ISSN 2434-0758
J.Asia.Reha.Sci.

Journal of Asian Rehabilitation Science

Vol.4 No.2 May 2021

Journal of Asian Rehabilitation Science

The Society of Asian Rehabilitation Science

The Journal of Asian Rehabilitation Science (ISSN 2434-0758) is published for the Society of Asian Rehabilitation Science. The journal is published quarterly.

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The Journal of Asian Rehabilitation Science
Vol.4 No.2, May
2021

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J. Asi. Reha. Sci.4(2):6-13,2021

The Journal of Asian Rehabilitation Science

Original Article

Changes of Muscle Thicknesses of the Trunk Muscles according to Independence Body position in Hospitalized Elderly Men Using Ultrasonography

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Abstract. [Purpose] The objective of this study was to clarify which muscles are essential for which posture independence for providing physiotherapy efficiently. [Subjects and Methods] In total, 40 men who were older than 70 years and receiving rehabilitation treatment were included in this study. The patients were grouped according to independence of position (14 standing, 16 sitting, and 10 lying). The muscle thicknesses of the right lumbar multifidus (L2) (LM (L2)), lumbar multifidus (L5) (LM (L5)), erector spinae (ES), external oblique (EO), internal oblique (IO), and transversus abdominis (TrA) were measured on longitudinal images obtained using ultrasonography. The muscle thicknesses were then compared among groups. [Results] The main effects were observed in the muscle thicknesses of the LM (L2), LM (L5), and ES. The muscle thicknesses of the LM (L2) and LM (L5) increased significantly in the independence group of standing position compared with those in the independence groups of lying and sitting position ($p<0.05$). Meanwhile, the muscle thickness of the ES increased significantly in the independence groups of sitting and standing position compared with that in the independence group of lying position ($p<0.05$). [Conclusion] Based on the results of the differences in each group, our findings suggest that back muscles are more important than abdominal muscles in these independent body positions; particularly, the ES is important for sitting independence, whereas the ES and LM are important for standing independence.

Key Words: Ultrasonography, Posture Independence, Trunk Muscle Thickness

(This article was submitted January.27, 2021, and was accepted April.5, 2021)

1. INTRODUCTION

The trunk muscles stabilize the trunk during movement, transmission of efficient power, and movement of stabilized arms and legs. In recent years, rehabilitation studies have aimed to shed light on the mechanisms of the trunk muscle and the effects of exercise on them. Verheyden et al.[1)] proved that the trunk performance of a stroke patient was significantly related to values of balance, gait, and functional ability. Ezure et al.[2)] performed functional assessments for the control of the trunk in patients with apoplexy and then compared the function, movement, and cognition associated with the paralyzed side based on Functional Independence Measure. They proved that a stroke patient's independence in daily life was related to the function of the trunk rather than the hemiparetic limbs. There are numerous cases in which the low strain of the trunk muscles requires care for basic positions and daily living activities.

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Therefore, it is important to evaluate and treat trunk muscle injuries in rehabilitation.

Moreover, studies have confirmed that the back muscles are correlated with independence in activities of daily lives and that exercise increases the efficiency. For example, when training a patient to achieve movement independence, it is necessary to efficiently train the trunk muscles in supine position. Saito et al.[3] divided weak elderly people into five groups according to sex and age and compared the muscle thicknesses. On computed tomography, the cross-sectional areas of the quadratus lumborum, greater psoas, and the spinal column (ES and LM) muscles are measured. When someone's independence is low, the size of the quadratus lumborum muscle is reduced. Moreover, Belavy et al.[4] examined nine healthy adult men who were bedridden for 60 days by comparing the cross-sectional areas of the ES, LM, quadratus lumborum, and iliopsoas muscles on magnetic resonance imaging before and after the bedridden period. All of the muscles were found to have reduced in size. However, these studies have problems including small numbers of participants, unexamined degree of autonomy of concrete movements, and lack of abdominal muscle measurements.

The objective of this study was to clarify which muscles are essential for which posture independence for providing physiotherapy efficiently. Therefore, considering the problems of the previous research, the thicknesses of the trunk muscles were compared among basic positions (standing, sitting, and lying) in hospitalized elderly men using ultrasonography.

2. SUBJECTS AND METHODS

The study protocol was approved by the Ethics Committee of International University of Health and Welfare Hospital (17-IO-101) and the International University of Health and Welfare (13-B-262). In total, 40 patients with ages over 70 years were included in this study (age, 83.2 ± 7.5 years; body mass index (BMI), 20.3 ± 3.4 kg/m^2: mean ± standard deviation). Each patient was undergoing rehabilitation treatment at the International University of Health and Welfare Shioya Hospital. The participants or their family members provided consent for their participation in this study. The exclusion criteria were as follows: paralysis (Brunnstrom Recovery Stage I–V), abnormal increase in the muscle tone of the upper and lower limbs or left/right difference, unstable general state (no permission from doctor to leave bed, and in view of the assessment criteria listed in Table 1), illness, injury, pain in the waist or abdomen, or previous lower back pain. Upper and lower limb muscle tone was assessed at the passive flexion extension of the elbow and knee joint referenced as Stroke Impairment Assessment Set.

Table 1 Evaluation criteria

Measurement is not performed in the following conditions
1. Resting pulse rate more than 120 / min
2. Diastolic blood pressure more than 120 mmHg
3. Systolic blood pressure more than 200 mmHg
4. Exertional angina
5. Fresh myocardial infarction within 1 month
6. Congestive heart failure
7. Significant arrhythmia other than atrial fibrillation
8. Palpitation and shortness of breath

The thicknesses of the right LM (L2), LM (L5), ES, TrA, IO, and EO were measured on longitudinal images obtained using a SonoSite 180+ ultrasound machine (FUJIFILM SonoSite Inc., Bothell, WA, USA). Based on previous studies[5 – 9], the thicknesses of the LM (L2) and LM (L5) were measured at 2 cm outside of the spinous process of the second and fifth lumbar vertebrae, with the probe placed perpendicularly to the spinal column. Furthermore, according to previous studies[8, 10, 11], the muscle thickness of the ES was measured at 5 cm outside of the spinous process of the third lumbar vertebra with the probe placed perpendicularly to the spinal column. As described in previous studies[8, 12, 13], the thicknesses of the TrA, IO, and EO were measured midway between the costal margin and the iliac crest along the right anterior axillary line. Table 1 shows the position of the probe for ultrasonography, whereas Table 2 shows the image

of ultrasonography for each muscle. The high-brightness region was not included in the measurement. Measurements were performed twice at the end of exhalation. The calculation of each muscle's thickness was performed using ImageJ (version 1.50i, National Institutes of Health, Bethesda, MD, USA). The average of two measurements was used as a representative value. Previous studies have confirmed the intra-rater reliability of abdominal muscle (EO, IO, and TrA) thickness measurements. A study has also demonstrated that sufficient intra-rater reliability can be obtained by performing the measurement twice[12]. The intra-rater reliability of back muscle (LM (L2), LM (L5), ES) thickness measurements was confirmed by the author himself because no previous study had examined this in the lateral position. For 20 healthy elderly men, the thickness of each back muscle was measured twice to confirm the result of ICC (1.2). The back muscle thicknesses were LM (L2), 0.95; LM (L5), 0.96; and ES, 0.97. The ICC (1.2) was 0.9 or higher, which indicated "great reliabilities." Therefore, it was measured twice. The muscle thicknesses of the EO, IO, and TrA were measured with the patients in the supine position. The muscle thicknesses of the LM (L2), LM (L5), and ES were measured with the patient in the left lying position to accommodate those who required intravenous fluid or nasogastric tube management. The left lateral position was maintained with a 45° hip joint flexion and 90° knee joint flexion. Verbal and manual corrections were made to prevent excessive pelvic and lumbar anterior–posterior rotation and rotation. In both postures, measurements were performed at the natural pelvic tilt. In both postures, measurements were performed at the natural pelvic tilt and straight the parietal region, ear canal, acromion, and greater trochanter. The participants were divided into three groups: the independence of lying position group (sitting assistance, standing assistance), the independence of sitting position group (no sitting assistance, standing assistance), and the independence of standing position group (no sitting assistance, no standing assistance). Sitting and standing position independence were defined as cases in which it was possible to hold a posture without support (backrest of a chair, wheelchair, or bed, support by a hand, or a seating system). The hold time was longer than 2 min, and it was similar to the evaluation criteria of the Berg's Balance Scale. The timing of measurement considered the participant's stabilized general state, and the physiotherapist, physician, or nurse representative considered that the independence of position did not change. Physicians and nurses are professionals who provide nearly 24-h general care and have the most accurate information in regards to determining the timing of measurements. Therefore, the timing of measurement was decided by three professionals Next, a physiotherapist with 8 years of experience evaluated changes in independence according to the timing of the measurement. Changes in independence were judged by referring to the general condition, Activities of Daily Living scale (Barthel Index) described in the medical record.

The normality of age, BMI, and each muscle thickness in each basic position were assessed using the Shapiro–Wilk test. Age and BMI were analyzed with one-way analysis of variance (ANOVA). ICC (1.2) was obtained based on the values calculated with the first and second measurements of each muscle thickness. Differences in the trunk muscle thickness among the independence group of position were examined using the ANOVA and Bonferroni tests. SPSS (version 19.0, IBM, Armonk, New York, USA) was used for analyses. The level of significance was set to 5 %.

This study was performed in accordance with the Declaration of Helsinki. The study's purpose and details were explained to the participants before the onset of this study. The measurements were made after consent was obtained.

3. RESULTS

The independence groups of standing, sitting, and lying position included 14, 16, and 10 patients, respectively. Age and BMI were determined to have no main effects. Details are listed in Table 2. The results of ICC (1.2) were abdominal muscle thickness (EO, 0.95; IO, 0.94; TrA, 0.95) and back muscle thickness (LM (L2), 0.99; LM (L5), 0.98; ES, 0.98). The muscle thickness values of each group are listed in Table 3. The muscle thicknesses of the LM (L2), LM (L5), and ES had main effects, whereas those of the EO, IO, and TrA did not. The muscle thicknesses of the LM (L2) and LM (L5) increased significantly in independence group of standing position versus the lying and sitting positions ($p<0.05$). There was no significant difference between the independence groups of lying and sitting position. The mean thickness of the ES muscle was determined to increase significantly in the independence groups of sitting and standing position compared with that in the independence group of lying position ($p<0.05$). There was no significant difference between the independence groups of sitting and standing position.

Table 2 The participant`s details

	The standing position independence group (n＝14)	The sitting position independence group (n＝16)	The lying position independence group (n＝10)	All (n＝40)
Cerebral infarction	n＝3	n＝3	n＝2	n=8
Pneumonia	n＝9	n＝8	n＝6	n＝23
Renal failure		n＝4	n＝2	n＝6
Cholangitis	n＝1			n＝1
Sepsis	n＝1			n＝1
Gastrointestinal bleeding		n＝1		n＝1
Age (years)	80.0 ± 7.4	84.5 ± 8.4	86.0 ± 5.7	83.3 ± 7.7
Heighat (cm)	160.2 ± 3.3	158.9 ± 4	158.9 ± 6.4	159.4 ± 4.5
Body weight (kg)	54.7 ± 9.0	48.2 ± 8.5	53.1 ± 9.2	51.7 ± 9.1
BMI (kg/m^2)	21.3 ± 3.4	19.0 ± 2.8	21.1 ± 3.8	20.3 ± 3.4

Table 3 The value of each muscle thickness of each independence of basic motion

	The standing position independence group (n＝14)	The sitting position independence group (n＝16)	The lying position independence group (n＝10)
LM(L2) (mm)	28.3 ± 5.9*, #	23.9 ± 3.6†	22.1 ± 3.1†
LM(L5) (mm)	31.1 ± 4.0*, #	27.3 ± 3.0†	25.9 ± 5.2†
ES (mm)	31.0 ± 3.1*	30.8 ± 1.7*	26.7 ± 6.3#, †
TrA (mm)	3.2 ± 1.6	2.4 ± 0.6	2.9 ± 0.9
IO (mm)	5.8 ± 2.3	6.1 ± 1.8	6.1 ± 2.7
EO (mm)	4.5 ± 1.4	3.9 ± 1.0	3.9 ± 0.9

Values are expressed as mean±SD

LM (L2): Lumber Multifidus(L2), LM (L5): Lumber Multifidus (L5), ES: Erector Spinae,
TrA: Transversus Abdominis, IO: Internal Oblique, EO: External Oblique

＊：p＜0.05 compared with The lying position independence group,
#：p＜0.05 compared with The sitting position independence group,
†：p＜0.05 compared with The standing position independence group

4. DISCUSSION

This study aimed to shed light on the relationship between trunk muscle thicknesses and independence of position. Therefore, considering the problems of previous studies, the trunk muscle thicknesses were compared among the independence group of standing, sitting, and lying position. Our findings suggested that the trunk muscle thicknesses differed among the independence groups.

The thicknesses of the LM (L2), LM (L5), and ES muscles had main effects, whereas those of the EO, IO, and TrA did not. This finding suggests that in elderly hospitalized patients, the back muscles are more important than the abdominal muscles in terms of achieving basic position independence. The abdominal muscles are farther from the lumbar spine than the back muscles, so they are considered to be less affected by gravity. The TrA and IO muscles are connected to the compartments with the LM and ES via the thoracolumbar fascia, which indirectly improves lumbar spine stiffness. In contrast, the LM and ES muscles directly attach to the lumbar spine, thus directly improving its stiffness[14]. In addition, compared with healthy elderly men, elderly hospitalized patients are prone to general muscle weakness and postural changes, such as kyphosis. Therefore, the above influence is likely to appear. Claus et al.[15] compared the measurements of the TrA, IO, EO, LM, and ES muscles in four sitting positions in healthy adults using wire and surface electromyography. As a result, compared with other postures, kyphosis involved diminished abdominal and back muscle activities.

The thickness of the ES muscles increased significantly in the independence group of sitting position ($p<0.05$). The thicknesses of the ES, LM (L2), and LM (L5) increased significantly in the independence group of standing position ($p<0.05$). According to this finding, it can be inferred that the required muscle mass of the spine increases during standing versus sitting. The base of support narrows and thus becomes unstable in the order of lying, sitting, and standing positions.

The thickness of the ES muscle increased significantly in the independence groups of sitting and standing position compared with that in the independence group of lying position ($p<0.05$). This finding suggested that the ES is important for sitting and standing independence. The thicknesses of the LM (L2) and LM (L5) did not differ significantly between the independence groups of lying and sitting position. The thickness of the ES muscle was significantly increased in the independence group of sitting position compared with the independence group of lying position ($p<0.05$). This suggested that the ES is important for sitting independence, whereas the LM is not. This is believed to be because the ES adheres to the ribs (retrosternal region) and thoracic spine (processus transversus) [14]. Given that the ribs and thoracic spine do not touch the ground, the ES is required. The ES is longer than the LM, and a large extension moment can be exerted that is mechanically convenient to support the thorax in the antigravity position. Bogduk et al.1[16] calculated the extension moment of each muscle using a model of the lumbar back muscles modeled by radiographs of nine normal volunteers in the upright position. The proportion of the extension moment was only 20 % for the LM, 30 % for the lumbar spine, and 50 % for the thoracic spine. The ES rather than the LM contributed to rib cage extension.

The thicknesses of the LM (L2) and LM (L5) muscles were increased significantly in the independence group of standing position compared with those in the independence groups of lying and sitting position ($p<0.05$). This suggested that the LM is important for standing independence because it acts as a shock absorber for receiving a moment coming from the lower limbs such as walking. Cheng et al.[17] studied the stresses of the intervertebral disc of the fifth lumbar vertebra and sacrum during walking and found the greatest burden at heel strike and just before the toes left the ground. Furthermore, Nielsen et al.[18] have examined the muscle activity of the back muscles during walking in healthy individuals using electromyography and found that the LM and ES muscles had increased activities in the initial contact and terminal stance phases compared with those in the mid-stance and mid-swing phases. Wilk et al.[19] studied a biomechanical model that included the ES and LM muscles and clarified that the LM muscle had stronger influences than the ES muscles on lumbar segment stability. Based on the results of these studies, patients in the independence of standing position group had to use their lower limbs sufficiently, which then increased the muscle mass of the LM, to sufficiently perform the standing action.

There are several limitations associated with this study.

In this study, comparisons were made according to the degree of independence. Independence was also shown to be dependent on factors other than muscle thickness such as physical fitness and activity level. Therefore, in the future, measuring factors such as physical ability and activity level simultaneously with muscle thickness will be necessary. This study examined the differences in trunk muscle thicknesses by position. However, for clinical applications, it is also necessary to examine the trunk muscles during various movements, such as load transfer and load change.

In this study, to eliminate the influence of sex-based differences, men were only included for analysis; in the future, it will be necessary to include women as well. Tanimoto et al.[20] and Gallagher et al.[21] measured body composition and found that the rate of decrease in muscle mass with age was faster in males than in females. Saito et al.[3] performed abdominal computed tomography imaging of sick elderly people In men, the higher the degree of independence in movement, the greater the amount of trunk muscle. In contrast, the trunk muscle mass did not change in women, regardless of the degree of independence in movement. These points demonstrate that it is necessary to examine sex-based differences.

Grouping of the participants unified the amount of assistance at the time of measurement. However, it does not consider the amount of assistance provided before hospitalization. In this study, the number of samples was small, and it was possible that the grouping would be difficult if the influence was considered. Therefore, the grouping was conducted without other considerations. In the future, it will be necessary to increase the number of samples and to consider their effects.

In this study, the diseases among the participants were diverse. Therefore, it is possible that these disease differences might have affected the research results. In order to generalize the results of this study, it is necessary to conduct the same study for each disease in the future.

This study has revealed the differences in trunk muscle mass among basic positions based on the degree of independence in elderly hospitalized patients. The basic knowledge based on which trunk muscles require focus during exercise therapy for the purpose of basic position independence has been established. The elderly population is currently increasing rapidly in Japan. Accordingly, the number of bedridden patients is increasing rapidly as well. Thus, the findings obtained in this study are considered very important and will help minimize the number of these patients. In the future, based on the results obtained in this study, we hope that exercise therapy will be performed and utilized in the rehabilitation field.

Funding and Conflict of interest

This work was supported by JSPS KAKENHI Grant Number 20K23259.

Conflict of Interest

The authors declare that they have no conflicts of interest related to this work.

Acknowledgement

We would like to thank Enago (www.enago.jp) for English language editing.
The authors are grateful to the participants for assistance with data acquisition.

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J. Asi. Reha. Sci.4(2): 14-20,2021

The Journal of Asian Rehabilitation Science

Original Article

Impact on the health-related quality of life of spouses caring for inpatients

－Cross-sectional survey of two hospitals in Shandong Province, China－

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Abstract. [Purpose] In this study, we clarify the factors that affect the health-related quality of life (HRQOL) of spouses (hereinafter, "family caregivers") who care for inpatients in Shandong Province, China. [Subjects and Methods] The participants were family caregivers (49 people) and care recipients (49 people) from two Shandong hospitals. For family caregivers, we used a self-administered questionnaire survey to collect data on the age, gender, caregiving duration, and HRQOL. For care recipients, healthcare professionals collected data on their main illness, gender, height, weight, and Barthel Index (BI). The analysis method used to compare the two groups was the Mann−Whitney test, and we used the Kruskal−Wallis test to compare three or more groups, with a statistically significant difference at the 5% level. [Results] The analysis results clarified that "caregiving period," "caregiving of six times or more per week," "no exercise habits," and "presence of substitute caregiver" affect HRQOL. We found that the care recipient's BI and the caregiver's age and HRQOL were not affected. [Conclusion] We found the following factors to affect the HRQOL of family caregivers: "caregiving period," "caregiving frequency," and "exercise habits."

Key Words: Inpatient spouse, Health-related quality of life, China

(This article was submitted April.1, 2021, and was accepted April.28, 2021)

1. INTRODUCTION

In China, those aged 60 years and over are considered elderly[1)]. China's elderly population is projected to exceed approximately 300 million in 2025, 360 million in 2030, and 400 million in 2035[2)]. In addition, the average life expectancy in China for males and females was 76.34 in 2015[3)]. At age 75 and over, the decline of their Activities of Daily Living (ADL), Instrumental Activities of Daily Living (IADL), etc., can be observed, and they are likely to require assistance, and in China, providing caregiving has become a serious problem[4)].

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In China, assistance (hereinafter referred to as "caregiving") that comes with the decreased ADL of inpatients is rarely carried out by hospital staff such as nurses and is customarily done by the patient's family. A large proportion of family members who care for patients are their spouses[5]. In general, caregiving imposes a heavy burden on the caregivers, Hanazato et al. (2016) revealed that for families who care for inpatients in China, assisting patients in toilet and bathroom transfers is associated with anxiety about caregiving[5]. In addition, the transfer movements needed to assist the patient tend to put a burden on the caregiver's lumbar region. Kawasaki et al. (2018) revealed that the prevalence of back pain among caregiving relatives in China is higher than among people who are over age 50[6]. Furthermore, in a study about caregivers who provide home care in China, Feng et al. revealed that eight hours or more of caregiving a day imposes a great burden on the caregiver[7]. Han et al. (2017) and Takemasa et al. (2012) found a link between the high sense of burden felt by caregivers and low health-related quality of life (HRQOL) [8, 9]. Since HRQOL is quality of life affected by illness and medical intervention, spouses caring for inpatients in China are at risk of health problems.

The region with the highest number of elderly persons in China is that of Shandong Province, which has 95,792,719 people [10]. Hospitals in China are broadly categorized from no-level to level 3, where level 3 concerns hospitals that can provide the most advanced medical care[11]. However, with the level 3 hospitals located in Shandong, no previous studies have focused on the HRQOL of spouses caring for inpatients in China. Therefore, the purpose of this study was to clarify the factors that affect the HRQOL of spouses who care for inpatients in Shandong Province, China.

2. SUBJECTS AND METHODS

The participants were family caregivers (49 people) and care recipients (49 people) from two level-3 hospitals well-equipped with rehabilitation facilities in Shandong Province, China. The survey period was from November 2015 to July 2017, and we asked the participants to complete a questionnaire survey. Family caregivers had to be spouses of the patient and have a good command of the Chinese language. The criteria excluded individuals with a history of illnesses such as cerebrovascular disease, Parkinson's disease, amyotrophic lateral sclerosis, and Alzheimer's disease that impede provision of care to patients; those who are wearing artificial limb prostheses due to amputation, and nurses or dispatched caregivers. A total of 49 people consisting of 16 males and 33 females met the criteria. The care recipients are the 49 spouses of the family caregivers. We provided the participants with an informed consent form that conformed to the principles of the Declaration of Helsinki and conducted the survey with the approval of the Research Ethics Committee of Miyagi University (Miyagi University-447).

We asked the family caregivers to fill out their own questionnaires. For the care recipients, the medical staff conducted the measurement tests, asked the questions, and filled out the questionnaires on their behalf. The questionnaire items gathered from the family caregivers were data on their age, gender, caregiving period, and HRQOL. Among these, the caregiving period used was the number of days from the day when caregiving started until the day the survey was conducted. For HRQOL, the study calculated utility value using Euro QOL five dimensions (EQ-5D). EQ-5D was calculated using the EQ-5D utility value conversion table after assessing five items: MOBILITY, SELF-CARE, USUAL ACTIVITIES, PAIN/DISCOMFORT, and ANXIETY/DEPRESSION.

For exercise habits, the questionnaire asked participants to select either "yes" or "no." For the sense of burden towards caregiving, the questionnaire asked participants to select an answer ranging from "none" to "a great deal" using the 5-point scale method. The questionnaire items gathered for the care recipient were data on the main illness name, gender, height, weight, and Barthel Index (BI). The study used the following analysis methods: the Mann–Whitney test for the comparison between two groups and the Kruskal–Wallis test for comparison between three or more groups. The study used the Bonferroni method to adjust the significance level in multiple comparisons and used IBM SPSS Statistics 26.0 as the statistical software, with a 5% statistical significance level ($p<0.05$).

3. RESULTS

The mean age (standard deviation) of family caregivers was 53.24 (8.95) years (males: 53.13 (10.06) years; females: 52.09 (8.51) years). As for gender, there were 16 males and 33 females. Asked about the presence of substitute caregivers, 28 participants answered "yes," and 21 answered "no." As for the sense of burden towards caregiving, 11 responded "not at all"; 25 responded "some"; 2 responded "normal"; 3 responded "considerably"; and 7 responded "a great deal." For the presence of exercise habits, 23 responded "yes," and 25 responded "no"; Caregiving frequency was 5x or fewer per week for 11 respondents and 6x or more per week for 37 respondents. Caregiving period was 0–3 months for 13 respondents, 4–6 months for 7 respondents, and 7 months or more for 29 respondents. The HRQOL was 0.89±0.12 (Table1).

Table 1 Basic attributes of family caregivers

	N	%		N	%
Age			**Exercise habits**		
Below 40 years old	4	8.2	Yes	23	46.9
40–60 years old	35	71.4	No	25	51
Over 60 years old	10	20.4	**Care time per day**		
Gender			Less than 8 hours	7	14.3
Male	16	32.7	More than 8 hours	42	85.7
Female	33	67.3	**Care frequency**		
Substitute Caregiver			5x or fewer per week	11	22.4
Yes	28	57.1	6x or more per week	37	75.5
No	21	42.9	**Caregiving period**		
Sense of burden towards caregiving			0–3 months	13	26.5
Not at all	11	22.4	4–6 months	7	14.3
Some	25	51	7 months and above	29	59.2
Normal	2	4.1		mean	SD
Considerably	3	6.1	**HRQOL**	0.89	0.12
A great deal	7	14.3			

As for the age of care recipients, four were under 40 years old; 28 were 40 to 60 years old; and 17 were over 60 years old. The main illnesses were as follows: stroke for 22 respondents, head trauma for 7, spinal cord injury for 8, Parkinson's disease for 1, Alzheimer's disease for 1, and other illness/no answer for 9. The BI was 50 points or more for 29 respondents, and fewer than 50 points for 20 respondents (Table2).

Table 2 Basic attributes of care recipients

	N	%
Age		
Below 40 years old	4	8.2
40–60 years old	28	57.1
Over 60 years old	17	34.7
Illness		
Stroke	22	44.9
Head trauma	7	14.3
Spinal cord injury	8	16.3
Parkinson's disease	1	2
Alzheimer's disease	1	2
Others	1	2
No answer	9	18.4
BI		
Over 50 points	29	59.2
Below 50 points	20	40.8

A comparison of HRQOL among three groups of patient caregivers, 0–3 months, 4–6 months, and 7 months or more, revealed a significant difference in the HRQOL of family caregivers ($p<0.003$). A multiple comparison of the three groups did not reveal a significant difference. Family caregivers who provided care more than 6x a week had significantly lower HRQOL than those who provided care fewer than 5x a week ($p<0.049$). Family caregivers with substitute caregivers had lower HRQOL than those who had no substitute caregivers ($p<0.006$).Family caregivers with no exercise habits had significantly

lower HRQOL than those with exercise habits ($p<0.014$). The results revealed no statistically significant difference between the care recipients' BI and the family caregivers' HRQOL ($P=0.728$). In addition, the results revealed no statistically significant difference between the age of family caregivers and their HRQOL ($P=0.669$).

4. DISCUSSION

The purpose of this study was to clarify the factors that affect the HRQOL of family caregivers who provide care for inpatients in Shandong Province, China. Results show that the factors that affect the HRQOL of family members are "caregiving period 7 months and above," "caregiving 6x or more per week," "no exercise habits," and "substitute caregiver is present," which are associated with HRQOL, suggesting that they had an effect. In addition, care recipients' BI and the age of family caregivers were not associated with HRQOL, which suggests that they had no effect.

The HRQOL of family caregivers who provide care 6x or more per week was low, and compared to family caregivers who provide care 5x or fewer per week, the caregiving time per week was longer. Presumably, the low HRQOL was due to the greater burden of caregiving that arises[7].

A comparison between the HRQOL among the three groups of family caregivers, 0–3 months, 4–6 months, and 7 months or more of providing care for inpatients, reveals a significant difference in the HRQOL of family caregivers ($p<0.003$). Multiple comparisons among the three groups did not reveal a significant difference. The HRQOL of family caregivers who have just started providing care is presumably affected because of the caregiving burden that arises due to their unfamiliarity with the method of caring for the patient and the hospital environment. Presumably, the longer caregiving period has helped family caregivers gradually become accustomed to caring for the inpatients, reducing the caregiving burden and increasing HRQOL.

The HRQOL of family caregivers with substitute caregivers was low. In recent years, the number of companies providing caregiving services in China has increased, and services that provide care on behalf of family caregivers have been established[12]. Hence, it is expected that family caregivers with low HRQOL values have dispatched caregiving workers from caregiving companies to care for the patient on their behalf.

Family caregivers without exercise habits had lower HRQOL values. Suzuki et al. (2012) state that lack of exercise habits tends to cause physical strain (stiff neck, shoulders, and lower back) [13]. In addition, according to Kawasaki et al. (2018), the prevalence of back pain among caregiving relatives in China is higher than among people over the age of 50, and many family caregivers may presumably be unable to exercise due to backpain and have low HRQOL values[6].

Han et al. (2017) discovered a relationship between the amount of care given to the care recipient and the sense of burden towards caregiving of the caregiver, but this study found no association between BI, which is the amount of care given to the care recipient, and HRQOL, which is associated with the sense of burden towards caregiving[8]. The participants in Han et al. (2017) were home caregivers whose care recipients have cerebrovascular diseases as their main illnesses[8]. This study includes illnesses such as cerebrovascular disease, head trauma, and spinal cord injuries, with the hospital as the caregiving environment. Therefore, there was presumably no association between the amount of care provided and the HRQOL of family caregivers because the participants' illnesses and caregiving environment differ from those of previous studies.

Although no statistical relationship was found between the age of family caregivers and HRQOL, the proportion of family caregivers in this study whose perceived caregiving burden was low from the midpoint was 73.4%. Since a large proportion of family caregivers felt that their sense of burden towards caregiving was less than the midpoint, there was presumably no relationship between age and HRQOL.
This study may serve as a reference for forming a support system to maintain and improve the HRQOL of family caregivers of inpatients in China.

One limitation of this study is that, since it was conducted on two hospitals in Shandong Province, China, the results cannot be considered applicable and would affect the HRQOL of family caregivers throughout China. In addition, because of a small number of samples, further verification with an increased number of samples will be necessary in the future.

This study is a revision of the content reported in the E-poster presentation at the 68th Autumn Meeting of the Japanese Society for the Study of Social Welfare.

Funding and Conflict of interest

There are no conflicts of interest to report in this study.

Conflict of Interest

The authors declare that they have no conflicts of interest related to this work.

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