=26)	present (n=10)	p-Value
Age in years	63.0 (51.0-67.0)	63.0 (57.0-67.5)	0.861	65.0 (54.0-67.0)	63.0 (57.0-67.0)	0.811	63.0 (53.0-67.0)	71.0 (62.0-75.5)	0.042*	63.0 (57-67)	71.5 (60.0- —)	0.406	63.5 (57.0-68.8)	61.0 (52.5-67.0)	0.512
Male gender n (%)*1	15 (78.9)	13 (76.4)	1.000*1	18 (75.0)	10 (83.3)	0.691	20 (74.1)	8 (88.9)	0.648	26 (76.4)	2 (100.0)	1.000	20 (76.9)	8 (80.0)	1.000
Causes of ESRD n (%)*1			0.090*1			0.499			0.443			0.167			0.468
Non-Diabetic	14 (38.9)	7 (19.4)		15 (41.6)	6 (16.7)		17 (47.2)	4 (11.1)		21 (58.3)	0 (0.0)		14 (38.9)	7 (19.4)	
Diabetic	5 (13.9)	10 (27.8)		9 (25.0)	6 (16.7)		10 (27.8)	5 (13.9)		13 (36.1)	2 (5.6)		12 (33.3)	3 (8.3)	
Duration of HD (years)	6.8 (2.6-13.5)	5.2 (2.7-7.6)	0.199	6.2 (2.9-11.5)	5.0 (2.6-7.9)	0.494	5.2 (2.6-8.1)	6.7 (3.9-14.0)	0.298	5.7 (3.1-10.2)	4.1 (2.2- —)	0.447	5.2 (2.6-8.6)	7.2 (4.8-12.5)	0.230
Albumin (g/dl)	4.0 (3.7-4.2)	3.8 (3.7-4.3)	0.524	3.9 (3.7-4.2)	4.0 (3.8-4.4)	0.345	4.0 (3.8-4.3)	3.7 (3.6-4.1)	0.085	3.9 (3.7-4.2)	4.2 (4.0- —)	0.238	3.9 (3.7-4.2)	4.0 (3.7-4.3)	0.929

Values given median (IQR) except n (%) Mann-Whitney's U test: *p<0.05

Table 8 Relationship between KDQOL score and potential barriers

Potential barrier	Poor knowledge			Poor appetite			Difficulty chewing			Difficulty swallowing			Gastrointestinal symptoms		
Demographic data	absent (n=19)	present (n=17)	p-Value	absent (n=24)	present (n=12)	p-Value	absent (n=27)	present (n= 9)	p-Value	absent (n=)	present (n= 2)	p-Value	absent (n=26)	present (n=10)	p-Value
Kidney Disease Quality of Life															
Symptoms/problems	83.3 (70.8-90.9)	83.3 (70.8-85.4)	0.493	83.3 (79.7-89.9)	81.3 (61.5-83.9)	0.068	83.3 (81.3-89.6)	70.8 (64.6-83.3)	0.078	83.3 (70.8-88.0)	77.1 (70.8- —)	0.509	83.3 (70.8-88.1)	83.3 (68.7-88.0)	0.817
Effect of kidney disease	71.9 (50.0-93.8)	71.9 (56.3-81.3)	0.962	73.4 (60.9-93.0)	60.9 (50.8-79.7)	0.157	75.0 (59.4-90.6)	53.1 (32.8-70.3)	0.016*	71.8 (52.3-90.6)	68.8 (65.6- —)	0.782	70.3 (52.3-90.6)	76.6 (57.0-84.4)	0.468
Burden of kidney disease	31.3 (18.8-50.0)	25.0 (10.9-37.5)	0.240	31.3 (12.5-48.4)	25.0 (9.4-37.5)	0.462	28.1 (12.5-42.2)	25.0 (9.4-50.0)	0.901	25.0 (12.5-43.8)	43.8 (37.5- —)	0.212	25.0 (12.5-43.8)	31.3 (18.8-35.9)	0.744
Work status	50.0 (0.0-100.0)	50.0 (0.0-100.0)	0.893	50.0 (0.0-100.0)	50.0 (0.0-100.0)	0.669	50.0 (0.0-100.0)	50.0 (0.0-75.0)	0.207	50.0 (0.0-100.0)	75.0 (50.0- —)	0.486	50.0 (0.0-100.0)	50.0 (0.0-100.0)	0.693
Cognitive function	100.0 (80.0-100.0)	93.3 (66.7-96.7)	0.064	93.3 (75.0-100.0)	86.7 (73.3-100.0)	0.768	93.3 (80.0-100.0)	73.3 (66.7-100.0)	0.156	93.3 (73.3-100.0)	86.7 (73.3- —)	0.943	93.3 (80.0-100.0)	76.7 (70.0-95.0)	0.060
Quality of social interaction	100.0 (80.0-100.0)	86.7 (70.0-100.0)	0.137	93.3 (80.0-100.0)	90.0 (70.0-100.0)	0.903	93.3 (80.0-100.0)	86.7 (70.0-96.7)	0.183	93.3 (80.0-100.0)	86.7 (73.3- —)	0.971	100.0 (86.7-100.0)	48.8 (46.9-66.3)	0.001**
Sleep	65.0 (55.0-72.5)	65.0 (47.5-75.0)	0.679	65.0 (48.1-74.4)	67.5 (51.9-72.5)	0.827	65.0 (50.0-75.0)	65.0 (51.3-71.3)	0.700	65.0 (50.0-72.5)	68.8 (47.5- —)	0.782	67.5 (56.9-75.0)	48.8 (46.9-66.3)	0.040*
Short Form Health Survey (SF-36)															
Physical functioning	90.0 (75.0-95.0)	75.0 (45.0-90.0)	0.055	90.0 (70.0-95.0)	75.0 (60.0-88.8)	0.192	90.0 (70.0-95.0)	75.0 (42.5-87.5)	0.184	87.5 (67.5-91.3)	50.0 (30.0- —)	0.134	87.5 (67.5-91.3)	77.5 (58.8-91.3)	0.924
Role functioning physical	100.0 (25.0-100.0)	25.0 (0.0-100.0)	0.168	87.5 (0.0-100.0)	37.5 (6.3-100.0)	0.801	100.0 (25.0-100.0)	0.0 (0.0-37.5)	0.011*	75.0 (0.0-100.0)	50.0 (0- —)	0.824	62.5 (0.0-100.0)	87.5 (0.0-100.0)	0.924
Bodily pain	67.5 (55.0-90.0)	67.5 (45.0-90.0)	0.701	67.5 (46.9-90.0)	67.5 (49.4-97.5)	0.761	77.5 (55.0-100.0)	45.0 (38.8-67.5)	0.010*	67.5 (51.3-90.0)	62.5 (45.0- —)	0.651	72.5 (53.1-100.0)	61.3 (45.0-73.1)	0.213
General health perceptions	45.0 (30.0-60.0)	40.0 (17.5-40.0)	0.062	40.0 (25.0-50.0)	40.0 (31.3-43.8)	0.800	40.0 (30.0-50.0)	35.0 (7.5-47.5)	0.162	40.0 (28.8-50.0)	25.0 (15.0- —)	0.198	40.0 (30.0-50.0)	35.0 (22.5-45.0)	0.302
Vitality	60.0 (45.0-85.0)	50.0 (35.0-75.2)	0.427	60.0 (45.0-78.8)	45.0 (31.3-70.0)	0.184	60.0 (45.0-85.0)	45.0 (35.0-55.0)	0.059	55.0 (43.8-75.0)	45.0 (10.0- —)	0.653	60.0 (43.8-81.3)	50.0 (27.5-63.8)	0.196
Social functioning	100.0 (75.0-100.0)	87.5 (75.0-100.0)	0.758	81.3 (75.0-100.0)	100.0 (75.0-100.0)	0.426	100.0 (75.0-100.0)	75.0 (50.0-87.5)	0.018*	93.8 (75.0-100.0)	87.5 (75.0- —)	0.852	100.0 (75.0-100.0)	81.3 (59.4-100.0)	0.446
Role functioning emotional	100.0 (0.0-100.0)	66.7 (0.0-100)	0.239	100.0 (0.0-100.0)	100.0 (0.0-100.0)	0.969	100.0 (33.3-100.0)	0.0 (0.0-50.0)	0.004**	100.0 (0.0-100.0)	50 (0.0- —)	0.722	100.0 (0.0-100.0)	100.0 (0.0-100.0)	0.872
Mental health	72.0 (56.0-92.0)	76.0 (54.0-88.0)	0.987	74.0 (53.0-92.0)	72.0 (61.0-82.0)	0.827	76.0 (56.0-92.0)	60.0 (46.0-70.0)	0.020*	72.0 (55.0-89.0)	74.0 (60.0- —)	0.809	76.0 (59.0-92.0)	58.0 (51.0-76.0)	0.071

Values given median (IQR) Mann-Whitney's U test: *p<0.05, **p<0.01

Table 9 Background of patients with difficulty chewing over 60 age

Background	Possession of difficulty chewing		
	absent	present	p-Value
Number (%)	16 (66.7)	8 (33.3)	
Age in years	65.5 (63.0–67.0)	71.0 (64.0–76.8)	0.123
Male gender n (%)*1	14 (87.5)	8 (100.0)	0.435
Causes of ESRD n (%)*1			0.333
Non-Diabetic	9 (37.5)	3 (12.5)	
Diabetic	7 (29.2)	5 (20.8)	
Duration of HD (years)	4.8 (2.7–7.5)	6.2 (3.1–11.0)	0.391
Albumin (g/dl)	4.1 (3.9–4.3)	3.6 (3.5–4.1)	0.090

Values given median (IQR) except n (%) Mann-Whitney's U test *1: χ^2 test

Table 10 Relationship betweeen KDQOL score and difficulty chewing over 60 age

Quality of life domain	Possession of Difiiculty Chewing		
	absent (n=16)	present (n= 8)	p-Value
Kidney Disease Quality of Life			
Symptoms/problems	83.3 (81.3–87.0)	77.1 (66.1–83.3)	0.162
Effect of kidney disease	71.9 (59.4–88.3)	57.8 (32.0–71.1)	0.097
Burden of kidney disease	28.1 (12.5–42.2)	31.3 (12.5–50.0)	0.711
Work status	50.0 (0.0–100.0)	25.0 (0.0–50.0)	0.282
Cognitive function	93.3 (80.0–100.0)	80.0 (66.7–100.0)	0.397
Quality of social interaction	96.7 (81.7–100.0)	86.7 (75.0–98.3)	0.250
Sleep	63.8 (51.3–75.0)	61.3 (49.4–70.0)	0.560
Short Form Health Survey (SF-36)			
Physical functioning	90.0 (70.0–93.8)	12.5 (0.0–43.8)	0.078
Role functioning physical	100.0 (31.3–100.0)	12.5 (0.0–43.8)	0.020*
Bodily pain	72.5 (63.8–90.0)	45.0 (35.6–64.4)	0.006**
General health perceptions	40.0 (35.0–48.8)	35.0 (8.8–48.8)	0.386
Vitality	60.0 (40.0–48.8)	47.5 (32.5–48.8)	0.149
Social functioning	87.8 (75.0–100.0)	75.0 (50.0–87.5)	0.126
Role functioning emotional	100.0 (41.7–100.0)	0.0 (0.0–75.0)	0.019*
Mental health	82.0 (49.0–92.0)	62.0 (53.0–71.0)	0.231

Values given median (IQR) Mann-Whitney's U test: *$p<0.05$, **$p<0.01$

Discussion

To our knowledge, this is the first study to investigate the relationship between KDQOL and potential barriers to adequate nutrition among Japanese patients receiving HD. In the present study, all investigated potential barriers were reported (poor knowledge (47.2%), poor appetite (33.3%), gastrointestinal symptoms (27.8%), difficulty chewing (25.0%), and difficulty swallowing (5.6%)), with the most common barrier being poor knowledge, which validates the findings of previous studies.[10,12,18]

Approximately half of the patients had insufficient nutritional knowledge, despite regularly receiving nutritional advice from nutritionists. However, it should be noted that 77.8% of the participants were male, and 67.9% of male patients reported not preparing their own meals (as compared to 0% for female patients; Table 2). In addition, only one patient had answered "Yes" to the question "Do you need help with preparing meals?". Thus, this sex-specific non-involvement in preparing meals likely relates to the poor nutritional knowledge of the patients, as sex is known to influence nutritional knowledge, with female patients having superior knowledge.[19] Similar findings are observed among the general Japanese population, with a National Health and Nutrition Survey reporting that male patients are less likely than female patients to have sufficient knowledge and skills to prepare a meal (31.8% of male patients and 55.1% of female patients).[20] Therefore, sex bias regarding nutritional knowledge may partially explain our findings.

In the present study, 47.2% of the participants had poor nutritional knowledge; a similar value has been reported in the US (42.6%), whereas a much higher value was observed in Iran (84.7%).[10,18] One possible explanation for these differences may be differences in the educational levels, as 69.4% of subjects in the Iranian study had an educational level of junior high school or lower, as compared to rates of 17% in the US and 19.4% in the present study. Thus, while the values for education and poor nutritional knowledge were similar in the US study and present study, the patients in the Iranian study had a lower education level and higher prevalence of poor nutritional knowledge. Therefore, lower education level tends to poor nutritional knowledge. Moreover, poor nutritional knowledge was significantly associated with nutritional sta-

tus in both of 2 previous studies. On the other hand, any potential barriers including poor knowledge were not associated with any clinical parameters including albumin in this study. The result is somehow different from 2 previous studies. However, according to Parmenter et al., higher education was associated with better nutritional knowledge.[19] Therefore, poor knowledge still remains remarkable factors of nutritional status, and educational level is important predictor to nutritional knowledge. There was no significant relationship with poor knowledge and any clinical parameters and QOL in this study. It is because small sample size might be affected on the result. Further investigation is necessary to assess the relationship between nutritional knowledge and clinical parameters.

A previous study found that assessing the QOL was more sensitive for predicting the patient prognosis than the serum albumin levels,[7] with low QOL values found to be associated with serious conditions such as hospitalization and death. In the present study, we found that the presence of ≥ 1 potential barrier to adequate nutrition was significantly associated with low scores on the KDQOL subscales, which may indicate that these barriers reflect the early stages of impaired QOL.

We also considered the effects of each potential barrier on QOL. Difficulty chewing was found to be significantly associated with reduced scores in six KDQOL subscale scores before adjusting for age, although it remained associated with three subscale scores after adjusting for age. Further, gastrointestinal symptoms were associated with two KDQOL subscale scores, whereas the other potential barriers were not associated with any subscale scores. These results suggest that difficulty chewing is the potential barrier with the greatest effect on the QOL. Furthermore, a previous Iranian study reported that difficulty chewing affected the clinical nutritional status of the patients,[18] which suggests that difficulty chewing can predict both QOL and malnutrition. In this context, chewing is very important for older adults, because it is associated with cognitive impairment, unintended weight loss, and mortality.[21] Moreover, patients receiving HD tend to have oral problems related to immunosuppression, renal osteodystrophy, or restricted oral fluid intake.[22] This would explain why patients who experience difficulty chewing would reduce their intake of hard-to-chew food, which may lead to energy shortage and nutritional imbalance.

Previous studies have also identified a close relationship between difficulty chewing and psychological problems. For example, difficulty chewing was closely related to a sense that life is not worth living (a lack of *ikigai*) in a previous Japanese study.[23] Our results also indicate that there is a significant relationship between difficulty chewing and psychological problems, as indicated by the *role functioning emotional* subscale ($p=0.004$). The Japanese National Health and Nutrition Survey found that no difficulty chewing was observed among 75.0% of 60−69-year-olds and 62.9% of 70−79-year-olds, and that malnutrition was associated with difficulty chewing among individuals aged >70 years old.[24] Thus, even in the general population, older adults have an increased risk of difficulty chewing. Moreover, the dental health in patients receiving HD is poorer than that in the general population.[22] Therefore, careful attention to oral problems is needed during the treatment of patients receiving HD in order to prevent the development of malnutrition and/or psychological problems.

Poor knowledge and poor appetite were significantly associated with low nutritional levels in previous studies.[10,18] However, we found that there was no difference in the serum albumin levels between the patients with vs. without potential barriers in the present study. On the other hand, the relationships between potential barriers and clinical parameters have been identified in previous observational and intervention studies;[10,12] however, there is currently little evidence regarding the relationships between the potential barriers and QOL. Nevertheless, our findings revealed that some potential barriers were closely associated with QOL, which suggests that potential barriers may have a greater effect on QOL than on clinical parameters. Identification of potential barriers can allow the patient and/or their caregivers to modify these factors. However, further studies are needed to confirm our findings and to determine whether the potential barriers have greater effects on QOL or on clinical parameters.

Limitation of this study

The present study has several limitations. First, we used a single-center cross-sectional design and examined a small sample of patients who could complete their activities of daily living and who did not have cognitive problems. These factors are associated with risks of selection bias. Also, adopted 6 kinds of potential barriers may not be represented for all HD patients in Japan since there is cultural difference between previous studies overseas and the present study. However, our patients were being treated in the outpatient setting and could live independently despite their advanced age, which suggests that our results are representative of patients who live independently in suburban non-nursing communities. Furthermore, population-level aging is common in developed countries, and our results indicate that the relationship between potential barriers and QOL of patients receiving HD, even if they live independently. Therefore, our result suggest the importance to study that the assessment and managing potential barriers will contribute better QOL of patients.

Conclusion

It was found that the presence of ≥ 1 potential barrier to adequate nutrition was associated with lower

KDQOL scores through this study. Difficulty chewing was the potential barrier associated with the greatest number of decreased KDQOL subscale scores, even after adjusting for age. These findings suggest that HD patients and their caregivers should carefully consider the potential barriers, especially difficulty chewing. Attempts to identify and address the assessment of potential barriers may help maintain or improve the QOL and reduce the risk of mortality. However, further longitudinal studies are needed to determine whether potential barriers exert the greatest effects on QOL or on clinical parameters.

Acknowledgements

The authors thank the director of study hospital and the chief of HD center at study hospital for allowing this study. We also thank the patients for their voluntary participation in the study. This work was supported by a Grant-in-Aid from the Project to Promote Leadership-workers for Community Health (Graduate School of Health Sciences, Gunma University).

Conflict of Interest: The authors declare that they have no conflict of interest.

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