■ORIGINAL ARTICLE

Influence of Shoulder Joint Function and Postoperative Subjective Symptoms on Health Related QOL of Breast Cancer Patients

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Abstract: Purpose: The purpose of this study was to investigate the psychological effects on health-related quality of life (HRQOL) of postoperative range of motion of the shoulder joint and subjective symptoms in patients with breast cancer who underwent rehabilitation.
Methods: In 79 patients with breast cancer surgery who underwent rehabilitation during hospitalization, we investigated temporal changes in the range of shoulder joint function (flexion of shoulder joint/abduction angle), postoperative subjective symptoms (surgical site pain, tightness, and anxiety regarding the disorder), and HRQOL scales (FACT-B and EQ-5D-5L) from before to 6 months after surgery and examined the factors relating to HRQOL.
Results: The range of shoulder joint movement was significantly decreased even from pre-operation to 1 month after surgery, but subjective symptoms had significantly improved at 6 months after surgery. Multivariable regression analysis showed that postoperative feelings of anxiety felt at 1, 3, and 6 months after surgery were a significant variable influencing the FACT-B and EQ-5D-5L scales. The path coefficients of the standard partial regression coefficients of breast cancer patients at 6 months postoperatively by covariance structure analysis were 0.66 for the EQ-5D-5L effective value, 0.94 for FACT-B, 0.47 for shoulder joint function, and −0.64 for postoperative subjective symptoms as the latent variables of HRQOL.
Conclusion: The results suggested the importance of interventions that focus on postoperative subjective symptoms to possibly improve not only patient function but also postoperative HRQOL.

Keywords: breast cancer, health-related QOL, shoulder joint, subjective symptoms, structural equation modeling

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1. Introduction

About 70,000 people were affected with breast cancer in Japan in 2012, and the prevalence rate was 113 per 100,000 people. Although breast cancer affects a high number of patients and the incidence rate is high, the 5-year relative survival rate is 91.1%. Among cancers with high survival rates, thyroid cancer has the highest rate, skin cancer is second, and breast cancer is third [1]. Thus, treatment of breast cancer is highly likely to be lifesaving.

Breast cancer treatment is performed through a combination of surgical therapy, radiotherapy, chemotherapy, and endocrine therapy. Over time, surgical therapy has changed to less invasive surgery. Sentinel lymph node biopsy reduces upper limb dysfunction associated with breast cancer surgery. The onset of upper limb dysfunction was reported to occur in 66% of patients in an axillary lymph node dissection group and in 36% in a sentinel lymph node biopsy group [2]. However, after sentinel lymph node biopsy, the frequency of limited shoulder joint flexion is 37−100%, that of limited abduction is 40.8−100%, and that of upper limb

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dysfunction is high [3]. McNeely *et al.* [4] reviewed the effects of postoperative rehabilitation in 24 randomized, controlled trials against upper limb dysfunction caused by breast cancer treatment. Rehabilitation of 3 months or more performed on the operation-side shoulder joint of postoperative breast cancer surgery patients significantly improved the range of shoulder joint flexion over the short term compared with the control group. Shoulder joint function was also reported to improve significantly at 1 month postoperatively. Another report on the prevention of breast cancer recurrence showed that the risk of breast cancer recurrence is suppressed by physical activity [5]. Also, a review of 31 prospective studies of the association between physical activity and breast cancer risk reported a high relative risk of 0.88 for the recurrence of female breast cancer in women with low physical activity [6].

However, Shimozuma [7] considered not only hard outcome measures such as postoperative impaired upper limb function and survival but also quality of life (QOL), an outcome measured from the patient's point of view. From the idea of measuring or evaluating areas that can be improved (or worsened) by interventions such as treatment and care, healthcare providers promote health, which is one part of the four main elements reported by Ferrell and colleagues [8] that makes up health-related QOL (HRQOL) of cancer patients: physical, psychological, social, role, and functional. In addition, HRQOL is based on patient-reported outcomes (PROs), i.e., any report on patient health status obtained directly from the patient without any interpretation. PROs can comprehensively measure the effect of mental and physical functions, approaches to activities, and participation on an individual's levels of happiness, satisfaction, and other factors [9]. In their review, Naaman *et al.* [10] reported a moderate improvement effect of psychological intervention on the HRQOL of breast cancer patients at all stages.

Leach *et al.* [11] reported that a 24-week exercise intervention improved HRQOL and depression, and Wittmann *et al.* [12] reported that postoperative HRQOL involves physical pain, anxiety, and depression. Gordon *et al.* [13] found that an 8-month exercise intervention was effective in improving HRQOL and cost-effectiveness.

Taghian *et al.* [14] reported that postoperative lymphedema development is associated with worsening of HRQOL. Coyne *et al.* [15] reported that breast cancer patients have been in good communication with their families, that they can play a domestic role that is the same as before surgery, and Ristevska-Dimitrovska *et al.* [16] reported that having resilience, which they defined as "Psychological resilience represents an ability of a person to protect his/her mental health when faced with adversity such is the cancer diagnosis [17]", is a factor that can keep HRQOL high. These reports on HRQOL of breast cancer patients showed multifaceted improvement in HRQOL due to psychological/motor intervention, the presence of lymphoedema, HRQOL in terms of family relations and psychological resilience for breast cancer. However, it has not been clarified how the HRQOL of the postoperative breast cancer patient is related to disorders of shoulder joint range of motion (ROM) and changes in the psychological state that may occur postoperatively. By considering these changes over time, we can clarify how rehabilitation after surgery contributes to the improvement of HRQOL in patients after breast cancer surgery.

Structural equation modeling (SEM) has attracted attention as a statistical method to verify causal relations [18]. SEM allows a visual understanding of the relation between variables and can verify the relation between latent variables by assuming multiple observation variables as latent variables. Thus, the causal relation of factors contributing to HRQOL of patients after breast cancer surgery can be concretely and visually verified using SEM. Furthermore, rehabilitation of breast cancer surgery patients to improve their HRQOL is thought to be possible.

The purpose of this study was thus to investigate psychological changes and HRQOL, mainly in terms of shoulder joint motion and subjective symptoms due to surgical invasion, from the preoperative period to 6 months postoperatively in patients with breast cancer who underwent rehabilitation to elucidate the factors relating to HRQOL and their causal relations.

2. Methods

2-1. Subjects

The subjects comprised patients admitted to the hospital affiliated with Hamamatsu University School of Medicine from April 2016 to September 2017. Patients receiving postoperative rehabilitation prescribed to female breast cancer surgery patients agreed to participate in the research and were investigate up to 6 months postoperatively. Exclusion criteria included patients who required reoperation due to wound infection, who underwent bilateral resection, who had serious complications such as dementia or higher brain dysfunction, who were judged as inappropriate by their attending physician, and who did not provide consent to participate in this research.

2-2. Investigation

Patients were evaluated at 5 points: the day before surgery, the start date of postoperative rehabilitation, and at 1, 3, and 6 months postoperatively. Survey items were shoulder joint ROM, passive shoulder joint flexion/abduction ROM (shoulder joint flexion/abduction), and the Visual Analogue Scale (VAS), which was used to evaluate subjective symptoms after surgery, including pain, the feeling of tightness (tightness), and the sense of anxiety about the disease (anxiety). There is much clinical experience with these three items. Regarding pain and tightness, Verbelen *et al.* [3] reported that at 2 years after surgery, rates of tightness accompanied by pain and numbness associated with shoulder dysfunction ranged from 5 to 50%.

In addition, because Naaman *et al.* [10] reported that reduction in anxiety (in terms of illness and future life) and alleviation of depression improved QOL of breast cancer surgery patients and Wittmann *et al.* [12] reported that postoperative HRQOL involves physical distress, anxiety, and depression, anxiety was thus used as an indicator of a change in the patients' psychological state.

In the VAS, the left end of the 10-cm scale was defined as "no subjective symptoms at all", and the right end was defined as "the subjective symptoms were very strong". The distance from the left end to the position indicated by the subject was then measured.

As breast cancer disease-specific scales assessing HRQOL, the Functional Assessment of Cancer Therapy-Breast (FACT-B) [19] and the inclusive scale EuroQol-5 Dimension-5 Level (EQ-5D-5 L) [20−23] were used. The FACT-B consists of 37 items, including sub-items related to physical, social, mental, and functional health, and breast cancer, and the score of the FACT-B: TOTAL ranges from 0 to 144. We also used the 24-item FACT-B Total Outcome Index (FACT-B: TOI), which assesses physical + functional + breast cancer-related items and is regarded as the indicator most reflecting the effect of intervention research. Scores range from 0 to 92.

The EQ-5D-5L calculates utility value. Health conditions of five items, "degree of movement", "management of personal belongings", "activities of ordinary people", "pain/discomfort", and "anxiety/obsessive", are assessed at 5 stages: stage 1, "none"; stage 2, "slight"; stage 3, "moderate"; stage 4, "quite"; and stage 5, "not possible" or "extreme". The utility value ranges from −0.025 to 1.000, with values closer to 1.000 indicating a more complete health condition. The utility value, which is calculated using a conversion table based on a healthy person in Japan [20], makes it possible to compare HRQOL for each disease. It is one indicator used to judge intervention effectiveness in the rehabilitation field in Japan and is the most frequently used comprehensive scale in Japan [24]. The English version was finalized in 1990 [20, 21], and the Japanese version was finalized in 1997 [22]. Originally comprised of three levels in 2015, the EQ-5D-5L Japanese version with 5 levels for higher accuracy subsequently became available as a comprehensive measure to calculate utility value [23].

We obtained the following basic attributes of the subjects from their medical records: age, time from operative day to each evaluation, sex, surgical side, handedness, occurrence (initial incidence/recurrence), cancer stage classification, operation type (partial excision/total resection), breast reconstruction surgery, range of lymph node dissection (sentinel lymph node biopsy/axillary lymph node dissection), and adjuvant therapy (chemotherapy/radiotherapy/endocrine therapy).

2-3. Rehabilitation intervention

During hospitalization and after receiving physician approval, an occupational therapist provided postoperative rehabilitation five times/week for 20 minutes each week. The intervention included automatic movement of the shoulder joint through flexion, external rotation, and lateral rotation within the pain range and stretching of the pectoralis major muscle including the skin/subcutaneous tissue and the incision site. Preoperatively and at discharge, guidance was provided on surgical site protection and prevention of lymphedema (guidance on three points of ADL/IADL behavior: 1) avoiding pressure on the operative side, 2) infection prevention, and 3) skin care). After discharge, we confirmed and provided the patients with self-practice and living instructions at the time of evaluation.

2-4. Statistical analysis

The results of the FACT-B and EQ-5D-5L were calculated using conversion tables. To examine the changes at the five evaluation time points, we used the multiple comparison test (Steel-Dwass method). We analyzed the association of HRQOL of the breast cancer patients at the five times with Spearman's rank correlation coefficient. The correlation between scores (i.e., r value) was graded as absent (< 0.20), poor (0.20−0.34), moderate (0.35−0.50), and strong (> 0.50) [22]. We used stepwise selection in multiple regression analysis to search for factors related to HRQOL at four times: postoperatively and at 1, 3, and 6 months later. Dependent variables included the HRQOL scales FACT-B: TOI/TOTAL and EQ-5D-5L, and the independent variables were the five items of flexion/abduction of the shoulder joints and the postoperative subjective symptoms of pain, tightness, and anxiety.

We used SEM to create a causal model of the HRQOL of the patients after breast cancer surgery. The postoperative HRQOL of the patients affected the utility value of the FACT-B: TOI/TOTAL and EQ-5D-5L, and from the evaluated items, it was hypothesized that two factors were influenced by the latent variables: postoperative shoulder joint function and postoperative subjective symptoms. Anxiety was used as the indicator of a change in psychological state. Thus, pain, tightness, and anxiety were assumed to represent the latent variables of postoperative subjective symptoms.

We examined the path diagram created by SEM. The degree of conformity in the figure was judged by the degree of freedom, $\chi 2$ value, comparative fit index (CFI), and root mean squares error of approximation (RMSEA). For the degree of conformity of the path diagram, the CFI is close to 1, RMSEA is < 0.1, and the fit is good. Analysis results were examined by the path coefficient, which directly represents the strength of the relation between the variables; the relation becomes stronger as the numerical value increases.

Because the number of patients required for SEM and multiple regression analysis is large, we determined the number of patients required on the basis of the detection power of the multiple regression analysis. We set one dependent variable and five independent variables. G-POWER 3.0 showed an $\alpha = 0.05$, $1 - \beta = 0.8$, and thus, the required number of patients was estimated to be 50. IBM SPSS Statistics, AMOS Ver 24, and Excel Statcel 4 were used for the statistical analyses, and the significance level was set to $p = 0.05$.

2-5. Ethical procedures

This research was approved by the Ethics Committee of Hamamatsu University School of Medicine (approval no. E16-142) and Niigata University of Health and Welfare (17739). This study was conducted with sufficient explanation of the procedures in writing, and written informed consent was obtained from all participants. Patients participated of their own free will and could leave the study at any time.

3. Results

Among the original 103 subjects, 79 patients (all women) could be followed through the full 6 months after surgery. Twenty-four patients met the exclusion criteria, which included male (2), bilateral resection (3), reoperation due to wound infection (3), treatment at another hospital (5), and exclusion due to patient circumstances (11). Patient characteristics are shown in Table 1. The average age of the subjects was 56.7 ± 12.0 years, and preoperative evaluations were carried out in all of them. The mean period from the operative day to each postoperative evaluation point was as follows: postoperatively, 2.5 ± 3.9 days; 1 month, 29.7 ± 7.3 days; 3 months, 91.0 ± 13.9 days; and 6 months, 179.0 ± 13.6 days.

The surgical side was right in 30 (38%) and left in 49 (62%) patients, and the dominant hand was right in 77 (97%) and left in 2 (3%) patients. Surgical methods included partial surgical procedures in 17 (22%) and total excision in 62 (78%) patients, and the lymph node

Table 1. Patient characteristics.

		Mean	SD
Age (yrs)		56.7	12.0
Period to evaluation (days)	Postoperative	2.5	3.9
	1 month	29.7	7.3
	3 mouths	91.0	13.9
	6 mouths	179	13.6
		N (79)	%
Operative side	Right	30	38
	Left	49	62
Dominant hand	Right	77	97
	Left	2	3
Onset	First	77	97
	Recurrence	2	3
Stage classification	0	21	26
	I (A, B)	23	29
	II (A, B)	25	32
	III (A, B, C)	10	13
	IV	0	0
Operation type	Partial removal	17	22
	Total removal	62	78
Breast reconstruction	Yes	13	16
	No	66	84
Dissection area	Sentinel lymph node biopsy	66	84
	Axillary lymph node dissection	13	16
Chemotherapy	Yes	31	39
	No	48	61
Radiation therapy	Yes	26	33
	No	53	67
Endocrine therapy	Yes	50	63
	No	29	37

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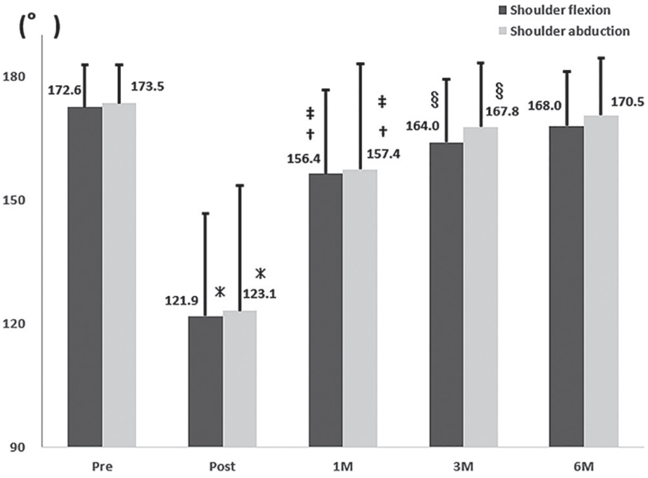
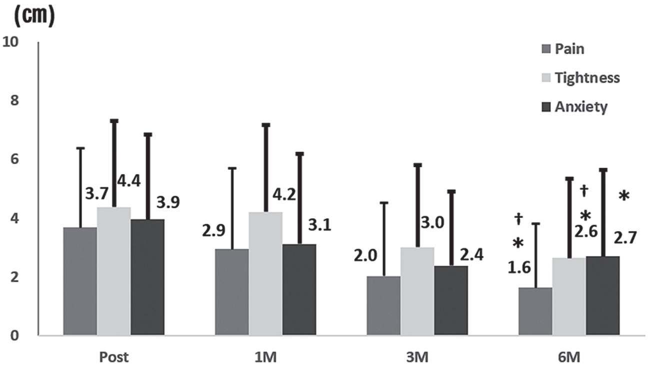


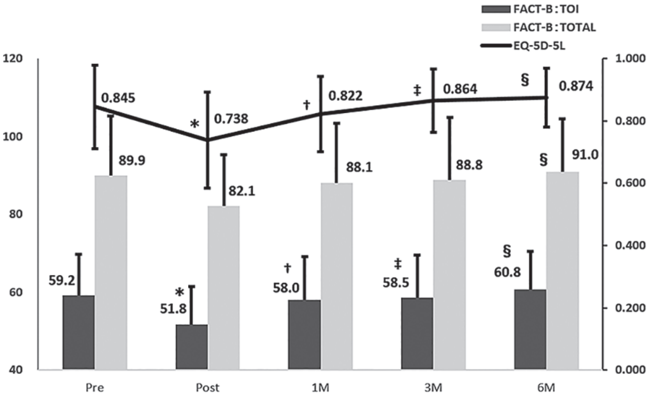
* Pre vs Post, † Pre vs 1M, ‡ Post vs 1M, § 1M vs 3M
Steel-Dwass method $p < 0.05$

Fig. 1. Changes in shoulder joint function.
Both flexion and abduction of the shoulder joints decreased significantly from the preoperative to postoperative period but significantly improved from 1 month after surgery. However, even at 1 month postoperatively, function was significantly lower compared with that preoperatively.



* Post vs 6M, † 1M vs 6M
Steel-Dwass method $p < 0.05$

Fig. 2. Changes in subjective symptoms after surgery.
Pain, tightness, and anxiety improved significantly from immediately postoperatively to 6 months postoperatively.



* Pre vs Post, † Post vs 1M, ‡ Post vs 3M, § Post vs 6M
Steel-Dwass method $p < 0.05$

Fig. 3. Changes in HRQOL scales.
The FACT-B: TOI and EQ-5D-5L scores decreased significantly from the preoperative to postoperative time points and began to improve significantly from one month after surgery. The FACT-B: TOTAL score improved significantly by 6 months after surgery.
EQ-5D: EuroQol 5 Dimension-5 Level, FACT-B: Functional Assessment of Cancer Therapy-Breast, TOI: Total Outcome Index.

dissection range included sentinel lymph node biopsy in 66 (84%) and axillary lymph node dissection in 13 (16%) patients.

3-1. Transition of each scale

The transition of shoulder joint function is shown in Fig. 1. Both flexion and abduction of the shoulder joints decreased significantly from the preoperative to postoperative period and began to significantly improve from 1 month after surgery. Even at 1 month postoperatively, function was significantly lower compared with that preoperatively. The transition of postoperative subjective symptoms is shown in Fig. 2. Pain, tightness, and anxiety improved significantly from immediately postoperatively to 6 months postoperatively.

The transition of each HRQOL scale is shown in Fig. 3. The FACT-B: TOI and EQ-5D-5L scores decreased significantly from the preoperative to postoperative time points and began to improve significantly from one month after surgery. The FACT-B: TOTAL score improved significantly by 6 months after surgery.

3-2. Relation between the scales at each time point

The EQ-5D-5L showed poor positive correlation with shoulder joint abduction after surgery (r = 0.234) and moderate negative correlation with pain (r = −0.414), tightness (r = −0.348), and anxiety (r = −0.408). Shoulder joint flexion/abduction showed poor positive correlations with EQ-5D-5L at 1 month (flexion/abduction: r = 0.266/r = 0.340), 3 months (r = 0.320/r = 0.288), and 6 months (r = 0.240/r = 0.300) after surgery. Postoperative subjective symptoms (pain/tightness/anxiety) also showed poor positive correlation and moderate to strong negative correlation with EQ-5D-5L at 1 month (pain/tightness/anxiety: r = −0.413/r = −0.330/r = −0.502), 3 months (r = −0.461/r = −0.418/r = −0.642), and 6 months (r = −0.480/r = −0.480/r = −0.550) after surgery.

The FACT-B: TOI showed poor to strong negative correlations with postoperative subjective symptom (pain/tightness/anxiety) postoperatively (r = −0.320/

r = −0.339/r = −0.434) and at 1 month (r = −0.453/r = −0.382/r = −0.562), 3 months (r = −0.347/r = −0.270/ r = −0.606), and 6 months (r = −0.411/r = −0.456/r = −0.626) after surgery. A poor to moderately positive correlation with shoulder joint flexion/abduction was observed at 6 months (r = 0.333/r = 0.405) after surgery. The FACT-B: TOTAL also showed poor to strong negative correlations with postoperative subjective symptom (pain/tightness/anxiety) postoperatively (r = −0.243/ r = −0.305/r = −0.504) and at 1 month (r = −0.443/r = −0.367/r = −0.560), 3 months (r = −0.313/r = −0.255/ r = −0.541), and 6 months (r = −0.476/r = −0.508/r = −0.587) after surgery. A poor positive correlation with shoulder joint flexion/abduction was present at 6 months (r = 0.325/r = 0.368) after surgery. All correlation coefficients were $P < 0.05$.

3-3. Factors influencing each HRQOL scale (Table 2)

The EQ-5D-5L was adopted as the model for anxiety/pain after surgery, anxiety at 1 month after surgery, shoulder joint abduction and anxiety at 3 months, and anxiety and pain at 6 months after surgery. The FACT-B: TOI was adopted as the model for anxiety/tightness after surgery, anxiety/pain at 1 month after surgery, anxiety at 3 months after surgery, and anxiety/shoulder joint flexion at 6 months after surgery. The FACT-B: TOTAL was adopted as the model for anxiety after surgery, anxiety/pain at 1 month after surgery, anxiety at 3 months after surgery, and anxiety/tightness at 6 months after surgery.

3-4. Covariance structure model of HRQOL in breast cancer patients

Figure 4 shows the path diagram of a patient at 6 months after breast cancer surgery. The suitability of this study as indicated by the CFI of 0.929 and RMSEA of 0.138 was generally good. The path coefficients for the latent variables of “HRQOL of patients after breast cancer surgery” were 0.93 for FACT-B: TOI, 0.94 for FACT-B: TOTAL, 0.66 for EQ-5D-5L, 0.47 for “Surgical shoulder joint function”, and -0.64 for “Postoperative

Table 2. Predictive factors of HRQOL scales.

		Extraction	B	95%CI	β	t	Adjusted R^2	p
EQ-5D-5L	Postoperative	Pain	−0.022	−0.035−−0.010	−0.376	−3.674	0.275	**
		Anxiety	−0.018	−0.029−−0.007	−0.335	−3.270		
	1M	Anxiety	−0.016	−0.023−−0.008	−0.390	−4.017	0.312	**
		Shoulder abduction	0.002	0.001−0.425	0.376	3.874		
	3M	Anxiety	−0.024	−0.032−−0.015	−0.587	−5.753	0.334	**
	6M	Anxiety	−0.014	−0.022−−0.007	−0.466	−3.747	0.311	*
		Pain	−0.012	−0.021−−0.003	−0.275	−2.539		
FACT-B:TOI	Postoperative	Anxiety	−1.293	−1.998−−0.585	−0.384	−3.600	0.260	**
		Tightness	−0.961	−1.665−−0.258	−0.286	−2.726		
	1M	Anxiety	−1.692	−2.412−−0.971	−0.459	−4.680	0.365	**
		Pain	−1.152	−1.949−−0.356	−0.283	−2.885		
	3M	Anxiety	−2.563	−3.456−−1.670	−0.586	−5.736	0.333	**
	6M	Anxiety	−2.077	−2.745−−1.410	−0.577	−6.217	0.422	**
		Shoulder flexion	0.211	0.065−0.356	0.268	2.888		
FACT-B:TOTAL	Postoperative	Anxiety	−2.528	−3.444−−1.612	−0.550	−5.506	0.292	**
	1M	Anxiety	−2.523	−3.526−−1.520	−0.495	−5.014	0.358	*
		Pain	−1.282	−2.390−−0.173	−0.277	−2.305		
	3M	Anxiety	−3.566	−4.913−−2.219	−0.555	−5.290	0.297	**
	6M	Anxiety	−2.440	−3.502−−1.378	−0.484	−4.588	0.408	*
		Tightness	−1.360	−2.440−−0.280	−0.266	−2.515		

EQ-5D-5L: EuroQol 5 Dimension-5 Level, FACT-B: Functional Assessment of Cancer Therapy-Breast, TOI: Total Outcome Index, CI: Confidence interval

Multiple regression analysis: Stepwise method *: $p < 0.05$, **: $p < 0.01$

The EQ-5D-5L was adopted as the model for anxiety/pain after surgery, anxiety at 1 month after surgery, shoulder joint abduction and anxiety at 3 months, and anxiety and pain at 6 months after surgery. The FACT-B: TOI was adopted as the model for anxiety/tightness after surgery, anxiety/pain at 1 month after surgery, anxiety at 3 months after surgery, and anxiety/shoulder joint flexion at 6 months after surgery. The FACT-B: TOTAL was adopted as the model for anxiety after surgery, anxiety/pain at 1 month after surgery, anxiety at 3 months after surgery, and anxiety/tightness at 6 months after surgery.

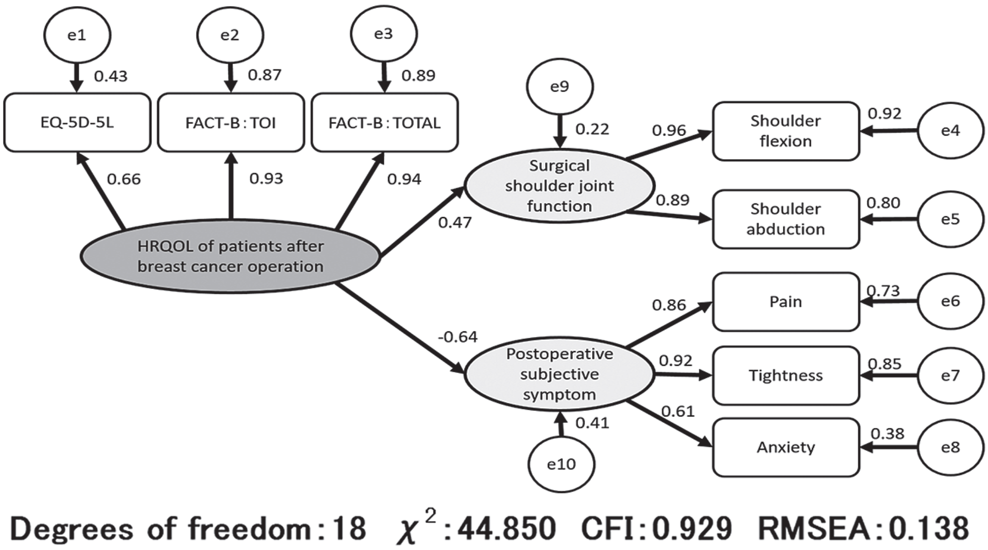


Fig. 4. Six-month postoperative path diagram.
The path coefficients for the latent variables of "HRQOL of patients after breast cancer surgery" were 0.93 for FACT-B: TOI, 0.94 for FACT-B: TOTAL, 0.66 for EQ-5D-5L, 0.47 for "Surgical shoulder joint function", and −0.64 for "Postoperative subjective symptoms". Those of the latent variables for "Surgical shoulder joint function" were 0.96 for "Shoulder flexion" and 0.89 for "Shoulder abduction", and those of the latent variables for "Postoperative subjective symptoms" were 0.86 for pain, 0.92 for tightness, and 0.62 for anxiety. CFI: comparative fit index, EQ-5D: EuroQol 5 Dimension-5 Level, FACT-B: Functional Assessment of Cancer Therapy-Breast, RMSEA: root mean squares error of approximation, TOI: Total Outcome Index.

subjective symptoms". Those of the latent variables of "Surgical shoulder joint function" were 0.96 for "Shoulder flexion" and 0.89 for "Shoulder abduction", and those of the latent variables of "Postoperative subjective symptoms" were 0.86 for pain, 0.92 for tightness, and 0.62 for anxiety.

4. Discussion

We investigated the psychological changes and factors affecting the HRQOL of breast cancer patients who underwent rehabilitation primarily in terms of shoulder joint movement and subjective symptoms due to surgery from preoperatively to 6 months after surgery. Recent HRQOL studies of breast cancer patients showed that 6 to 8 months of exercise intervention and also psychological interventions such as counseling improve HRQOL [11, 13]. The scales used to assess HRQOL outcomes in a previous study included the disease-specific FACT-B scale and the comprehensive Short-Form-36-Item Health Survey [10].

We could find no reports combining the use of the EQ-5D-5L and FACT-B to examine the changes in preoperative to postoperative HRQOL over time in patients with breast cancer surgery. Calculating disease specificity and utility value at each time point after surgery can diversely capture the HRQOL of breast cancer patients and can lead to analyses of the cost-effectiveness of treatment. By investigating the causal relations, rehabilitation to improve the HRQOL of breast cancer patients can be examined. We believe that the results of the present study are of high significance and discuss the three salient findings obtained from the results of this study below.

4-1. Shoulder joint function, postoperative subjective symptoms, and characteristics of HRQOL over time

Shoulder joint function decreased significantly at 1 month postoperatively compared to that preoperatively. The postoperative subjective symptoms of pain, tightness, and anxiety improved significantly 6 months after surgery. HRQOL significantly decreased from the preoperative to initial postoperative period as indicated by the FACT-B: TOI and EQ-5D-5L scales but significantly improved from 1 month after surgery. Declining shoulder joint function due to surgical invasion can have an effect even after more than 1 year of follow-up [26]. Thus, it seems that shoulder joint function cannot be improved within the first month after surgery. Because pain and tightness did not show significant improvement until 6 months after surgery, the influence of surgical invasion was thought remain until then.

Anxiety was significantly improved at 6 months postoperatively. Lessening of the degree of involvement of physical pain, anxiety about recurring metastasis, and difficulty in adapting to life after treatment can help to improve HRQOL [12], but the psychological burden can lower HRQOL even at 18 months after surgery [10]. Although significant improvement was shown at 6 months after surgery in the present study, subjective symptoms could still remain after surgery. FACT-B is a specific scale for breast cancer disease, and FACT-B: TOTAL showed significant improvement from immediately postoperatively to 6 months after surgery. However, FACT-B: TOI and EQ-5D-5L scores significantly decreased from the preoperative to immediate postoperative period but significantly improved from 1 month after surgery.

FACT-B: TOI is regarded as the index that most closely reflects the effect of intervention research, and its subitems include physical, functional, and breast cancer-related items [19]. It is thought to best reflect the physical and psychological burden of surgical invasion and adjuvant therapy, and we thought that this influence was reflected in this study as well. The EQ-5D-5L comprehensively reflects the physical and psychological situation during the measurement period [23], and it similarly reflected the situation in the present study.

4-2. Elucidation of factors affecting HRQOL

There was a poor positive correlation between the EQ-5D-5L and shoulder joint function. Postoperative subjective symptoms showed a negative correlation with moderate pain at all times, a poor-to-moderate negative correlation with tightness, and a moderate-to-strong negative correlation with anxiety. This suggests that interventions not only for shoulder joint function but also for postoperative subjective symptoms are necessary. The multiple regression analysis showed the factors affecting the EQ-5D-5L to be pain and anxiety after surgery, anxiety and shoulder joint abduction at 1 month, anxiety at 3 months, and anxiety and pain at 6 months postoperatively.

These findings revealed that surgical invasion from immediately postoperatively to 1 month postoperatively affected pain at the operative site and ROM of the shoulder joint, especially the restriction of abduction. In addition, anxiety affected both periods, and the relation become stronger as the postoperative course continued. As part of a rehabilitation program after surgery, automatic movement incorporating shoulder joint abduction and stretching mainly of the pectoralis muscle, which acts on the skin and subcutaneous tissue of the surgical wound, within a range in which pain does not occur to relieve subjective symptoms after surgery, and the necessity of life guidance and psychological follow-up after discharge are suggested.

However, both the FACT-B: TOI and TOTAL showed a poor-to-moderate positive correlation with shoulder joint function at 6 months after surgery. Postoperative subjective symptoms showed a poor-to-moderate negative correlation between pain and tightness and a negative correlation with moderate-to-strong anxiety at all times.

The multiple regression analysis revealed that the factors influencing FACT-B: TOI were anxiety and tightness after surgery, anxiety and pain at 1 month, anxiety at 3 months, and anxiety and shoulder joint flexion at 6 months after surgery. The factors affecting FACT-B: TOTAL were anxiety after surgery, anxiety and pain at 1 month, anxiety at 3 months, and anxiety and tightness at 6 months after surgery. As with the EQ-5D-5L, anxiety affects all periods, and the relation is stronger as the time course progresses. In addition to evaluating the comprehensive HRQOL of cancer patients, FACT-B contains breast cancer-related items that include symptoms (hair loss, pain, lymphedema, weight change, and decrease in physical strength) due to morphological changes after excision and adjuvant therapy and the patient's identification as a woman. Also, because anxiety was present across the entire time course, it was thought that these factors were also affected.

4-3. Causal relation of factors constituting HRQOL of patients after breast cancer surgery

In this study, HRQOL of breast cancer patients at 6 months postoperatively influenced each HRQOL scale (path coefficient of EQ-5D-5L, 0.66; FACT-B TOTAL, 0.94; FACT-B: TOI, 0.93), postoperative subjective symptoms (−0.64), and shoulder joint function (0.47), in that order. On the HRQOL scale, the disease-specific scale of FACT-B was more influential than the comprehensive scale of the EQ-5D-5L, and in the rehabilitation intervention, postoperative subjective symptoms influenced HRQOL more than did shoulder joint function. The path coefficient from postoperative subjective symptoms showed that tightness had the highest value at all of the times. This suggested that in the subjective symptoms after surgery, tightness affected the decline in HRQOL by limiting daily activities. The next highest value was for pain, suggesting that chronic pain at the operative site derived from surgical invasion interferes with daily life and also affects the decline in HRQOL. In addition, it is suggested that any remaining tightness and pain encourage anxiety, thus forming a vicious circle.

There were problems and limitations with this research. In this study, we did not adjust for surgical type, surgical side, pre- and postsurgery adjuvant therapy, timing of onset (period since onset, first incidence, or recurrence), and postoperative complications of the breast cancer patients who underwent rehabilitation. The postoperative complications of axillary lymphangiectasia syndrome [27] and lymphedema [28] can affect prognosis, shoulder joint function, and the psychological state. Particularly, temporal changes in the HRQOL scales can be expected to differ due to shoulder joint function on the operative side, subjective symptoms after surgery, surgical type, adjuvant therapy, postoperative complications, and onset time. However, even if these specific controls are carried out on the subjects, it is not possible to exclude factors related to shoulder joint function on the operative side and the influence of improving the subjective symptoms after surgery.

In the future it will be desirable to increase the number of subjects in whom the above attributes can be compared and to further follow long-term changes over time.

Conclusion

By using both a breast cancer-specific scale and utility values as comprehensive measures, we could follow up breast cancer patients until 6 months after surgery to assess the detailed changes in their HRQOL and the causal relations associated with these changes. Not only functional aspects but also postoperative subjective symptoms may affect improvements in the HRQOL of these patients. The utility value of breast cancer patients obtained in this study from the day before surgery to the 6th month after surgery showed the effects of rehabilitation that accumulate in the future and can be a basis for the future allocation of medical resources. From now on, by increasing the number of cases and following the long-term changes over time, methods of rehabilitation intervention can be studied according to different postoperative periods.

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References

[1] Hori M, Matsuda T, Shibata A, Katanoda K, Sobue T, Nishimoto H, *et al.* Cancer incidence and incidence rates in Japan in 2009: a study of 32 population-based cancer registries for the Monitoring of Cancer Incidence in Japan (MCIJ) project. Jpn J Clin Oncol. 2015; 45(9): 884–91.

[2] Langer I, Guller U, Berclaz G, Koechli OR, Schaer G, Fehr MK, *et al.* Morbidity of sentinel lymph node biopsy (SLN) alone versus SLN and completion axillary lymph node dissection after breast cancer surgery: a prospective Swiss multicenter study on 659 patients. Ann Surg. 2007; 245(3): 452−61.

[3] Verbelen H, Gebruers N, Eeckhout FM, Verlinden K, and Tjalma W. Shoulder and arm morbidity in sentinel node-negative breast cancer patients: a systematic review. Breast Cancer Res Treat. 2014; 144(1): 21−31.

[4] McNeely ML, Campbell K, Ospina M, Rowe BH, Dabbs K, Klassen TP, *et al.* Exercise interventions for upper limb dysfunction due to breast cancer treatment. Cochrane Database Syst Rev. 2010; 16(6): CD005211.

[5] Lahart IM, Metsios GS, Nevill AM, and Carmichael AR. Physical activity, risk of death and recurrence in breast cancer survivors: A systematic review and meta-analysis of epidemiological studies. Acta Oncol. 2015; 54(5): 635−54.

[6] Wu Y, Zhang D, and Kang S. Physical activity and risk of breast cancer: a meta-analysis of prospective studies. Breast Cancer Res Treat. 2013; 137(3): 869−82.

[7] Shimozuma K. Quality of life assessment. Breast Cancer. 2002; 9: 100−6.

[8] Ferrell BR, Dow KH, and Grant M. Measurement of the quality of life in cancer survivors. Qual Life Res. 1995; 4: 523−31.

[9] Snyder CF, Jensen RE, Segal JB, and Wu AW. Patient-reported outcomes (PROs): putting the patient perspective in patient-centered outcomes research. Med Care. 2013; 51(8 Suppl 3): S73−9.

[10] Naaman SC, Radwan K, Fergusson D, and Johnson S. Status of psychological trials in breast cancer patients: a report of three meta-analyses. Psychiatry. 2009; 72(1): 50−69.

[11] Leach HJ, Danyluk JM, Nishimura K, and Culos-Reed SN. Benefits of 24 versus 12 weeks of exercise and wellness programming for women undergoing treatment for breast cancer. Support Care Cancer. 2016; 24(11): 4597−606.

[12] Wittmann V, Látos M, Horváth Z, Simonka Z, Paszt A, Lázár G, *et al.* What contributes to long-term quality of life in breast cancer patients who are undergoing surgery? Results of a multidimensional study. Qual Life Res. 2017; 26: 2189−99.

[13] Gordon LG, DiSipio T, Battistutta D, Yates P, Bashford J, Pyke C, *et al.* Cost-effectiveness of a pragmatic exercise intervention for women with breast cancer: results from a randomized controlled trial. Psychooncology. 2017; 26(5): 649−55.

[14] Taghian NR, Miller CL, Jammallo LS, O'Toole J, and Skolny MN. Lymphedema following breast cancer treatment and impact on quality of life: a review. Crit Rev Oncol Hematol. 2014; 92(3): 227−34.

[15] Coyne E, Wollin J, and Creedy DK. Exploration of the family's role and strengths after a young woman is diagnosed with breast cancer: views of women and their families. Eur J Oncol Nurs. 2012; 16(2): 124−30.

[16] Ristevska-Dimitrovska G, Filov I, Rajchanovska D, Stefanovski P, and Dejanova B. Resilience and quality of life

in breast cancer patients. Open Access Maced J Med Sci. 2015; 3(4): 727−31.

[17] Carlson LE, Waller A, and Mitchell AJ. Screening for distress and unmet needs in patients with cancer: review and recommendations. J Clin Oncol. 2012; 30(11): 1160−77.

[18] Byrne BM. Structural equation modeling with Amos: Basic concepts, applications, and programming, 3rd edn. New York: Routledge; 2017.

[19] Brady MJ, Cella DF, Mo F, Bonomi AE, Tulsky DS, Lloyd SR, *et al.* Reliability and validity of the functional assessment of cancer therapy-breast quality-of-life instrument. J Clin Oncol. 1997; 15(3): 974−86.

[20] EuroQoL Group. EuroQoL—a new facility for the measurement of health-related quality of life. Health Policy. 1990; 16: 199−208.

[21] Brooks R. EuroQol: the current state of play. Health Policy. 1996; 37(1): 53−72.

[22] Tsuchiya A, Ikeda S, Ikegami N, Nishimura S, Sakai I, Fukuda T, *et al.* Estimating an EQ-5D population value set: the case of Japan. Health Econ. 2002; 11: 341−53.

[23] Ikeda S, Shiroiwa T, Igarashi A, Noto S, Fukuda T, Saito S, *et al.* Developing a Japanese version of the EQ-5D-5L value set. Journal of the National Institute of Public Health. 2015; 64(1): 47−55 (in Japanese).

[24] Izumi R, Noto S, Ikeda S, Fukuda T, Shiroiwa T, and Igarashi A. Comparison of three utility measures in stroke patients using item response theory analysis. Niigata Journal of Health and Welfare. 2013; 13(1): 1−12.

[25] Juniper EF, Guyatt GH, and Jaeschke R. How to develop and validate a new health-related quality of life instrument. In: Spiker B, editor. Quality of life and pharmacoeconomics in clinical trials, 2nd edn. Philadelphia: Lippincott-Raven; 1996; 49−56.

[26] Levangie PK, and Drouin J. Magnitude of late effects of breast cancer treatments on shoulder function: a systematic review. Breast Cancer Res Treat. 2009; 116(1): 1−15.

[27] Koehler LA, Blaes AH, Haddad TC, Hunter DW, Hirsch AT, and Ludewig PM. Movement, function, pain, and postoperative edema in axillary web syndrome. Phys Ther. 2015; 95(10): 1345−53.

[28] Torres Lacomba M, Yuste Sánchez MJ, Zapico Goñi A, Prieto Merino D, Mayoral del Moral O, Cerezo Téllez E, *et al.* Effectiveness of early physiotherapy to prevent lymphoedema after surgery for breast cancer: randomised, single blinded, clinical trial. BMJ. 2010; 340: b5396.

ORIGINAL ARTICLE

Effect of Adjusting the Challenge-Skill Balance for Occupational Therapy in a Recovery Rehabilitation Unit: A Pilot Study

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Abstract: The primary goal of occupational therapy is to enable people to participate in normal everyday activities. To understand and support a client's desired activities, it is necessary to share the meaning of occupation between the therapist and client. One concept that has been used to capture the psychological state for an activity is flow. Therefore, we devised a process of adjusting the challenge-skill balance for occupational therapy based on flow theory.

In this pilot study, we aimed to verify whether adjusting the challenge-skill balance for occupational therapy improved subjective quality of life in a recovery rehabilitation unit. To inform the future design of randomized controlled trials, we therefore compared standard occupational therapy with this new approach. Both interventions took place from recovery rehabilitation unit entry to discharge, and outcomes (continuous variables) were analyzed using a Bayesian approach explored with generalized linear mixed modeling.

Among a total of 22 patients, those receiving the new approach showed a significant improvement in Ikigai-9 (quality of life) compared with those receiving standard occupational therapy. The mean improvement was 4.44 ± 2.17 with a 95% credible interval of 0.104−8.713. The dependence factor, effective sample size, and autocorrelation time were 3.769, 8093, and 6.18, respectively. We conclude that adjusting the challenge-skill balance during occupational therapy could improve a client's subjective quality of life.

Keywords: occupational therapy process, flow model, quality of life, recovery rehabilitation unit

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Introduction

Occupational therapy is a client-centered profession concerned with promoting health and well-being through occupation. The primary goal of occupational therapy is to enable people to participate in normal everyday activities [1]. In occupational therapy, appropriate activities are typically set based on a comprehensive assessment of a client's physical and mental functions, occupational performance, and personal factors, as well as any relevant environmental factors. Several practical frameworks exist, including the Occupational Therapy Practice Framework [2], the Occupational Therapy Intervention Process Model [3], and the Management Tool for Daily Life Performance [4], together with important theories, such as the Canadian Model of Occupational Performance [5] and Model of human occupation [6]. However, despite attempts to ensure that occupational therapists provide client-centered therapy, it has been reported that there can be differences in the perception of skill and challenge difficulty between the occupational therapist and client [7].

To understand and support a client's desired activities, it is necessary to share the meaning of occupation between the therapist and client. In other words, subjective assessments about a client's occupation should be acquired in a way that facilitates easy recognition. One concept that has been used to capture the psychological state for an activity is "flow" [8]. Csikszentmihalyi reported that flow occurs when individuals are "so intensely involved in an activity that nothing else seems to

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matter; the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it" [9]. Flow can contribute to increased happiness, self-esteem, work productivity, and joy of life [10−13]. Additionally, studies have described the relationship between the experience of flow and everyday life activities [6, 14−16].

According to flow theory, flow can also be defined operationally according to a challenge–skill balance called the "flow model" [8]. This model proposes that flow occurs when the perceived level of challenge provided by the activity is in balance with the participant's level of skill. By contrast, activities in which the individual has high perceived skill relative to the challenge might lead to boredom, whereas activities in which there is low perceived skill and high perceived challenge might lead to anxiety. As research based on the flow model, there were analyzes targeting activities engaged by students and occupational therapists. [17−19], while other analyses have looked at the relationship between flow and health-related quality of life (QoL) in elderly people [20−22]. We previously analyzed the activities supported by occupational therapy among elderly people in an adult day program and showed a difference in recognition about the activity, consistent with previous research [7, 22]. Based on the flow model, we thought that adjusting the challenge–skill balance might facilitate occupational therapy. In a randomized controlled trial, we examined the effect of occupational therapy in which the challenge–skill balance was adjusted for elderly people who used an adult day program, and we showed improvements in health-related QoL [23].

However, since this previous study targeted only one specific activity in the maintenance rehabilitation phase, the influence of the intervention period and the effectiveness of support for multiple activities have not been clarified. Therefore, in this study, we conducted the process adjusting the challenge-skill balance (called adjusting the challenge–skill balance for occupational therapy; ACS-OT) in a situation that supports multiple activities at recovery phase, we examined whether ACS-OT was more universally effective in occupational therapy. Our aim was to verify if ACS-OT improved subjective QoL in a recovery rehabilitation unit.

Method/Design

Method

This controlled clinical trial was designed to compare the ACS-OT method (experimental group) with standard occupational therapy (control group). The primary outcome was change in subjective QoL (*ikigai*) for both groups from admission (pre) to discharge (post). The secondary outcomes were changes in health-related QoL, flow experience, and ADLs. The study protocol was approved by the Ethics Review Committee of the Harue hospital (No.29-1).

Inclusion and exclusion criteria

From May 2017 to November 2017, Clients were included if they were admitted to the recovery rehabilitation unit of Harue hospital with either cerebrovascular disease or musculoskeletal disease. On admission to the recovery rehabilitation unit, we excluded clients aged < 50 years and ≥ 100 years, as well as those whose Mini Mental State Examination scores were ≤ 23 points [24].

Procedure

Intervention

Occupational therapy was provided according to the guidelines of the American Occupational Therapy Association [2] in both the experimental and control groups. All interventions were implemented by occupational therapists experienced (≥ 200 hours) in delivering client-centered occupational therapy. In reference to the Graff's research design [25], the criteria for the amount of experience was set to more than 6 cases (40 minutes, 50 days, 6 cases, total 200 hours). Moreover, all had received at least 50 hours of training for ACS-OT (30 minutes, 50 days, 2 cases, Total 50 hours). Occupational therapy was conducted individually and was focused on the performance of activities. The key difference between groups was whether the evaluation and intervention were conducted based on an assessment of the challenge–skill balance. Treatment consisted of 40−60 minutes per day, six times in total in a week. The study period was from admission to discharge from the recovery rehabilitation unit.

Experimental group

The ACS-OT process was implemented in the following way. In the first session, the therapist assessed the client's problems in daily living using the Canadian Occupational Performance Measure [26]. Based on the problems identified, some activities that could be supported by occupational therapy were selected. In the second session, the client performed the tasks related to selected activities and evaluated the "challenge level" and "skill level" as follows: challenge level defined as the "challenge of the activity" and rated on a seven-point scale from "very simple" (1) to "very difficult" (7); and "skill level" was defined as "your skills in the activity," rated from "not at all skillful" (1) to "very skillful" (7) [18, 27]. The therapist checked with the client why certain ratings were given.

Subsequently, evaluation by the client and therapist in collaboration helped decide on the factors that made occupational performance difficult (i.e., challenge components, such as environment, execution time, and and size of the location in which the activity is carried out) and that improved performance (i.e., skill components, such as frequency, range, distance, accuracy, and dexterity related to activity). The challenge–skill balance for tasks was then changed based on these conclusions. The criteria for adjusting the challenge–skill balance was that the difference in evaluation of the challenge and skill levels between the therapist and client had to be one or less.

After the client performed the adjusted tasks, the challenge and skill levels were re-evaluated. If the challenge and skill levels were balanced, therapy was started to improve performance in those activities. If the challenge and skill levels were not balanced, the tasks were further adjusted and therapy was only started after they were balanced. This process was repeated at least once a week. It should be noted that, activity was changed (added or finished) according to the status of treatment progress. For example, in the initial session, activities such as walking and toilets are targeted. Then, the toilet is achieved (finished), walking tasks are shifted to stairs and applied walking, bathing and cooking are added.

Control group

The first and second sessions were conducted similarly to the experimental group, with the exception that therapists were not allowed to confirm the client's subjective perceptions of the challenge posed by, or skill needed to complete, the activities. From the third session, therapists assessed the client's performance and conducted therapy in a typical manner, following the general guidelines for occupational therapy [2].

Outcomes

Subjective QoL

We measured subjective QoL using the Ikigai-9 [28], a client's psychological measure of feeling a reason for living (*ikigai*). It consisted of nine items rated on 5-point scales (total score, 9−45 points).

Health-related QoL

Health-related QoL was assessed by the EuroQol-5 Dimensions (EQ-5D) [29]. The EQ-5D defines health in five dimensions (i.e., mobility, self-care, usual activities, pain and discomfort, and anxiety or depression). A visual analog scale (EQ-VAS) enables self-assessment on a scale from 0 (worst possible health) to 100 (best possible health) per dimension.

Flow experience

Flow experience was assessed using the Flow State Scale for Occupational Tasks [30] developed for clinical situations. This consists of 14 items and 3 factors (scores range from 7 to 98), and its reliability and validity have been confirmed [30].

ADL

ADLs were measured by the Functional Independence Measure (FIM) [31]. This comprises 18 items on 7-point scales that uniformly assess the severity of a client's disability and functional outcome from medical rehabilitation (overall score, 7 to 126).

Organization

The primary investigator plans and executes this research and supervises three research assistants. The research assistants obtained informed consent and performed procedures, measurements. Data entry and control were conducted by the primary investigator. A statistician also helped with the data analysis.

Statistical analysis

All statistical analyses were performed using EZR [32] and SAS® (SAS Institute, Sally, NC, USA). Data were entered in Microsoft Excel 2016 and subsequently exported into EZR and SAS for analysis. Baseline characteristics were compared by chi-square tests for categorical variables and by independent *t*-tests and Mann–Whitney *U* tests for continuous variables. The comparison of categories of activities targeted in two groups was analyzed using Fisher's exact test.

Each continuous outcome variable was analyzed using a generalized linear mixed model (GLMM). Considering the sample size of this study, outcome analysis adopted a Bayesian method that enables reasonable estimation even when the sample size is small. We took a Bayesian approach and explored the Markov chain Monte Carlo (MCMC) [33] fitting of GLMM, including the following as fixed effects: group allocation (experimental and control groups), time (pre and post), and the interaction of group and time. Participants were included as a random effect. MCMC is a method of generating a sample having a distribution characteristic matching the posterior distribution by Markov chain using Bayesian method and using it to calculate an estimate value of the objective variable. The convergence criterion for data in the MCMC fitting was set to a dependence factor of 5 for Raftery–Lewis Diagnostics [34]. In addition, autocorrelation time (ACT) and effective sample size (ESS) are also effective indices for the diagnosis of MCMC algorithm. The ACT measures dependency among Markov chain samples. The ESS estimates how many truly independent samples of a given parameter the output of the MCMC represents. High ESS or low ACT indicates good mixing of the Markov chain. Therefore, we also confirmed the ACT and ESS for MCMC convergence. All credible intervals were given with a 95% credible interval.

Since the Bayesian method only calculates the estimated value, effect sizes indicating the difference between the two groups with respect to each outcome after the intervention were calculated to show the magnitude of the effect in the experimental group.

Results

We included 22 clients (experiment Group; 11, control Group;11) and confirmed that the pre-test characteristics were well matched between the two study groups (Table 1). The total number of activities targeted by both groups was 81 (average per client: 3.68), ADL was 54 (66.6%), and instrumental ADL was 20 (24.7%). There was no significant difference in activity between the two groups (Fig. 1).

The changes from the pre-test to the post-test characteristics are shown in Table 2. Regarding each outcome after intervention, Ikigai-9 was 33.18 ± 7.04 in the experimental group and 26.64 ± 8.98 in the control group. EQ-5D was 0.668 ± 0.091 in the experimental group and 0.653 ± 0.122 in the control group, Flow state scale for occupational task was 82.27 ± 8.90 in the experimental group and 73.27 ± 16.85 in the control group. FIM total score was 118.73 ± 4.29 in the experimental group and 117.64 ± 8.89 in the control group. The results analyzed by MCMC for GLMM are shown in Table 3. The mean improvement in the Ikigai-9 between the experimental and control groups was 4.44 ± 2.17, with a 95% credible interval of 0.10−8.71. The difference between the two groups in EQ-5D was 0.061 ± 0.089 with a 95% credible interval of −0.115−0.236, in Flow state scale for occupational task was −0.73 ± 5.01 with a 95% credible interval of −10.88−8.94, in FIM was 3.26 ± 4.88 with a 95% credible interval of −6.37−12.72. Thus, a significant difference was confirmed in Ikigai-9. Confirming the information on the convergence situation of sampling about MCMC analysis for Ikigai-9, The dependence factor, ACT, and ESS were 3.769, 6.178, and 8093.4, respectively. In addition to the results of dependence factor (less than 5), ESS and ACT, posterior distribution by sampling data was in a smooth normal distribution state, indicating that appropriate sampling was being performed (Fig. 2).

There were no significant differences in the EQ-5D, Flow State Scale for Occupational Tasks or FIM between the experimental and control groups. Regarding the FIM, there was a significant difference between the

Table 1. Baseline data.
The results of the baseline data in the experimental and control groups were shown. The pre-test characteristics were well matched between the two groups.

	Experimental Group (n = 11)	Control Group (n = 11)	*p value*
Age (M, SD)	75.36 (10.51)	73.64 (13.00)	*p* = 0.742
Sex (n)			
Male	3	6	*p* = 0.387
Female	8	5	
Disease (n)			
Cerebrovascular	3	5	*p* = 0.659
Musculoskeletal	8	6	
Treatment period: Day (M, SD)	46.27 (18.81)	44.64 (28.41)	*p* = 0.742
MMSE (M, SD)	25.64 (2.16)	26.18 (2.99)	*p* = 0.629
EQ VAS (M, SD)	60.45 (18.64)	63.36 (22.59)	*p* = 0.745
Flow state scale for Occupational task (M, SD)	79.73 (14.11)	70.00 (20.63)	*p* = 0.212
Ikigai-9 (M, SD)	31.09 (10.15)	28.00 (8.25)	*p* = 0.442
FIM (M, SD)			
Motor	63.36 (14.35)	65.36 (8.66)	*p* = 0.696
Cognitive	33.09 (2.12)	33.27 (3.90)	*p* = 0.237
Total	96.45 (14.69)	98.64 (10.55)	*p* = 0.693

Note. M = mean; SD = standard deviation; EQ-VAS = EuroQol–5 Dimension visual analog scale;
MMSE = Mini Mental State Examination; FIM = Functional Independence Measure.

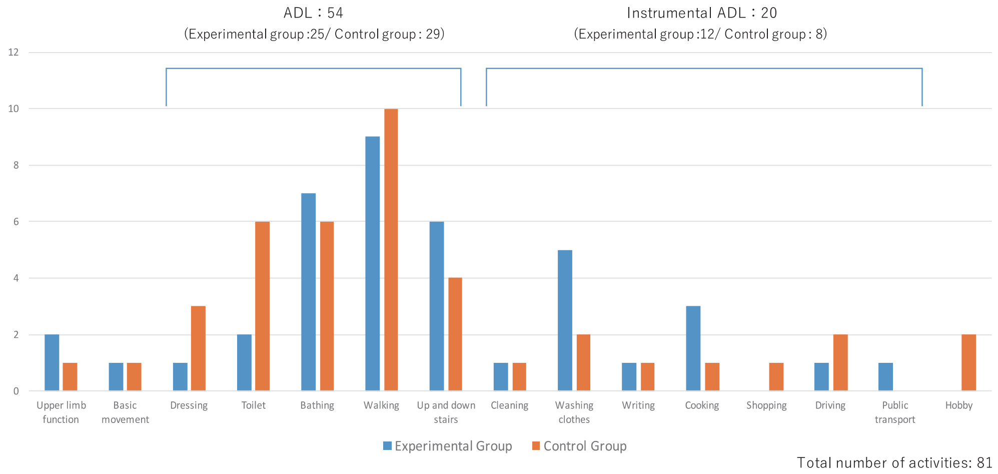


Fig. 1. Activities targeted by experiment group and control group.
In this figure, it showed the classification of the activities that was the target in the experiment group and the control group. As a result of Fisher's exact test, there was no significant difference in activity between the two groups.

Table 2. Pre and post data in experimental and control group.
Changes from pretest to post-test characteristics about Ikigai-9, EQ-5D/EQ VAS, Flow state scale for occupational task, and FIM between the experimental and control groups were shown. Effect sizes between two groups with respect to each outcome after the intervention were also shown.

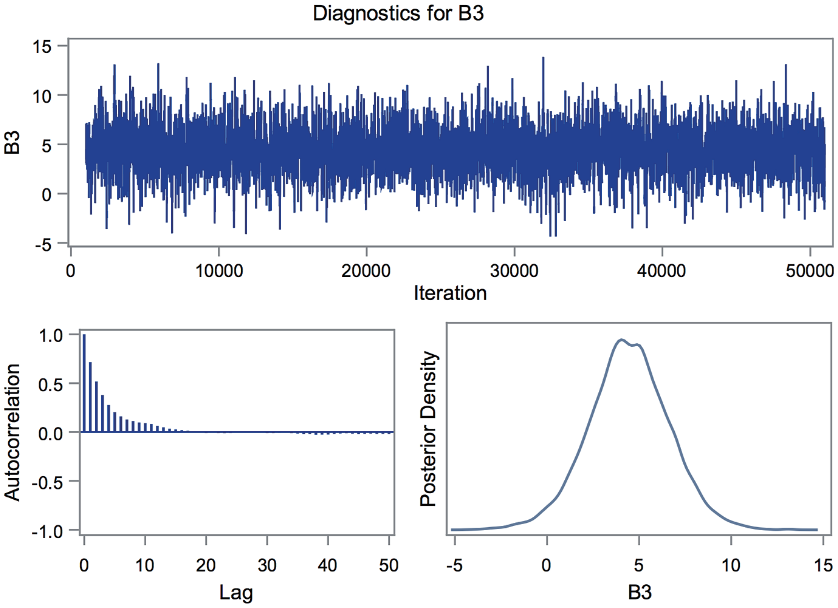
	Observed M (SD)		Observed M (SD)		Effect size [95% CI]
	Experimental group (n = 11)		Control group (n = 11)		Between two groups after the intervention
	pre	post	pre	post	
Ikigai-9	31.09 (10.15)	33.18 (7.04)	28.00 (8.25)	26.64 (8.98)	0.78 (−0.09 to 1.65)
EQ-5D	0.497 (0.187)	0.668 (0.091)	0.544 (0.243)	0.653 (0.122)	0.19 (−0.70 to 0.97)
EQ VAS	60.45 (18.64)	77.09 (15.43)	63.36 (22.59)	72.27 (20.42)	
Flow state scale for occupational task	79.73 (14.11)	82.27 (8.90)	70.00 (20.63)	73.27 (16.85)	0.67 (−0.21 to 1.50)
FIM					
Total-score	96.45 (14.69)	118.73 (4.29)	98.64 (10.55)	117.64 (8.89)	0.16 (−0.69 to 0.99)
Motor-score	63.36 (14.35)	85.27 (3.82)	65.36 (8.66)	84.73 (5.76)	
Cognitive-score	33.09 (2.12)	33.45 (1.81)	33.27 (3.90)	32.9 (5.07)	

Note. M = mean; SD = standard deviation; CI = confidence interval; EQ-5D = EuroQol–5 Dimension;
EQ-VAS = EuroQol–5 Dimension visual analog scale; FIM = Functional Independence Measure;
Effect sizes between two groups = Calculated as standardized mean differences (Cohen's d).

Table 3. Results analyzed by MCMC for generalized linear mixed model (GLMM).
The results of each outcome analysis by GLMM using MCMC were shown. There was a significant difference in the subjective QOL (Ikigai-9) between the experimental and control groups.

	Time M (SD)	Group M (SD)	Group*Time M (SD)
Ikigai-9	−1.36 (1.54) 95%CI [−4.49−1.62]	−2.36 (5.16) 95%CI [−12.70−7.49]	4.44 (2.17) 95%CI [0.10−8.71]
EQ-5D	0.110 (0.063) 95%CI [−0.015−0.235]	−0.108 (0.150) 95%CI [−0.405−0.188]	0.061 (0.089) 95%CI [−0.115−0.236]
Flow state scale for occupational task	3.28 (3.53) 95%CI [−3.65−10.33]	10.50 (10.42) 95%CI [−9.17−31.60]	−0.73 (5.01) 95%CI [−10.88−8.94]
FIM	18.99 (3.45) 95%CI [11.97−25.57]	−5.30 (8.42) 95%CI [−21.98−11.27]	3.26 (4.88) 95%CI [−6.37−12.72]

Note. M = mean; SD = standard deviation; CI = confidence interval; EQ-5D = EuroQol–5 Dimension;
FIM = Functional Independence Measure; Time = pre and post; Group = experimental and control groups.



Note. B3 = Difference between experimental group and control group in Ikigai-9.

Fig. 2. PROC MCMC procedure about Ikigai-9.
This figure shows mixing of the Markov chain, which has relatively constant mean and variance over iterations. The trace plot shows indication of convergence.

pre-test and post-test results in both groups (18.99 ± 3.45, 95% credible interval: 11.974−25.571).

Analysis by actual measurement values showed effect sizes (d) and 95% confidence intervals of 0.78 (−0.09 to 1.65), 0.19 (−0.70 to 0.97), and 0.67 (−0.21 to 1.50) for the Ikigai-9, EQ-5D, and Flow State Scale for Occupational Tasks, respectively. In addition, all of the clients in both groups were discharged home.

Discussion

To the best of our knowledge, no other study has compared the outcomes between ACS-OT and standard occupational therapy in a recovery rehabilitation unit. When we compared subjective QoL (Ikigai-9) between the two groups, there was a significant difference in the Bayesian GLMM. Although the effect size was moderate (d = 0.78), no significant effect was shown (95% confidence interval, −0.09 to 1.65). In addition, there were no significant differences in health-related QoL (EQ-5D) or flow status (Flow State Scale for Occupational Tasks). Regarding FIM, there was no difference between the two groups, though both improved from before to after the intervention.

The ACS-OT method was based on the flow model, adjusting the client's therapy to their perceived skill with the support of an occupational therapist. The challenge–skill balance was key to this flow model, requiring that the difficulty level of the occupational therapy engaged in by the client matched the ability of the client; it was therefore logical that occupational therapy and flow models should have a very high affinity. Although flow experiences can be addictive [35], this might relate to a lack of opportunity for meaningful chances to develop the skills needed to perform activities [36]. We believe that our ACS-OT method, by helping to improve skill by adjusting the challenge level to the patient's needs, helped promote the client's own initiative.

Bayesian estimation by MCMC was used to provide a statistical framework. In this method, data were combined with subjective prior information about parameter values to derive posterior probabilities of different models or parameter values. MCMC is a Bayesian statistical technique that samples parameters according to a stochastic algorithm that converges on the posterior probability distribution of parameters, combining information from the likelihood and the posterior distributions [37]. By using the prior distribution properly, this method can give a reasonable estimation even with small sample sizes. Adopting this analysis allowed us to calculate a more accurate estimated value with fewer samples.

The Ikigai-9 [28] used in this study consisted of the following three concepts: 1) optimistic and positive attitude toward present living and life, 2) active and positive attitude toward the future, and 3) recognition of the meaning of self-existence. In general, rehabilitation and occupational therapy focus on long-term goals. Pessimism of goal achievability might therefore be evidenced by high anxiety if the patient perceives a high challenge level and a low skill level. Equally, if the client judges that the goal has already been achieved (low challenge with high skill), he or she may be less likely to concentrate on an assigned activity. This relates to the psychological phenomenon of "mind wandering" [38], in which thoughts drift away from the task at hand and onto unrelated thoughts, such as memories, thoughts of the future, negative emotions, and misfortune [39]. Therefore, because the ACS-OT method focused on activities adjusted to achieve a challenge–skill balance in this study, it is possible that negative emotions and mind wandering may have been reduced, increasing being present or self-esteem. Since there was no significant difference between the two groups in the comparison on the contents of the selected activity, and tasks related to the activities were set taking into consideration the client's condition (skill), it is unlikely that the difference in the activities targeted for support affected the outcomes of the two groups. We believe that the use of the ACS-OT method has made it possible to support clients more appropriately and has led to positive psychological state.

We noted that the flow scale score did not differ between the two groups. Given that the ACS-OT method was based on the flow model, it is possible that clients in this study did not reach the flow state experienced with a high challenge–skill balance.

Regarding the FIM results, improvement was observed for ADL before and after intervention in both groups, but no significant difference was found between ACS-OT and normal occupational therapy. This suggested that for ADL, it could not be concluded that ACS-OT intervention was more effective than standard occupational therapy. The reason for this was that improvement of ADL was one of the main objectives in the recovery rehabilitation unit, and the improvement of ADL was also shown in conventional occupational therapy [40−42], it was considered that clear difference was not reached even with ACS-OT.

A limitation of this research is that it was only a controlled clinical trial. Therefore, we are planning a randomized controlled trial to obtain more evidence in the future (UMIN ID: UMIN000029505). Moreover, we used the GLMM to estimate values in this study because of the small number of subjects. Although we confirmed the sampling accuracy, we would like to clarify the effects of the ACS-OT method, including verification of the validity of the Bayesian estimate, in a future randomized controlled trial.

Conclusion

In conclusion, this study showed that the ACS-OT method could improve a client's subjective QoL (i.e., *ikigai*) during recovery in a rehabilitation unit. Combined with the results of previous studies [22, 23], this method could have application in different areas of occupational therapy.

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References

[1] World Federation of Occupational Therapists [online]. Statement on Occupational Therapy [cited 2012]. Available from: http://www.wfot.org/ResourceCentre.aspx

[2] American Occupational Therapy Association. Occupational therapy practice framework: Domain and process (3rd ed.). Am J Occup Ther. 2014; 68: S1−S48.

[3] Fisher AG, and Jones KB. Occupational therapy intervention process model: a model for planning and implementing top-down, client-centered and occupation-based interventions. Three Star Press; 2009.

[4] Nishii M. Management Tool for Daily Life Performance (in Japanese). Journal of Allied Health Science. 2016; 7(1): 17−21.

[5] Boniface G, Fedden T, Hurst H, Mason M, Phelps C, Reagon C, *et al.* Using theory to underpin an integrated occupational therapy service through the Canadian Model of Occupational Performance. Br J Occup Ther. 2008; 71(12): 531−9.

[6] Kielhofner G, editors. Model of human occupation: Theory and application. Lippincott Williams & Wilkins; 2008.

[7] Maitra KK, and Erway F. Perception of client-centered practice in occupational therapists and their clients. Am J Occup Ther. 2006; 60(3): 298−310.

[8] Csikszentmihalyi M. Play and intrinsic rewards. J Humanist Psychol. 1975.

[9] Csikszentmihalyi M. Flow: The Psychology of Optimal Experience, New York. Harper and Row; 1990.

[10] Csikszentmihalyi M, Csikszentmihalyi IS, editors. Optimal experience: Psychological studies of flow in consciousness. Cambridge university press; 1992.

[11] Haworth J, and Evans S. Challenge, skill and positive subjective states in the daily life of a sample of YTS students. J Occup Organ Psychol. 1995; 68(2): 109−21.

[12] Nielsen K, and Cleal B. Predicting flow at work: Investigating the activities and job characteristics that predict flow states at work. J Occup Health Psychol. 2010; 15(2): 180−90.

[13] Ilies R, Wagner D, Wilson K, Ceja L, Johnson M, DeRue S, *et al.* Flow at Work and Basic Psychological Needs: Effects on Well-Being. Applied Psychology. 2017; 66(1):

3−24.

[14] Rebeiro KL, and Polgar JM. Enabling occupational performance: optimal experiences in therapy. Can J Occup Ther. 1999; 66(1): 14−22.

[15] Wright JJ, Sadlo G, and Stew G. Further explorations into the conundrum of flow process. J Occup Sci. 2007; 14(3): 136−44.

[16] Larson E, and von Eye A. Beyond flow: temporality and participation in everyday activities. Am J Occup Ther. 2010; 64(1): 152−63.

[17] Jonsson H, and Persson D. Towards an experiential model of occupational balance: An alternative perspective on flow theory analysis. J Occup Sci. 2006; 13(1): 62−73.

[18] Engeser S, and Rheinberg F. Flow, moderators of challenge-skill-balance and performance. Motiv Emot. 2008; 32(3): 158−72.

[19] Jacobs K. Flow and the occupational therapy practitioner. Am J Occup Ther. 1994; 48(11): 989−96.

[20] Hirao K, Kobayashi R, Okishima K, and Tomokuni Y. Flow experience and health-related quality of life in community dwelling elderly Japanese. Nursing & health sciences. 2012; 14(1): 52−7.

[21] Yasunaga M, Kobayashi N, and Yamada T. The challenge skill ratio of users' experiences at an adult daycare center: Emotional states based on the Flow model (in Japanese). The Journal of Japanese Occupational Therapy Association. 2012; 31(1): 83−93.

[22] Yoshida I, Mima H, Nonaka T, Kobayashi R, and Hirao K. Analysis of subjective evaluation in occupations of the elderly: A study based on the flow model (in Japanese). The Journal of Japanese Occupational Therapy Association. 2016; 35(2): 70−9.

[23] Yoshida I, Hirao K, and Nonaka T. Adjusting Challenge–Skill Balance to Improve Quality of Life in Older Adults: A Randomized Controlled Trial. Am J Occup Ther. 2018; 72(1): 1−8.

[24] Anthony JC, LeResche L, Niaz U, Von Korff MR, and Folstein MF. Limits of the 'Mini-Mental State'as a screening test for dementia and delirium among hospital patients. Psychological medicine. 1982; 12(2): 397−408.

[25] Graff MJ, Vernooij-Dassen MJ, Thijssen M, Dekker J, Hoefnagels WH, and OldeRikkert MG. Effects of community occupational therapy on quality of life, mood, and health status in dementia patients and their caregivers: a randomized controlled trial. J Gerontol A Biol Sci Med Sci. 2007; 62(9): 1002−9.

[26] Law M, Baptiste S, and Mills J. Client-centered practice: What does it mean and does it make a difference? Can J Occup Ther. 1995; 62(5): 250−7.

[27] Csikszentmihalyi M, and Larson R. Being adolescent: Conflict and growth in the teenage years. Basic Books; 1986.

[28] Imai T, Osada H, and Nishimura Y. The reliability and validity of a new scale for measuring the concept of Ikigai (Ikigai-9) (in Japanese). Japanese Journal of Public Health. 2012; 59(7): 433−9.

[29] EuroQol G. EuroQol-a new facility for the measurement of health-related quality of life. Health policy. 1990; 16(3): 199−208.

[30] Yoshida K, Asakawa K, Yamauchi T, Sakuraba S, Sawamura D, Murakami Y, *et al.* The flow state scale for occupational tasks: development, reliability, and validity. Hong Kong J Occup Ther. 2013; 23(2): 54−61.

[31] Granger CV, Hamilton BB, Keith RA, Zielezny M, and Sherwin FS. Advances in functional assessment for medical rehabilitation. Topics in geriatric rehabilitation. 1986; 1(3): 59−74.

[32] Kanda Y. Investigation of the freely available easy-to-use software 'EZR' for medical statistics. Bone marrow transplantation. 2013; 48(3): 452−8.

[33] Brémaud P. Markov chains: Gibbs fields, Monte Carlo simulation, and queues. Springer Science & Business Media; 2013.

[34] Raftery AE, and Lewis S. How many iterations in the Gibbs sampler? Washington Univ Seattle Dept of Statistics; 1991.

[35] Csikszentmihalyi M. Activity and happiness: Towards a science of occupation. J Occup Sci. 1993; 1: 38−42.

[36] Helbig K, and McKay E. An exploration of addictive behaviours from an occupational perspective. J Occup Sci. 2003; 10(3): 140−5.

[37] Bolker BM, Brooks ME, Clark CJ, Geange SW, Poulsen JR, Stevens MHH, *et al.* Generalized linear mixed models: a practical guide for ecology and evolution. Trends in ecology & evolution. 2009; 24(3): 127−35.

[38] Smallwood J, Fitzgerald A, Miles LK, and Phillips LH. Shifting moods, wandering minds: negative moods lead the mind to wander. Emotion. 2009; 9(2): 271.

[39] Killingsworth MA, and Gilbert DT. A wandering mind is an unhappy mind. Science. 2009; 330(6006): 932.

[40] Jackson J, Carlson M, Mandel D, Zemke R, and Clark F. Occupation in lifestyle redesign: The well elderly study occupational therapy program. Am J Occup Ther. 1998; 52(5): 326−36.

[41] Noto S, Murai C, Takeuchi S, and Nakamura H. Effect of occupational therapy using "the management tool for daily life performance" for dependent community-dwelling elderly: A randomized controlled multi-center trial (in Japanese). The Journal of Japanese Occupational Therapy Association. 2014; 33(3): 259−69.

[42] Tomori K, Nagayama H, Ohno K, Nagatani R, Saito Y, Takahashi K, *et al.* Comparison of occupation-based and impairment-based occupational therapy for subacute stroke: A randomized controlled feasibility study. Clinical rehabilitation. 2015; 29(8): 752−62.

ORIGINAL ARTICLE

A Qualitative Study on the Practice Structure of Home-Based Occupational Therapy for the Realisation of Daily Living Activities in the Elderly: Promoting Co-Operative Construction of the Life Performance

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Abstract: We aimed to clarify intervention processes for facilitating patients' living activities by understanding the practical structure of home-based occupational therapy (OT). Study participants were occupational therapists with at least three years of home-based OT experience. Data analysis was based on the grounded theory. For categorisation, MAXQDA 10 was used to conduct continuous comparative analysis. Analysis resulted in the following categories: 1,572 text segments, 195 labels, 40 small categories, 15 medium categories and 6 large categories. The large categories were (a) identifying unique living activities, (b) analysing and predicting living activities, (c) employing practices to confront living activities, (d) creating an environment that fosters living activities, (e) implementing independent living activities and (f) co-operating to realise living activities. Occupational therapists used patients' living spaces to support them in terms of independently performing living activities, accumulating living activity experience in familiar homes and communities.

Keywords: home-based occupational therapy, life performance, quality of life

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Introduction

Comprehensive community care systems are being promoted in Japan to help elderly people live in familiar communities for as long as possible [1]. The main objectives of comprehensive community care of the elderly are to expand support for elderly people from a multidisciplinary, professional perspective that ensures the continuity of elderly people's unique lives through improvements to social infrastructure. Occupational therapists can contribute to sustainable community life of the elderly by providing well-balanced approaches to activities, opportunities to participate in the environment, and supporting mental and physical functions [2].

In light of these circumstances, the Japanese Association of Occupational Therapists has proposed the Management Tool for Daily Life Performance (MTDLP) to the public as one approach that occupational therapists can use in comprehensive community care [3]. Activities of daily living, work, hobbies and leisure activities are designed to maintain self-care [4, 5]. The MTDLP is a process tool for occupational therapists that is intended to improve living activities of elderly individuals living in the community.

Home-based occupational therapy (OT) contributes to improving living activities at home and specifically provides services that are congruent with a patient's lifestyle. The reported outcomes of home-based OT are improvement of patients' practical functions and reduction of carer burden [6−8], as well as increased social participation through interventions congruent with patients' interests and concerns [9, 10].

Home-based OT is therefore considered to be effec-

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tive at improving living activities [9]. Accordingly, our objective in this study was to analyse the intervention processes employed to enable patients in fulfilling living activities by gaining an understanding of the practical structure of home-based OT. We referred reference to the theoretical framework of MTDLP to identify the purpose of the intervention process. We expect our findings to help standardise the process of facilitating patients' daily living activities and further expand the scope of patient activities and participation.

Materials and Methods

Study Design

We used a qualitative design for this study. We conducted interviews with experienced occupational therapists and created a structural diagram—aiming to present home-based OT as a storyline—that depicts the co-operative building of daily living activity goals as related to home-based OT.

Participant and Procedure Selection

This study's participants were experienced occupational therapists involved in home-based OT. They were selected by requesting the names of occupational therapists from the Japan Association of Home-Visit Rehabilitation (in Japanese), and snowball sampling was employed to select participants whenever a referral was obtained from a director of OT. The participants were occupational therapists with at least eight years' experience after obtaining their therapist's licences and at least three years' experience in home-based OT. The sample size of a qualitative study varies depending on whether or not theoretical saturation has been reached; thus, we did not identify the sample size needed in this study [11, 12].

We created an interview survey and conducted semi-structured interviews. To create a supportive environment for the interviews, we informed the participants of the study objectives and ensured them that their stories would be confidential. To protect privacy, we clarified in writing that the participants' rights would be respected. Translation from Japanese to English was performed by experts in the translation of rehabilitation information after generation of categories. Subsequently, reverse translation from English to Japanese was performed using translation software (MED-Trancer V12), and transparency was confirmed. Backward translation was repeated with healthcare professionals until the correct meaning was obtained. The interviews involved listening carefully to the participants' answers to a list of open-ended questions (Table 1), which was distributed in advance, asking participants to freely answer. The items in the interview list included (1) the participants' unique viewpoints on home-based rehabilitation, (2) outcomes of home-based OT, (3) environmental adjustments and (4) open-ended questions. With the participants' consent, interview data were recorded using a digital voice recorder. The recorded interview content was transcribed verbatim.

Table 1. Questions Included in the Semi-structured Interview.

1 Practice of home-based rehabilitation and unique viewpoint of home-based OT
- □ Please tell me the specific content that directly interfered with the target person during the home-based OT.
- □ Please tell me anything specific to OT.
- □ Please tell us a unique perspective of home-based OT.
- □ Any other practices of home-based OT

2 Intervention of OT with respect to the subjects
- □ Please tell me about actual environmental adjustment and introduction of welfare equipment.
- □ Please tell me specifically whether there is a point of view unique to home-based OT.
- □ Please tell me the role of home-based OT.
- □ Any other approach of home-based OT

Data analysis was conducted using the Grounded Theory Approach [13]. In Japan, there are few empirical data from previous studies on the subject of this study and there is no hypothesis about it. Therefore, to clarify the occupation structure, we first adopted a qualitative research design. Labels were generated using the Steps for Coding and Theorization (SCAT) [14], and coding and continuous comparative analysis were conducted sequentially, in conjunction with experienced instructors in the field of health sciences, until opinions matched. The labels obtained from SCAT were categorised according to similarities; however, coding in this study differed from that done in broad integration, such as in SCAT, in that labels were assigned to each line. Labels were named with gerunds, as recommended by Charmaz (2014) [15].The study used the qualitative data analysis software MAXQDA 10 (VERBI, GmbH, Berlin, Germany). The raw data were referred to, and the labels were revised many times during their generation.

The Schnabel method was adopted for measuring theoretical saturation [11]. This method can show the capture rate from a rational perspective. Toyoda et al. used the data capture rate as an indicator of the degree of saturation [12]. To determine if theoretical sampling had been achieved, the capture rate was calculated and evaluated at the point when almost no new findings were seen. Schnabel method evaluations were determined on the basis of the relationship between the overall labels obtained from SCAT and the labels obtained from the last case. Category reliability was examined by calculating the concordance rate, using Scott's pi [16],

Table 2. Characteristics of the nine interviewed occupational therapists.

Subject	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
Gender	M	M	F	M	F	M	F	M	M
Age (y)	40s	30s	30s	30s	30s	30s	40s	40s	50s
Mean OT experience (y)	19	15	12	8	16	11	16	14	30
Mean home-based OT experience (y)	16	14	9	7	4	11	6	7	20
Mean number of weekly home visits	20	20	8	22	24	2	23	20	1
Interview time (min)	48	112	50	74	60	79	91	84	60

M: male; F: female; OT: occupational therapy

which can verify the concordance rate corrected for concordance arising from coincidence. A concordance rate of 70% was deemed to ensure reliability in accordance with a previous study [17].

Once the reliability of categorisation was confirmed, we created a structural diagram depicting the relationship between categories. The structural diagram was then used to create a storyline for the support process of home-based OT.

Results

Theoretical saturation of data and establishment of reliability

Two researchers were involved in data analysis. First, we individually created the code and then compared the codes to reach a consensus. The researchers conducted the analysis with university faculty members who have conducted doctoral programs in the field of health care. In the interviews, from the seventh participant onwards, the interview content appeared to repeat the same narrative. We therefore examined theoretical saturation using the Schnabel method. We verified reliability by confirming the capture rate with the Schnabel method up to the ninth participant, who had 30 labels, 28 of which were the same as the overall labels and two of which qualified as newly obtained labels, yielding a capture rate of 94.5%. Since the capture rate exceeded 90%, theoretical saturation was deemed to be achieved [16]. The nine participants comprised six men and three women with a mean age of 35 (SD, ±6.8) years, mean OT experience of 15 (SD, ±5.9) years, mean home-based OT experience of 10.4 (SD, ±4.9) years and a mean of 15.5 (SD, ±8.6) for number of weekly home visits (Table 2).

The reliability of categories was verified using Scott’s pi. Third parties were shown small categories and asked to identify the middle category in which they would place these small categories to confirm the concordance rate with the analysts. The third parties included a professor in health sciences, a qualitative researcher and an occupational therapist not involved in qualitative research. There were three third parties. They worked in practical research in the field of OT and had more than 8 years of experience in community medical care. They included two men and one woman with a mean age of 37 (SD, ±6.4) years and mean home-based OT experience of 14 (SD, ±4.9) years. The concordance rate according to Scott’s pi was at least 78.3% in all three parties, which was deemed to indicate ensured reliability [18].

Generation of categories for the process of realising home-based OT

Categories were generated by conducting a continuous comparative analysis until opinions matched those of experienced instructors in the field of health sciences. The categories were coded by the researchers who compared codes. Analysis generated the following categories: 1,572 text segments, 195 labels, 40 small categories, 15 medium categories and six large categories. The large categories consisted of (a) identifying unique living activities, (b) analysing and predicting living activities, (c) employing practices to confront living activities, (d) creating an environment that fosters living activities, (e) implementing independent living activities and (f) co-operating to realise living activities. When the large categories were classified by type for the realisation of living activities, they formed the (A) co-operative building of living activity goals (a, b); (B) practical building of living activities (c, d); and (C) autonomous building of living activities (e, f) (Fig. 1).

Storylines of supportive techniques in co-operative building of living activity goals

In the process of realising living activities in this study, the category for the co-operative building of living activity goals included (a) identifying unique daily living activities and (b) analysing and predicting daily living activities (Fig. 2). These practices were supportive techniques forming the foundation for the practical building of daily living activities. The storylines of each supportive technique are indicated as follows by […] for large categories, 〈…〉 for middle categories, “…”

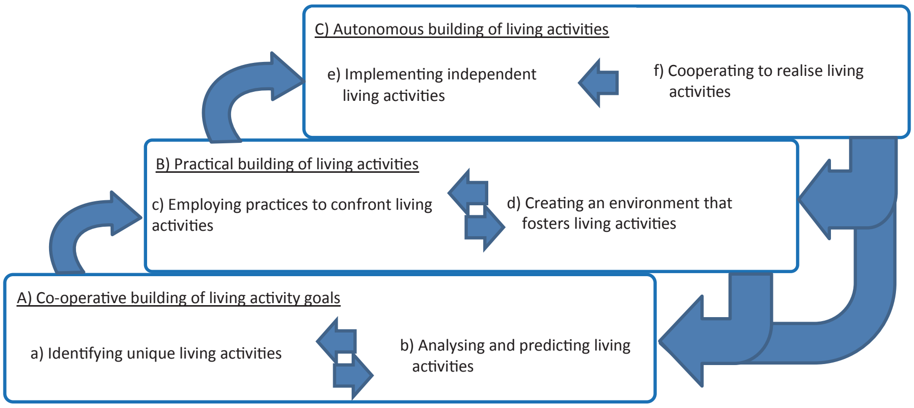
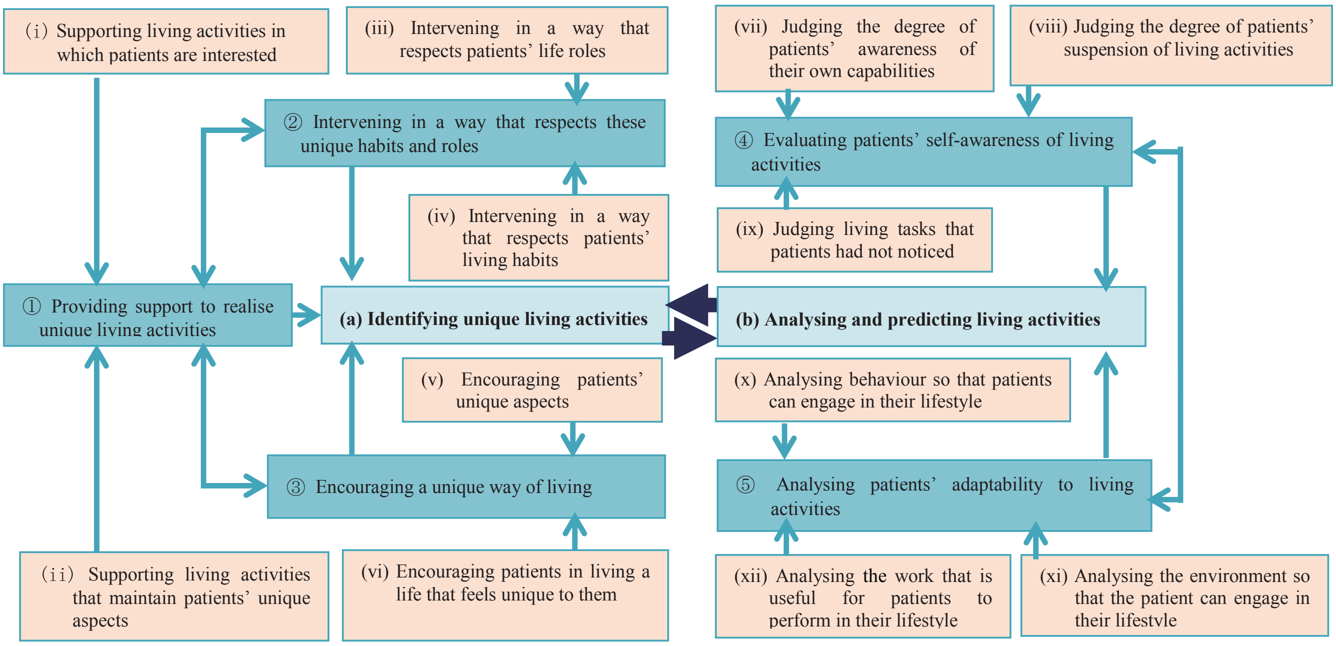


Fig. 1. Practical structural diagram of home-based occupational therapy for the realisation of living activities.



- 'Unique' is regarded as a person's unique world feeling. In this research, we were aware of the existence of a person's unique lifestyle and regard it as a breakthrough for a new life.
- 'Autonomous' is regarded as the authority to make his/her own decisions independently. This research considers the person to have authority to independently decide to challenge life.
- 'Adaptability' is regarded as the quality required in a constantly changing environment. This research observes the extent of ability recognised in a person's daily activities.

Fig. 2. Co-operative building of living activity goals set by occupational therapists and patients.

for small categories and '…' for raw data.

a) Storyline for identifying unique living activities

[Identifying unique living activities] involved ⟨(1) providing support to realise unique living activities⟩ to encourage living activities in which patients are interested and to ensure that interest can be maintained. Occupational therapists also gained an understanding of life roles and habits followed by ⟨(2) intervening in a way that respects these unique habits and roles⟩. Furthermore, occupational therapists gained an understanding of the living situations of patients and encouraged patients to embrace the feeling of living in that situation so as to ⟨(3) encourage a unique way of living⟩.

In ⟨(1) providing support to realise unique living activities⟩, occupational therapists supported patients in actualising their own living activities by "(i) supporting living activities in which patients are interested" while "(ii) supporting living activities that maintain patients' unique aspects". For example, an occupational therapist responsible for a patient who was a Japanese dance teacher focused on daily living activities in which the bedridden patient was interested, thereby revealing that patient's unique lifestyle. In their story, the occupational therapist described how ‘the patient talked about creating a form of Japanese dance that could be done sitting down and actually created this form of dance’. This ‘greatly changed the patient’s lifestyle’.

In 〈(2) intervening in a way that respects these unique habits and roles〉, occupational therapists supported patients in experiencing a unique lifestyle by “(iii) intervening in a way that respects patients’ life roles” while also “(iv) intervening in a way that respects patients’ living habits”. For example, an occupational therapist of a patient with incomplete tetraplegia from a neck tumour supported the patient in living activities tailored to his lifestyle. In their story, the occupational therapist described how they ‘walked together, during working hours, covering the 800-m distance from the patient’s workplace to his house’.

In 〈(3) encouraging a unique way of living〉, occupational therapists supported patients through intervention by “(v) encouraging patients’ unique aspects” more at home and “(vi) encouraging patients in living a life that feels unique to them”. This involved supporting patients so that they could perform their own individual routines and live unique lifestyles in their familiar homes. Occupational therapists intervened by surmising how beneficial it is for the patient to live in his/her home. In one of the stories, an occupational therapist described how ‘it is natural to intervene in a way that allows one to feel that the person is living’.

b) Storyline for analysing and predicting living activities

[Analysing and predicting living activities] involved 〈(4) evaluating patients’ self-awareness of living activities〉 to gain an understanding of their awareness of their own capabilities while 〈(5) analysing patients’ adaptability to living activities〉 to ascertain the degree of engagement in living activities and predict patients’ future living activities.

In 〈(4) evaluating patients’ self-awareness of living activities〉, occupational therapists used “(vii) judging the degree of patients’ awareness of their own capabilities” to gain an understanding of patients’ self-awareness of their own capabilities and used “(viii) judging the degree of patients’ suspension of living activities” to ascertain the living activities from which patients were turning away. Occupational therapists also used “(ix) judging living tasks that patients had not noticed to analyse living activities that patients were unable to recognise. Occupational therapists evaluated patients’ adaptability to living activities. In one of the stories, an occupational therapist described how ‘patients play a large role in identifying needs of which they are not yet aware’.

In 〈(5) analysing patients’ adaptability to living activities〉 in home-based OT, occupational therapists used “(x) analysing behaviour so that patients can engage in their lifestyle” to gain an understanding of the patient’s lifestyle and used “(xi) analysing the environment so that patients can engage in their lifestyle” to ascertain the patient’s situation. Occupational therapists also used “(xii) analysing work that is useful for patients to perform in their lifestyle” to analyse activities that can contribute to maintaining their lifestyle. Occupational therapists therefore analysed patients’ adaptability to a different lifestyle. In one of the stories, an occupational therapist remarked, ‘If a patient in a wheelchair wishes to visit a golf course and grasps and swings a golf club, I would check the balance and swing, taking into account the environment of the golf course’. This was linked to the next step, ‘I was able to listen to the patient’s stories about where they went and what they did the week before’.

Discussion

“Identifying unique living activities” and “Analysing and predicting living activities” were based on the co-operative building of living activity goals. Practising support for patients in confronting living activities identified a structure in which patients carry the ability to autonomously lead their own lives. Occupational therapists used patients’ living spaces to support them in performing their own living activities, accumulating living activity experience, and engaging in living activities independently.

Christiansen (1999) [19] argued that occupation expresses and identifies an individual’s identity. In other words, it is estimated that a lot of personal experiences are accumulated in the living activities at home. In the current report, “identifying unique living activities” is understood in the context of co-operative building of daily activity goals in home-based OT, and intervention appears to focus on encouraging patient uniqueness and their sense of living a unique lifestyle. Furthermore, in “identifying unique living activities” in home-based OT, occupational therapists directly intervene in patients’ lifestyles, which indicates an interventional structure wherein evaluation and support take place simultaneously in OT.

Meanwhile, when patients lack experience in engaging in daily living activities because of an illness or disorder, they have no opportunities to recognise their own capabilities and may stop performing living activities at home [20]. Home-based OT involves “analysing and predicting living activities” to gain an understanding of patients’ self-awareness of living activities, which may serve to prevent the suspension of living activities.

Furthermore, occupational therapists evaluated patients' self-awareness of living activities to analyse and predict patients' adaptability to living activities. This suggests that occupational therapists predict patients' future living activities on the basis of the degree of living activity recognition and adaptability of patients.

In addition, occupational therapists promote occupational engagement of patients [2, 21]. This is presumed to be a challenge for patients themselves. This involves "identifying unique living activities" and "analysing and predicting living activities" to analyse adaptability to living activities and encourage motivation in patients. In the practice of home-based OT, conventional behavioural and environmental analyses and analyses of work that is useful to patients' lifestyles are conducted to examine opportunities to motivate patients. Patients are consequently thought to willingly engage in living activities.

The MTDLP includes confirmation, analysis and prognosis of living behaviour. Our findings indicated that providing support to realise unique living activities, intervening in a manner that respects these unique habits and roles and encouraging a unique way of living are influential factors in the identification of living activities. Evaluating patients' self-awareness of living activities and analysing their adaptability to living activities were identified to affect the analysis and prediction.

In other words, home-based OT has no fixed way as many personal experiences of patients are accumulated. Occupational therapists suggested that it is important to collaboratively explore the patient's unique living activities.

Conclusions

The process of facilitating daily living activities in elderly individuals living in the community is supported by home based occupational therapists. Therefore, the practices of experienced occupational therapists respect the uniqueness of patients, and the process of cooperatively building goals with occupational therapists appears to allow patients to autonomously perform living activities.

By this research, interventions for occupational therapists working in elderly people and communities to maintain and improve daily living functions make the current state of their daily activities visible, and show the daily activities to be tackled along with their abilities. In other words, it is inferred that it is adapting the living act within the range that the elderly knows.

In this study, the viewpoint of occupational therapy realised the living behaviour of the patient. However, we could not judge whether we responded to our own emotions and feelings in this research nor show the relationship with patient intention.

In the future, according to the process of this research, we need to develop a questionnaire and a checklist as indicators and examine the viewpoint of occupational therapy.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

References

[1] Tsutsui T. Implementation process and challenges for the community-based integrated care system in Japan (In Japanese with English abstract). Int J Integr Care. 2014; 14: 1−9.

[2] Stav WB, Hallenen T, Lane J, and Arbesman M. Systematic review of occupational engagement and health outcomes among community-dwelling older adults. Am J Occup Ther. 2012; 66(3): 301−10.

[3] Tanikawa Y, Murai C, and Kobayashi R. Challenges in ambulatory rehabilitation employing Management Tool for Daily Life Performance (In Japanese with English abstract). Journal of Hiroshima Cosmopolitan University: Health Sciences and Human Formation. 2015; 1: 49−55.

[4] Kobayashi K, Takeuchi S, Inomata E, and Nagai A. Utility of the occupational therapy perspective in adult day service center in Japan: Inter-professional collaboration by using Management Tool for Daily Life Performance (MTDLP). 16th International Congress of the World Federation of Occupational Therapists, 2014.

[5] Iokawa K, Hasegawa K, and Ishikawa T. Effect of Collaboration Between Occupational Therapists and Care Managers Using the Management Tool for Daily Life Performance for Stroke Patients. Am J Occup Ther. 2017; 71: 1−10.

[6] Graff MJ, Vernooij-Dassen MJ, Thijssen M, Dekker J, Hoefnagels WH, and Rikkert MGO. Community based occupational therapy for patients with dementia and their care givers: randomised controlled trial. Bmj. 2006; 333(7580): 1196.

[7] Graff MJ, Vernooij-Dassen MJ, Thijssen M, Dekker J, Hoefnagels WH, and OldeRikkert MG. Effects of community occupational therapy on quality of life, mood, and health status in dementia patients and their caregivers: a randomized controlled trial. J Gerontol A Biol Sci Med Sci. 2007; 62(9): 1002−9.

[8] Tsuboi A, Arai M, and Matsuwaka T. Effect of visiting rehabilitation training for disabled older in home (In Japanese with English abstract). The Journal of Japanese Occupational Therapy Association. 2000; 19: 120−6.

[9] Otsuka M, and Yoshikawa H. A comparison of the effects of occupational-based and functional programs in home-based occupational therapy. Journal of Japanese Occupational Therapy Association. 2010; 29: 435−46.

[10] Kawamata H, and Yamada T. Reviewing the support of home life from the changes one picture-postcard brought about (In Japanese with English abstract). Japanese Journal of Occupational Behavior. 2004; 8: 24−9.

[11] Schnabel ZE. The estimation of total fish population of a lake. Am Math Mon. 1938; 45(6): 348−52.

[12] Toyoda H, Ohashi K, and Ikehara K. The capture rate as an indicator of degrees of saturation in free descriptions with categorization (In Japanese with English abstract). Bulletin of Data Analysis of Japanese Classification Society. 2013; 3: 49−61.

[13] Strauss A, and Corbin J. Basics of qualitative research techniques. Sage publications, 1998.

[14] Ootani T. “SCAT” A qualitative data analysis method by four-step coding: Easy startable and small scale data-applicable process of theorization (In Japanese with English abstract). Bulletin of the Graduate School of Education and Human Development (Educational Sciences), Nagoya University. 2007−2008; 54: 27−44.

[15] Charmaz K. Constructing grounded theory. Sage. 2014.

[16] Scott WA. Reliability of content analysis: The case of nominal scale coding. Public opinion quarterly. 1955; 321−5.

[17] Lombard M, Snyder-Duch J, and Bracken CC. Content analysis in mass communication: Assessment and reporting of intercoder reliability. Human Communication Research. 2002; 28(4): 587−604.

[18] Frey LR, Botan CH, and Kreps GL. Investigating communication: An introduction to research methods (2nd ed.). Boston: Allyn & Bacon, 2000.

[19] Christiansen CH. Defining lives: Occupation as identity: An essay on competence, coherence, and the creation of meaning. Am J Occup Ther. 1999; 53(6): 547−58.

[20] Dunn W, Brown C, and McGuigan A. The ecology of human performance: A framework for considering the effect of context. Am J Occup Ther. 1994; 48(7): 595−607.

[21] Kielhofner G. A model of human occupation: Theory and application. Lippincott Williams & Wilkins, 2002.

ORIGINAL ARTICLE

Clinical Indicators and Thresholds for Determining Discharge Destination from Acute Stroke Ward

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Abstract: Objective: The present study aimed to investigate the complex interaction of factors affecting discharge destination after the acute phase of stroke.
Methods: In 304 patients with stroke who required rehabilitation, we focused on three discharge destinations (i.e., home, convalescent rehabilitation ward, and other facility). Sociodemographic, medical, and acute symptoms data, within the first week of stroke onset and discharge destination, were collected from acute stroke wards. The complex interaction of factors relating to discharge destination from an acute stroke ward was investigated by classification and regression tree analysis.
Results: Patients with a total Functional Independence Measure (FIM) score > 35, a Brunnstrom recovery stage of the lower limb > V, and a comprehension FIM score > 5 had a 91.7% chance of home discharge. By contrast, patients with a total FIM score ≤ 35, age ≤ 79.5 years, and > 2.5 family members had an 80% chance of discharge to a convalescent rehabilitation ward. Finally, patients with a total FIM score ≤ 35, age > 79.5 years, and an expression FIM score ≤ 3 had a 78.6% chance of discharge to other facilities.
Conclusion: The interaction of independence on FIM, function of the paralyzed lower limb, age, number of family members, and comprehension or expression function affect the choice of discharge destination from acute stroke wards.

Keywords: rehabilitation, stroke, prediction, discharge destination, classification and regression tree

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Introduction

Discharge planning is important for patients after acute stroke to ensure that medical resources are used effectively through appropriate rehabilitation planning [1, 2]. Acute care hospitals typically determine discharge destinations on the basis of a patient's initial status at hospitalization, with home, convalescent rehabilitation ward, other hospital, or long-term care facility being the main options. Prediction of discharge destination at an early stage is necessary for implementing effective occupational therapy for patients with acute stroke. A previous study has reported that improved prediction of discharge destination could shorten acute stays, improve outcomes, and reduce treatment costs [3]. Therefore, a patient’s discharge destination should be considered soon after admission [2, 4].

The rehabilitation team plays a key role in evaluating activity limitations and rehabilitation tolerance, and they are therefore important for determining discharge destinations [5]. Especially, occupational therapists are required to be involved in determining discharge destinations in the rehabilitation team because they are responsible for supporting patients’ activities and social participation. In general, stroke rehabilitation in Japan

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is delivered in acute, convalescent, and maintenance phases [6]. During the acute phase in acute care settings, rehabilitation aims to encourage compensatory functions in the cerebrum to restore the functional impairment while preventing disuse syndromes [6]. Once this phase has passed, patients enter the convalescent phase. If further improvement of function can be expected, these patients undergo intensive rehabilitation in convalescent rehabilitation wards until they are discharged from hospital [6]. The main purpose of rehabilitation in the maintenance phase is to maintain the acquired functions, activities, and social participation for as long as possible. In the maintenance phase, patients use home-visit rehabilitation or facility services, such as the welfare facilities for the elderly requiring long-term care, in long-term care insurance system. However, patients are often discharged to their homes after using the rehabilitation of facility service in the health care facilities for the elderly requiring long-term care.

Discharge destination after acute stroke has been reported to be predicted by many factors, including age, race, gender, medical complications/comorbidities, neurological complications, and environmental and socioeconomic factors [4]. In particular, younger age has been identified as a significant factor for being discharged home [7−9]. High scores on Functional Independence Measures (FIM) of activities of daily living (ADL) at admission have also been associated with home discharge versus discharge to other settings [10]. Indeed, functional dependence of ADL on admission is considered the most important determinant of discharge destination by some researchers [7, 11, 12], though the number of family members and the marital status have also been associated with better chances of being discharged home [11, 13]. Thus, the choice of discharge destination is influenced, not by a single factor, but by a combination of factors [2], that has yet to be clarified. This is further confounded by the fact that many previous studies on discharge destination after acute strokes have used dichotomous categories (i.e., home versus other facilities) [2, 9, 13−15], limiting their usefulness. That is, the dichotomous categories of discharge destination can predict patients who are likely to be discharged home, but cannot predict patients who are likely to be transferred to convalescent rehabilitation ward.

In Japan, there is a need to develop appropriate decision-making policies for discharge planning to convalescent rehabilitation wards, other hospitals, or long-term care facilities. Moreover, this needs to be applicable in the acute phase of stroke. Therefore, we aimed to investigate the complex interaction of factors that influence discharge destination after acute stroke, focusing specifically on discharge to home, convalescent rehabilitation wards, or other facilities. Furthermore, we aimed to analyze the combinations of related factors of discharge destination in clinically useful method (decision tree analysis). This information could be used by not only professionals in acute stroke ward, such as medical doctor, occupational therapists and physical therapists, but also patients and family members to facilitate discharge planning as early as possible during hospitalization. Furthermore, by being able to predict discharge destination, the problems of ADL of patients and the needs of patients and their families will become concrete, and the goal of occupational therapy can be set more clearly. In other words, the prediction of discharge destination enables more effective occupational therapy program and environment adjustment (including welfare equipment) of the living situation in the acute phase of stroke. Moreover, by the early decision of the discharge destination, collaboration between acute care ward and post-discharge institution becomes possible from the early stage; therefore, occupational therapists can adjust necessary service contents and support system for patients, and seamlessly provide necessary occupational therapy to patients after discharge.

Materials and Methods

We enrolled patients admitted to the Takeda General Hospital with a diagnosis of stroke who were prescribed rehabilitation therapy between July 2014 and June 2016. For inclusion, patients were required to be aged ≥20 years and to have their initial rehabilitation assessment conducted within 1 week of symptom onset. We excluded patients who died or had missing data. All enrolled patients were required to provide written consent for participation and were given an opportunity to refuse to participate in the study.

Takeda General Hospital is a certified Aizu Community-Based Rehabilitation Center in the Fukushima prefecture that has 897 hospital beds and offers multidisciplinary care for cerebrovascular disease [16]. The rehabilitation team consisted of a neurologist, a rehabilitation physician, an occupational therapist, a physiotherapist, a speech therapist, a nurse, and a social worker. Multidisciplinary team meetings were conducted weekly to discuss rehabilitation and discharge planning (including destination). During these meetings, the occupational therapists were asked by the doctors about the ADL goal based on functional prognosis. Furthermore, based on the results of the initial evaluation and the needs of patients and their families, occupational therapists were asked for opinions on the place of transference and the required services when performing patient’s acute post-rehabilitation. Based on the information collected at these meetings, the support staff creates a patient's discharge plan.

This study protocol was reviewed and approved by the Ethics Committee of Tohoku Fukushi University (RS14071106).

Occupational therapists collected all sociodemographic and medical data, such as age, sex, number of family members, dominant hand, type of stroke, affected side, and the history of illness. Furthermore, occupational therapists assessed the acute symptoms of stroke patients within the first week of symptom onset, as follows: consciousness [Japan Coma Scale (JCS) score] [17], upper limb function [Brunnstrom recovery stage (BRS) for the upper limb] [18], lower limb function (BRS for the lower limb) [18], sensation in the upper and lower limbs, upper and lower limb joint range of motion, limb and trunk ataxia, agnosia, apraxia, aphasia, hemianopia, trunk control test [19], Functional Ambulation Categories classification [20], cognitive function [Hasegawa Dementia Scale—Revised (HDS-R) score] [21], and ADL (using the FIM) [22]. Moreover, evaluation in case of severe consciousness disorder was objectively evaluated based on the fact that it was confirmed by each test of the acute symptoms in principle. However, in particular, those with a consciousness level of 100−300 in JCS were rated as 0 in HDS-R. BRS was evaluated based on reactions that could be confirmed by palpation and observation scenes, and the sensation was mainly evaluated through a response by pain stimulus. Finally, we identified the discharge destination from the acute care ward.

Statistical analysis

Subjects were divided into three groups based on discharge destination (i.e., home, convalescent rehabilitation ward, or other facilities). Differences in sociodemographic profiles, medical profiles, and acute symptoms were tested among these groups by one-way analysis of variance for continuous variables or by the Kruskal–Wallis and chi-squared test for categorical variables. All statistical analyses were performed using the IBM SPSS Version 25.0 (IBM Corp., Armonk, NY, USA). The level of statistical significance was set at a p-value of < 0.05. Descriptive data are presented as numbers (percentages) or as means ± standard deviations (SDs).

Classification and regression tree (CART) analysis was used to investigate the complex interaction of factors related to discharge destination in the previous analyses. Binary trees were used to split predictor variables recursively with yes/no questions about each variable [23]. The CART algorithm produced a tree from the root by selecting the best predictor variable, defined as that with the lowest Gini index value as an internal node [24]. We specified a growing depth of three with the parent node having at least 10 subjects and a child node having at least three subjects [25]. The partitioning process was recursively applied until the stopping criteria were fulfilled or splitting was impossible [24]. Additionally, we performed a 10-fold cross-validation in which we randomly divided data into 10 groups (nine used to build and one used to validate the model) [26]. The sample size of this study was based on the previous study that used a CART analysis [27] because it is difficult to determine the number of samples required for a study on the interaction of factors affecting discharge destination after the acute phase of stroke using CART analysis.

Results

In total, 414 patients were enrolled during the study period, from which we excluded 110 patients (12 died and 98 had missing data). Consequently, our final analysis included 304 patients. The mean time to assessment from symptom onset was 1.4 ± 1.2 days. The mean age was 78.5 ± 11.7 years, and the male to female distribution was similar (154 men and 150 women). Approximately 75% of patients had suffered cerebral infarctions. Histories of stroke and hypertension were present in 36.2% and 62.8%, respectively, and approximately 60% of patients had a history of circulatory disease. The mean HDS-R score was 12.8 ± 11.4, and the mean FIM score was 44.0 ± 25.2. The clinical characteristics of the patients are summarized by discharge destination in Table 1.

Among the 304 patients, 102 (33.6%) were discharged home, 107 (35.2%) were transferred to a convalescent rehabilitation ward, and 95 (31.3%) were transferred to other facilities. Concerning the sociodemographic and medical profiles, there were significant differences in the age, sex, number of family numbers, and history of mental and behavioral disorders among groups based on discharge destination. There were also significant differences in all acute symptoms except for trunk ataxia, apraxia, and hemianopia. Finally, significant differences were present for all FIM scores, except for stair climbing (Table 2).

In the CART analysis, the total FIM score (> 35 or ≤ 35) was identified as the single best discriminator of discharge destination (Fig. 1). Patients with a total FIM score > 35, a BRS of the lower limb > V, and an FIM comprehension score > 5 had a 91.7% probability of home discharge. Moreover, patients with a total FIM score > 35, a BRS of the lower limb ≤ V, and an FIM motor score > 44 had an 81.2% probability of home

Table 1. Characteristics of the study subjects (n = 304)

Variables	Discharge destination from acute care ward			*P* value
	Home (n = 102)	Convalescent rehabilitation ward (n = 107)	Other facilities (n = 95)	
Age, years, mean ± SD	75.4 ± 12.1	75.3 ± 10.7	85.6 ± 9.3	< .001
Female, n (%)	47 (46.1)	46 (43.0)	57 (60.0)	.039
Number of family members, mean ± SD	3.2 ± 1.8	2.8 ± 1.7	2.4 ± 1.8	.007
Dominant hand side (right), n (%)	102 (100)	105 (98.1)	94 (98.9)	.392
Type of stroke (ischemic/ hemorrhage), n (%)	84 (82.4)/18 (17.6)	74 (69.2)/33 (30.8)	69 (72.6)/26 (27.4)	.165
Paralyzed side (right), n (%)	45 (44.1)	59 (55.1)	58 (61.1)	.052
History of illness, n (%)				
Stroke	34 (33.3)	39 (36.4)	37 (38.9)	.713
Hypertension	62 (60.8)	67 (62.6)	62 (65.3)	.808
Heart disease	29 (28.4)	32 (29.9)	33 (34.7)	.608
Hyperlipidemia	15 (14.7)	21 (19.6)	13 (13.7)	.463
Diabetes mellitus	24 (23.5)	32 (29.9)	17 (17.9)	.135
Japan Coma Scale, n (%)				
Grade 0, Normal	59 (57.8)	26 (24.3)	6 (6.3)	< .001
Grade 1, Single digit	37 (36.3)	61 (57.0)	47 (49.5)	
Grade 2, Double digits	6 (5.9)	17 (15.9)	30 (31.6)	
Grade 3, Triple digits	0 (0)	3 (2.8)	12 (12.6)	
BRS of the upper limb, n (%)				
I	2 (2.0)	6 (5.6)	16 (16.8)	< .001
II	4 (3.9)	28 (26.2)	28 (29.5)	
III	6 (5.9)	18 (16.8)	15 (15.8)	
IV	11 (10.8)	20 (18.7)	16 (16.8)	
V	26 (25.5)	22 (20.6)	12 (12.6)	
VI	53 (52.0)	13 (12.1)	8 (8.4)	
BRS of the lower limb, n (%)				
I	3 (2.9)	4 (3.7)	13 (13.7)	< .001
II	3 (2.9)	22 (20.6)	25 (26.3)	
III	5 (4.9)	13 (12.1)	14 (14.7)	
IV	5 (4.9)	24 (22.4)	19 (20.0)	
V	32 (31.4)	33 (30.8)	16 (16.8)	
VI	54 (52.9)	11 (10.3)	8 (8.4)	
Sensation of the upper limb, n (%)				
Deficit	36 (35.3)	54 (50.5)	55 (57.9)	.006
Sensation of the lower limb, n (%)				
Deficit	30 (29.4)	53 (49.5)	53 (55.8)	< .001
ROM of the upper limb, n (%)				
Deficit	6 (5.9)	11 (10.3)	21 (22.1)	.002
ROM of the lower limb, n (%)				
Deficit	7 (6.9)	9 (8.4)	18 (18.9)	.014
Ataxia of limbs, n (%)				
Presence	5 (4.9)	14 (13.1)	3 (3.2)	.013
Ataxia of trunk, n (%)				
Presence	2 (2.0)	7 (6.5)	1 (1.1)	.060
Agnosia, n (%)				
Presence	4 (3.9)	15 (14.0)	16 (16.8)	.011
Apraxia, n (%)				
Presence	2 (2.0)	6 (5.6)	4 (4.2)	.395
Aphasia, n (%)				
Presence	11 (10.8)	25 (23.4)	31 (32.6)	.001
Hemianopia, n (%)				
Presence	9 (8.8)	7 (6.5)	11 (11.6)	.454
Trunk control test, mean ± SD	69.2 ± 37.0	33.4 ± 37.9	12.7 ± 26.2	< .001
Functional Ambulation Categories, mean ± SD/median (range)	1.6 ± 1.6/2.0 (0–3)	0.3 ± 0.8/0.0 (0–0)	0.2 ± 0.6/0.0 (0–0)	< .001
HDS–R scores, mean ± SD	19.3 ± 9.9	14.3 ± 10.8	4.2 ± 7.5	< .001

BRS: Brunnstrom recovery stage; ROM: Range of motion; HDS–R: Hasegawa Dementia Scale–Revised; SD: standard deviation.

Table 2. The Functional Independence Measure scores by discharge destination

Variables	Discharge destination from acute care ward			*P* value
	Home (n = 102)	Convalescent rehabilitation ward (n = 107)	Other facilities (n = 95)	
Eating, mean ± SD/median (range)	4.3 ± 2.2/5 (1−6)	2.6 ± 2.0/1 (1−5)	1.5 ± 1.4/1 (1−1)	< .001
Grooming, mean ± SD/median (range)	3.1 ± 2.1/3 (1−5)	1.5 ± 1.2/1 (1−1)	1.2 ± 0.8/1 (1−1)	< .001
Bathing, mean ± SD/median (range)	2.2 ± 1.7/1 (1−4)	1.2 ± 0.6/1 (1−1)	1.1 ± 0.5/1 (1−1)	< .001
Dressing upper body, mean ± SD/median (range)	2.3 ± 1.5/1 (1−4)	1.4 ± 0.8/1 (1−1)	1.1 ± 0.5/1 (1−1)	< .001
Dressing lower body, mean ± SD/median (range)	2.5 ± 1.8/1 (1−4)	1.4 ± 0.9/1 (1−1)	1.1 ± 0.5/1 (1−1)	< .001
Toileting, mean ± SD/median (range)	3.3 ± 2.3/4 (1−5)	1.6 ± 1.3/1 (1−1)	1.2 ± 0.8/1 (1−1)	< .001
Bladder management, mean ± SD/median (range)	3.9 ± 2.8/3.5 (1−7)	1.9 ± 1.7/1 (1−2)	1.2 ± 1.1/1 (1−1)	< .001
Bowel management, mean ± SD/median (range)	3.9 ± 2.8/4 (1−7)	2.1 ± 2.0/1 (1−2)	1.2 ± 1.1/1 (1−1)	< .001
Transfers to bed/chair/wheelchair, mean ± SD/median (range)	3.4 ± 2.1/4 (1−5)	1.7 ± 1.3/1 (1−2)	1.2 ± 0.8/1 (1−1)	< .001
Transfers to toilet, mean ± SD/median (range)	3.4 ± 2.1/4 (1−5)	1.7 ± 1.3/1 (1−1)	1.2 ± 0.9/1 (1−1)	< .001
Transfer to tub/shower, mean ± SD/median (range)	1.2 ± 0.9/1 (1−1)	1.0 ± 0.3/1 (1−1)	1.0 ± 0.0/1 (1−1)	.029
Walking or wheelchair propulsion, mean ± SD/median (range)	2.1 ± 1.7/1 (1−4)	1.1 ± 0.6/1 (1−1)	1.1 ± 0.6/1 (1−1)	< .001
Stair climbing, mean ± SD/median (range)	1.0 ± 0.1/1 (1−1)	1.0 ± 0.0/1 (1−1)	1.0 ± 0.0/1 (1−1)	.372
Comprehension, mean ± SD/median (range)	5.6 ± 1.8/7 (5−7)	4.7 ± 2.0/5 (3−6)	2.5 ± 1.7/2 (1−4)	< .001
Expression, mean ± SD/median (range)	5.7 ± 1.8/6 (5−7)	4.5 ± 2.1/5 (3−6)	2.4 ± 1.8/2 (1−3)	< .001
Social interaction, mean ± SD/median (range)	5.7 ± 2.2/7 (6−7)	4.9 ± 2.6/6 (1−7)	2.6 ± 2.5/1 (1−5)	< .001
Problem solving, mean ± SD/median (range)	4.7 ± 2.6/6 (1−7)	3.3 ± 2.5/1 (1−5)	1.7 ± 1.6/1 (1−1)	< .001
Memory, mean ± SD/median (range)	5.0 ± 2.2/6 (3−7)	4.0 ± 2.2/3 (2−6)	1.9 ± 1.6/1 (1−2)	< .001
Motor FIM Score, mean ± SD/median (range)	36.7 ± 19.9/36.5 (16−56)	20.1 ± 10.9/14 (13−24)	15.0 ± 7.9/13 (13−13)	< .001
Cognitive FIM score, mean ± SD/median (range)	26.7 ± 9.7/32 (18.8−35.0)	21.3 ± 9.6/22 (14−30)	11.0 ± 7.7/8 (5−14)	< .001
Total FIM score, mean ± SD/median (range)	63.4 ± 27.3/64.5 (38.8−89.0)	41.3 ± 17.1/39 (27−51)	26.1 ± 13.3/21 (18−27)	< .001

FIM: Functional Independence Measure; SD: standard deviation.

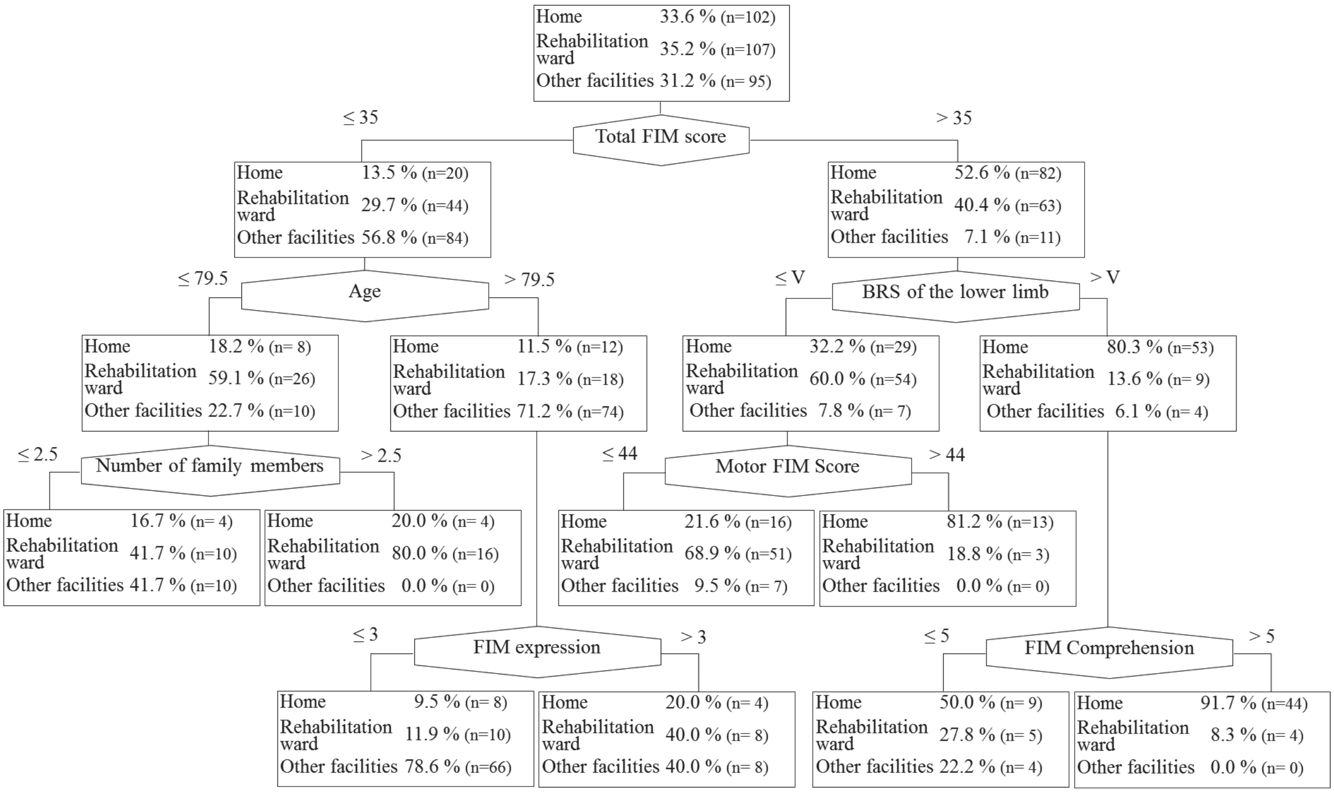
discharge, whereas those with a total FIM score ≤ 35, age ≤ 79.5 years, and with > 2.5 family members had an 80% probability of discharge to a convalescent rehabilitation ward. Finally, patients with a total FIM score ≤ 35, age > 79.5 years, and FIM expression score ≤ 3 had a 78.6% probability of discharge to other facilities (e.g., long-term care). The 10-fold cross-validation showed that the outcomes of 61.5% of the patients were correctly predicted by the CART analysis.

Discussion

CART analysis indicated that functional ADL status, lower limb function, and comprehension ability at admission were most strongly associated with home discharge. Of note, the total FIM score at admission (> 35 or ≤ 35) was the best predictor of discharge destination. A total FIM score of 35 points is almost at the level of total or maximal ADL assistance, indicating that complete dependence of ADLs (i.e., a total FIM score ≤ 35) at the initial assessment within 1 week of stroke onset made home discharge very unlikely. By contrast, when patients with a total FIM score > 35 had retained lower limb function (BRS of the lower limbs > V) and comprehension (FIM comprehension score > 5), home discharge was more likely. Therefore, we recommend that occupational therapists use these results as clinical indicators and thresholds for determining discharge destination.

A BRS of the lower limb of VI implies normal muscle tone and control [28], and an FIM comprehension score > 5 implies independence level [29]. After a stroke, patients are usually forced to rest in bed for medical treatment despite having functional ability. However, under conditions where ADLs were restricted, home discharge was the most likely, in our cohort, in case of BRS of the lower limbs > V and FIM comprehension score > 5. Home discharge was also highly probable if patients with a total FIM score > 35 and a BRS of the lower limb ≤ V (i.e., apparent motor paralysis) had an FIM motor score > 44. Despite the poor BRS, patients with an FIM motor score > 44 can be expected to have relatively mild motor paralysis of the lower limbs because the average FIM motor score was 36.7 ± 19.9 in the home discharge group.

When the FIM motor score reaches the 40-point



BRS: Brunnstrom recovery stage; FIM: Functional Independence Measure; Rehabilitation ward: Convalescent rehabilitation ward.

Fig. 1. Classification and regression tree for discharge destination after the acute phase of stroke
Patients with a total FIM score > 35, a BRS of the lower limb > V, and an FIM comprehension score > 5 had a 91.7% probability of home discharge. Patients with a total FIM score > 35, a BRS of the lower limb ≤ V, and an FIM motor score > 44 had an 81.2% probability of home discharge, whereas those with a total FIM score ≤ 35, age ≤ 79.5 years, and with > 2.5 family members had an 80% probability of discharge to a convalescent rehabilitation ward. Patients with a total FIM score ≤ 35, age > 79.5 years, and FIM expression score ≤ 3 had a 78.6% probability of discharge to other facilities (e.g., long-term care).

level, it has been reported that other items of the motor FIM indicate less than moderate assistance, except for items related to bathing (bathing and transfer to tub/shower) and locomotion (walk or wheelchair) [30]. Eating, bladder management, and bowel management are considered the easiest of the FIM motor items, whereas walking or wheelchair use, tub/shower transfer, using stairs, and bathing are the most difficult [31]. The results of the present study are consistent with these studies [30, 31]. On the other hand, bathing-related activity and locomotion are highly likely to reduce the amount of assistance needed through welfare equipment and social resources [30]. Therefore, patients with 40 or more FIM motor points are likely to be discharged home [30]. Occupational therapists should conduct a detailed assessment of each activity of ADL, and it is important to carry out environmental interventions using assistive devices or welfare equipment from the acute stage. Additionally, if necessary, various services and social resources should be utilized.

When patients had a total FIM score ≤ 35, were aged ≤ 79.5 years, and had > 2.5 family members, the chance of discharge to a convalescent rehabilitation ward increased. This suggested that, even if the ADL at stroke onset indicated the need for full assistance, there remained a high probability of transfer to a convalescent rehabilitation ward if the patient was younger than 79.5 years and had three or more family members. Patients are expected to improve further when admitted to a convalescent rehabilitation ward [6]. Previous studies have also shown that a patient's age and the number of family members were related to home discharge [7−9]. Our data indicate that transfer to a convalescent rehabilitation ward may be more appropriate in this group, with the ultimate goal being home discharge. Moreover, patients with a total FIM score > 35, a BRS of the lower limb ≤ V, and an FIM motor score ≤ 44 had approximately a 70% chance of discharge to a convalescent rehabilitation ward. Requiring moderate to maximal assistance in the total FIM at stroke onset, excluding items related to bathing and locomotion, may predict recovery in future rehabilitation.

Factors associated with discharge to other facilities, such as other hospitals or long-term care facilities, were near-total assistance on the ADL assessment, age 80 years or over, and the need for more than moderate assistance with expression. This suggests that not only motor function but also cognitive function must be severely impaired for patients to be discharged to other facilities. In clinical practice, even if there is severe dysfunction at onset, patients can recover function in the future, and patients with family support at home are often first transferred to a convalescent rehabilitation ward. Although severe disability makes home discharge difficult, there are cases in which it may remain possible, such as when there is adequate support from family and welfare services. The results of this study were consistent with those of previous studies [11].

Several studies have been done using regression analysis to predict discharge destinations after stroke [7−11, 13], but few have used CART analysis. For example, Falconer et al. used CART analysis to show that independence in toilet management, bladder management, and toilet transfer, as well as adequacy of financial resources, affected the outcomes of patients after stroke [27]. Furthermore, El-Solh et al. reported that several variables predicted the discharge destination of stroke patients in post-acute geriatric rehabilitation units. These were as follows: age; preadmission living environment; nursing severity index; cardiac, musculoskeletal–integument, and lower gastrointestinal symptoms; toileting transfer; and toilet management [32]. By using signal detection analysis, Miyamoto et al. also showed that ADLs, key person preference, age, gender, route taken to hospitalization, residence before hospitalization, and diagnosis of dementia were significant predictors of discharge destination [2]. Even though there are differences in the methods of analysis, the variables associated with discharge destination tend to be the same in these studies. However, because CART analysis can provide a model diagram (e.g., Fig. 1) of the complex interaction of factors relating discharge destination, it provides more useful information for clinical reasoning compared with logistic regression analysis. Furthermore, this study showed multiple clinical indicators in the acute phase of patients, who were expected long-term recovery and eventually would be discharged to their home by placing convalescent rehabilitation ward in the category of discharge destination.

We believe that the present study would provide useful information for occupational therapy practice in the acute phase of stroke. First, occupational therapists will be able to concretely examine the priority of patients' daily life problems in the acute phase with a long-term perspective, by using these clinical indicators to make discharge predictions. Second, occupational therapists will be able to more accurately conceptualize the occupational therapy goals under discharge prediction, taking into consideration the needs of patients and their families, and as a result, it would be possible to introduce interventions, not only viewpoints of physical and cognitive functions but also activities, occupations or environment adjustment in the acute phase. We believe that the goals of occupational therapy according to patients' future life are definitely reflected in the goals of the acute rehabilitation team. Third, occupational therapists will be able to communicate patients' problems, particularly with respect to the next stage after the acute phase; i.e., occupational therapists are required to coordinate service contents and support systems necessary for patients in post-discharge institution, and the results of this study are considered to be useful as appropriate discharge plan in acute stroke patients. American Occupational Therapy Association (AOTA) recommends that occupational therapy's holistic approach should focus on patient's goals and integrate occupation-based activities into the rehabilitation process of acute care [33]. Moreover, AOTA also recommends that occupational therapists collaborate closely with other health care professionals to create an interdisciplinary plan of care and a coordinated and appropriate discharge plan [33]. Therefore, the present study is believed to further promote occupational therapists' practices in the acute phase of stroke.

Study Limitations

This study has several limitations. First, we only included patients from one acute care ward, making it is difficult to generalize our findings and making multicenter collaboration necessary in the future. Second, previous studies have reported that it is desirable to consider a patient's discharge destination soon after symptom onset to screen for further interventions [2, 7]. However, predicting discharge as a short-term outcome is not necessarily synonymous with predicting optimal rehabilitation and long-term outcomes [34]. Given that it has also been reported that outcomes should not be predicted before day seven after a stroke [35], there remains a need to confirm the optimal time at which outcomes should be predicted. Third, we did not include key background factors, such as household income, housing conditions, and local community resources, that are known to be important when making discharge decisions. Verification of the role of these is needed in future research, aiming to determine whether their inclusion produces different decision trees in CART analysis. Finally, with regard to statistical analysis, because there are many items to consider in this study, there are concerns about the problem of multiple testing. Thus, further verification is necessary in the future.

Conclusion

The findings of this study suggested that degree of independence on the FIM, function of the paralyzed lower limb, age, number of family members, and comprehension or expression function influence the choice of discharge destination for patients from acute stroke wards. However, further studies are needed to clarify the clinical indicators that determine the likely discharge destination from acute stroke wards. This is because intervention of occupational therapists based on accurate prognostic prediction in acute stroke rehabilitation is extremely important for supporting patients' activities and social participation.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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References

[1] Summers D, Leonard A, Wentworth D, Saver JL, Simpson J, Spilker JA, *et al.* Comprehensive overview of nursing and interdisciplinary care of the acute ischemic stroke patient: a scientific statement from the American Heart Association. Stroke. 2009; 40(8): 2911−44.

[2] Miyamoto H, Hagihara A, and Nobutomo K. Predicting the discharge destination of rehabilitation patients using a signal detection approach. J Rehabil Med. 2008; 40(4): 261−8.

[3] Brauer SG, Bew PG, Kuys SS, Lynch MR, and Morrison G. Prediction of discharge destination after stroke using the motor assessment scale on admission: a prospective, multisite study. Arch Phys Med Rehabil. 2008; 89(6): 1061−5.

[4] Van der Cruyssen K, Vereeck L, Saeys W, and Remmen R. Prognostic factors for discharge destination after acute stroke: a comprehensive literature review. Disabil Rehabil. 2015; 37(14): 1214−27.

[5] Duncan PW, Zorowitz R, Bates B, Choi JY, Glasberg JJ, Graham GD, *et al.* Management of adult stroke rehabilitation care: a clinical practice guideline. Stroke. 2005; 36(9): e100−43.

[6] Abo M, and Kakuda W. Rehabilitation for cerebrovascular disease: current and new methods in Japan. Japan Med Assoc J. 2012; 55(3): 240−5.

[7] Bohannon RW, Lee N, and Maljanian R. Postadmission function best predicts acute hospital outcomes after stroke. Am J Phys Med Rehabil. 2002; 81(10): 726−30.

[8] Freburger JK, Holmes GM, Ku LJ, Cutchin MP, Heatwole-Shank K, and Edwards LJ. Disparities in postacute rehabilitation care for stroke: an analysis of the state inpatient databases. Arch Phys Med Rehabil. 2011; 92(8): 1220−9.

[9] Agarwal V, McRae MP, Bhardwaj A, and Teasell RW. A model to aid in the prediction of discharge location for stroke rehabilitation patients. Arch Phys Med Rehabil. 2003; 84(11): 1703−9.

[10] Roberts PS, Mix J, Rupp K, Younan C, Mui W, Riggs RV, *et al.* Using functional status in the acute hospital to predict discharge destination for stroke patients. Am J Phys Med Rehabil. 2016; 95(6): 416−24.

[11] Tanwir S, Montgomery K, Chari V, and Nesathurai S. Stroke rehabilitation: availability of a family member as caregiver and discharge destination. Eur J Phys Rehabil Med. 2014; 50(3): 355−62.

[12] Mees M, Klein J, Yperzeele L, Vanacker P, and Cras P. Predicting discharge destination after stroke: A systematic review. Clin Neurol Neurosurg. 2016; 142: 15−21.

[13] Dutrieux RD, van Eijk M, van Mierlo ML, van Heugten CM, Visser-Meily JM, and Achterberg WP. Discharge home after acute stroke: Differences between older and younger patients. J Rehabil Med. 2016; 48(1): 14−8.

[14] Tinl ML, Kale MK, Doshi S, Guarino AJ, and Beninato M. The mobility scale for acute stroke predicts discharge destination after acute hospitalization. J Rehabil Med. 2014; 46(3): 219−24.

[15] Maeshima S, Okamoto S, Okazaki H, Mizuno S, Asano N, Maeda H, *et al.* Potential factors, including activities of daily living, influencing home discharge for patients with putaminal haemorrhage. BMC Neurol. 2016; 16: 16.

[16] Sone T, Nakaya N, Iokawa K, Hasegawa K, Tsukada T, Kaneda M, *et al.* Prediction of upper limb recovery in the acute phase of cerebrovascular disease: evaluation of "functional hand" using the manual function test. J Stroke Cerebrovasc Dis. 2015; 24(4): 815−22.

[17] Ohta T, Waga S, Handa W, Saito I, and Takeuchi K. New grading of level of disordered consiousness (in Japanese). No Shinkei Geka. 1974; 2(9): 623−7.

[18] Brunnstrom S. Movement therapy in hemiplegia: a neurophysiological approach. New York: Harper & Row, 1970.

[19] Collin C, and Wade D. Assessing motor impairment after stroke: a pilot reliability study. J Neurol Neurosurg Psychiatry. 1990; 53(7): 576−9.

[20] Holden MK, Gill KM, Magliozzi MR, Nathan J, and Piehl-Baker L. Clinical gait assessment in the neurologically impaired. Reliability and meaningfulness. Phys Ther. 1984; 64(1): 35−40.

[21] Kato S, Shimogaki H, Onodera A, Ueda H, Oikawa K, Ikeda K, *et al.* Development of the revised version of Hasegawa's Dementia Scale (HDS-R) (in Japanese). Jpn

J Geriatr Psychiatry. 1991; 2: 1339−47.

[22] Granger CV, Hamilton BB, Keith RA, Zielezny M, and Sherwin FS. Advances in functional assessment for medical rehabilitation. Top Geriatr Rehabil. 1986; 1(3): 59−74.

[23] Tanaka R, Umehara T, Fujimura T, and Ozawa J. Clinical prediction rule for declines in activities of daily living at 6 months after surgery for hip fracture repair. Arch Phys Med Rehabil. 2016; 97(12): 2076−84.

[24] Hung LC, Hu YH, and Sung SF. Exploring the impact of intravenous thrombolysis on length of stay for acute ischemic stroke: a retrospective cohort study. BMC Health Serv Res. 2015; 15: 404.

[25] Arai T, Kaneko S, and Fujita H. Decision trees on gait independence in patients with femoral neck fracture (in Japanese). Nihon Ronen Igakkai Zasshi. 2011; 48(5): 539−44.

[26] Bernhardt J, Churilov L, Ellery F, Collier J, Chamberlain J, Langhorne P, *et al.* Prespecified dose-response analysis for A Very Early Rehabilitation Trial (AVERT). Neurology. 2016; 86(23): 2138−45.

[27] Falconer JA, Naughton BJ, Dunlop DD, Roth EJ, Strasser DC, and Sinacore JM. Predicting stroke inpatient rehabilitation outcome using a classification tree approach. Arch Phys Med Rehabil. 1994; 75(6): 619−25.

[28] de Haart M, Geurts AC, Huidekoper SC, Fasotti L, and van Limbeek J. Recovery of standing balance in postacute stroke patients: a rehabilitation cohort study. Arch Phys Med Rehabil. 2004; 85(6): 886−95.

[29] Granger CV, Hamilton BB, Linacre JM, Heinemann AW, and Wright BD. Performance profiles of the functional independence measure. Am J Phys Med Rehabil. 1993; 72(2): 84−9.

[30] Tsuji T, Sonoda S, and Chino N. The ADL structure for stroke patients at admission and dischage based on the functional independence measure (in Japanese). Jpm J Rehabil Med. 1996; 33(5): 301−9.

[31] Tsuji T, Sonoda S, Domen K, Saitoh E, Liu M, and Chino N. ADL structure for stroke patients in Japan based on the functional independence measure. Am J Phys Med Rehabil. 1995; 74(6): 432−8.

[32] El-Solh AA, Saltzman SK, Ramadan FH, and Naughton BJ. Validity of an artificial neural network in predicting discharge destination from a postacute geriatric rehabilitation unit. Arch Phys Med Rehabil. 2000; 81(10): 1388−93.

[33] The American Occupational Therapy Association, Inc [online]. Montgomery: Occupational Therapy in Acute Care [cited 2018 October 30]. Available from: https://www.aota.org/About-Occupational-Therapy/Professionals/RDP/AcuteCare.aspx

[34] Meijer R, van Limbeek J, Peusens G, Rulkens M, Dankoor K, Vermeulen M, *et al.* The Stroke Unit Discharge Guideline, a prognostic framework for the discharge outcome from the hospital stroke unit. A prospective cohort study. Clin Rehabil. 2005; 19(7): 770−8.

[35] Woldag H, Gerhold LL, de Groot M, Wohlfart K, Wagner A, and Hummelsheim H. Early prediction of functional outcome after stroke. Brain Inj. 2006; 20(10): 1047−52.

ORIGINAL ARTICLE

The Influence of Physical Function on Drawing Performance and Drawing Motion in Clumsy Children

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Abstract: Background: Children with developmental disorders who require occupational therapy often show clumsiness in handwriting (hereafter referred to as clumsy children). The quality of handwriting has been reported to be deteriorated in children who had physical function-related issues for using handwriting tools. However, to date there has not been any clinical research to investigate the types and severity of deficits in physical function that influence the using handwriting tools. Similarly, how the trends and the severity of problems in physical function affect the characteristics of the results of handwriting task was previously unaddressed.
Objective: This study investigated the influence of characteristics of physical function on drawing performance and drawing motion in clumsy children.
Method: Participants were healthy children and clumsy children enrolled in grades 2–6 of elementary school. The participants' drawing performance was evaluated using the triangle drawing task on a tablet personal computer. The participants' drawing motion was evaluated using the two-dimensional movement analysis device. The physical function of clumsy children was evaluated using the clinical observational assessment.
Results: The largest stray distance, the range of speed and the difference of speed for the healthy child group by grade and each clumsy child. The sway length ratio of the clumsy children differed from those of the healthy children group. Clumsy children who exhibited poor drawing skills also had problems in posture maintenance, muscle condition, upper limb coordination, and eye movement.
Conclusion: We found the influence of poor physical function on poor drawing and drawing motion in clumsy children.

Keywords: developmental disabilities, clumsy children, drawing performance, drawing motion, physical function

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Introduction

Children with developmental disorders who require occupational therapy often show clumsiness in writing and drawing (hereafter referred to as clumsy children) [1].

Previous studies have examined the accuracy of drawing tasks using PC tablets to measure changes in speed and pen pressure while drawing figures. These studies have reported that clumsy children exhibit a lower level of accuracy in drawing and show patterns of drawing speed changes that are different from those of children with typical development (hereafter referred to as healthy children) [2–4]. These studies also noted that accuracy and speed changes both differ greatly between individual clumsy children. However, clumsy children who present with problems associated with using a pen are uniformly assessed as having poor handwriting skills, then clinical support based on individual problems has not been examined.

Previous reports have identified numerous factors

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that affect the test results of children assessed as having poor handwriting skills in using a pen. These factors include problems in physical function, such as decreased cooperativeness and manual dexterity of the upper limbs, difficulty in maintaining posture, controlling muscle tone and poor eye movements. Additionally, the quality of handwriting has been reported to be deteriorated in children who had physical function related issues for using handwriting tools [5–9]. However, to date there has not been any clinical research to investigate the types and the severity of deficits in physical function that influence the using of handwriting tools. Similarly, how the trends and the severity of problems in physical function affect the characteristics of the results of handwriting task was previously unaddressed.

In this study, we clarified the relationship between drawing performance and drawing motion in clumsy children as compared to that in healthy children by analyzing the results of a drawing task and their drawing motions while doing the task. Additionally, by analyzing physical function we also elucidated how characteristics of physical function influence drawing performance and drawing motion in clumsy children.

The hypotheses of this study were as follows.

1) The clumsy children were different from the healthy children in the accomplishment result of drawing motion in the drawing task.
2) The accomplishment result and the campaign for drawing motion in the drawing task of the clumsy children were related to characteristic of physical function.

Methods

Research Design

A cross-sectional design was used to study the relationship between drawing performance and drawing motion in clumsy children, and to determine how characteristics of physical function influence drawing performance and drawing motion in clumsy children. Each clumsy and healthy child was asked to perform a drawing task, and each clumsy child was asked to perform an additional physical function test. This study was approved by the institutional review board at Sapporo Medical University. Parents were informed of the study and given a right to remove their child from this study.

Subjects

The clumsy child group comprised 10 boys who had received a diagnosis of developmental disorders by a doctor, and who showed difficulty in handwriting. There is not an evaluation scale of clumsiness standardized in Japan. Therefore, in this study, the clumsy child was defined as judged to be weak in writing compared to each grade children by occupational therapists and parents. This group included 2 second grade students, 3 third grade students, 1 fourth grade student, 2 fifth grade students, and 2 sixth grade students.

The healthy child group comprised 54 boys who did not have any apparent physical or learning disabilities. We classify them in 2–6 grade by age. The healthy child group included 8 second grade students (7–8 years old), 10 third grade students (8–9 years old), 12 fourth grade students (9–10 years old), 12 fifth grade students (10–11 years old), and 12 sixth grade students (11–12 years old),. All subjects normally used their right hand to handwrite.

Instrument

Drawing Performance and Drawing Motion

A tablet personal computer (Sony VAIO Duo 11; hereafter referred to as PC tablet), a stylus to draw directly on the screen, and software developed for the assessment of upper limb function in handwriting tasks [10] were used for the drawing task. Microsoft Visual Basic 2012 was used to create the figures used for assessing upper limb function. During the drawing task, changes in the positioning of the stylus and elapsed time were recorded using a sampling frequency of 133 Hz.

Subjects were seated with both feet placed on the floor and with their forearms on the table. The PC tablet was placed 12.5 cm from the front edge of the desk, and subjects held the stylus with their right hand. Their left hand was placed on the bottom left of the tablet. Video cameras were placed above and to the right of the subjects to record the drawing motion. Based on a previous study [1], markers were placed on the right acromion, lateral epicondyle of the right humerus, right radial styloid process, and stylus to serve as indicators for the analysis of motions.

The drawing task was to draw a line between two concentric equilateral triangles displayed on the PC tablet, spaced 3 mm apart, the side length of the outer equilateral triangle was 10 cm. The subjects drew a line in a counterclockwise direction, starting from the top point. Subjects were instructed to draw accurately, to try to not write outside the lines, and to not lift up the stylus from the screen while drawing. The drawing task was performed three times after the subjects had practiced using the PC tablet and stylus and after they were accustomed to the necessary movements. Based on the position coordinates of the stylus on the PC tablet, the distance that the stylus strayed outside of the parallel lines (hereafter referred to as stray distance) and the speed of the stylus movement (hereafter referred to as speed) were calculated.

Fig. 1. Environment Configuration of Drawing Motion Analysis.
Note. Video cameras were placed above and to the right of the subjects to record the drawing motion, and markers were placed on the right acromion, the lateral epicondyle of the right humerus, right radial styloid process, and stylus to serve as indicators for the analysis of actions.

Dartfish 4.0 (Dartfish Company) was used to analyze the movements of each marker recorded by the cameras placed above and to the right of the subjects. The markers attached to the right acromion, lateral epicondyle of the right humerus, right radial styloid process, and stylus during the drawing tasks indicated movements of the body, shoulder joint, elbow joint, and fingers, respectively (Fig. 1). We calculated the trace length for each marker (hereafter referred to as sway length) and the total trace length (hereafter referred to as total sway length) while performing the drawing task. The ratio of the sway length for each marker was calculated by setting the total sway length of each marker to 100%.

Physical Function

Twenty-six tasks were selected from the clinical observational assessment items of the Japanese Academy of Sensory Integration: three tasks were related to the postural reflex, three tasks were related to the residual primitive reflexes, four tasks were related to the muscle tone condition, two tasks were related to posture maintenance, four tasks were related to cooperativeness of the upper limbs, six tasks were related to compound motions and four tasks were related to eye movements. The tasks were conducted by occupational therapists in accordance with the procedures in the manual, and some subjects were filmed during the tests when the subjects and their parents gave consent.

The result of each task was classified into one of three categories: poor, moderately poor, or normal. Based on these results, the occupational therapist responsible for the experiment and a second occupational therapist with at least 5 years of clinical experience confirmed the scores while checking the recordings. In cases where subjects were not filmed, the second occupational therapist re-evaluated the clinical observations and, if the scores did not match, the two assessors discussed the results and confirmed the scores. The results of the clinical observations were quantified as follows: poor, 2 points; moderately poor, 1 point; and normal, 0 points. Total points for the seven categories and all tasks were then calculated.

Data Analysis

Drawing Performance

For healthy children, we calculated the largest stray distance in three times of the drawing task, the speed of the trial with the largest sway length, the difference between the fastest and the slowest speed (hereafter referred to as the range of speed) for each school grade, and the difference between the fastest and slowest speed of each healthy children (hereafter referred to as the difference of speed). For clumsy children, the largest stray distance, the range of speed, and the difference of speed were calculated and then compared with those of healthy children of the same grade. Clumsy children who had a larger stray distance than the largest stray distance of the healthy children of their grade were considered to have a drawing problem. Clumsy children who had a faster speed than the fastest speed of the healthy child group of each grade were defined as having a fast drawing speed. Similarly, those who had a slower speed than the slowest speed of the healthy child group of each grade were defined as having a slow drawing speed. Clumsy children who had a larger range of speed than the largest range of speed of the healthy child group of each grade were considered to have a varied drawing.

Drawing Motion

In regards to drawing motion in the healthy child group, we calculated the mean and standard deviation (SD) of both the sway length and the total sway length for each marker for each grade. Subjects who had a sway length of greater than the mean value +1SD of the healthy child group were defined as having a large sway length, and those who had a sway length of less than the mean value −1SD were defined as having a little sway length. We concluded that the clumsy children had different drawing motion than healthy children when their sway length was qualified as large or little.

Further, we calculated the mean ratio of the sway length for each marker for each grade. A goodness-of-fit test was used to analyze the ratio of sway length. The mean ratio value of the healthy child group for each grade was defined as the expected value and the mean ratio of the each clumsy child in each grade was defined as the actual measurements. When the ratio of sway length for each marker in the healthy child group and the clumsy child did not match, we concluded that the drawing motion differed between healthy child group and the clumsy child.

IBM SPSS statistical software version 16.0 J for Windows (IBM Global Services Japan Solution and Services Company) was used for statistical analysis and $p < 0.05$ was used to determine statistical significance.

Physical Function

The physical function tasks were measured using the assessment scores of each area of the clinical observations and converted to a score with a possible total of 100 points. In the present study, subjects who had high assessment scores and high total points were determined as having a physical function problem.

Finally, clumsy children who had any problem in drawing performance or drawing motion were classified and analyzed according to trends noted in their physical dysfunction.

Results

Drawing Performance

The largest stray distance, the range of speed and the difference of speed for the healthy child group by grade and each clumsy child are shown in Table 1. Clumsy children were classified into two groups according to the largest stray distance: 6 children in Group I (Case A, B, G, H, I and J) had a drawing problem; 4 children in Group II (Case C, D, E and F) did not have a drawing problem. In clumsy children from Group I, they had a tendency for larger mean stray distance and greater speed variability than the healthy child group, when categorized by grade.

Table 1. Drawing performance for healthy and clumsy children.

	Grade (age)	the trial of the largest stray distance		range of speed	difference of speed	
		sway length	speed		min	max
Healthy children	2 (7−8)	2.39	2.13	1.36−3.28	0.16	1.32
	3 (8−9)	2.32	2.44	0.95−4.10	0.24	1.97
	4 (9−10)	1.80	2.69	0.96−3.11	0.03	0.85
	5 (10−11)	1.34	2.22	0.88−3.59	0.14	1.37
	6 (11−12)	0.20	1.74	1.20−2.67	0.05	0.76

	grade	the trial of the largest stray distance		range of speed	difference of speed
		sway length	speed		
Group I with drawing problem	A (2)	3.70*	4.79*	2.10−4.79	2.69*
	B (2)	2.94*	2.15*	1.96−2.72	0.76
	G (5)	5.18*	2.65*	1.10−2.65	1.55*
	H (5)	1.54*	1.30	0.91−2.63	1.72*
	I (6)	1.58*	3.84*	2.48−3.84	1.36*
	J (6)	13.76*	7.26*	3.93−7.26	3.33*
Group II without drawing problem	C (3)	0.27	2.43	1.95−2.81	0.86
	D (3)	1.94	3.07*	3.07−4.57	1.50
	E (3)	2.18	1.03	1.03−2.94	1.91
	F (4)	0.34	1.09	1.09−1.39	0.30

Stray distance; cm, Speed; cm/sec, *; above the standard of the healthy child group of each grade
Note. In clumsy children from Group I, they had a tendency for longer mean stray distance and greater speed variability than the healthy child group, when categorized by grade.

Drawing Motion

The mean sway length and total sway length of each marker for the healthy child group and the clumsy children were classified into two groups according to drawing performance are shown in Table 2. The sway length and total sway length of each marker for clumsy children were defined as being large when the sway length deviated above the normal range of movement as measured by one of the cameras monitoring the subject. The sway length was defined as little than the normal range when the sway length deviated below the normal range as measured by either camera monitoring the subject.

We then compared the trends in the drawing motion between the two drawing performance groups are shown in Table 3. In clumsy children from Group I, most markers deviated from the normal range. In clumsy children from Group II, most markers remain within the normal range. Further, body sway length in all Group II subjects was within the normal range.

The goodness-of-fit test results for the ratio of sway length and total sway length for the healthy and clumsy children were classified into two groups are shown in Table 3. When the goodness-of-fit test revealed that the sway length ratio of the clumsy children differed from those of the healthy children group. And then there were differences in normal range of movement as measured by either camera monitoring the subject, the sway length ratio for each marker was determined not to be a fit. Therefore, we compared the trends in drawing motion between the two groups from the results of the drawing performance tests. All children in Group I had differing ratios when compared with individuals in the healthy child group, and were therefore determined not to fit.

Physical Function

The clinical observations of drawing performance for each of the two groups of clumsy children are shown in Fig. 2. The results revealed numerous problems, including residual primitive reflexes, muscle tone condition, posture maintenance, cooperativeness of the upper limbs, and eye movement in both groups. However, a tendency for greater severity of problems was observed in Group I than that in Group II. Furthermore, a tendency for increased severity of problems related to postural reflex was noted in Group I. The total point score revealed that subjects in Group II tended to have fewer problems related to physical function characteristics.

Discussion

Drawing Performance and Drawing Motion

We found that some clumsy children who had poor drawing skill tended to have large motion of the body and shoulder joint for all drawing tasks, as compared to healthy children. On the other hand some clumsy children who tended to use finger movements to draw and exhibit a small handwriting motion, as compared

Table 2. The mean sway length and total sway length of each for healthy and clumsy children.

	Grade (age)	sway length (above)					sway length (right side)				
		body	shoulder	elbow	finger	total	body	shoulder	elbow	finger	total
Healthy children	2 (7−8)	1.47 (0.77)	0.74 (0.38)	0.96 (0.59)	2.22 (1.06)	5.37 (2.00)	1.44 (0.86)	0.82 (0.38)	0.81 (0.37)	1.65 (0.88)	4.70 (1.48)
	3 (8−9)	1.01 (0.63)	0.74 (0.44)	1.10 (0.63)	2.09 (0.87)	4.91 (1.92)	0.90 (0.57)	0.91 (0.53)	0.57 (0.45)	1.05 (0.71)	3.39 (1.69)
	4 (9−10)	0.86 (0.62)	0.59 (0.37)	0.92 (0.48)	1.83 (0.58)	4.19 (1.53)	0.74 (0.55)	0.55 (0.38)	0.55 (0.48)	0.87 (0.56)	2.72 (1.53)
	5 (10−11)	0.73 (0.57)	0.67 (0.38)	1.14 (0.56)	2.38 (1.09)	4.93 (1.99)	0.67 (0.45)	0.67 (0.38)	0.64 (0.46)	1.05 (0.71)	3.02 (1.63)
	6 (11−12)	0.60 (0.41)	0.48 (0.40)	0.96 (0.72)	2.02 (0.62)	4.08 (1.63)	0.64 (0.46)	0.75 (0.44)	0.66 (0.64)	1.33 (0.56)	3.38 (1.37)

	grade	trace length (above)					trace length (right side)				
		body	shoulder	elbow	finger	total	body	shoulder	elbow	finger	total
Group I with drawing problem	A (2)	17.46	22.17	24.39	30.13	94.15	9.40	22.03	16.19	16.27	63.89
	B (2)	28.73	28.64	36.44	37.76	131.57	20.04	30.02	16.43	19.99	86.49
	G (5)	15.68	14.52	17.67	21.37	69.24	10.97	10.46	7.64	11.11	40.18
	H (5)	45.71	28.54	29.32	41.46	145.03	25.19	33.82	19.87	36.69	115.57
	I (6)	2.24	2.00	16.00	21.16	41.40	1.51	2.09	5.79	8.57	17.96
	J (6)	4.01	3.15	14.43	19.05	40.65	2.61	4.93	9.59	10.74	27.86
Group II without drawing problem	C (3)	15.56	22.66	36.18	34.83	109.23	6.47	19.37	11.67	14.26	51.78
	D (3)	10.13	20.06	31.00	29.72	90.92	5.71	20.88	14.90	14.01	55.51
	E (3)	8.05	10.72	18.97	23.64	61.38	3.43	5.88	11.18	12.19	32.67
	F (4)	15.30	12.25	20.37	30.22	78.15	5.33	8.67	7.87	12.71	34.57

Trace length : cm
Note. The mean sway length and total sway length of each marker for the healthy child group and the clumsy children were classified into two groups according to drawing performance.

Table 3. Drawing motion by mean sway length and total sway length in clumsy children.

	child (grade)	sway length judgment					goodness of fit test						
							above			right side			judgment
		body	sholder	elbow	finger	total	X^2	df	*p* value	X^2	df	*p* value	
Group I with drawing problem	A (2)	large	large			large	7.7107	3	≧ 0.05	2.2623	3	0.52	non fit
	B (2)	large	large		large	large	13.1850	3	< 0.01	12.9190	3	< 0.01	non fit
	G (5)	large		little			14.7510	3	< 0.01	17.1680	3	< 0.01	non fit
	H (5)	large	large		large	large	44.7810	3	< 0.01	8.7063	3	< 0.05	non fit
	I (6)	little	little	little	little	little	20.9390	3	< 0.01	34.0620	3	< 0.01	non fit
	J (6)	little	little	little	little	little	10.7470	3	< 0.05	16.3830	3	< 0.01	non fit
Group II without drawing problem	C (3)		large			large	1.1378	3	0.77	1.4787	3	0.69	
	D (3)						0.6731	3	0.88	2.0445	3	0.56	
	E (3)		little			little	0.8870	3	0.83	11.6710	3	< 0.01	non fit
	F (4)		little	little			7.6320	3	≧ 0.05	4.4216	3	0.22	non fit

Note. A goodness of fit test was used to analyze the ratio of sway length. The mean value of the healthy child group scores for each grade were defined as the expected values and the ratio of sway length of each clumsy child in each grade were defined as the actual measurements.

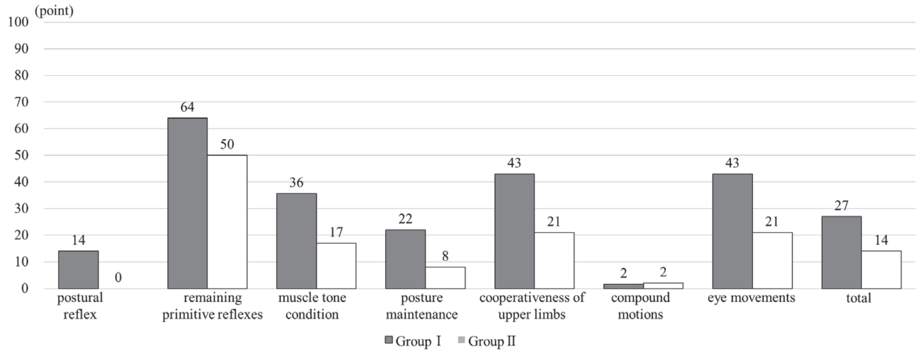

Fig. 2. The Physical Function in Clumsy Children.
Note. A tendency for increased severity of problems related to postural reflex was noted in Group I. The total point score revealed that subjects in Group II tended to have fewer problems related to physical function characteristics.

to healthy children. In either case, the drawings were inaccurate due to drawing problems, the mechanism by which these drawing problem manifest are not uniform.

The drawing tasks used in the present study contained an equilateral triangle with 10 cm sides. Tasks such as this that involve drawing large lines require movements of the shoulder and elbow joints [11, 12]. Therefore, inaccurate drawings may be associated with instability of the body or scapula, or decreased cooperativeness of the upper limbs. When the drawing motion was generally large, movements of the body and shoulder joints also tended to become larger due to posture instability. This is similar to the results of previous studies [13] and may be due to the influence of problems in maintaining continued muscle tone [7]. Children who have decreased muscle tone and problems in maintaining continued muscle tension often stabilize or immobilize another part of the body for increased support [14]. Subjects who used small drawing motions to draw the 10 cm triangle placed their upper limbs on the desk to obtain support for handwriting, allowing them to compensate for the instability in posture and problems in maintaining continued muscle tension.

Physical Function

The results of the clinical observations revealed that when drawings were inaccurate, there were problems with postural reflexes, posture maintenance, or cooperativeness of the upper limbs. However, based on the results of the clinical observations, the trends observed for characteristics of physical function problems in clumsy children whose drawings were inaccurate appeared to be similar, but the severity of the problems was unclear.

Each clumsy child used a different strategy when using the writing tools to cope with their individual deficits in physical function, which may have led to differences in drawing motion. However, the strategies used by clumsy children did not seem to be appropriate, and the subjects could not control the writing tools accurately.

Moreover, body stability appeared to have the most influence on drawing accuracy in clumsy children who had no problems in drawing, and had similar drawing motion as healthy children. This was based on the fact that these subjects tended to show no problems in posture reflexes, posture maintenance, or performance of composite movements.

Study Limitation

It may be inappropriate to apply the results of this research to females, because this research was performed exclusively in male subjects. The figure in this drawing task was a triangle; hence, these results may not apply directly to other drawing tasks. A problem of handwriting indicated by daily life is that it includes writing as well as drawing. The drawing task performed in this study can generate a quantitative result, but handwriting evaluation is inevitably subjective to some degree. We can't evaluate three-dimensional movement enough because this study analyzed drawing motion of two dimensions movement analysis software.

Implication for Occupational Therapy Practice

The results of our study have the following implications for occupational therapy practice:

- The evaluation of physical function is necessary to a supported occasion for a problem of drawing, and we have to confirm the muscle tone condition, posture maintenance, cooperativeness of the upper limbs and eye movement in particular
- Children with drawing problems exhibit different drawing motion than healthy children, and it is necessary to support it in drawing motion as well as the physical function.

Conclusion

From our findings, clumsy children with developmental disorders seem to present with difficulty in physical functions. Limitations in drawing and drawing motion are influenced primarily by body stability. Moreover, although we originally thought that the severity of problems in muscle tone and cooperativeness of the upper limbs had an influence on the ability to control writing tools, in some cases, subjects could nevertheless control the tools accurately depending on the method of drawing.

When providing support to children who have problems in writing or drawing, improvements may be gained by teaching them the strategies that are uniquely used by healthy children. However, it is possible that changing strategies may decrease drawing ability in clumsy children. In order to examine methods of support for the physical function of individual clumsy children, it is necessary to not only evaluate the drawing performance and physical function of subjects but also to assess the methods of drawing.

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References

[1] Casellato C, Zorzi G, Pedrocchi A, Ferrigno G, and Nardocci N. Reaching and writing movements: sensitive and reliable tools to measure genetic dystonia in children. J Child Neurol. 2011; 26(7): 822−9.

[2] Nakajima S, Ohyanagi T, Nakamura Y, Sakamoto K, and Sengoku Y. The assessment of handwriting performance based on changes in pen velocity and pen pressure (in Japanese). The Journal of Japanese Occupational Therapy research (sagyouryouhou). 2011; 30(5): 563−71.

[3] Nakajima S, Ohyanagi T, Nakamura Y, Takizawa S, Ikeda C, and Sengoku Y. Developmental characteristics of handwriting performance of normal children and healthy adults (in Japanese). Japan Journal of Occupational Therapy in Pediatrice (nihonhattatukeisagyouryouhougakkaishi). 2014; 3(1): 46−52.

[4] Sakamoto K, Nakajima S, Sera A, Ohyanagi T, and Sengoku Y. Relationship between drawing line performance and other abilities of clumsy children with developmental disorder (in Japanese). Japan Journal of Occupational Therapy in Pediatrice (nihonhattatukeisagyouryouhougakkaishi). 2012; 1(1): 39−45.

[5] Olive T, and Kellogg RT. Concurrent activation of high- and low-level production processes in written composition. Mem Cognit. 2002; 30(4): 594−600.

[6] Van Hoorn JF, Maathuis CG, Peters LH, and Hadders-Algra M. Handwriting, visuomotor integration, and neurological condition at school age. Dev Med Child Neurol. 2010; l52(10): 942−7.

[7] Chang SH, and Yu NY. Characterization of motor control in handwriting difficulties in children with or without developmental coordination disorder. Dev Med Child Neurol. 2010; 52(3): 244−50.

[8] Klein S, Guiltner V, Sollereder P, et al. Relationships Between Fine-Motor, Visual-Motor, and Visual Peresception Scores and Handwriting Legibility and Speed. Phys Occup Ther Pediatr. 2011; 31(1): 103−14.

[9] Giroux P, Woodall W, Weber M, and Bailey J. Occupational Therapy Practitioners' Perceptions of Important Competencies for Handwriting Evaluation and Intervention in School-Aged Children. Phys Occup Ther Pediatr. 2012; 32(1): 66−79.

[10] Ohyanagi T, Nakajima S, Nakamura Y, and Sengoku Y. Development of new software for the assessment of upper

extremity function with handwriting task (in Japanese). Sapporo Medical University bulletin of School of Health Sciences (sapporoikadaigakuhokenniryougakubukiyou). 2010; 12: 1−8.

[11] Lacquanti F, Ferrigno G, Pedotti A, Soechting JF, and Terzuolo C. Changes in spatial scale in drawing and handwriting. J Neurosci. 1987; 7(3): 819−28.

[12] Van Drempt N, McCluskey A, and Lannin NA. A review of factors that influence adult handwriting performance. Aust Occup Ther J. 2011; 58(5): 321−8.

[13] Flatters I, Mushtaq F, Hill LJ, Holt RJ, wilkie RM, and Mon-Williams M. The relationship between a child's postural stability and manual dexterity. Exp Brain Res. 2014; 232(9): 2907−17.

[14] Nichols DS. Development of postural control. In J Case-Smith, editor. Occupational therapy for children, 4th ed. St Louis, Mosby; 2001; 266−88.

ORIGINAL ARTICLE

A Mixed Methods Study Exploring Difficulties in Child Care Among Japanese Mothers with Depression

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Abstract: Background: Depression causes mothers to experience difficulties in child care and increases stress, which can influence the development of the child. Japan currently has insufficient support for mothers with depression.
Objectives: We aimed to reveal the difficulties in child care and related factors of three Japanese mothers with depression by examining their narratives.
Methods: A mixed method design was applied. We conducted in-depth, semi-structured interviews with mothers with depression and analyzed the data using both the grounded theory approach and text mining software (KH Coder).
Results: As a result of focus coding, 11 focus codes were extracted. In addition, as a result of multi-dimensional scaling, two codes ("Physical burden caused by family and child care" and "The mother coping with difficulties by herself") were in close proximity and formed a unit. Another two codes ("Anxiety over not having complete control over child care" and "One-sided coping methods") were in close proximity, creating a second unit.
Conclusion: This study suggested the following: 1) in spite of being aware of their excessive burden, mothers with depression believed that they should take care of their children by themselves; 2) because of the desire to be a perfect mother, mothers with depression tended to have extremes in their child care. We need further research based this result for the developing support systems.

Keywords: depression, mother, support, narrative, text-mining

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Having a role to play is one of the most important factors for occupational therapy clients to reconstruct their daily lives. Their roles allow them to engage in activities and social interactions, and contribute to their self-esteem and identity [1]. For women, mother is one of the most typical roles. Since the 1990s, many studies in the field of occupational therapy have focused on the role of the mother and parental behavior [2]. Additionally, the parental consciousness of women have been reported to be higher than that of men [3]. When mothers have difficulty in parenting activities, they tend to have more stress than fathers. Previous reports have investigated the disruption of mothering activities due to illness. Vallido, Wilkes, Carter and Jackson (2010) [4] suggested the following themes in their systematic review of women's experiences of mothering disrupted by illness: mechanism of disruption, reframing the mother's role, experiencing guilt or shame, protecting the children, experiences with health care professionals, living to mother, and mothering to live. Additionally, they mentioned that we should consider these themes when developing intervention and support programs.

Depression is an illness that disrupts mothering. The lifetime prevalence of depression in women is twice that in men. This difference is attributed to changes in the hormonal balance or changes in life stages throughout women's lives [5, 6]. Women are reported to have a high prevalence of depression in the postpartum and menopausal periods. Postpartum depression develops within 1 year after childbirth [7, 8, 9], and is a notable topic in women's health. About 10% to 15% of new mothers worldwide develop depression [10]. Moreover, symptoms can continue depending on the severity of

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depression for some years [8, 11].

In 2009, The National Research Council and Institution of Medicine [12] recommended a coordinated approach that combines treating the mother's depression and training mothers on parenting skills. Goodman and Garber [13] suggested the necessity of integrated intervention that reduces mothers' depression and promotes mothers' parenting behavior. The United States has introduced several interventions to improve parenting by mothers of infants and young children, such as home visiting programs (HVP), including in-home Cognitive Behavioral Therapy (CBT) and the Positive Parenting Program, also known as Triple P. In these programs, the evidence for improving parenting and effectively reducing depression in mothers is strong [14−16]. However, in Japan, we have no outreach services equivalent to HVP. Therefore, Japanese mothers with depression have little support available. Furthermore, this topic is not given sufficient attention in Japan, and previous reports in this area have been limited to investigations of the experiences of mothers with infants; for example, infants under the age of 1 year [17]. Therefore, there are not enough reports to serve as a basis for the development of support systems for Japanese mothers. Since parental behavior and child care are influenced by the culture of mothers, it is necessary to investigate the situations of Japanese mothers with depression in order to develop a support system in Japan.

As a first step of the basis for the development of support system, in this study, we aimed to obtain clues for revealing the difficulties in child care and related factors of Japanese mothers with depression by examining their narratives. We focused on three Japanese mothers, who are serve as a prime examples supported in the future, of preschool children to investigate postpartum depression in particular. Qualitative Analysis based on their narratives can make clear their characteristics based on their individualities. On the other hand, we have necessity of revealing common factors among mothers, because aim of this study is the first investigation for the development of support. Therefore, addition to usual qualitative analyses, we used the text mining which is one of the quantitative analyses.

Method

Design

The approach in this study was a mixed methods design through semi-structured interviews.

Participants

The study participants were recruited from three private psychiatric clinics in Aichi Prefecture, Japan. The inclusion criteria were as follows: women aged 20 to 50 years old; living in Japan in a household with more than two family members, including a preschool child; being responsible for the majority of the housework and child care; psychiatry clinic outpatients receiving treatment including psychotherapy and pharmacology for major depression diagnosed by an attending psychiatrist according to the Diagnostic and Statistical Manual of Mental Disorders-4 Text Revision (DSM-4); and scoring over 16 points on the Center for Epidemiologic Studies Depression (CES-D) scale.

The CES-D is a self-assessment questionnaire with 20 items scored on a four-point scale; it was designed to quantify the level of depressive symptoms during the past week, with a cut-off point of 16 to discriminate the depressive state [18]. Therefore, all participants in the present study were in a depressive state at time of the interview. The validity and reliability of the Japanese version of the CES-D have been confirmed [19, 20].

Semi-structured interviews

In-depth, semi-structured interviews were conducted by the first author. The interviews lasted for 1 hour and were conducted in a private room (e.g., a room in the participant's workplace or psychiatry clinic). A monetary reward (1000 Japanese yen per 1 hour) was given to the participants. An interview guide was used, and the contents of the interviews were recorded. The interview guide included open-ended questions that explored the participants' experiences with difficulties in child care and housework (e.g., when did you experience difficulties in child care or housework, could you tell me about a child care or housework situation that you felt was very difficult). Basic information (e.g., family structure, participant's age, age of their child(ren), and contents of child care and housework that the participants undertook) was collected at the start of the interview. Then, the interviews explored the participants' concrete experiences with housework and/or child care situations that they found difficult, their thoughts about these situations, and the ways they managed them.

Analyses

Data were analyzed using a conversion mixed design following Teddlie and Tashakkori [21]. In this method, a correlational approach was used together with a dictionary-based approach. Application of a conversion mixed design enables the visualization of data from both processing language computer analysis and the interpretations of researchers. In this study, we used a mixed conversion approach [22] that included both a text mining approach and a grounded theory approach (GTA).

Table 1. Participants' remarks, initial codes and focus codes

Participant	Remark	Initial code		Focus code
		Name of code	In vivo code (one word)	
Participant A	"My baby is so inflexible and he never moves when he does not want to."	Baby is inflexible	inflexible	The child does not act as the mother expected.
Participant B	"They don't really listen to me."	Children don't listen to me.	don't listen	The child does not act as the mother expected.
Participant C	"For example, after I make him breakfast, he has so many requests and complaints for me; he is so selfish. I know he is a little boy, but I am so tired."	The child does not act as the mother expected.	selfish	The child does not act as the mother expected.

First, recorded interview data were transcribed verbatim into text data. After that, the text data were read repeatedly and checked for accuracy in Japanese wording and expression. In cases of transcription mistakes or a lack of uniformity of expression, the data were carefully modified. This process was conducted in order to avoid misinterpretation in the subsequent computer analyses. Second, the data for each participant were sectioned at every remark and coded as initial coding. In this process, we also extracted one word that was related to the purpose of this study and made in vivo code for each word. Third, we conducted focus coding in order to organize these codes (Table 1). Focus coding enables the interpreted data to be integrated into one code depending on meaning of the code. These analyses were based on the GTA [23] and the results were examined by research colleagues with experience in qualitative research based on GTA. The qualitative data analysis software MAXQDA (VERBI GmbH, Germany) was used in this process.

After completing the GTA process, analyses based on text mining were conducted. Text mining clarifies the characteristics and tendencies of text data through natural language processing based on morphological analysis. In this study, we used KH Coder (Ritsumeikan University, Japan) which is a free software tool for text mining and text analyses that can handle six languages, including English and Japanese, and has been recently used by several researchers [24−26]. Using KH Coder, it is possible to make a table of the frequency words, and extract words that co-occur with certain words through morphological analysis. It also has functions to allow visualization of co-occurrence networks or the results of multivariate analysis. Moreover, with KH Coder, we could define results of "in vivo code in each word" and "focused coding" as a coding rule, and perform multivariate analysis based on this rule. These results or the relationships between codes could then be visualized using a multidimensional scale (MDS) method. MDS is a visualizing method based on similarities between data. Namely, data that have high similarities are positioned near each other, and those with low similarities are positioned far from each other.

In this study, we defined "in vivo code in each word" as the coding file in each "focused coding". After that, the results of the analyses were visualized with coding functions and multivariate analysis using KH Coder.

Ethical considerations

All procedures were approved by the Research Ethics Committee of the Graduate School of Medicine, Nagoya University, Japan (authorization number: 2016-0015), and all participants provided informed written consent.

Results

Participants

Three participants (Participant A, B, C) were enrolled in this study. All three were in their thirties or forties and the ages of their preschool children were 11 months (son), 3 years old (son) and 6 years old (son). All family members including their children they lived with were healthy, and no one had any illness and disability. Participant B and Participant C were both employed full time whereas Participant A was a stay-at-home mother. Participant B had a clerical position at a medium-sized company and Participant C was a care worker at a nursing home. Both Participant B and Participant C had two children (a preschool child and an elementary school child, respectively). All of their households were nuclear families. Participant C was divorced and her household consisted of only herself and her children. All three participants talked about receiving support from their husbands or ex-husband. The mean score of CES-D in three patients was 24.6 ± 5.0. Detailed information on the participants' basic information is provided in Table 2.

Table 2. Participants' basic information

	Participant A	Participant B	Participant C
Age (years)	33	46	38
Family structure (living together)	Husband One son (11 months)	Husband Two sons (9 years old/3 years old)	One daughter (9 years old) One son (6 years old)
Ordinary contents of child care and housework	Child care and housework except preparing meals	Everything	Everything
Employment status	Unemployed	Full-time clerical work	Full-time care worker
Support they received (name of supporter(s)/ frequency)	Preparing meals (husband/every day) Child care (maternal grandmother/ once a week)	General support (husband/ when the participant works overtime) Picking up sons from nursing home (paternal grandmother/everyday)	General support (ex-husband/ about once a week or depending on the husband's convenience)

Results of focus coding

As a result of focus coding, 11 focus codes were extracted.

Positive feelings for the child's father who supports the mother. The mothers expressed grateful feelings towards their husband or ex-husband who provided support.

"*He makes food for us, so I thank him.*" (*Participant A*)

Negative feelings about the support that the child's father gives. On the other hand, they also complained about the kind of support that the father gives.

"*My ex-husband helps me only when it is convenient for him. Convenient time for him means that he is free, or that he wants to eat dinner with the children. It is not usual daily life.*" (*Participant C*)

The child does not act as the mother expected. The mothers' expectations differed depending on the mental and physical development of their children. However, they experienced difficulty when their children's behaviors and actions were contrary to their expectations and intentions.

"*My baby didn't act as I expected.*" (*Participant A*)

"*I always think, 'you are so slow, please hurry up!'*" (*Participant C*)

The child's characteristics. The participants talked about the characteristics of their children.

"*Mischievous.*" (*Participant B*)

The mothers had difficulties with not only their children's characteristics, but in situations caused by their children's characteristics.

One-sided coping methods.

"*When I use gas to cook, I am always afraid of my baby getting burned because he is always around me. So, now I eat only food that doesn't need to be cooked on the stove.*" (*Participant A*)

These narratives illustrate ways of dealing with or avoiding difficult situations caused by child care. The mothers' methods were limited and were "one-sided" in that they placed too much priority on merely coping with children rather than actually addressing the real problems.

The mother coping with difficulties by herself.

"*There is no one except me.*" (*Participant A*)

"*I have always done everything.*" (*Participant C*)

These narratives illustrate that the mothers seemed to think that they always have to solve any and all problems.

The mother does not want to use support systems.

"*I think that I am spoiling myself whenever I use support systems.*" (*Participant C*)

The mothers talked about their negative feelings towards using support systems. They not only worried about leaving their child in someone else's care, but also experienced a sense of guilt.

Anxiety over not having complete control over child care.

"*When I'm sleeping, I am afraid that something bad will happen to my baby. So, I am too scared to sleep.*" (*Participant A*)

"*I should take perfect care of my child, but I cannot.*" (*Participant C*)

The mothers seemed to believe that they should have complete control over child care and the impossibility of being perfect caused them a great deal of stress and anxiety.

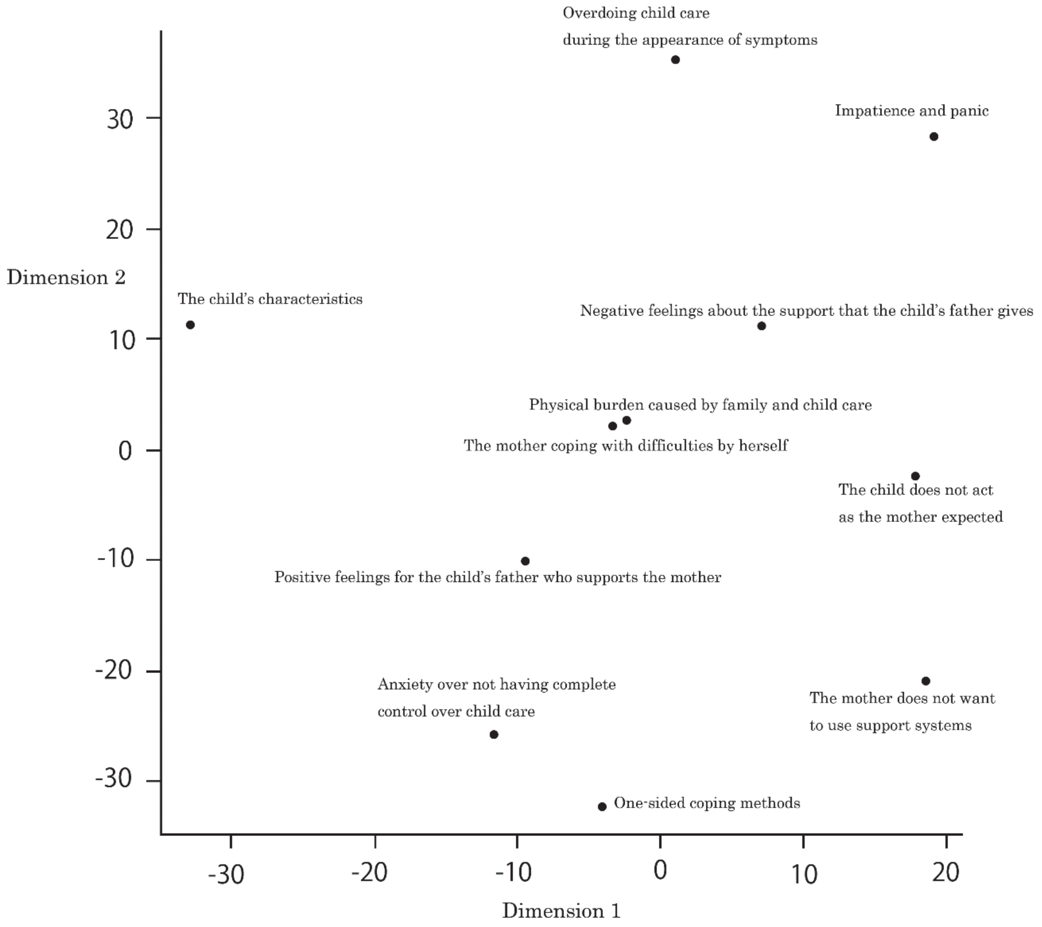

Fig. 1. Visualized similarity map based on MDS with KH Coder.

Overdoing child care during the appearance of symptoms.

"*Even if I had heavy symptoms, I had to go about my routine as usual.*" (*Participant C*)

Regardless of the severity of their symptoms, the mothers still had to engage in child care and housework. At such times, they felt their situation was difficult.

Physical burden caused by family and child care.

"*I desperately try to finish my tasks in the morning, for example, making breakfast, brushing my child's teeth, etc. After finishing those tasks, I go to work at the nursing home. But by the time I get there, I am already exhausted.*" (*Participant C*)

These narratives show that the mothers experience a physical burden from the quantity of tasks they have to perform.

Impatience and panic.

"*I felt more and more impatient and I was in a panic. What should I do? I am scared.*" (*Participant C*)

These narratives illustrate that impatience brought the mothers a high degree of stress.

Relationships among codes analyzed by MDS.

Data were visualized based on MDS analysis through a coding file. Based on the similarity map, we could visualize the structure of our data (Fig. 1).

Two codes ("Physical burden caused by family and child care" and "The mother coping with difficulties by herself") were in close proximity and formed a unit. Another two codes ("Anxiety over not having complete control over child care" and "One-sided coping methods") were in close proximity, creating a second unit.

Discussion

Japanese mothers' consciousness of their role as a mother and the influence of depression

The MDS results showed that two codes ("The mother coping with difficulties by herself" and "Physical burden caused by family and child care") were in close proximity. We can infer that the participants had to cope with their situation regardless of their awareness of their excessive burden. In our previous study, we showed that the amount of support that women with depression receive is lower than that of healthy women [27]. Similarly, the result of this study showed that the participants also could not get support when they need.

One of the closest supporters of the participants seemed to have been their husband or ex-husband. The participants had positive and negative opinions about the support they received from their child's father. However, in both the positive and negative comments, they used the word "help" to express their husband's support. From this viewpoint, they seemed to have the idea that all child care was basically the mother's responsibility. In Japanese mother, compared with European counties, they were found to have a lower quality of life due to gender roles and to receive less support [28]. Also, Mori compared mothering between two Asian countries, China and Japan, and found that Japanese mothers had a firmer belief that children should be reared by their mother than Chinese mothers [29]. Additionally, in an investigation by the Japanese Cabinet Office in 2018, that examined adults aged 20−49 years old in five countries (the United States, South Korea, Sweden, France and Japan) [30], 66.9% of Japanese respondents selected "Child care should be always done by the mother" or "Mainly the mother should rear a child, and the father should help sometimes." On the other hand, in similar surveys in Sweden, the United States and France, over 50% of respondents selected "Both the mother and father should care for their child." Based on these results, Japan has a culture of child care being provided mainly by the mother. In addition, mothers in the present study, who were in a depressive state, noted that they were strongly aware of their responsibilities and experienced guilt. Combining this pathological mindset and the strong consciousness of a mother's role in Japanese culture, serious situations might result for mothers with depression. This result gave us worthy viewpoint, but that point were limited in three Japanese mother with depression in this study. Therefore, we need more investigation in many participants.

Necessity of considering strong anxiety and self-esteem related to child care

The code "Anxiety over not being able to completely control child care" showed mothers' desire to have complete control over child care and be a perfect mother, and strong anxiety when that desire was not fulfilled. As a result, they tended to select extreme methods of child care to cope with difficult situations, such as "*avoiding cooking with gas*". Also, the code "Mothers do not want to use support systems" was located in proximity to the previously mentioned code. Therefore, background of those behavior might be their wish which they should be a perfect mother. In other word, their wish of being perfect mother might prevent from using support, because being perfect mother based might be related to their self-esteem and their identity in Japanese culture.

In Japan, one of the general methods for treating outpatients with depression is to enlist the help of a grandparent or another close relative or friend in child care activities to lighten the parents' burden and to allow them a short break from their role as a parent. However, speaking of three participants in this study alone, this might increase anxiety and decrease the self-esteem of mothers. Like in outreach services, mothers caring for their children together with the help of others would be ideal.

Limitations

There are some limitations of the present study. First, the amount of basic information collected for the participants was insufficient. Housework and child rearing might be influenced by several factors such as economic status, employment status, and degree of support provided by family members. Addition to those, we needed to have collected more basic information about mother's depression, for example amount of medicine they had, timing of their onsets and duration of illness. Therefore, we should have conducted a more in-depth investigation of the mothers' backgrounds. Second, we had possibilities which participants were not prime examples strictly. This investigation was limited to three participants, further research with a larger number of participants is required to verify the results.

Conclusion

This study suggested the following: 1) in spite of being aware of their excessive burden, participants believed that they should take care of their children by themselves; 2) because of the desire to be a perfect mother, they tended to have extremes in their child care.

Japan has few support systems for mothers with depression and their children, we believe it is necessary to further research this topic to develop effective means of support.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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References

[1] Kielhofner G. Model of human occupation: theory and application. 4th ed. Philadelphia: Wolters Kluwer Health; 2007.
[2] Francis-Connolly E. Toward an understanding of mothering: a comparison of two motherhood stages. Am J Occup Ther. 2000; 54(3): 281−9.
[3] Simon R. Parental Role Strains, Salience of Parental Identity and Gender Differences in Psychological Distress. J Health Soc Behav. 1992; 33: 25−35.
[4] Vallido T, Wilkes L, Carter B, Jackson DJ. Mothering disrupted by illness: a narrative synthesis of qualitative research. J Adv Nurs. 2010; 66(7): 1435−45.
[5] Gutiérrez-Lobos K, Scherer M, Anderer P, Katschnig H. The influence of age on the female/male ratio of treated incidence rates in depression. BMC Psychiatry. 2002; 2: 1−8.
[6] Sloan DM, Kornstein SG. Gender differences in depression and response to antidepressant treatment. The Psychiatric Clinics of North America. 2003; 26: 581−94.
[7] Leger J, Letourneau N. New mothers and postpartum depression: a narrative review of peer support intervention studies. Health and Social Care in the Community. 2015; 23(4): 337−48.
[8] Letourneau N, Duffett-Leger L, Stewart M, Hegadoren K, Dennis CL, Rinaldi C, et al. Canadian mothers' perceived support needs during postpartum depression. J Obstet Gynecol Neonatal Nurs. 2007; 36: 441−9.
[9] McQueen K., Montgomery P, Lappan-Gracon S, Evans M, Hunter J. Evidence-based recommendations for depressive symptoms in postpartum women. J Obstet Gynecol Neonatal Nurs. 2008; 37: 127−36.
[10] Patel M, Bailey RK, Jabeen S, Ali S, Barker NC, Osiezagha K. Postpartum depression: A review. J Health Care Poor Underserved. 2012; 23: 534−42.
[11] Dennis CL. The effect of peer support on postpartum depression: A pilot randomized controlled trial. Can J Psychiatry. 2003; 48: 115−24.
[12] National Research Council; Division of Behavioral and Social Sciences and Education; Institute of Medicine; Board on Children, Youth, and Families Committee on Depression, Parenting Practices, and the Healthy Development of Children. Depression in Parents, Parenting, and Children: Opportunities to Improve Identification, Treatment, and Prevention. Washington, DC: National Academies Press; 2009.
[13] Goodman SH, Garber J. Evidence-Based Interventions for Depressed Mothers and their Young Children. Child Development. 2017; 88(2): 368−77.
[14] Ammerman RT, Putnam FW, Altaye M, Stevens J, Teeters AR, Van Ginkel JB. A clinical trial of in-home CBT for depressed mothers in home visitation. Behavior Therapy. 2013; 44: 359−72.
[15] Ammerman RT, Altaye M, Putnam FW, Teeters AR, Zou Y, Van Ginkel JB. Depression improvement and parenting in low-income mothers in home visiting. Archives of Women's Mental Health. 2015; 18: 555−63.
[16] Morawska A, Sanders M, Goadby E, Headley C, Hodge L, McAuliffe C, et al. Is the Triple P-Positive Parenting Program acceptable to parents from culturally diverse backgrounds? J Child Fam Stud. 2011; 20: 614−22.
[17] Katayama M, Kitaoka K. Psychosocial process in mothers with depressed mood who continue to fulfill their parenting responsibilities. Journal of Wellness and Health Care. 2017; 41(2): 9−22.
[18] Radloff LS. The CES-D scale, a self-report depression scale for research in the general population. Applied Psychological Measurement. 1997; 1: 385−401.
[19] Shima S, Shikano T, Kitamura T, Asai M. Atarashii yokuutsusei jiko hyouka syakudo ni tuite (in Japanese). Clinical Psychiatry. 1985; 27: 717−23.
[20] Wada K, Tanaka K, Theriault G, Satoh T, Mimura M, Miyaoka H, et al. Validity of the Center for Epidemiologic Studies Depression Scale as a screening instrument of major depressive disorder among Japanese workers. Am J Ind Med. 2007; 50(1): 8−12.
[21] Teddlie CB, Tashakkori AM. Foundations of Mixed Methods Research Integrating Quantitative and Qualitative Approaches in the Social and Behavioral Sciences. New York: SAGE publishing; 2009.
[22] Inaba M, Kakai H. Proposing the Grounded Text Mining Approach for Qualitative Data Analysis: An Analysis of a Focus Group Discussion on Cancer Disclosure (In Commemoration of Prof. Gordon L. RATZLAFF) (in Japanese). Policy science. 2011; 18(3): 255−76.
[23] Charmaz K. Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis. New York: Sage Publications; 2006.
[24] Okuhara T, Ishikawa H, Okada M, Kato M, Kiuchi T. Contents of Japanese pro- and Anti-HPV Vaccination Websites: A Text Mining Analysis. Patient education and counseling. 2018; 101(3): 406−13.
[25] Okuhara T, Ishikawa H, Okada M, Kato M, Kiuchi T. Japanese anti- versus pro-influenza vaccination websites: a text-mining analysis. Health Promotion International. 2018, in press.
[26] Seinko K, Enomoto Y, Miyazawa S. Narrative Analysis of Employment Support for Students with Developmental Disabilities: Using an Objective Analysis of Free-Expression Answers. Content Generation Through Narrative

Communication and Simulation IGI Global. 2018, in press.

[27] Hoshino A, Amano S, Suzuki K, Suwa M. Relationships between Depression and Stress Factors in Housework and Paid Work Among Japanese Women. Hong Kong J Occup Ther. 2016; 27: 35–41.

[28] Mautner E, Ashida C, Greimel E, Lang U, Kolman C, Alton D, et al. Are there differences in the health outcomes of mothers in Europe and East-Asia? A cross-cultural health survey. Biomed Res Int. 2014; Article ID 856543: 9 pages.

[29] Mori E, Liu C, Otsuki E, Mochizuki Y, Kashiwabara E. Comparing child-care values in Japan and China among parents with infants. International Journal of Nursing Practice. 2012; 2: 18–27.

[30] Cabinet office, government of Japan [on line]. White paper on coping with Society with Declining Birthrate [cited 2018 October 26]. Available from: http://www8.cao.go.jp/shoushi/shoushika/whitepaper/index.html.

ORIGINAL ARTICLE

Wearing a Ball Vest in Everyday Activities: Experiences from Adolescents with Neuropsychiatric Disorders, their Parents and Teachers

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Abstract: Background: Children with neuropsychiatric disorders may have a limited participation in everyday activities. It is common that they tend to avoid engaging in activities due to a decreased ability to interpret sensory information. To increase these children's' activity performance ball vests are provided and prescribed as an intervention. The aim of this study was to explore the use of a ball vest in everyday activities from the perspective of adolescents with neuropsychiatric disorders, their parents and teachers.

Method: A qualitative method, where six adolescents with neuropsychiatric disorders, their parents and teachers were interviewed concerning experiences of the adolescents' use of a ball vest for eight weeks. A qualitative content analysis approach was used.

Results: The analysis identified four themes. The adolescents with neuropsychiatric disorders, their parents and teachers portrayed different aspects of the use of the vest which all were mainly positive. The adolescents experienced that their high activity level was influenced by using the ball vest in activities. A slightly delayed calming effect was also described which influenced the adolescents plan when to use of the ball vest during the day.

Conclusion: This study identifies a positive though limited hypothesis regarding how a ball vest can be experienced in relation to everyday activities at home and in the school setting for adolescents with high activity levels and neuropsychiatric disorders.

Keywords: ADHD, autism, leisure activities, qualitative research, weighted vest

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INTRODUCTION

Through performing everyday activities at home and in the school setting, children develop abilities and skills [1]. Which activities are chosen and how they are performed are influenced by the context, and the performance of an activity builds one's motivation, routine and abilities. Children and adolescents with attention deficit hyperactivity disorder (ADHD) display developmental difficulties concerning inattention, hyperactivity, impulsivity and social interaction, which bring difficulties in activities in everyday life [2−5]. The symptoms diminish as the children grow up, but at least 50% percent of the children still have impairing symptoms in adulthood. Autism spectrum disorder (ASD) is the behavioral expression of a neurological disturbance which is triggered in different ways and in different stages of development [5−7]. Children with autism have difficulties within the areas of verbal and nonverbal communication, understanding of social codes, image ability and play [6−8]. They may have difficulties with social interaction in different ways and limited opportunities to initiate activities. An updated literature review indicates that many symptoms overlap between ADHD and ASD in children and adolescents and that comorbidity between the two diagnoses is common [9].

Children with ADHD and ASD [10] often show sensory processing challenges [11−13]. These children often raise their activity levels when they are exposed to

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sensory input (hearing and visual) and have difficulties lowering it again and therefore easily become stressed [2, 7]. Research show that there are similarities between children with ADHD and ASD regarding sensory processing patterns and behavior strategies to manage sensory stimuli [14]. A decreased ability to interpret sensory information often leads to evasion of participation in activities [15], and restricted participation in daily activities decreases children's opportunities for everyday learning [16, 17].

In summary, children with neuropsychiatric disorders are at risk of having limited participation in everyday activities and it is of great importance to examine new interventions which may enable increased activity performance. A common intervention in children with ADHD is stimulant medication [18, 19]. To improve functioning and lower risks for future disabilities, it is important to combine stimulant medication with other interventions such as psychosocial treatments, parenting interventions and child psychological therapy [3, 4, 18]. Common intervention approaches for children with autism are psychosocial and educational interventions such as the Treatment and Education of Autistic and Communication Handicapped Children (TEACCH) program [20], which uses structured teaching procedures, and Applied Behavior Analysis [21]. There is also a general increase of psychotropic medications among children and especially among children with autism [22, 23].

Occupational therapy provides Sensory Integration Therapy (SI) to this group of children [24, 25]. SI was designed by A. Jean Ayres [25] when she studied the question of a relationship between learning difficulties among children and a decreased ability to interpret sensory input. SI is defined as the neurological process which organizes sensory input from the context and makes it possible to use the body effectively [24, 25]. The integrative functions are normally activated at engagement in an activity and the ability to process and integrate sensory information is of vital importance to maintain balance and encourage health and wellbeing [26]. Sensory Integration difficulties are labelled Sensory Processing Disorder (SPD), which can worsen the impairment that the diagnosis of ASD brings the child [27]. Ayres [25] observed that children with ADHD and ASD were calmed by deep pressure stimulation when rolled up in a gym mat. For the purpose of enabling activity participation interventions are developed that use deep pressure to calm down [15, 24, 28]. One example is to use the weight of a ball blanket, which supports the body to feel its boundaries [29]. A case control study which explored this method found that children with ADHD benefitted from a ball blanket to fall asleep and to sleep well during the night. Participants in this study were 21 children with ADHD and 21 typical developing children during 28 nights. All children slept 14 nights with a ball blanket and 14 nights without. Results showed that the time it took to fall asleep when using the ball blanket was the same for the children with ADHD and the typical children. Inattention and hyperactivity were rated by both parents and teachers at the end of both periods and also after 7 nights after the use of the blanket. The children with ADHD were observed by their teachers rated to improve their activity function in the school setting even after the period the ball blanket was used. Their activity levels were lowered and their attention spans increased according to the measurement using the ADHD rating scale [30]. Fertel-Daly, Bedell and Hinojousa [31] studied deep pressure intervention for preeschool children with ASD who used weighted vests during daytime while performing activities. The participating children increased focus and attention and showed less distractibility when they wore weighted vests. Follow-up showed that the gains in behavior were partly enduring, suggesting that the intervention had some lasting effect. Occupational therapists who participated in a survey reported that the use of weighted vest intervention increased focus on tasks and extended attention spans when used on preschool children with autism, ADHD and delayed development [32]. Students with ADHD showed increased focus in a study when they wore weighted vests, and three of the four students wanted to wear the vests on occasions other than wearing vest for the study [33]. A randomized two-period crossover design with children with ADHD resulted in significant improvements in attention, less talking, decreased fidgeting and leaving their seats while wearing a weighted vest, compared to wearing a vest without weights [34]. In addition to the positive result above, another study found that weighted vests did not decrease stereotyped behaviors or support arousal for the six participated children with autism performing table-top activities in the school setting [35]. Davis et al. [36] examined the effects of weighed vests on aggressive and self-injurious behavior of a young boy with autism and their result found no effect on the behaviors that were analyzed.

A weighted vest and a ball vest are similar to each other. The weighted vest has pockets in front, back and on top of shoulders where weights are inserted, and this vest is supposed to give deep touch pressure to the body of the wearer [34]. A ball vest is tighter on the body and has canals on front and back filled with heavy plastic balls. The balls are supposed to give pointwise deep touch pressure to the skin and body and are also supposed to stimulate the kinesthetic sense of the muscle joints. Accordingly, both vests are supposed to give deep pressure and a ball vest also to give stimulation of the sensory system of the body.

In a literature review Morrison [37] observed that, among occupational therapists weighted vests are perceived as beneficial but the evidence to support the positive effect is restricted. There is a similar case with ball vests that research reflecting the use of these vests is limited although they have become a more common intervention. Consequently, there is a need to investigate the usefulness of a ball vest for the wearer. Because the context influences activity performance which is a dynamic interplay between the performer and the environment [1] we decided to address observations of parents and teachers in this study. The current study addresses questions on how the adolescents with neuropsychiatric disorders and the adults in their context experienced the use of a ball vest in various activities and daily situations. Furthermore, this study seeks to contribute knowledge that facilitates the performance of daily activities for children and adolescents with neuropsychiatric diagnoses. The aim of this study was to explore the use of a ball vest in everyday activities from the perspective of adolescents with neuropsychiatric disorders, their parents and teachers.

METHODS

Design

A qualitative descriptive approach was used [38]. Interviews were conducted after the participants had used a ball vest for a period of eight weeks.

Procedures

A secretary sent out cover letters with information and consent forms on the study, and an enquiry to participate to parents of adolescents who met the inclusion criteria (n = 40). The adolescents got an easy-read letter with consent form that was especially addressed to them. Seven adolescents and their parents accepted and were invited to an information meeting, where ball vests were on loan. What was important to think of during the introduction was given by the first author, and the families were given opportunity to ask questions. Information was given about the time range of the loan and that interviews would be conducted subsequently. Because of the qualitative design of the study there were no further instructions given on the use of the ball vest.

Participants

Inclusion criteria were adolescents in mainstream schools with ADHD, ASD or both diagnoses in ages 9 to 14 years, their parents and teachers. Adolescents with intellectual disability were excluded, because they were expected to have difficulties carrying out an interview and developing their answers. Participants were recruited from both Neuropsychiatric Teams of the Children's and Youth habilitation Centre (CYHC) in a northern county of Sweden. Seven out of forty enquiries were returned with an agreement to participate and the remaining thirty-three did not respond. The two female teachers of the participants who wore the ball vests regularly in the school setting were also asked to participate, and they agreed.

After a month one family discontinued their participation. Thus six adolescents, five boys and one girl, six parents (four mothers and two fathers), and two teachers participated in the study. Two of the adolescents had an ADHD diagnosis, two had an ASD diagnosis and two had both diagnoses.

Materials

The participating adolescents were invited to try wearing a ball vest to get the opportunity to discover what experiences they could have from wearing it in their daily life. The vest was in most cases handled by the adolescents, but sometimes parents or teachers asked them to wear it. A ball vest in junior size weighs 2.5 kg and is manufactured with an elastic fabric that fits tight to the body. On the front and back there are channels filled with heavy plastic balls. The vest is closed with a zipper and has a simple system of strings on the back and at the sides which makes it easier to adjust individually. The vest is portable and the wearer can choose to use it in different activities and contexts.

https://www.komikapp.se

Data collection

The first author collected the data by semi-structured interviews with a focus on the participants' experiences of using the ball vest in everyday activities [38, 39]. Interviews were booked and carried out individually with all participants directly after the vests were returned. The participants chose the surroundings where the interviews took place; some chose the school setting, and some chose the premises of the CYHC. The interviews lasted between 30 to 45 minutes.

The interviews followed an interview guide with open-ended questions to facilitate supplementary inquiry. Examples of questions were: *Give an example of how it was for you to wear the ball vest at home. Tell* *me about a usual situation when you wore the vest. Tell me about how it was to use it in the beginning. Describe what situations make you wear it. Give an example of how it was for you to wear the ball vest in school.*

Data analysis

The interviews were written out verbatim and data were analyzed by the first author using qualitative content analysis following guidelines by Graneheim and Lundman [39]. At first the transcripts representing each of all fourteen interviews were read through a couple of times to receive an overview of the data. The transcripts were compared to discover and identify similarities and differences in experiences, outlining the substance of the data. Patterns concerning the use of the ball vest at home and in the school setting were identified. In a second step each interview was reread and meaning units which seized the use of the ball vest and the experiences of wearing it in various activities were identified. The captured meaning units were condensed so that the core of the meaning in each unit was recognized. These condensed meaning units were abstracted into codes and categories regarding the adolescents' and their networks' experiences of the ball vest. In the third stage the codes and categories were compared concerning differences and similarities and sorted into four themes of which two also were divided into subthemes. The content of the meaning units were foundation to what themes and subthemes that were chosen. In the fourth stage, the content of the themes and the subthemes were compared to the original text, and it was confirmed that they reflected the content of the interviews. Throughout performing the analysis, emerging findings were discussed with the co- authors.

Every theme and subtheme that the analysis identified described different aspects of the experiences of wearing a ball vest and how it was used. Table 1 shows an example of the qualitative content analysis process in which the theme *The ball vest as mind and body helper* emerged. Table 2 shows one example of the qualitative content analysis process in which the subtheme *Possibilities to be active and participate in school setting* emerged.

Ethical aspects

The fact that the recipients of the enquiry letters were families who had contact with the CYHC could have made it difficult to decline. However, the letter clearly informed that the decision of participation or not would not influence the further contact with the CYHC.

The participating adolescents belong to a group which may have difficulties expressing themselves verbally. This circumstance put demand on the interviewer to be extra attentive in order to fulfil ethical standards. The interviewer had to be considerably conscious about the balance of power between adults and adolescents and to create a comfortable situation while questioning [40]. The questions had to be put in a substantially natural, attentive and simultaneously distinct way. In the result, pseudonyms are used for the adolescents' names. The Regional Ethics Board in Umeå, Sweden approved the study, study code 2014-92-31M.

RESULTS

The result of the analysis is presented in four themes, of which two themes were sorted into three subthemes that each described the experiences of wearing a ball vest and how it was used. The four themes are: *1. A desire to relive an earlier experienced feeling; 2. The ball vest as mind and body helper with three subcategories; 3.The Ball Vest as an Activity Friend with three subcategories and 4. Attitudes of people influenced the use of the ball vest.*

A desire to relive an earlier experienced feeling

The analysis showed that most adolescents had earlier tried a ball blanket which was remembered as cozy to wind down with and hoped that the ball vest would bring the same sensation. Oscar, nine years old, said: "*Directly when we got the letter about the vest I thought I should try it because the ball blanket had been so calming and maybe this also would feel real nice*".

In the beginning of the period of wearing the vest for the study, a calming feeling was experienced, which brought a desire and a longing to experience this positive feeling again. Patrick, 10 years old, said: "*I actually can buy a vest, if we have the money. I would like to, because I could concentrate better, and it was really comfortable to wear. I thought that it reminded me of the ball blanket, it felt almost the same. It felt good when the balls squeezed*".

The ball vest as mind and body helper

A great sense of comfort and fatigue made life brighter

The analysis revealed that the ball vest provided a pleasant feeling of fatigue and comfort. The vest gave heaviness on the body described as a pleasant hug and a feeling of being safe and brought a need to yawn. Agnes' father explained: "*She likes to wear it, and that proves that something happens in her body. I think there is something with the balls that makes her feel calmer and safer that gives her body a nice feeling on the whole, that gives a kind of massage on her back and both sides of her body. Otherwise you could wear any vest at all*".

The vest brought a confident feeling and was worn

Table 1. Examples of the qualitative content analysis process in which the theme *The ball vest as mind and body helper* emerged

Identified meaning unit	Condensed meaning unit	Code, underlying meaning	Subcategory	Category
Well, when we got the letter I thought that it would feel rather nice like, and that I should become calmer of it, of having it.	… got the letter, thought it would feel nice, become calmer.	Had an expectation that the vest would feel nice and bring composure.	Had an expectation that the vest would feel nice and to bring composure.	Had an expectation that the vest would feel nice and to bring composure.
It has been rather heavy to use, but has been calming in the same time. Thus I have become calmer; I have not been that stressful.	Become calmer, haven't been that stressful.	Become calmer, haven't been that stressful.	Used as shelter in the afternoon when messy at home when the family gathered.	Winded down by the vest. Calmer, not stressful. The vest gave a nice heavy feeling. Used as shelter in the afternoon when messy at home.
I used in the afternoon when it was pretty messy at home, when everyone came home and hurried round.	Used in the afternoon when it was messy at home, when everyone came home	Used as shelter in the afternoon when messy at home when everyone came home		
When I was very excited and became calmer when I put the vest on and so.	I was very excited and became calmer when I put the vest on	Winded down by the vest	Winded down by the vest. Became calmer wasn't that stressful.	
It felt very nice to wear it, in the same time a little heavy in a nice way the balls gave a nice feeling.	It felt very nice to wear it, in the same time a little heavy in a nice way, the balls gave a nice feeling.	The vest was very nice to wear, it was a little heavy in a nice way, the balls gave a nice feeling.	The vest was very nice to wear, gave a nice heavy feeling.	

Table 2. Examples of the qualitative content analysis process in which the subtheme *Possibilities to be active and participate in school setting* emerged

Identified meaning unit	Condensed meaning unit	Code, underlying meaning	Subcategory	Category
I have used the vest every day since I got it. It has felt good to use the ball vest. It feels important	Used the vest every day since I got it. Feels good, important	The vest was used every day, felt good and important	Used the vest vey day since I got it. It feels important	The vest was worn during lessons in school whenever the need was. Felt good, brought calmness, made it easier to listen and to sit longer time.
I had it mostly in school during lessons, took it off during breaks and lunch.	Mostly in school during lessons, off during breaks and lunch.	The vest was worn in school during lessons, not breaks and lunch.	The vest was worn during lessons in school because it brought calm and made it easier to listen.	
It has been good when I had it on in the classroom, the lesson went better.	It has been good when I had it on in the classroom	Wearing the vest felt good.		
I had the vest on during Swedish, English classes and reading. All was better; I was calmer and listened better.	Wore the vest during Swedish, English classes and reading. All was better; I was calmer and listened better.	Wore the vest during Swedish, English classes and reading. All was better; I was calmer and listened better.		
I put it on when I want, when I feel for it, it can be that I feel I will not be able to sit in the classroom for so long, not the whole lesson. Then I put the vest on.	Put it on when I want, can be that I feel I will not be able to sit in the classroom the whole lesson.	Put it on when I want, can be that I feel I will not be able to sit in the classroom the whole lesson.	Wear it whenever the need, can be a feeling not being able to sit in the classroom the whole lesson.	
It feels good to have it on I like the balls.	Feels good to have it on I like the balls.	The vest feels good to wear and the balls are nice	The vest feels good to wear	

to be able to perform an activity or to be able to relax and calm down in stressful moments. Andrew liked that the vest made him relax so well that he fell asleep when he was sitting on the couch and had nothing to occupy himself with. Ben's mother stated that when her son tried the vest for the very first time, he after 10 minutes uttered: "Mum, it feels in my body like I'm going to burst into laughter!" Ben then looked very pleased and she recognized a positive feeling in him that sort of poured through his body. He was very calm and looked like he had received a kick of endorphins. During the following intervention period he took the initiative to wear it himself on half of the occasions, saying: "*Well, now mum I have to have the vest. Now I must have it. Mum, I use the vest for a while*".

Lucas' mother noticed he had the strongest need to wear the ball vest in the afternoon, when the effect of the stimulant medication disappeared. Patrick discovered that the vest gave massage on the back and shoulders when he pulled his shoulders up and down and thought it was comfortable to do this now and then to become more aware of his body.

Loosened up to be able to socialize

The analysis revealed that the vest brought a soothing effect on mood and temper and contributed to the ability to endure sounds, light and smells better. During the afternoons after school the adolescents often got irritated because they experienced this time as messy. At this time of day the adolescents could get very edgy if someone touched them, or when they stood close together with their siblings or sat at the table during dinner. Some participants experienced that wearing the vest could reduce such incidences and make it possible to handle the teasing of younger siblings without getting tantrums. Wearing the vest made it easier to loosen up and focus on what parents and siblings said and handle the situation in a proper way. The vest was also used to wind down all on their own when contact with others was unwanted. One of the boys put it on deliberately for half an hour afterwards to be able to meet and socialize with family and friends for a long while in a balanced way. Andrew, 13 years old, explains: "*The ball vest was comfortable to wear. It made thus I did not get so fast angry with my brother*".

Lucas, 13 years old, explained that when he wore the vest while playing computer games, he did not get as upset as he used to when the keys got stuck. He said: "*Well, then I can lose in certain games. When I had the vest on I could just simply start from the beginning and I did not get so enraged either*". When he had discovered this, he began to put the vest on before he started playing.

The ball vest as a friend and pet

The ball vest brought a feeling of comfort when things were strenuous both in school and at home. In general, the vest helped to hold one together and supported the adolescents when they were sad or missed someone. The vest was handled gently and protected and sheltered from other students in school and from younger siblings at home. It was described as a friend that could make the adolescents calm down when they were angry and support them to feel better when they were sad. Lucas said: "*Yes, it feels like someone is there to hug you all the time. You need to have a little, well… if you feel alone, maybe miss someone or so. Well, I missed my cat, and then I put the vest on and then it felt much better*".

The vest was experienced as hugging and consoling by the adolescents, and when hurting themselves they said they were less distressed. Giving the ball vest back after the loan was described by one participant as similar to have to leave a dog or a cat with a new owner because not being able to take care of it.

The ball vest as an activity friend

Easier to think of what to do and keep it in mind

Several participants described that the vest made it easier to be concentrated on activities they wanted to do. The vest also enabled to perform activities they did not want to do, such as tidying up the room, doing homework, and writing, doing math's, and making a snack. Andrew explained that he could walk wildly around not knowing what to do but when he put on the vest, on it became easier to do activities that were planned. He uttered: "*I concentrate when I wear the vest because then I am calm, I can think of what I have to do and keep it in my mind – do not think of other things, and I finish what I have to do. Then I do those things first. If I don't wear it I don't concentrate as well. I can sit and write or do something, and then whoop – start to do something else and immediately stop doing what I have to, for example write. Instead I fetch and build with Lego, because that is one of the most fun things I can do, I think, actually*".

Possibilities to be active and participate in the school setting

The two adolescents who brought the vest to school regularly wore it during lessons containing exposition, instruction and individual school work. Wearing the vest brought an ability to pull together and participate and stay in the classroom during a whole lesson performing school activities. Oscar was calm and listened better when he used the vest during academics. His teacher observed him being proud wearing the vest and that the vest gave him gravity, as if he felt, Here I am! Patrick, 11 years old, thought that the best time to wear the vest was when his teacher gave instructions and information, which then were easier to receive. Agnes explained that during the two days she wore the ball vest in the school setting, she relaxed more than she used to. Because of negative attention from other students, she discontinued bringing it but wore it at home at breakfast before going to school, and then had a calming feeling of still wearing it when she entered school.

Satisfaction with performing interesting and funny activities

The analysis showed that it was common to switch between activities such as building with Lego and watching a film, without finishing any of these activities. The vest brought the capacity to view a whole film without a break in the middle and made it possible to follow the storyline in a TV series you wanted to see. Lucas explained that if he wondered what to do, he sat down on his bed, put the vest on and then had an idea of what to do. He then could use his iPad, watch TV, play Minecraft, play cards or use his smartphone. Patrick said: "*I have watched TV with it too, yes. It is comfortable to sit calm and nice and concentrate to watch a little… without walking away directly and think… nooooo, boring, kind of. Then I can stay and watch a while, to see what it is all about and think yes, this was pretty enjoyable after all, in spite of starting dull*".

Wearing the vest made it possible to build more creative and advanced constructions of Legos and other materials and it was deliberately worn to get imaginative and funny ideas. It also gave the opportunity to implement ideas for activities and how to use the vest could be arranged. When Ben got an idea of an advanced building project, he put the vest on in advance because he had discovered he had to wear it to be able to sit calmly and concentrate to carry the plan out. He thought the vest had a disadvantage in that it was clumsy and, in the way, when he sat on the floor building Legos, but he used it anyway because it made him relax.

Attitudes of people influenced the use of the ball vest

The analysis revealed that all six adolescents used the vest at home and that two of them also used it regularly in school. Another two wanted to wear it in school and brought it there for a couple of days and felt comforted by it but discontinued the use because of other pupils' teasing. The adolescents who wore the ball vest regularly in school were younger and their teachers were engaged in the use. The vest was accepted by everyone in their school context and they got questions but not teasing. The older adolescents felt uncomfortable to wear the ball vest in school despite its benefits. They who attended upper secondary school felt deviant and stigmatized because of all the questions from other students who did not understand the purpose of wearing it.

DISCUSSION

This qualitative study brought an insight into how wearing a ball vest while performing everyday activities could be experienced by adolescents', their parents and teachers. The theme "The ball vest as an activity friend" indicate that the ball vest may be an enabler to increase activity performance both at home and in the school setting among adolescents with neuropsychiatric disorders. This is illuminating because the ability to focus on and concentrate to perform an activity is a known issue among this group of adolescents [2−4, 6, 7, 18]. Regarding children with ADHD this result can be compared to another study where researchers found that weighted vests showed improvement in attention, responding and processing speed, executive management and on-task behavior [34]. Their study showed no significant improvement in impulse control and automatic vocalizations in a randomized, two-period crossover design, but the study supported the use of weighted vests to increase attention to task problems of children with ADHD.

In the present study, the adolescents reported an increased ability to perform various activities which means that this was essential to them. This condition supports earlier findings where students with disabilities communicated that to them the most important element was to be active and to be seen participating with others in their context [41]. That adolescents with disabilities emphasize the need to prioritize mainstream solutions were also found in other studies [42, 43]. In the Model of Human Occupation (MOHO) [1], participation is acknowledged as an important aspect of activity performance, and is perceived as engagement in play, work or daily activities, which are part of our sociocultural context and are desirable or necessary to our wellbeing. That the adolescents in the present study found that the ball vest brought possibilities to perform interesting and funny activities corresponds with how Kielhofner [1] describes pleasure as an important aspect of creating an active life.

The vest was useful at home but not all adolescents felt comfortable to wear it in the school setting. The subtheme "Attitudes of people influenced the use of the ball vest" indicate that the social context in the upper secondary school influenced negatively on the possibilities of using the ball vest. This finding supports earlier research that found the social context more important to students' deciding to use or abandon their assistive technology than the benefits they received from the devices [42]. However, this study also shows that the adolescents who used the ball vest in the school setting had teachers who were positive. The success of the use of assistive technology devices may depend on teachers' encouragement [44].

Another finding in the theme "A desire relieve an earlier experienced feeling" is that the majority of the participating adolescents earlier had tried a ball blanket and felt the need to experience the same sensation that the ball blanket had given them. That they felt a need to relive an earlier experienced feeling indicates the importance of opportunities for children and adolescents to try and experience new assistive technology devices. This finding also supports earlier research that found that children and adolescents need to have their own experiences to know whether a device is useful or not [42, 45]. Associated with this result, one could discuss what impact the fact that the majority of the adolescents had a positive experience of trying a ball blanket before had on how they experienced the ball vest. That the adolescents associated the ball blanket with the ball vest suggests that children and adolescents should get the opportunity to try a ball blanket before they try a ball vest. An implication could be to try a ball blanket before prescription. This also suggests further studies with more participants to get answers about if there is a correlation between these two interventions.

An interesting finding is that a delayed effect was discovered which was made use of preventively. One example is that the vest was worn during breakfast at home, to be able to enter school in a calm mood. Other examples are that the vest was worn for half an hour in the afternoons to prepare to socialize with the family and in advance of building a complicated Lego project to be able to carry the building plan out. A delayed effect of deep pressure treatment goes in line with earlier studies [29, 31]. This finding suggests that clinicians should inform ball vest users to try to wear the vest ahead of performing an important activity where they have to concentrate. Overall, it should be recommended that ball vest users themselves decide when and where to use their vest.

The present study supplies knowledge of how a ball vest can be useful to adolescents that need to relax to be able to focus and stay engaged in an activity. This supports earlier research on calming down using deep pressure which earlier was given by holding, stroking, hugging and swaddling [45]. The results revealed that the ball vest gave a feeling of confidence and was worn during stressful moments or to make one able to perform an activity or to just relax and calm down. The ball vest was described as giving a pleasant feeling and provided comfort when the balls squeezed, phrased as a kind of massage on the body. This finding shows that a ball vest can be an alternative to techniques used for stress reduction such as mindfulness meditation, which is used to find relaxation through cognitive and intention-based self-regulation [46]. Morrison [37] found in her review that the results of the articles were questionable or positive and concluded that the effectiveness of the weighted vests was limited, and further research using larger samples using standardized protocol and less homogenous groups is needed. The present study has a qualitative approach, and does not meet any of these proposals, but can serve as an important guide forward.

Limitations

The findings can be utilized as a guide to understanding what might occur in other situations and samples. Despite this, the following limitations need to be taken into account. This study sought insights into the adolescents' experiences of using a ball vest in everyday activities, but it is common that when interviewing children, data is not as exhaustive as one intends [40]. Addressing the adolescents themselves to gather data was significant for the study. To also address their parents and teachers increased the trustworthiness. Another limitation was the eight-week-long period of using the ball vest, which means that the long-term outcome has not been studied. In this matter this study can be viewed as a pilot study.

CONCLUSION AND IMPLICATION

This qualitative study identifies an interesting hypothesis regarding how a ball vest can be experienced in relation to the performance of everyday activities at home and in the school setting for students with high activity levels and neuropsychiatric disorders. This study suggests that the participating adolescents themselves were conscious about the importance of their own activity performance and activity participation. An implication for practice and further use of ball vest includes that detailed information from the occupational therapist to the teacher and the school class should be given to create a friendlier climate for ball vest use. There is a need of structural information to the children and adolescents themselves. The occupational therapist and the teacher should also give more time for information and adaptation in the school setting.

In addition, the adolescents need to wear the ball vest in different contexts and activities to get experiences in which settings it was most useful, which seems to be of importance for the experience of benefit. Further research is needed to explain what factors are important and to influence the decision to wear a ball vest or not in the school setting.

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References

[1] Kielhofner G. Model of Human Occupation: Theory and application. 4, editor. Baltimore: Lippincott Williams & Wilkins; 2008.

[2] Brodin J, Ljusberg A-L. Teaching children with Attention Deficit Hyperactivity Disorder in remedial classes. Int J Rehabil Res. 2008; 32(4): 351−5.

[3] Biederman J, Faraone SV. Attention-deficit hyperactivity disorder. The Lancet. 2005; 366: 237−48.

[4] Tarver J, Daley D, Sayal K. Attention-deficit hyperactivity disorder (ADHD): an updated review of the essential facts. Child: Care, Health & Development 2014; 40: 762−74.

[5] American Psychiatric Association. Diagnostic and statistical manual of mental disorders (DSM-5). Washington DC; 2013.

[6] Wing L. The autistic spectrum: A guide for parents and professionals. London: Robinson Publishing; 2003.

[7] Gillberg C, Peeters T. Autism: Medical and educational aspects. London: Whurr Publishers; 1999.

[8] Holmes E, Willoughby T. Play behaviour of children with autism spectrum disorders. J Intellect Dev Disabil. 2009; 30(3): 156−64.

[9] Antshel KM, Zhang-James Y, Wagner KE, Ledesma A, Faraone SV. An up date on the comorbidity of ADHD and ASD: a focus on clinical management. Expert Rev Neurother. 2016; 16: 279−93.

[10] Association AP. Diagnostic and statistical manual of mental disorders (DSM-V). 5 ed. Washington 2013.

[11] Yochman A, Parush S, Ornoy A. Responses of preschool children with and without ADHD to sensory events in daily life. Am J Occup Ther. 2004; 58: 294−302.

[12] Tomchek D, Dunn W. Sensory Processing in Children With and Without Autism: A Comparative Study Using the Short Sensory Profile. Am J Occup Ther. 2007; 61: 190−200.

[13] Pfeiffer B, Daly B, Nicholls E, Gullo D. Assessing Sensory Processing Problems in Children With and Without Attention Deficit Hyperactivity Disorder. Phys Occup Ther Pediatr. 2014; 35(1): 1−12.

[14] Little L, Dean E, Tomchek S, Dunn W. Sensory Processing Patterns in Autism, Attention Deficit Hyperactivity Disorder, and Typical Development. Phys Occup Ther Pediatr. 2018; 38(3): 243−54.

[15] Smith Roley S, Blance E, Schaaf R. Understanding the Nature of Sensory Integration with diverse populations USA: PRO-ED, Incorporated; 2001.

[16] Dunst C, Bruder M, Trivette C, Hamby D. Everyday activity set tings, natural learning environments, and early intervention practices. J Policy Pract Intellect Disabil. 2006; 3: 3−10.

[17] Humphry R, Wakeford L. An occupation-centred discussion of development and implications for practice. Am J Occup Ther. 2006; 60: 267−358.

[18] Antshel KM, Barkley R. Psychosocial Interventions in Attention Deficit Disorder. Child Adolescent Psychiatric Clinics of North America. 2008; 17(2): 421−37.

[19] Lakhan SE, Kirchgessner A. Stimulants in Individuals With and Without ADHD. Brain and Behviour. 2012; 2: 661−77.

[20] Virues-Ortega J, Julio FM, Pastor-Barriuso R. The TEACCH program for children and adults with autism: A meta-analysis of intervention studies. Clinical Psychology Review. 2013; 33: 940−53.

[21] Leaf JB, Leaf R, McEachlin J, Taubman M, Ala'i-Rosales S, Ross RK, et al. Applied Behavior Analysis is a Science and, Therefore, Progressive. J Autism Dev Disord. 2016; 46: 720−31.

[22] Spencer D, Marshall J, Post B, Kulakodlu M, Newschafer C, Dennen T, et al. Psychotropic Medication Use and Polypharmacy in Children With Autism Spectrum Disorders. Pediatrics. 2013; 5: 831−40.

[23] Schubart JR, Camacho F, Leslie D. Psychotropic medication trends among children and adolescents with autism spectrum disorder on the Medicaid program. Autism. 2014; 18(6): 631−7.

[24] Bundy A, Lane S, Murray E. Sensory Integration: Theory and Practice. 2 ed. Philadelphia: F. A Davis; 2002.

[25] Ayres A, J. Sensory integration and the child. Los Angeles: Western Psychological Services; 1979.

[26] Smoot Reinert S, Jackson K, Bigelow K. Using Posturography to Examine the Immediate Effects of Vestibular Therapy for Children with Autism Spectrum Disorders: A Feasibility Study. Physical & Occupational Therapy In Pediatrics. 2015; 35(4): 365−80.

[27] Suarez MA. Sensory Processing in Children with Autism Spectrum Disorders and Impact on Functioning. Pediatric Clinics of North America. 2012; 59(1): 203−14.

[28] Edelson S, Edelson M, Kerr D, Grandin T. Behavioral and Physiologi cal Effects of Deep Pressure on Children With autism: A Pilot Study Evaluating the Efficiacy of Grandin's Hug Machine. Am J Occup Ther. 1999; 53: 145−52.

[29] Hvolby A, Bilenberg N. Use of Ball Blanket in attention-deficit/hyperactivity disorder sleeping problems. Nord J Psychiatry. 2011; 65(2): 89−94.

[30] Pappas D. ADHD Rating Scale-IV: Checklists, Norms, and Clinical Interpretation. J Psychoeduc Assess. 2006; 24(2): 172−8.

[31] Fertel-Daly D, Bedell G, Hinojousa J. Effects of a

Weigthed Vest on Attention to Task and Self-Stimulatory Behaviours in Preschoolers With Pervasive Developmental Disorders. Am J Occup Ther. 2001; 55: 629−40.

[32] Olsson LJ, Moulton HJ. Use of Weighted Vests in Pediatric Occupational Therapy Practice. Phys Occup Ther Pediatr. 2004; 24: 45−60.

[33] VandenBerg N. The Use of a Weighted Vest To Increase On-Task Behavior in Children With Attention Difficulties. Am J Occup Ther. 2001; 17: 621−8.

[34] Lin H-Y, Lee P, Chang W-D, Hong F-Y. Effects of Weighted Vests on Attention, Impulse Control, and On-Task Behavior in Children With Attention Deficit Hyperactivity Disorder. Am J Occup Ther. 2014; 68: 149−58.

[35] Hodgetts S, Magill-Evans J, Misiaszek J. Weighted Vests, Stereotyped Behaviors and Arousal in Children with Autism. J Autism Dev Disord. 2011; 41: 805−14.

[36] Davis T, Dacus S, Strickland S, Copeland D, Chan J, Blenden K, et al. The effects of a weighted vest on aggressive and self-injurious behavior in a child with autism. Dev Neurorehabil. 2013; 16(3): 210−5.

[37] Morrison E. A Review of Research on the Use of Weighted Vests with Children on the Autism Spectrum. Education. 2007; 127(3): 323−7.

[38] Patton MQ. Qualitative Research & Evaluation Methods. 3, editor. Thoasand Oaks, California: Sage Publication, Inc.; 2002.

[39] Graneheim UH, Lundman B. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. Nurse Educ Today. 2004; 24: 105−12.

[40] Curtin C. Elicitng Children’s Voices in Qualitative Research. Am J Occup Ther. 2000; 55(3).

[41] Eriksson L, Granlund M. Conceptions of Participation in Students With Disabilities and Persons in Their Close Environment. J Dev Phys Disabil. 2004; 16(3): 229−45.

[42] Hemmingsson H, Lidström H, Nygård L. The use of Assistive Technology Devices in mainstream schools: the students’ perspective. Am J Occup Ther. 2009; 63(4): 463−72.

[43] Egilson S. School experiences of pupils with physical impairments over time. Disabil Soc. 2014; 29(7): 1076−89.

[44] Breivik I, Hemmingsson H. Experiences of handwriting and using a computerized ATD in school: Adolescents with Asperger's syndrome. Scand J Occup Ther. 2013; 20(5): 349−56.

[45] Grandin T. Calming effects of deep pressure in patients with autistic disorder, college students and animals. Journal of Child and Adolescent Pharmacology. 1992; 2: 63−72.

[46] Zylowska L, Ackerman DL, Yang MH, Futrell JL, Horton NL, Hale T, et al. Mindfulness Mediation Training in Adults and Adolescents With ADHD. J Atten Disord. 2008; 11(6): 737−46.

ORIGINAL ARTICLE

Difficulties in Everyday Technology Use of the People with Acquired Brain Injury Living at Home

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Abstract: Everyday technology (ET) has become central to modern life, but its use poses challenges to those with cognitive impairments. We sought to describe the level of perceived difficulties in using ET by people with Acquired Brain Injury (ABI) and to assess the correlation between perceived level of difficulty and cognitive impairment. The Everyday Technology Use Questionnaire revised Japanese version (ETUQ-Japan) was used to assess perceived difficulties in ET use for twenty-two participants with ABI. A trend of negative correlation was observed between the ratio of ET used with assistance of someone else and all neuropsychological test results. In particular, strong negative correlation was observed between the executive function (Behavioral Assessment of the Dysexecutive Syndrome, BADS) and the use of ET with assistance. It is likely that impairments to executive function are associated with difficulties in using ET use and patients with ABI living at home will require aid to address these problems.

Keywords: acquired brain injury, everyday technology, executive function

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1. Introduction

The daily life of people with acquired brain injury (ABI) is influenced by their cognitive impairments including memory disorder, attention disorder, and executive dysfunction [1]. Wilson and her colleagues have reported the challenges for their patients with ABI in their daily lives, including forgetting where they have placed objects or parked their cars and being unable to manage money or leave the house alone [2]. Others reported that people with ABI have limitations to their level of activity [3] and social adaptation [4]. Many young persons with ABI who live at home need services and supports in their environments [5]. In addition to the inconveniences faced by persons with ABI themselves, there is also extensive burden placed upon caregivers [6, 7]. Cognitive impairment is associated with the loss of social autonomy and an inability to return to work after ABI [8].

For people with ABI to live comfortably at home, it is important to have abilities to handle many everyday technologies (ET). ET has been defined to include a variety of technical, electronic, and mechanical equipment, including both recently developed devices and well-known technology and services [9]. Not only does the use of ET contribute to an improved lifestyle [10], it has also become an integral part of most tasks at home and in society, including the workplace in recent decades [11]. However, the use of ET, even by people without cognitive impairments, can be difficult at times [12], and the benefits that people with ABI, who have various types of cognitive impairment, can gain from ET are even more limited than those without cognitive impairment [13].

Multiple studies have evaluated the relationships between people with ABI and their ET use in everyday life. Lindén and her colleagues have demonstrated that people with ABI have difficulties using everyday technology, in particular, advanced technology such as computers, telephones, and other electronic systems which require the use of cognitive functions [14]. Fallahpour

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and her colleagues have revealed that perceived difficulty in ET use is significantly increased among people with ABI, with severe to moderate disability, compared with controls [15]. Malinowsky and Lund have described the relationship between the perceived difficulty and the observed ability of ET use in people with ABI of working age [16].

Although there are a few studies that evaluated different aspects of ET use in people with ABI, to the best of our knowledge, there have been no studies regarding the relationship between the difficulties using ET and various types of cognitive impairments. Therefore, our study sought to explore the level of the difficulties in using ET among people with ABI and to assess how the level of difficulties is associated with cognitive impairment in people with ABI. Lund et al. also emphasized the need for occupational therapists to evaluate the extent to which people with ABI experience difficulties while using ET as a result of cognitive impairment [17], and occupational therapists need knowledge about the relationship between the difficulties experienced by people with ABI during ET use and their cognitive impairments.

In conclusion, this study aimed to clarify the relationship between various cognitive functional impairments in people with ABI living at home and their perceived level of difficulty of ET use.

2. Participants

Inclusion criteria required that participants in this study (i) had a diagnosis of cognitive impairment caused by acquired brain injury and, (ii) lived at home and, (iii) either had no physical dysfunction or only limited physical dysfunction that scarcely affected their ET use in daily life. Exclusion criteria included (i) a diagnosis of cognitive impairment with no clear cause, (ii) a diagnosis made by someone other than a physician and (iii) those who lacked the communicative ability to undergo interviews. Upon commencing research, requests for research cooperation were sent to eight general hospitals, clinics, community workshops specialized in cognitive disorders and ABI Patient-Family Associations in the Kansai area and Okayama prefecture. People from these institutions and organizations introduced the research to potential participants using written explanations. Twenty-two participants who met the criteria were enrolled (Table 1). The participants, of which 17 were men and five were women, were aged from 20 to 62 years with a mean age of 41.3 ± 13.4 years. Causes of head injuries included head trauma (15 participants), cerebrovascular accident (five participants) and hypoxic encephalopathy (two participants). Two participants lived alone and 20 participants lived with their families. Three participants were in regular employment, nine participants were in assisted employment at welfare facilities, and 10 participants were unemployed (including retirees, housewives and students).

Table 1. Characteristics of 22 participants in the study

Age (years)		
	Mean (SD)	41.3 (13.4)
	Range	20−62
Gender (n)		
	male	17
	female	5
Living situation (n)		
	with family	20
	alone	2
Employment Status (n)		
	not employment	10
	assisted employment	9
	regular employment	3
Type of ABI (n)		
	Trauma	15
	Stroke	5
	hypoxia	2

This study proposal was approved by the Ethical Committee of Kobe University Graduate School of Health Sciences. All participants provided written informed consent before data collection.

3. Materials and Methods

Data-collection tools

For collecting information of perceived difficulty in ET use by the participants with ABI, the Everyday Technology Use Questionnaire revised Japanese version (ETUQ-Japan) was used. The original ETUQ is a semi-structured standardized interview questionnaire, developed to investigate perceived difficulties among elderly people with cognitive deficits living at home [9, 12]. The original ETUQ is composed of 93 ET-items organized into 8 domains, namely: household activities (e.g., microwave oven and vacuum cleaner), activities at home (e.g., TV and DVD), personal care (e.g., thermometer and hair dryer), power tools (e.g., lawnmower and electric screwdriver), accessibility (e.g., elevator and intercom), data and telecommunications (e.g., push-button telephone and PC), economy and shopping (e.g., credit card and the Internet banking), transportation (e.g., an automatic turnstile and automatic ticket machine). The ETUQ-Japan was composed of 101 items in the same 8 domains [18−20].

For evaluating cognitive functions of the people with

Table 2. Neuropsychological test results of ABI patients

	WMS-R			WAIS-III			BADS
	verbal memory	visual memory	total memory	VIQ	PIQ	FIQ	BADS score
Mean	70.9	75.1	68.5	85.7	75.5	78.5	79.0
SD	14.9	19.2	16.1	20.8	15.9	17.6	22.8
Median	68.5	81	67	85.5	75	77	80.5

ABI, we used the Wechsler Adult Intelligence Scale-Third Edition (WAIS-III) for Intelligence, the Wechsler Memory Scale-Revised (WMS-R) for memory functions, and the Behavioral Assessment of the Dysexecutive Syndrome (BADS) for executive function. These cognitive functions were evaluated in the participant's home, and some was submitted from the cooperating facility with consent.

Data collection methods

Interviews regarding perceived difficulty in ET use were obtained by conducting the ETUQ-Japan in the participant's home. These interviews were done by first author. He, as well as the members of the research team, had extensive knowledge about the ETUQ obtained from a workshop on the original ETUQ and work on developing the ETUQ-Japan [20].

In the ETUQ interviews participants were first asked if each ET was "relevant" or "not relevant" for them. If an ET was relevant, then they were asked regarding ease or difficulty of use, which was scored according to the level of perceived difficulty in using it. There were three scoring categories: (i) "use independently without difficulty," (ii) "use independently with difficulty," or (iii) "use with assistance of someone else."

Data analysis

In each participant, a value was obtained by dividing the number of ET included in each category (i, ii, and iii) by the total number of relevant ET. These three values and the number of using ET (relevant ET) were defined as "condition of using ET".

The condition of using ET and the results of neuropsychological tests ("performance intelligence quotient (PIQ)," "verbal intelligence quotient (VIQ)," "full scale intelligence quotient (FIQ)" of WAIS-III, "verbal memory," "visual memory," "total memory" of WMS-R, and BADS score) were analyzed with the Spearman's rank correlation coefficient in order to clarify the relationship between the various measured cognitive functions and use of ET. All risk ratios were considered significant with scores below 5% based on the two-sided test. For data analysis, the SPSS version 20.0 for windows was used for this study.

4. Results

The relationship between various cognitive and executive functional impairments and perceived level of difficulty of ET use

The mean ± standard deviation for ET used in people with ABI was 34.7 ± 8.3, out of a total of 101 items of the ETUQ-Japan. Neuropsychological test results for subject with ABI are shown in Table 2.

The coefficient ratio of each neuropsychological test and the condition of using ET are shown in Table 3. A positive correlation was observed between "the number of using ET" and the BADS score ($r = 0.466$, $p < 0.05$). A positive correlation was also observed between "use independently without difficulty" and the BADS score ($r = 0.430$, $p < 0.05$). A negative correlation was observed between "use with assistance of someone else" and verbal intelligence following WAIS-III "VIQ" score ($r = -0.479$, $p < 0.05$). A negative correlation was also observed between "use with assistance of someone else" and WMS-R "verbal memory" ($r = -0.570$, $p < 0.01$), "visual memory" ($r = -0.561$, $p < 0.01$), "total memory" ($r = -0.568$, $p < 0.01$), WAIS-III performance intelligence "PIQ" score ($r = -0.613$, $p < 0.01$), full scale intelligence "FIQ" score ($r = -0.598$, $p < 0.01$), and executive function BADS score ($r = -0.843$, $p < 0.01$).

No significant correlation was observed between "use independently with difficulty" and neuropsychological scores.

5. Discussion

A trend of negative correlation was observed between the ratio of ET "used with assistance of someone else" and all of neuropsychological test results. In particular, a strong negative correlation was observed with the BADS score. On the other hand, there was a positive correlation between the BADS score "the number of using ET" and "use independently without difficulty" categories, but no correlations were observed for the condition of ET use and the other neuropsychological tests results, except for the "use with assistance of someone else" category. Therefore, it is believed that the BADS score reflects the condition of ET use and everyday quality of

Table 3. Relationship between the states of ET use and each score of neuropsychological test (Spearman's rank correlation coefficient)

Types of neuropsychological test	the number of using ET (rs)	use independently without difficulty (rs)	use independently with difficulty (rs)	use with assistance of someone else (rs)
verbal memory	0.364	0.411	0.167	−0.570**
visual memory	0.409	0.195	0.339	−0.561**
total memory	0.416	0.355	0.214	−0.568**
VIQ	0.281	0.360	0.162	−0.479*
PIQ	0.271	0.382	0.197	−0.613**
FIQ	0.342	0.397	0.204	−0.598**
BADS	0.466*	0.430*	0.371	−0.843**

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

life of patients with ABI. Furthermore, there is a greater likelihood of requiring assistance, especially when the BADS score is low. BADS was developed by Wilson and her colleagues as a standardized battery for evaluating executive dysfunction [21] and was thought to be an effective tool for evaluating the ability to perform an action independently and efficiently [22]. Executive functions are the controlling mechanisms of the brain and include the processes of planning, initiation, organization, inhibition, problem solving, self-monitoring and error correction [23]. People with executive dysfunction lack the ability to create ideas and build practical strategies, have difficulties in starting and maintaining actions, as well as taking independent actions [1, 22]. In conclusion, occupational therapists should heed BADS scores as indicating the possible existence of difficulties with using ET.

No previous research makes explicit reference to the relationship between ET use and executive dysfunction; but several studies have suggested the relationship. Organizing or sequencing steps and actions in a logical order may affect using ET in daily activities [24]. Also, Larsson and colleagues reported one of the response actions while using ET being random and inflexible repeating [17]. Kassberg et al identified that people with ABI require varied support to identify their problems and goals related to ET use [25]. In a recent research we conducted, we characterized the difficulties faced by people with ABI in daily life, by classifying the encountered difficulties [26]. According to that research, various types of level of perceived difficulties among people with ABI were identified, such as, "pressing the buttons of DVD player at random, due to having difficulty in recording" or "being unable to distinguish the difference between the ways of cooking on the rice cooker." These difficulties are classified as "cannot correct one's error when using ET" and "inflexible in changing one's correspondence according to each device." These difficulties are thought to be caused by executive dysfunction. Therefore, when these people perceive any difficulties at the time of ET use, they tend to give up or depend on others, rather than trying to solve the problems by themselves through trial and error. This is thought to be characteristic of "use with assistance." Furthermore, in that study there were some problems, such as "spend a day without adjusting the air conditioner according to the room temperature" or "often use the hair dryer when reminded by the caregiver and get told that the time for drying is not enough." The present study's results support the notion that for people with executive dysfunction, difficulties arise when they start or continue operating ET, and then it is necessary for someone to watch and tell them what to do at the time of their ET use.

Regarding these problems that he/she cannot start or continue operating ET, the use of assistive technology that prompt his/her actions is thought to be effective. The paging system designed by Wilson and her colleagues is an assistive technology for memory impairment, but can also be used to give cues regarding initiating actions [27]. As for a trial to replace caregivers with assistive technology, Tanemura and her colleagues have developed a daily life management application named "Arata," which achieved good results [28].

In a study of mental health and related factors, Suzuki and his colleagues indicated that memory disorder was less related to mental health, and it was executive dysfunction and social behavior disorder that were associated with mental health [29]. In addition, they pointed out that the number of prompting and time spend watching over a person with executive dysfunction required for each occupational performance process in everyday life may affect the mental health of caregivers. Based on the results of that study and the present study, it seems that with executive dysfunction increasing so does the tendency to depend on others when using ET, and as a result the burden on caregivers is increasing. Decreasing the need for prompting and watching over required for each occupational performance process in everyday life might result the reduction of caregiver burden. Also, assistive technology that prompts the actions of people with executive dysfunction instead of caregivers is useful for the reduction of caregiver burden.

Executive dysfunction is also said to have a mutual relation with social participation [30]. Executive function is associated to the abilities of planning efficiently to do daily routines skillfully and to adjust well with the surrounding people to solve social problems [31]. The result of this study indicated that there is a relationship between ET use and executive dysfunction. We have to focus both on the situation of using ET and the level of executive dysfunction to understand the daily life of the people with ABI from their ADL to social integration.

Study limitations

We looked at the influence of cognitive impairment, however there are many other influences. It is known that personal identification and environmental factors affect the difficulty of ET use [33]. Considering these factors is necessary when providing interventions for people with ABI.

The surveyed area of this study was limited in the Kansai region and Okayama prefecture. Accordingly this study's findings might not reflect geographical differences that might influence the use of ET and the relationship between client and caregiver.

Even though the participants did not have difficulty with physical function, it is well-known that people with ABI have additional problems, not only with memory disorder and executive function, but also with motivation and personality. Taking such problems into consideration might lead to different findings regarding cognitive impairment and conditions of ET use. For instance, there is a possibility that motivation and personality are more important than executive function.

Conclusions

The level of perceived difficulties in ET use by people with ABI were explored and revealed. The results suggest that the quality of executive function influence the ability of an individual to use ET. People with ABI have many difficulties in ET use, and they might have a need for support from others in many cases. Consequently, difficulties of using ET not only impedes the use of ET in clients, but also hinders their participation in society and places burdens on caregivers. It is necessary for occupational therapists who are involved in the home life of patients with ABI to pay attention to the patient's ability to use ET as well as their executive dysfunction.

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References

[1] Sohlberg MM, Mateer CA. Cognitive Rehabilitation: An Integrative Neuropsychological Approach. New York, NY: Guildford Press; 2001.

[2] Wilson BA. Case Studies in Neuropsychological Rehabilitation. Oxford University Press; 1999.

[3] Legg LA, Drummond AE, Langhorne P. Occupational therapy for patients with problems in activities of daily living after stroke. Cochrane Database Syst Rev. 2008.

[4] Eriksson G, Tham K, Borg J. Occupational gaps in everyday life 1−4 years after acquired brain injury. J Rehabil Med. 2006; 38(3): 159−65.

[5] DeMatteo CA, Cousins MA, Lin CY, Law MC, Colantonio A, Macarthur C. Exploring postinjury living environments for children and youth with acquired brain injury. Arch Phys Med Rehabil. 2008; 89: 1803−10.

[6] Verhaeghe S, Defloor T, Grypdonck M. Stress and coping among families of patients with traumatic brain injury: a review of the literature. J Clin Nurs. 2005; 14(8): 1004−12.

[7] Suzuki Y, Tanemura R. Community-based Interventional Programmes for Family Caregivers of Persons with Traumatic Brain Injury. Asian J Occup Ther. 2011; 29: 15−22.

[8] Mazaux JM, Masson F, Levin HS, Alaoui P, Maurette P, Barat M. Long-term neuropsychological outcome and loss of social autonomy after traumatic brain injury. Arch Phys Med Rehabil. 1997; 78(12): 1316−20.

[9] Nygård L, Starkhammar S. The use of everyday technology by people with dementia living alone: mapping out the difficulties. Aging Ment Health. 2007; 11: 144−55.

[10] Lange M, Smith R. Technology and occupation: Contemporary viewpoints. The future of electronic aids to daily living. Am J Occup Ther. 2002; 56: 107−9.

[11] Kassberg AC, Prellwitz M, Lund ML. The challenges of everyday technology in the workplace for persons with acquired brain injury. Scand J Occup Ther. 2013; 20: 272−81.

[12] Rosenberg L, Nygård L, Kottorp A. Everyday technology use questionnaire: Psychometric evaluation of a new assessment of competence in technology use. OTJR: Occup Particip Health. 2009; 29: 52−62.

[13] Emiliani PL. Assistive technology (AT) versus mainstream technology (MST): The research perspective. Technol Disabil. 2006; 1: 19−29.

[14] Lindén A, Lexell J, Lund ML. Perceived difficulties using everyday technology after acquired brain injury: Influence on activity and participation. Scand J Occup Ther. 2010; 17: 267−75.

[15] Fallahpour M, Kottorp A, Nygård L, Lund ML. Perceived difficulty in use of everyday technology in persons with acquired brain injury of different severity. J Rehabil Med. 2014 Jul; 46(7): 635−41.

[16] Malinowsky C, Lund ML.The association between perceived and observed ability to use everyday technology in people of working age with ABI. Scand J Occup Ther. 2014 Nov; 21: 465−72.

[17] Lund ML, Engström AL, Lexell J. Response actions to difficulties in using everyday technology after acquired brain injury. Scand J Occup Ther. 2012; 19(2): 164−75.

[18] Tanemura R, Noda K, Nagao T, Nakata O, Sagara J, Bontje P. Actual usage of leisure and communicative devices among elderly people. The 6th World Congress of the International Society for Physical and Rehabilitation Medicine, Puerto Rico, 2011, June.

[19] Nakata O, Sagara J, Bontje P, Noda K, Nagao T, Tanemura J, Tanemura R. Difficulties in Everyday Technology use after brain injury: assessment using the Everyday Technology Use Questionnaire (ETUQ). The 6th World Congress of the International Society for Physical and Rehabilitation Medicine, Puerto Rico, 2011, June.

[20] Malinowsky C, Kottorp A, Tanemura R, Asaba E, Nagao T, Noda K, et al. Validation of the Everyday Technology Use Questionnaire in a Japanese context. Hong Kong Journal of Occupational Therapy. 2015; 26: 1−8.

[21] Tabuchi H. Assessment of executive function. Japanese Journal of Clinical Psychiatry. 2006; 35: 1517−25 (in Japanese).

[22] Youine T, Karinaga H, Yamamoto Y, Yagi M, Tanemura J. Relationship between return to society and neuropsychological assessment by intelligence, attention, memory, and executive function tests among brain-damaged patients. Higher Brain Function Research. 2008; 28: 416−425 (in Japanese with English abstract).

[23] Chung CS, Pollock A, Campbell T, Durward BR, Hagen S. Cognitive rehabilitation for executive dysfunction in adults with stroke or other adult non-progressive acquired brain damage. 2013; Cochrane Database Syst Rev.

[24] Ryd C, Nygård L, Malinowsky C, Öhman A, Kottorp A. Associations between performance of activities of daily living and everyday technology use among older adults with mild stage Alzheimer's disease or mild cognitive impairment. Scand J Occup Ther. 2014; 22(1): 33−42.

[25] Kassberg AC, Prellwitz M, Malinowsky C, Lund ML. Interventions aimed at improving the ability to use everyday technology in work after brain injury. Scand J Occup Ther. 2016; 23(2): 147−57.

[26] Nakata O, Tanemura R, Noda K, Nagao T. Extraction and Classification of Difficulties Faced by Patients with Brain Injury Living at Home While Using Everyday Technology. Bulletin of health sciences Kobe. 2016; 32: 55−67.

[27] Wilson BA, Emslie HC, Quirk K, Evans JJ. Reducing everyday memory and planning problems by means of a paging system: a randomised control crossover study. J Neurol Neurosurg Psychiatry. 2001; 70: 477−82.

[28] Tanemura R, Nagao T, Noda K, Nakata O, Tanemura J. A trial use of the assist tool 'Arata' for patients with cognitive impairment. The 39th Annual Scientific Meeting of Japan Society for Higer Brain Dysfunction. 2015.

[29] Suzuki Y, Tanemura R, Motomura Y. Mental health and related factors for the caregivers of patients living at home with traumatic brain injury. Journal of health and welfare statistics. 2010 Apr; 57(4): 20−6 (in Japanese).

[30] Tanemura J. Clinical Problems in Rehabilitation of Patients with Dysexecutive Syndrome. Higher Brain Function Research. 2008; 28: 312−9 (in Japanese with English abstract).

[31] Bivona U, Ciurli P, Barba C, Onder G, Azicnuda E, Silvestro D, et al. Executive function and metacognitive self-awareness after severe traumatic brain injury. J Int Neuropsychol Soc. 2008; 14: 862−8.

[32] Engström AL, Lexell J, Lund ML. Difficulties in using everyday technology after acquired brain injury: a qualitative analysis. Scand J Occup Ther. 2010; 17: 233−43.

ORIGINAL ARTICLE

A Comparative Study of Adjustability of Grasping Force between Young People and Elderly Individuals

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Abstract: Purpose: This study aimed to compare adjustability of grasping force (AGF) between people belonging to young and elderly age-groups.
Methods: Twenty young people and 20 elderly people, with no previous pathology involving the hands and fingers, were included in the study, and an AGF assessment was performed for all the subjects using an iWakka. Subjects adjusted the grasping force according to the target value displayed on the monitor by opening or closing the iWakka.
Results: The assessment of AGF was performed separately from that of the gripping force, and the latter was found to be comparable between the two groups. The mean AGF was found to be 8.9 ± 4.0 g and 7.6 ± 2.8 g for the dominant and the non-dominant hand, respectively, in the elderly group, as compared to the mean AGF for the dominant and the non-dominant hand of 4.4 ± 1.2 g and 4.4 ± 0.6 g, respectively estimated in the young age-group. A t-test conducted after controlling the disparate factors (sex, handedness, gripping force) between the subjects of the two groups, showed that there was a significant difference in AGF between the young and the elderly groups for both the dominant ($p = 0.03$) and the non-dominant hand ($p = 0.02$), indicating that the AGF of the elderly people was significantly lower than that of the young study-subjects.
Conclusions: Our findings suggest that AGF decreases with aging and that it is necessary to assess AGF separately from the gripping force, to make a precise comparison.

Keywords: adjustability of grasping force, iWakka, elderly people, gripping force

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1. Introduction

The functions of hands and fingers involve making grabbing, gripping, pinching, hooking, scooping, and pressing movements, which play an important role in performing daily activities [1]. Therefore, in many instances, rehabilitation centers have developed interventional programs for training patients to resume activities of daily living (ADL), based on the results of functional assessment of their hand and finger movements. Currently, an assessment of gripping force, the Purdue Pegboard Test [2], the O'Connor Finger Dexterity Test [3, 4], the Jebsen-Taylor Hand Function Test [5], and an examination of the physical capacity of hand-related skills [6], are utilized widely for assessing the hand and finger functions. Since these tests depend on an evaluation of both the time taken to complete a task and the degree to which the task is achieved, they can assess the maximum functional output while attempting to complete a task. However, while performing ADL, though there are tasks for which maximum force output is indicated, there are also those which require the capability of adjusting the exertional force, both chronologically and spatially, in a continuous manner and at a level below the maximum, without dropping a grasped object, further defined by its

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shape, weight, and type of material. This capability is referred to as the adjustability of grasping force (AGF).

A specialized device, called an iWakka, has been developed for the purpose of measuring AGF. Assessments performed using this device allow insights into the patient's actual AGF capability, which other existing modalities cannot evaluate [7–9]. Kaneno *et al.* [10] verified the reliability of an AGF-assessment method in young adults using an iWakka. Kaneno *et al.* [11] also verified the reliability of using this device for AGF evaluation in elderly individuals. These studies reported that AGF assessments performed using an iWakka provide reliable data on the AGF of people belonging to both the young and elderly age-groups.

Studies have reported that compared to young subjects, the elderly ones tend to have reduced hand and finger functions, indicated by evaluating various parameters including gripping force and fine motor skills [12, 13]. Conversely, with respect to certain mental skills such as comprehending a story from the context and for recall related to prospective memories [14, 15], elderly people demonstrate a capability equivalent to that observed in young subjects. These insights about the types of abilities that elderly individuals need assistance can help provide targeted preventive assistance. However, there have been no reports on a comparison of AGF between young and elderly individuals, and no data are available on whether elderly individuals have a reduced AGF as compared to the young age-group. Therefore, this study aims to compare AGF between people belonging to young and elderly age-groups.

2. Methods

2.1 Subjects

The eligibility criteria for the young subjects included in the study were $20 \leq$ age < 30 years and being affiliated to the Faculty of Health Sciences, Mejiro University, in Japan. Exclusion criteria were having an experience of carrying out tasks similar to those required to be performed for this study, or having a current or past (history of) orthopedic or neurological disease of the hands and fingers that impacted ADL. The eligibility criteria for elderly individuals subjects were age ≥ 65 years, those living in their own homes (main place of residence), and those able to ambulate without a walking-aid and able to travel to the study venue by themselves. The exclusion criteria for the latter group were having an experience of carrying out tasks similar to those required to be performed for this study, having a current or past (history of) an orthopedic or neurological disease of the hands and fingers that impacted ADL, or scoring ≤ 23 on the Mini-Mental State Examination (MMSE).

In order to estimate the sample size required for this study, we conducted a pilot survey of a small group (n = 10) consisting of 5 young people and elderly people, respectively. The results showed that the effect size of the AGF value (the main outcome of this study) for this small-sized sample was 1.17. We estimated the size of the study-sample required for the study, from the effect size of AGF value on the test group, using software G*Power [16] at a setting of $\alpha = 0.05$ and $\beta = 0.20$, which showed that an evaluation of at least 10 subjects in each group would be necessary to obtain statistically viable results. In order to adjust for confounding factors arising from matching of subjects, we recruited 20 subjects each for the young and elderly study groups.

All subjects received written and verbal explanation of the objectives and the study protocol in advance. All subjects included in the study provided written, informed consent for participation. The study protocol was approved by the research ethics review board of the Mejiro University (Approval number: 17-007).

2.2 Outcome measures

2.2.1 AGF assessment

In this study, we used the device iWakka (Aimu Co., Ltd.) for assessing the AGF of the study subjects. The device has a cylindrical shape with an 80-mm height and a 65-mm diameter. It consists of attached hinges for fixation to one of the edges of the cut- vinyl chloride pipe, and plate springs are placed within the pipe in such a manner that they cross each other [7, 8] (Fig. 1). Opening or closing the iWakka causes the plate springs to distort. We measured the level of distortion with a gauge and used a computerized analysis to create a real-time graph indicating the variability of the grasping force (in grams) over time (in seconds). Subjects were instructed to adjust the grasping force according to the target value displayed on the monitor. The maximum target value used was 400 g. The target value was changed in a stepwise manner at certain time intervals. The displayed values moved from right to left on the graph, with the passage of time. Quantitative evaluation is possible by calculating the absolute value of error, between the target value and the measured value of grasping force as AGF. A smaller the absolute values were indicative of a better AGF (Fig. 1).

With reference to the methods described in older studies [11, 17], the test environment was arranged as follows (Fig. 1). The assessment was conducted in a quiet environment. An adjustable table was utilized with its height adapted to the test subject's preference, based on the distance from their seat or chair to the table, to increase the ease of using the device. In order to

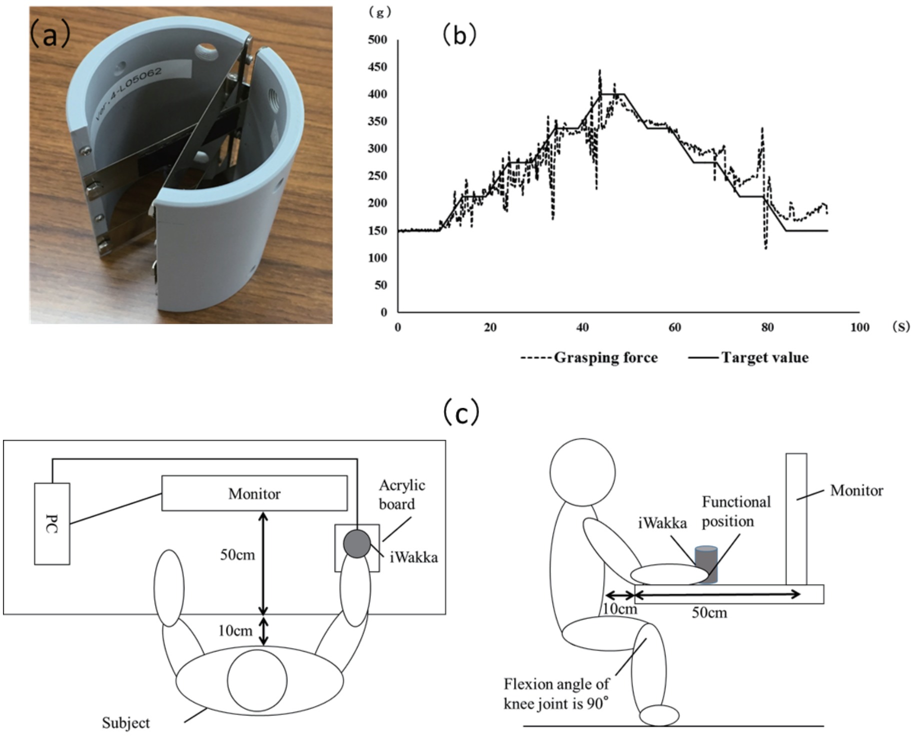

Fig. 1. Adjustability of grasping force assessment using the iWakka.
(a) The iWakka device (b) Real-time graph indicated on the monitor, with the graph indicating the variability of the grasping force (in grams) over time (in seconds) (c) Schematic of the test arrangement.
Reproduced with permission of the Society of Physical Therapy Science from [Kaneno, *et al.*]. [Assessing the adjustability of grasping force using the iWakka in elderly individuals. J Phys Ther Sci. 2017; 29: 2215−9].

maintain a uniform seating position and posture for all study subjects, no backrest was provided. The subjects were seated with their legs shoulder-width apart and their knee joint was kept in a 90 degrees flexed position. The distance from the table to the body was maintained at 10-cm, and the monitor was placed at a distance of 50-cm from the edge of the table. Subjects were instructed to maintain the position of the test-hand in the "Functional position", i.e. in dorsiflexion at 30° with the metacarpophalangeal joint of the digitus minimus attached to an acrylic plate. In order to eliminate the impact of the upper arms and maintain an equal shoulder height during measurement, the subjects were seated with both elbows on the table with both their forearms positioned at a point in-between pronation and supination, while the iWakka was placed on the acrylic plate, so that the device would not be tilted.

2.2.2 Assessment of gripping force

An analog tester (Takei Scientific Instruments Co., Ltd.) was utilized to measure the gripping force for all subjects. With reference to the positioning method described by Edo *et al.* [18], in this study, the gripping-force measurements were performed with subjects seated upright with their upper limbs placed down along the body. The gripping width was set in such a manner that the proximal interphalangeal joint of the index finger was bent at 90°. Since it has been reported that measuring the one-time gripping-force provides reliable data [19], we also carried out only one-time measurement of the gripping force for each study-subject.

2.3 Measurement procedure

Firstly, basic information such as age and gender was collected in an interview. Following this, a laterality index was estimated using the Edinburgh Handedness Inventory [20] to determine the dominant hand in each subject. As per the criteria described by Sakano [21], those with a laterality index value from 80−100 were determined to be right hand-dominant, and those with scores from −20 to −100 were considered to have a dominant left hand. Thereafter, prior to the assessment, a short practice session was conducted for each subject to familiarize them with the details of the tasks to be performed using the iWakka. Different target values were used from those in the assessment for this practice. A five-minute break was given after completion of the practice tasks, and the assessment were carried out in the same environment as that used for practice. Subjects performed assessment tasks twice each with the dominant and the non-dominant hand, and the mean value of the two attempts was used as the measurement value. In order to eliminate the effect of order of testing, counterbalancing was used by dividing the subjects into those who started the assessment with their dominant hands and with their non-dominant hands, respectively.

2.4 Data analysis

Subjects were categorized into a young group and an elderly group. The Chi-square test was used to analyze the distribution of baseline characteristics including sex and handedness, between the two groups. Furthermore, the groups were compared using t-tests for independent samples, in order to evaluate deviations in the values of both gripping force and AGF.

We performed adjustment to control variations in factors including sex, handedness and gripping force so that the difference between the two groups would only be limited with respect to age to the maximum possible extent. Subject-matching was conducted between both groups for the comparative analysis of AGF. While performing the analysis, factors, including both sex and the dominant hand of the subjects, were completely matched (e.g., right-handed young men and right-handed elderly men). In addition, the permissible ranges of gripping force were set at ± 5 kg and ± 3 kg for males and females, respectively, and the pair whose values of gripping force were as similar as possible were matched. As per data on variations in gripping force with age, issued by the Japanese Government Ministry of Education, Culture, Sports, Science and Technology, the standard deviations in both males and females aged 70−74 years were smaller than in those aged 20−24 years. In our study, the standard deviations among males and females aged from 70−74 years were referred to for setting the standard deviation values [12]. After matching, a t-test for analysis of independent samples was repeated.

The software IBM SPSS Statistics 25 was used for statistical analysis, and the level of significance was set at 5%.

3. Results

The mean age of the group of 20 young subjects was 21.0 ± 0.7 years (95% confidence interval [CI]: 20.7, 21.3), and it included 4 males and 16 females. Nineteen subjects were right-dominant, while 1 was left-dominant (Table 1). The mean gripping force for the dominant and the non-dominant hand was found to be 26.9 ± 6.4 kg (95% CI: 24.0, 29.9) and 24.9 ± 7.1 kg (95% CI: 21.6, 28.2), respectively. The mean AGF for the dominant and the non-dominant hand was calculated as 4.4 ± 1.2 g (95% CI: 3.8, 5.0) and 4.4 ± 0.6 g (95% CI: 4.1, 4.7), respectively, in the young age-group.

The mean age of the group of 20 elderly subjects was 71.1 ± 4.1 years (95% CI: 69.1, 73.0), and it included 15 males and 5 females (Table 1). The mean MMSE score of the group was 28.8 ± 2.0 points (95% CI: 28.1, 29.4), and all 20 subjects were found to be right-dominant. The mean gripping force was 29.1 ± 7.8 kg (95% CI: 25.4, 32.7) and 28.4 ± 8.2 kg (95% CI: 24.5, 32.2) for the dominant and the non-dominant hand, respectively. The mean AGF was 8.9 ± 4.0 g (95% CI: 7.0, 10.7) and 7.6 ± 2.8 g (95% CI: 6.3, 8.9) for the dominant and the non-dominant hand, respectively, in the elderly group.

An analysis of AGF between the two groups through a t-test indicated that it was significantly lower in the elderly group than in the young group for both the dominant and non-dominant hands ($p < 0.01$ for both, Cohen's $d = 1.52$, Cohen's $d = 1.58$, respectively) (Table 1). No significant difference in gripping force was observed between the two groups for both dominant and non-dominant hands ($p = 0.35$ and $p = 0.17$, respectively). The number of female subjects was significantly larger in the young group, and that of male subjects was significantly larger in the elderly group ($p = 0.03$). No significant difference in the number of right and left-dominant was observed between the two groups ($p = 0.31$).

The two groups were matched for sex, the dominant hand, and the gripping force of the subjects, in order to control these factors (Table 2). Following matching, the number of subjects in in each of the two groups was 6 with a sex-distribution of 2 males and 4 females in each group. A t-test conducted after controlling the disparate factors (sex, handedness, gripping force), showed that there was a significant difference in AGF between the young and the elderly groups for both the dominant ($p = 0.03$, Cohen's $p = 1.61$) and the non-dominant ($p = 0.02$, Cohen's $p = 2.04$) hands, indicating that the AGF of the elderly subjects was significantly lower than that of the young subjects.

4. Discussion

Since there have been no AGF-assessment methods described in existing literature, it was unclear whether elderly individuals had a higher or lower AGF as compared to that of young people. However, this study showed that elderly people have lower AGF than young people, even after performing adjustment for sex, handedness and gripping force of the test-subjects. It has been reported that since innervation ratio increases with

Table 1. A comparison of adjustability of grasping force between the young and the elderly study-groups.

		Young group n = 20	Elderly group n = 20	*p*	Cohen's *d*
Age (year)		21.0 ± 0.7	71.1 ± 4.1		
Gender (no. of people)	Male	4	15	0.03	
	Female	16	5		
MMSE (score)			28.8 ± 2.0		
Dominant hand (no. of people)	Right	19	20	0.31	
	Left	1	0		
Gripping force (kg)	Dominant hand	26.9 ± 6.4	29.1 ± 7.8	0.35	0.31
	Non-dominant hand	24.9 ± 7.1	28.4 ± 8.2	0.17	0.46
AGF (g)	Dominant hand	4.4 ± 1.2	8.9 ± 4.0	< 0.01	1.52
	Non-dominant hand	4.4 ± 0.6	7.6 ± 2.8	< 0.01	1.58

AGF: adjustability of grasping force; MMSE: Mini-Mental State Examination.
MMSE was measured for elderly subjects only. Chi-square tests were performed to assess the differences between the two groups with respect to the sex and the dominant hand of the subjects. To comparatively evaluate gripping force and AGF, t-tests for independent samples were performed. AGF indicates the absolute value of error of the actual grasping force from the target grasping force. Therefore, when AGF is high, the measurement value is small.

Table 2. A comparison of adjustability of grasping force between the young and the elderly groups after performing adjustment for factors including sex, handedness and gripping force of the subjects.

		Young group n = 6	Elderly group n = 6	*p*	Cohen's *d*
Age (years)		21.2 ± 1.0	70.5 ± 3.9		
Gender (no. of people)	Male	2	2	1.00	
	Female	4	4		
MMSE (score)			29.0 ± 2.2		
Dominant hand (no. of people)	Right	6	6	1.00	
	Left	0	0		
Gripping force (kg)	Dominant hand	24.8 ± 7.4	24.6 ± 7.7	0.97	0.03
	Non-dominant hand	22.9 ± 9.5	21.9 ± 7.5	0.84	0.12
AGF (g)	Dominant hand	4.9 ± 2.0	12.2 ± 6.1	0.03	1.61
	Non-dominant hand	4.5 ± 0.8	9.4 ± 3.3	0.02	2.04

AGF: adjustability of grasping force; MMSE: Mini-Mental State Examination

age, elderly people tend to find it difficult to perform precise movements that require a subtle adjustment of force [22, 23], and the impairment was considered to be related to a decrease in AGF in this population. Additionally, a report has also suggested that the in elderly individuals, the capability of adjusting force while holding an object reduces, because the sensitivity of sensory receptors including those responsible for tactile sensibility and mechanoreception, declines with age [24]. The Japanese Association of Occupational Therapists [25] has reported that about 30% of elderly people, who have no specific diseases and are living in the community, find it difficult to perform certain everyday tasks, indicating a difficulty in conducting their ADL. The Association develops occupational therapeutic interventions with a focus on ADL, and the effects of such interventions have been published [26]. This study demonstrated that local elderly residents who can apply the same level of gripping force as that exerted by young people demonstrate a lower AGF than young people. Since AGF is the capability of adjusting the force exerted while holding any object (depending on its shape, weight and material), it can be considered that individuals with reduced AGF may face difficulties in performing actions in their everyday lives, such as dropping a grasped object or accidentally crushing an object in the hand. Therefore, this study suggested that it is necessary to assess the AGF of elderly people separately from gripping force and have an understanding of to what degree their AGF has been reduced from an early stage, in order to alleviate difficulties which local elderly residents face in their everyday lives.

The elderly population is expanding at a global level, and it is particularly expected to rapidly increase in Japan [27]. Consequently, Japan is also expected to start facing difficulties related to the care of this age-group relatively earlier than other countries, and the manner in which, the country would address such issues is currently of interest to the international community. The World Federation of Occupational Therapists [28] has expanded its scope for occupational therapy to be extended not only to those with health problems but also to any individuals, who are occupationally involved, indicating that those who do not have health issues can also benefit from the therapy. Preventive interventions have been provided through occupational therapy, based on knowledge related to the reduced capabilities of elderly people as compared to those of young people [29–31]. This study elucidated that elderly individuals have significantly reduced AGF as compared to young people, suggesting that it is necessary to provide interventions for this reduced capability from a preventive perspective.

This study, after making adjustments for factors including sex, handedness and gripping force of the subjects, was able to determine that the AGF of elderly people was lower than that of young people. However, the number of pairs assumed in advance was not created as a result of matching. Therefore, we calculated the actual power from the effect size of AGF value on the two groups following matching, using software G*Power at a setting of $\alpha = 0.05$ and sample size of 6. The results indicated that the power of our comparison for both dominant hand and non-dominant hand was sufficient (power = 0.71, power = 0.89, respectively), as the effect size after matching was higher than before matching. In addition, the impact of reduced AGF on ADL has not been elucidated till date, indicating the necessity of further research on this aspect. Moreover, while this study indicated that AGF may reduce with aging, it did not clarify what kind of factors may have been responsible for the reduction. In particular, AGF may be affected by hand size and sensory function. Therefore, in the future, in order to provide effective interventions for reduced AGF, it is necessary to elucidate these factors that influence AGF. Also, further investigations of AGF, not only of elderly individuals able to live in the community, but also of weaker elderly people and those facing difficulties in their everyday lives are required, in order to accumulate knowledge that will be useful in developing effective intervention programs for this vulnerable age-group.

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References

[1] Neumann DA. Kinesiology of the musculoskeletal system: Foundations for rehabilitation. 2nd edition. St. Louis: Elsevier; 2010.

[2] Tiffin J. Purdue Pegboard Examiner Manual. Rev ed. Chicago: Science Research Associates, 1968.

[3] Chen HM, Chang JJ. The skill components of a therapeutic chopsticks task and their relationship with hand function tests. Kaohsiung J Med Sci. 1999; 15(12): 704–9.

[4] Casanova JE, Casanova JS, Young MJ. Hand function in patients with diabetes mellitus. South Med J. 1991; 84(9): 1111–3.

[5] Jebsen RH. An objective and standardized test of hand function. Arch Phys Med Rehabil. 1969; 50(6): 311–9.

[6] Bell E, Jurek K, Wilson T. Hand skill measurement: a gauge for treatment. Am J Occup Ther. 1976; 30(2): 80–6.

[7] Morita Y, Ukai H, Sato N, Yamazaki K, Kitayama K, Nakajima S, et al. Japanese Unexamined Patent Application Publication No. 2014–57636, 2012.

[8] Morita Y, Ukai, H, Hamasaka J, Yamazaki K, Komori K. Japanese Unexamined Patent Application Publication No. 2012–24394, 2010.

[9] Morita Y, Nakajima S, Sato N, Yasaki K. Quantitative evaluation system of adjustability for grasping force (in Japanese). Jap J Soc Welf. 2016; 18(2): 5–10.

[10] Kaneno T, Sato A, Yasaki K, Morita Y, Shibagaki H, Akizuki K. The error range of the assessment method of grip force adjustment ability (in Japanese). Rigakuryoho Kagaku, 2017; 32(1): 117–21.

[11] Kaneno T, Sato A, Akizuki K, Yamaguchi A, Yasaki K, Morita Y. Assessing the adjustability of grasping force using the iWakka in elderly individuals. J Phys Ther Sci. 2017; 29(12): 2215–19.

[12] Ministry of Education, Culture, Sports, Science and Technology of Japan [online]. Tokyo: Physical fitness and exercise capacity survey (in Japanese) [cited 2019 April 5]. Available from: https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00402102&tstat=000001088875&cycle=0&tclass1=000001119456&cycle_facet=cycle&second2=1

[13] Michimata A, Kondo T, Suzukamo Y, Chiba M, Izumi S. The manual function test: norms for 20-to 90- year-olds and effects of age, gender, and hand dominance on dexterity. Tohoku J Exp Med. 2008; 214(3): 257–67.

[14] Henry JD, MacLeod MS, Phillips LH, Crawford JR: A meta-analytic review of prospective memory and aging. Psychol Aging. 2004; 19(1): 27–39.

[15] Pichora-Fuller MK, Schneider BA, Daneman M. How young and old adults listen to and remember speech in noise. J Acoust Soc Am. 1995; 97(1): 593−608.

[16] Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007; 39(2): 175−91.

[17] Kaneno T, Sato A, Akizuki K, Kiguchi N, Yabuki J, Yamaguchi A, *et al*. The impact of the hand and finger position on grasping force adjustment capabilities (in Japanese). Rehabilitation Engineering. 2018; 33(4): 147−53.

[18] Edo A, Murata I, Horie J, Otao H, Murata J, Miyazaki J, *et al*. The significance of assessing finger motor function in community dwelling elderly people-comparison between old female and old male (in Japanese). Jpn J Health Prom Phys Therapy. 2012; 2(2): 47−52.

[19] Aguiar LT, Martins JC, Lara EM, Albuquerque JA, Teixeira-Salmela LF, Faria CD. Dynamometry for the measurement of grip, pinch, and trunk muscles strength in subjects with subacute stroke: reliability and different number of trials. Braz J Phys Ther. 2016; 20(5): 395−404.

[20] Oldfield RC. The assessment and analysis of handedness: the Edinburgh inventory. Neuropsychologia. 1971; 9(1): 97−113.

[21] Sakano N. Latent left-handedness: its relation to hemispheric and psychological functions. Jena: VEB Gustav Fischer Verlag, 1982.

[22] Keogh J, Morrison S, Barrett R. Age-related differences in inter-digit coupling during finger pinching. Eur J Appl Physiol. 2006; 97(1): 76−88.

[23] Patten C, Kamen G. Adaptations in motor unit discharge activity with force control training in young and older human adults. Eur J Appl Physiol. 2000; 83(2−3): 128−43.

[24] Cole KJ. Grasp force control in older adults. J Mot Behav. 1991; 23(4): 251−8.

[25] The Japanese Association of Occupational Therapists [online]. Tokyo: FY2012 Projects for Senior Health Facilitation and Others [cited 2018 January 21]. Available from: http://www.jaot.or.jp/wp-content/uploads/2012/10/H24seikatukoui-digest.pdf.

[26] Iokawa K, Hasegawa K, Ishikawa T. Possible Effectiveness of Collaboration between Occupational Therapists and Care Managers using the Management Tool for Daily Life Performance for Stroke Patients in Transitional Care. Asian Journal of Occupational Therapy. 2017; 13(1): 79−86.

[27] United nations [online]. New York: World Population Prospects [cited 2017 February 15]. Available from: https://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf.

[28] World Federation of Occupational Therapists [on line]. Geneva: Statement on occupational therapy [cited 2017 June 4]. Available from: http://www.wfot. org/Portals/0/PDF/STATEMENT%20ON%20OCCUPATIONAL%20THERAPY%20300811.pdf.

[29] Steultjens EM, Dekker J, Bouter LM, Jellema S, Bakker EB, van den Ende CH. Occupational therapy for community dwelling elderly people: a systematic review. Age Ageing 2004; 33(5): 453−60.

[30] Arbesman M, Mosley LJ. Systematic review of occupation- and activity-based health management and maintenance interventions for community-dwelling older adults. Am J Occup Ther. 2012; 66(3): 277−83.

[31] Clark F, Azen SP, Zemke R, Jackson J, Carlson M, Mandel D, *et al*. Occupational therapy for independent-living older adults. A randomized controlled trial. JAMA. 1997; 278(16): 22−9.

ORIGINAL ARTICLE

Hand and Finger Functions and Characteristics of Line Drawing Movement in Preschool Children with Autism Spectrum Disorder: Preliminary Study

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Abstract: It is well known that children with autism spectrum disorder show handwriting difficulty. Although it is considered that not only cognitive but also motor impairments affect the difficulty, remarkably little is known about the motor characteristics of handwriting in autistic children. Therefore, the purpose of this study is to investigate: 1) peculiarities of hand and finger functions; and 2) characteristics of handwriting movement in preschool children with ASD during the chrysalis stage of handwriting. Participants were children with ASD and age- and partially IQ-matched controls. We conducted assessment of muscle strength, motor coordination, separate finger movement, dexterity, grasp posture and line drawing movement. We compared data between ASD and control groups. Significant differences were observed in repetitive hand tapping, pronation and supination, sequential finger tapping, finger lifting and pegboard. Considering components of handwriting, there seems to be no prominent difference between the two groups in grasp posture, although ASD showed poorer motor coordination on the drawing line task compared to that of controls. The present results also showed atypical characteristics of hand and finger motor functions and line drawing movement in ASD. These findings provide further insight into the motor aspects of handwriting and suggest investigating correlation between hand and finger functions, especially separate finger movement and manual dexterity and motor aspect of handwriting may be important to clarify effective bottom up training for acquisition of handwriting skills.

Keywords: handwriting, developmental disorders, tool use, motor coordination

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Introduction

The Diagnostic and Statistical Manual of Mental Disorders 5th edition (DSM-5) characterizes autism spectrum disorder (ASD) by deficits in social communication and social interaction as well as restricted, repetitive patterns of behavior, interests or activities [1]. In addition to the main peculiarities, it is well known that persons with ASD demonstrate various motor impairments, such as impaired gross motor function, motor coordination and manual dexterity [2−6]. These impairments are also referenced in DSM-5 [1]. Those difficulties have a large impact on activities of daily living as well as social activities in persons with ASD.

There is literature on handwriting difficulty in children with ASD. Several studies have demonstrated handwriting impairments in ASD using a standard assessment battery of handwriting [7−13]. A previous study suggested that more than 65% of persons with ASD have handwriting difficulties [8]. Handwriting is a highly important skill for schoolchildren to achieve academic progress, acquire language and build self-esteem.

Fuentes *et al.* suggested that general motor skills could predict handwriting impairments in children with ASD [10]. However, they used the score for gross motor functions to represent motor skills, therefore, it remains unclear how hand and finger movements affect their

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handwriting skill.

Writing is a complex behavior involving motor control, visual perception, language, memory and other functions. Considering its motor aspects, it is a complex tool use activity and adequate hand and finger motor development is essential for skillful writing. Hand and finger function is required for appropriate pen grip and fine adjustments while drawing and writing [14]. There are a few studies demonstrating relevance between hand and finger function and handwriting in normal, healthy children. Schneck showed correlation between pencil grip pattern and writing skill [15] and Berninger and Rutberg found that finger functions (e.g., finger tapping, finger lifting and finger cognition) correlated with writing skills in early elementary school children [16]. Finger lifting is a test for separate finger movement and it is necessary for approximate posture of pen grip and fine control of a pen point [14, 17, 18]. In clinical settings, children with ASD who had lower performance on separate finger movement test showed difficulty in manipulating a writing utensil [19].

As described above, even though hand and finger function is known to be important for handwriting, little is known about these functions in ASD. Dufield *et al.* reported ASD showed lower performance on functional tests such as grip power, tapping and pegboard, but subjects in their study showed a wide age range from 5 to 33 years old [20]. Thus, there is no information about these functions in preschool children who are acquiring handwriting skill. Clarifying the development of hand and finger functions and its relation to handwriting in ASD is expected to contribute to the establishment of efficient interventions to address these difficulties.

Therefore, the purpose of this study is to investigate: 1) peculiarities of hand and finger functions; and 2) characteristics of handwriting movement in preschool children with ASD during the chrysalis stage of handwriting. As a preliminary study, we conducted several tests and tasks for this research; tests of muscle strength, motor coordination, separate finger movement and dexterity and assessment of grasp posture and line drawing task. Line drawing task was selected to focus on motor aspects of writing, while minimizing the influence of cognitive aspects as much as possible.

Methods

Participants

This study examined 17 children with and without ASD. Subjects were eight children diagnosed with ASD aged 4−6 (yrs.) and nine age- and nonverbal IQ-matched children demonstrating typical developmental milestones as controls. A summary of subjects is shown in Table 1. Children in control group were recruited with leaflet in community around the research institute where this study was conducted. Regarding ASD group, there was child and adolescent psychiatrist among cooperative researchers and children with ASD were recruited from her patients. Children with ASD were diagnosed with autism spectrum disorder following DSM-5 criteria or diagnosed Pervasive Developmental Disorder and Asperger’s Syndrome following DSM-4 revised criteria. In addition, all subjects were evaluated by the Japanese version of the Social Responsiveness Scale (SRS) [21]. SRS is a standardized battery for assessment autistic traits for individuals aged 4 to 18 years. It consists of 65-items questionnaire categorized into five subscales; social awareness, social cognition, social communication, social motivation and autistic mannerism. T-score calculated by raw score and standard deviation is applied to assess autistic trend. The score above 76 is considered as “ASD-possible”, from 60 to 75 as “ASD-probably” and bellow 59 as “ASD-unlikely”. Diagnoses were confirmed in all ASD children by scores above the cut-off value and all control children were confirmed as not having ASD by scores below the cutoff value on SRS (Table 1). All subjects had a full-scale IQ (FIQ) greater than 75 and Perceptual Reasoning Indices (PRI) greater than 80 on the *Wechsler Intelligence Scale for Children, 4th edition* (WISC-IV) [22]. There are significant differences in FIQ and primary index scores except for PRI between two groups. PRI was considered the primary intelligence measure for our study since we employed a nonverbal, motor-based task. None of the subjects was receiving any medication. None of the controls had any history of neurological or psychiatric disorders. All

Table 1. Summary of subjects.

	number	age (yrs.)	SRS T score (range)	full IQ	VCI	PRI	WMI	PSI
ASD	8 (M:F = 6:2)	5.6	70.8 (61−105)	82.4	82.1	92.4	76.3	91.3
controls	9 (M:F = 4:5)	5.6	41.9 (40−51)	104.8	104.0	103.5	96.6	108.0

Subject backgrounds are shown in the table. All data from “age” to “PSI” are presented as the average of the group. Range of SRS T score is presented in brackets. Items of “Full IQ” to “PSI” are the results of intelligence quota assessments on WISC-IV. “VCI”, “PRI”, “WMI” and “PSI” indicating Verbal Comprehension Index, Perceptual Reasoning Index, Working Memory Index and Processing Speed Index, respectively.

subjects had normal or corrected-to-normal vision and no one had any detectable sensory abnormality of the hands or fingers. Each subject could understand the task instructions and was able to continuously concentrate their attention on the task for at least 30 minutes while maintaining an appropriate posture. All participants were right handed according to the results of Edinburgh Handedness Inventory [23] as well as an interview with their parents about activities of daily living.

Prior to the study, written informed consent was obtained from the parents of each child in a manner approved by the ethical committee of the National Rehabilitation Center for Persons with Disabilities in accordance with the Declaration of Helsinki.

Materials and Procedure: Assessments for hand and finger functions

Assessments for hand and finger motor functions, muscle strength (grip and lateral pinch), motor coordination (hand tapping, pronation and supination, finger tapping and sequential finger tapping), separate finger movement and fine motor skills (Perdue pegboard), were conducted. All assessments were basically conducted for both hands. We applied some parts of Zurich Neuromotor Assessment: ZNA which is standardized assessment of duration and degree of motor functions [24] for assessment of motor coordination. "Hand tapping" requires movement of tapping knee with one hand repeatedly and "finger tapping" requires movement of tapping with thumb and index finger. Participant is asked to repeat the movement 20 times and the duration is measured. "pronation and supination" is task of pronation and supination with forearm repeatedly. Ten sets of movements (pronation and supination are one set) is required and the duration is measured. In the task of "sequential finger tapping", participant is required to tapping with their fingers; thumb and the other fingers. The tapping is done in order of thumb-index finger, thumb-middle finger, thumb-ring finger and thumb-little finger. Three sets of order are required and the duration is measured [24]. For separate finger movement, we applied a modified version of the test developed by Wolff *et al.* [17]. Subjects were asked to put their hands palms-down on the table and lift the finger touched by the experimenter in random sequence. They were asked to immediately lift the touched finger only. We evaluated voluntary control of separate finger movements by counting how many other fingers lifted when the child tried to lift the touched finger only.

Materials and Procedure: Components of handwriting

We measured pen grasping posture and line drawing movement as components of handwriting.

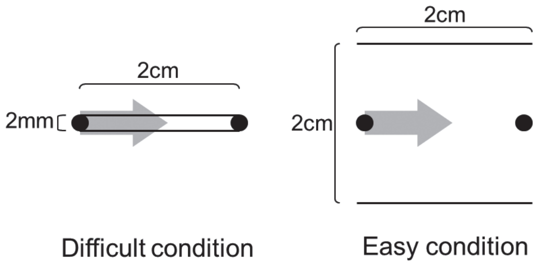

Fig. 1. Line drawing task.
Two conditions of line drawing task. Participants drew a line from dot to dot.

Pen grasping posture was evaluated using a five-part score (score of 1 indicating the lowest and 5 the highest) on *Pencil-Grip Assessment* by Schneck and Henderson [25].

Subjects were asked to draw a 2 cm straight line using a pen-type writing pressure gauge (DP-1000 USB version; Japan System Development Co., Ltd) to measure motor elements. We recorded pen pressure as power control and trajectory of line as motor coordination. Subjects were asked to draw a line from dot to dot within the limited space. They moved the pen point forward at their own speed without touching either of the parallel lines (Fig. 1). We referred to standard assessment battery; *Developmental Test of Visual Perception* (DTVP), subtests 1, visuomotor coordination to fix the task setting [26]. The line drawing task consisted of two conditions ranked by difficulty in order to investigate whether their movement is affected by a difference in the visual information provided during the task. Two parallel lines were presented in order to designate the limits of the drawing space and subjects were asked to draw a line between the parallel lines. The parallel lines were 2cm apart in the easy condition and 2mm apart in the difficult condition. Two dots were presented as the starting and ending points of drawing line. Before the trials, subjects practiced a few times to confirm their understanding of the instructions. The task was limited to 12 trials in order to avoid tiring the subjects. Six trials were in the easy condition, while the other six were in the difficult condition. Each child held the pen with their dominant hand in their own grasp posture.

Statistical analysis

We conducted statistical analyses of all test results to compare ASD to controls. All data were analyzed using R (version 3.1.0.). Because there were few subjects, we applied Wilcoxon rank sum test as a nonparametric test.

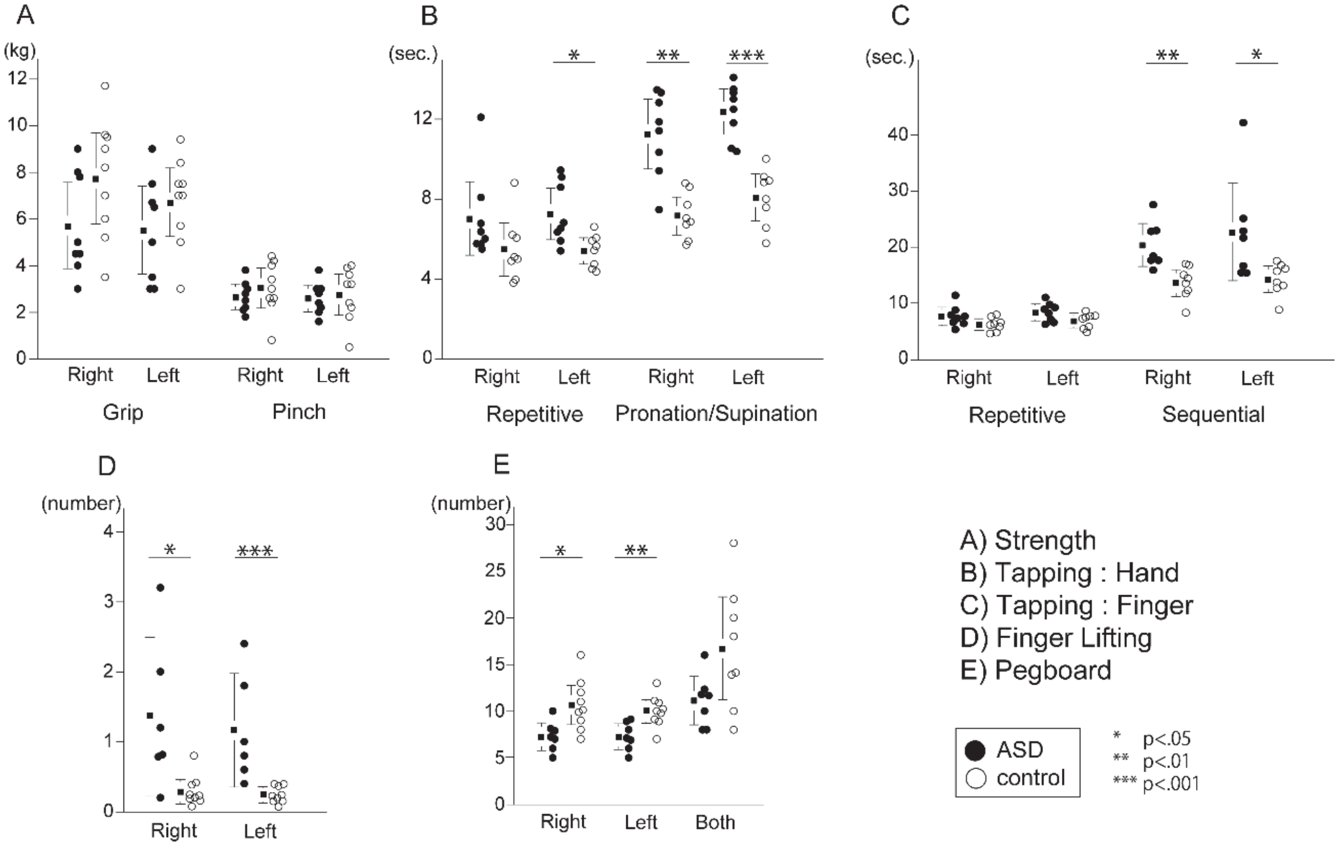

Fig. 2. Results of assessments for hand and finger functions.
A−E: Assessment results for Strength, Tapping, Finger Lifting, Pegboard are shown in Figures A to E. The score of each participant was plotted in the figure. Bar and square besides each plots indicates range of 2 standard deviation and median, respectively.

Results

Although all subjects in both groups completed the tests and task, data on finger lifting, pegboard, pen force and deviation from one or two subjects in the ASD group were considered unreliable because they appeared to respond facetiously. Therefore, those data were excluded from analysis. Ultimately data from six participants for finger lifting, pen force and deviation and data from seven participants for pegboard in ASD were statistically analyzed. Results of assessments for hand and finger functions and components of handwriting were shown in Figs. 2, 3.

Assessments for hand and finger functions

We compared data of hand and finger functions between ASD and control groups (Fig. 2). Measured value of muscle strength, time durations of motor coordination test, score of separate finger movement and fine motor skills were applied. Significant differences were observed in repetitive hand tapping on the left side ($p = 0.02$), pronation and supination on the right and left sides ($p = 0.001$, $p < 0.001$ respectively), sequential finger tapping on the right and left sides ($p = 0.001$, $p = 0.04$ respectively), finger lifting on the right and left sides ($p = 0.01$, $p < 0.001$ respectively), and pegboard on the right and left sides (single hand use) ($p = 0.01$, $p < 0.01$ respectively).

Components of handwriting

Considering grasp posture, that of all participants in both groups were scored at the level 4 or 5. There were four grasp types observed; Four-finger grasp and Cross thumb grasp as in level 4 and Lateral tripod grasp and Dynamic tripod grasp as in level 5 (Fig. 3). There were no prominent differences between the two groups.

For the line drawing task, we evaluated deviation of the line trajectory to evaluate motor coordination based on differences between the length of the actual drawn line and a straight 2 cm line connecting the two dots. There was significant difference in deviation in the difficult condition ($p = 0.01$) (Fig. 3). Thus, deviation demonstrated the degree of motor coordination. ASD group showed poorer motor coordination than controls.

Furthermore, two participants in ASD whose results of deviation were superior to the others got better results

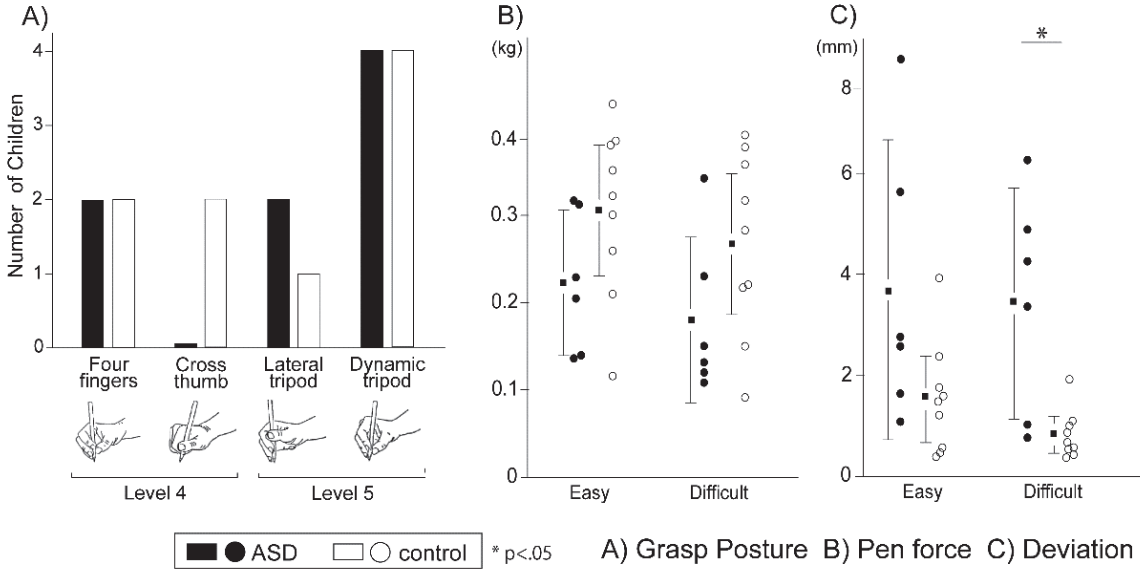

Fig. 3. Results in components of handwriting.
A−C: Results of evaluation for Grasp Posture are shown in figure A. Grasp posture identified in the figure is based on *Pencil-Grip Assessment* by Schneck and Henderson [24], which shows 10 postures at 5 levels. Average scores for each participant for Pen force and Deviation on drawing line were calculated and are shown on figures B and C. Bar and square besides each plots indicates range of 2 standard deviation and median, respectively.

in finger lifting and pegboard among ASD group.

Discussion

We investigated: 1) hand and finger motor functions; and 2) components of handwriting in ASD. Persons with ASD show motor impairments in some areas. In this study, we demonstrated atypical motor characteristics in ASD that have not been reported previously.

Hand and finger functions

ASD showed significantly lower performance on both sides for pronation and supination, sequential finger tapping, finger lifting and pegboard (single hand use). Our results were consistent with those of previous studies demonstrating impairments in manual dexterity [4, 20, 27]. Duffield *et al.* reported that ASD showed significantly lower performance on finger tapping and pegboard test, but not on grip strength [20]. For grip strength and pegboard, our results were consistent with their research. Simple finger tapping did not show a significant difference between groups in our study, although there was a difference in their study. The smaller number of subjects in our study may have affected the result. Previous structural or functional neuroimaging studies also support our findings in terms of atypical neural patterns in ASD [20, 28, 29]. The lower performance on sequential finger tapping and finger lifting test in ASD indicates a developmental delay in separate finger movement. Previously, Virginia and Berninger reported a correlation between handwriting and both sequential finger tapping and finger lifting in normal children [16]. Investigating correlation between separate finger movement and handwriting skill in ASD is required.

Components of Handwriting

Certain characteristics of line drawing were observed in ASD. Slightly less pen force was observed in ASD, although the difference did not reach significance. Deviation was significantly larger for ASD than controls in the difficult condition. Heuvel *et al.* previously reported that in normal adults, pen force increased for large targets and decreased for small targets [30], that is, pen force decreased under more difficult conditions. Our results for both controls and ASD were consistent with those findings. Since there was no difference in hand or finger strength between groups, the lower pen force in ASD may indicate that appropriate power control is difficult for ASD. Larger deviation in ASD suggests impaired sensorimotor coordination, especially visuomotor coordination. Glazebrook *et al.* and Rinehart *et al.* reported that ASD exhibited more spatial variability during reaching tasks [31−33]. Papadopoulos *et al.* showed more widely variable errors in ASD during a reciprocal reaching task [34]. It may be beneficial that influence of impaired motor coordination on handwriting in ASD.

There seems to be no difference in grasp posture between groups. Considering previous literature [15, 16], handwriting difficulty in ASD may be caused by motor impairment rather than grasp posture.

Although we could not analyze correlation between hand and finger functions and handwriting components in this study, in ASD group, two children who scored better in deviation performed better in finger lifting and pegboard. The result may suggest that separate finger movement and manual dexterity are factors of skill of drawing line regarded as motor aspects of handwriting.

Limitations and Recommendations for Further Research

There are methodological limitations of our study. In the study, eight autistic children and nine control children participated. Limited number of participants might have influenced the findings. Gender and IQ differences except for PRI might be another factor. In addition, participants were asked to perform a limited number of trials for each condition in order to avoid their loss of interest in doing the same task repeatedly. Recruiting more autistic and control participants whose IQ are totally equal and analyzing the correlation between hand and finger functions and characteristics of drawing line should be considered in future studies.

Summary and Conclusions

The present results showed atypical characteristics of hand and finger motor functions and line drawing in ASD. These findings provide further insight into the motor aspects of handwriting in ASD. Investigating correlation between hand and finger functions, especially separate finger movement and manual dexterity and motor aspect of handwriting may be suggested to clarify effective bottom up training for acquisition of handwriting skills.

Conflict of Interest

The authors affirm that there were no conflicts of interest related to this study.

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References

[1] Diagnostic and Statistical Manual of Mental Disorders. 5th ed. American Psychiatric Association, 2013.

[2] Manjiviona J, Prior M. Comparison of Asperger syndrome and high-functioning autistic children on a test of motor impairment. J Autism Dev Disord. 1995; 25: 23−39.

[3] Leary MR, Hill D. Moving on: autism and movement disturbance. Ment Retard. 1996; 34: 39−53.

[4] Green D, Baird G, Barnett AL, Henderson L, Huber J, Henderson SE. The severity and nature of motor impairment in Asperger's syndrome: a comparison with Specific Developmental Disorder of Motor Function. J Child Psychol Psychiatry. 2002; 43: 655−68.

[5] Ming X, Brimacombe M, Wagner GC. Prevalence of motor impairment in autism spectrum disorders. Brain Dev. 2007; 29: 565−70.

[6] Staples KL, Reid G. Fundamental movement skills and autism spectrum disorders. J Autism Dev Disord. 2010; 40: 209−17.

[7] Beversdorf D, Anderson J. Brief report: macrographia in high-functioning adults with autism spectrum disorder. J Autism Dev Disord. 2001; 31: 97−101.

[8] Mayes SD, Calhoun SL. Frequency of reading, math, and writing disabilities in children with clinical disorders. Learn Individ Differ. 2006; 16: 145–57.

[9] Cartmill L, Rodger S, Ziviani J. Handwriting of Eight-Year-Old Children with Autistic Spectrum Disorder: An Exploration. J Occup Ther Sch Early Interv. 2009; 2: 103−18.

[10] Fuentes CT, Mostofsky SH, Bastian AJ. Children with autism show specific handwriting impairments. Neurology. 2009; 73: 1532−7.

[11] Fuentes CT, Mostofsky SH, Bastian AJ. Perceptual reasoning predicts handwriting impairments in adolescents with autism. Neurology. 2010; 75: 1825−9.

[12] Kushki A, Chau T, Anagnostou E. Handwriting difficulties in children with autism spectrum disorders: a scoping review. J Autism Dev Disord. 2011; 41: 1706−16.

[13] Hellinckx T, Roeyers H, Van WH. Predictors of handwriting in children with Autism Spectrum Disorder. Res Autism Spectr Disord. 2013; 7: 176−86.

[14] Henderson A, Pehoski C. Hand Function in the Child: Foundations for Remediation. 2nd ed. Science Direct, 2006.

[15] Schneck C. Comparison of pencil-grip patterns in first graders with good and poor writing skills. Am J Occup Ther. 1991; 45: 701−6.

[16] Virginia W. Berninger JR. Relationship of finger function to beginning writing: application to diagnosis of writing disabilities. Dev Med Child Neurol. 1992; 34: 198−215.

[17] Wolff PH, Gunnoe CE, Cohen C. Associated movements as a measure of developmental age. Dev Med Child Neurol. 1983; 25: 417−29.

[18] Largo RH, Caflisch JA, Hug F, Muggli K, Molnar AA, Molinari L. Neuromotor development from 5 to 18 years. Part 2: associated movements. Dev Med Child Neurol. 2001; 43: 444−53.

[19] Yamaguchi K., Fukatsu R. Handwriting intervention for preschool children with developmental disorders (in Japanese). Japanese Occupational Therapy Research

(sagyouryouhou). 2016; 35(4): 426−35.

[20] Duffield TC, Trontel HG, Bigler ED, Froehlich A, Prigge MB, Travers B, *et al.* Neuropsychological investigation of motor impairments in autism. J Clin Exp Neuropsychol. 2013; 35: 867−81.

[21] Kamio Y, Inada N, Moriwaki A, Kuroda M, Koyama T, Tsujii H, *et al.* Quantitative autistic traits ascertained in a national survey of 22,529 Japanese school children. Acta Psychiatr Scand. 2013; 128: 45−53.

[22] Wechsler D. Antonil S, ed. Wechsler Intelligence Scale for Children. Fourth Edition. NCS Pearson, Inc, 2013.

[23] Oldfield RC. The assessment and analysis of handedness: the Edinburgh Inventory. Neuropsychologia. 1971; 9: 97−113.

[24] Largo RH, Caflisch JA, Hug F, Muggli K, Molnar AA, Molinari L, *et al.* Neuromotor development from 5 to 18 years. Part 1: timed performance. Dev Med Child Neurol. 2001; 43: 436−43.

[25] Schneck CM, Henderson A. Descriptive Analysis of the Developmental Position for Pencil and crayon control in nondysfunctional children. Am J Occup Ther. 1990; 44: 893−900.

[26] Frostig M. Developmental Test of Visual Perception. Consulting Psychologists Press, Inc, 1977.

[27] Hardan AY, Kilpatrick M, Keshavan MS, Minshew NJ. Motor performance and anatomic magnetic resonance imaging (MRI) of the basal ganglia in autism. J Child Neurol. 2003; 18: 317−24.

[28] Müller RA, Pierce K, Ambrose JB, Allen G, Courchesne E. Atypical patterns of cerebral motor activation in autism: a functional magnetic resonance study. Biol Psychiatry. 2001; 49: 665−76.

[29] Mostofsky SH, Powell SK, Simmonds DJ, Goldberg MC, Caffo B, Pekar JJ. Decreased connectivity and cerebellar activity in autism during motor task performance. Brain. 2009; 132: 2413−25.

[30] Heuvel CEVD, Galen GPV, Teulings HL, Gemmert AWA. Axial pen force increases with processing demands in handwriting. Acta Psychol (Amst). 1998; 100: 145−59.

[31] Glazebrook C, Elliott D, Lyons J. A kinematic analysis of how young adults with and without autism plan and control goal-directed movements. Motor Control. 2006; 10: 244−64.

[32] Glazebrook CM, Elliott D, Szatmari P. How do individuals with autism plan their movements? J Autism Dev Disord. 2008; 38: 114–26.

[33] Rinehart NJ, Bellgrove MA, Tonge BJ, Brereton AV, Howells RD, Bradshaw JL. An examination of movement kinematics in young people with high-functioning autism and Asperger's disorder: further evidence for a motor planning deficit. J Autism Dev Disord. 2006; 36: 757−67.

[34] Papadopoulos N, McGinley J, Tonge BJ, Bradshaw JL, Saunders K, Rinehart NJ. An investigation of upper limb motor function in high functioning autism and Asperger's disorder using a repetitive Fitts' aiming task. Res Autism Spectr Disord. 2012; 6: 286−92.

ORIGINAL ARTICLE

Effects of Seat Cushion Material on Center of Pressure and Movement Trajectory during a Reaching Task

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Abstract: This study investigated the effects of seat cushion material during a reaching task. Ten healthy adults and three individuals with cerebral palsy participated. All subjects performed the reaching task on two urethane cushions and one silicone cushion. Anterior/posterior and medial/lateral displacement of the center of pressure and straight rate were assessed. In addition, the movement trajectory of the hand was recorded. No differences among seat cushions were observed in healthy adults. However, all of individuals with cerebral palsy were able to perform the task more efficiency while seated on the silicone cushion than the others. These findings suggest that seat cushion design may improve movement in individuals with cerebral palsy who have postural control disabilities.

Keywords: cerebral palsy, reaching task, center of pressure

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I. Introduction

Individuals with cerebral palsy (CP) usually experience disabilities in postural control, such as direction-specific patterns of adjustments and center of mass stability [1]. Therefore, many such individuals require support to maintain balance while sitting and are limited in the performance of upper-limb tasks that move the center of gravity. Individuals with postural issues require extrinsic support to perform activities of daily living with unobstructed voluntary movement. Seat cushion adjustment in wheelchairs is one approach for providing postural support. Previous studies show that seat surface inclination can affect sitting posture and upper-extremity function in children with CP. A more vertical trunk position is associated with more efficient performance [2–4], and the use of an anterior inclined seat is related to initial head position [5]. However, such an anterior inclination could cause forward slippage or burden the lower limbs if used during activities of daily living. The use of seat cushions may help avoid the risks of seat surface inclination. Many seat cushions have been developed to disperse pressure for individuals with CP. However, soft seat cushions and materials that avoid high pressure have some problems concerning instability during movements [6]. As individuals with severe motor disability spend much of their life sitting, it is necessary to investigate seat cushions appropriate for dynamic tasks. Therefore, we developed a seat cushion that aims to facilitate movement for individuals with CP and instability. The cushion specifically uses silicone material, which not only has flexibility but also viscoelasticity, providing mobility to the material of the seat cushion itself.

We previously measured the effect of this siliconee seat cushion in terms of the displacement of center of pressure (COP) during a dynamic task. The COP, which is calculated by the dispersion of pressure and an area added to the seat surface, is an index of body disturbance that is closely associated with body sway [7–9]. We observed no difference in COP displacement between seat cushions of different materials in healthy

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Table 1. Charateristics of cerebral palsy.

	Gender	Age	Heigth	Weigth	BMI	Arm Length	Type	GMFCS	Fine motor skill	Trunk tone
cp1	F	49	149.0	61.0	27.5	49.6	SQ	III	severe	Low
cp2	M	47	151.7	46.5	20.2	50.2	SQ	IV	severe	Low
cp3	F	41	162.0	55.0	21.0	55.0	SD + Ath	III	severe	Low

Note. M = male. F = female. SQ = spastic quadriplegia. SD = spastic diplegia. Ath = Athetosis
GMFCS = Gross Motor Function Classification System. (Palisono et al.,1997).
Fine motor skill: severe = The performance is slow and achieved with limited success regarding quality and quantity.
modulate = Handles most objects but somewhat reduced quality and speed of achivement.
mild = At most, limitations in the ease of perfmorming manual tasks requiring speed and accuracy.

adults; however, the silicone seat cushion was associated with decreased COP displacement in individuals with CP [10]. However, the effects of the silicone seat cushion on the timing of movement onset during a reaching task in individuals with CP were not thoroughly investigated. The onset of trunk motion related to movement stability occurs significantly earlier than the onset of peripheral motion related to manipulation during a dynamic task that requires trunk movement [11]. Thus, when evaluating stability, it is necessary to evaluate not only COP displacement but also the timing of movement onset in the peripheral limb and trunk to establish the efficiency of the new silicone seat cushion. Therefore, this study examined COP displacement and the timing of movement onset during a reaching task using three different cushions including a new design made with silicone materials and two others made with conventional urethane materials.

II. Methods

1) Subjects

The study group consisted of 10 healthy adults and three individuals with CP. The healthy adults (all males, mean age 22.9 ± 2.5 years, height 172.5 ± 5.0 cm, weight 64.5 ± 6.4 kg, body mass index [BMI] 21.7 ± 1.7 kg/m^2, and arm length 72.0 ± 2.4 cm) had no physiological impairments. Individuals with CP (1 male and 2 females, mean age 45.7 ± 4.2 years, height 154.2 ± 6.9 cm, weight 54.2 ± 7.3 kg, BMI 22.9 ± 4.0, arm length 51.6 ± 3.0 cm) were able to maintain an independent sitting position and follow oral instructions (Table 1). Two subjects with CP had level III disability, and one had level IV disability according to the Gross Motor Function Classification System (GMFCS) [12]. They had low muscle tone in the trunk, indicating the absence of postural stability. Two subjects had instability but a low magnitude of body sway and no involuntary movement in activities of daily living. The other subject had both instability and involuntary movement, and sometimes fell during walking. In addition, all of them had functions of reach for the objects during sitting, however limitations manipulating objects of varying quality and quantity. All subjects signed informed consent forms approved by the Ethics Committee of Sapporo Medical University. In addition, this study was performed in compliance with the Declaration of Helsinki and placed careful attention on protecting the privacy and human rights of the subjects. And the authors have no conflicts of interest directly relevant to the content of this article.

2) Instrumentation

During the reaching task, the pressure distribution at the body–seat interface was recorded at 10 Hz using a FSA mat (Vista Medical, Canada), which consists of 225 force sensors organized on a flexible mat in a 15 × 15 grid. The FSA mat was calibrated up to its maximum pressure of 520 mmHg. A web camera (BWC-130MS03A, Buffalo, Japan) was connected to the FSA.

Movements were recorded kinematically with a Locus 3D MA-3000 video monitoring system (Anima Corp, Japan) using a six-camera configuration at a sampling frequency of 100 Hz. Reflective markers were placed on the side of the body corresponding to the dominant hand on the following landmarks: (1) processus spinosus at C7, (2) processus spinosus at T10, (3) processus spinosus at L5, (4) right acromion, (5) left acromion, (6) olecranon of the dominant hand, and (7) styloid process of the ulna of the dominant hand (Fig. 1).

3) Reaching task

The distance between the popliteal fossae and front edge of the seat was adjusted to 5 cm. Subjects were seated on a stool with their hips and knees both bent at 90°, feet hanging free, and without back, leg rest, or arm support. Arm length was measured using a measuring tape from the acromion process to the tip of the third finger while the subject sat in a seated position with the upper limb extended in the horizontal plane and pointing in a forward direction. A small 1 × 1-cm yellow switch was used as a target and set at a distance of 120% of the arm length, level with shoulder height. The task used in

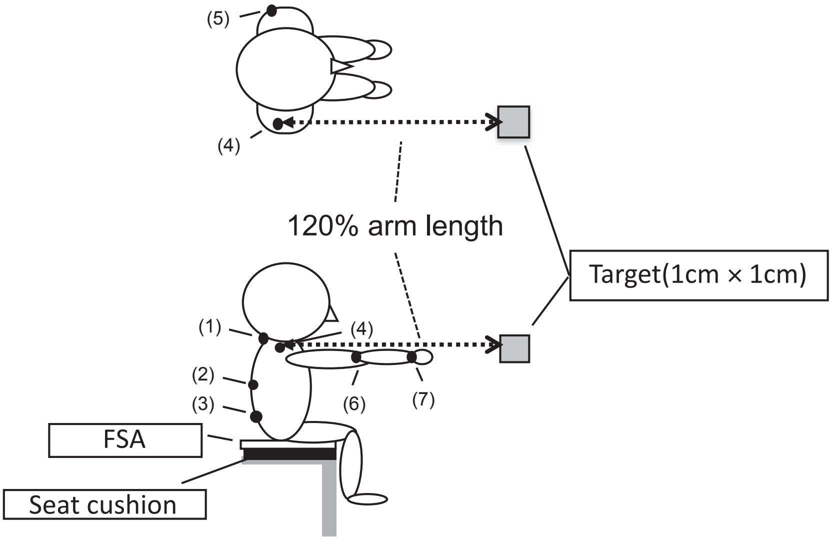

Fig. 1. Test condition.
Dots denote the postion of the ANIMA reflective markers used for kinematic recordings.
(1) processus spinosus at C7 (2) processus spinosus at T10 (3) processus spinosus at L5 (4) right acromion
(5) left acromion (6) olecranon of the dominant hand (7) styloid process of the ulna of the dominant hand.

this study involved reaching for the target repeatedly. The subject started with his or her hand resting on the ipsilateral thigh for the initial position. During reaching, the unused hand was placed on the contralateral thigh to ensure stability.

Subjects performed the reaching task for 60 seconds using the following three seat cushions in random order: a low-rebounding urethane cushion (cushion A, density 55 ± 5 kg/m^3, impact resilience > 15%), a high-rebounding urethane cushion (cushion B, density 40 ± 2 kg/m^3, impact resilience > 30%), and the new silicone seat cushion (cushion C). The silicone cushion consisted of 12 × 12 columns (height 5 cm, diameter 3 cm) with individual columns separated by 5 mm. The hardness of the silicone, determined by a durometer (TECLOCK, Japan), was A15.

The pace of the reaching task for healthy adults was modulated with a metronome (46 beats/min). No instructions on movement speed were given to individuals with CP. They were instead instructed to perform the reaching movement as many times as possible without losing their postural balance. The subjects practiced the task three times before measurement.

4) Analysis

Movement time (MT) was defined as the duration between the beginning of one reaching movement and the next in healthy adults. Mean MT was calculated over 20 trials for each seat cushions as the achievement of task. We set the target of analysis 20 times after the start in order to clarify the effect of the movement by the seat material. For subjects with CP, the number of successful reaches was assumed the achievement of task for each seat cushions.

The pressure exceeding 20 mmHg measured by the FSA was analyzed as COP displacement. The straight rate (SR) was calculated as the total hand path from beginning the reaching movement to touching the target divided by the difference between the target and starting position. SR represents the straightness of the hand trajectory [13] and has an ideal value of 1; the smaller the SR, the straighter the hand trajectory and more efficient the movement. In addition to SR, displacement in the anterior/posterior (AP) and medial/lateral (ML) directions was also calculated. The mean values ± 2SD of the SR, AP, and ML in healthy adults were considered the standard values in this study.

Statistical analyses were performed using SPSS version 21 (SPSS Inc., USA). Repeated-measures ANOVA was used to examine the effects of seat cushions on SR, AP, and ML. The threshold for statistical significance was $p < 0.05$.

The marker on the styloid process of the ulna of the dominant hand was defined as the hand marker. The movement trajectory of the hand marker in the horizontal and sagittal planes was calculated. In addition, the maximum velocity of each joint marker was calculated during the reaching task, and movement onset was defined as the continuous change in hand velocity exceeding 5% peak velocity. The timing of movement onset was calculated in terms of the difference in movement onset of each joint marker from that of the hand marker.

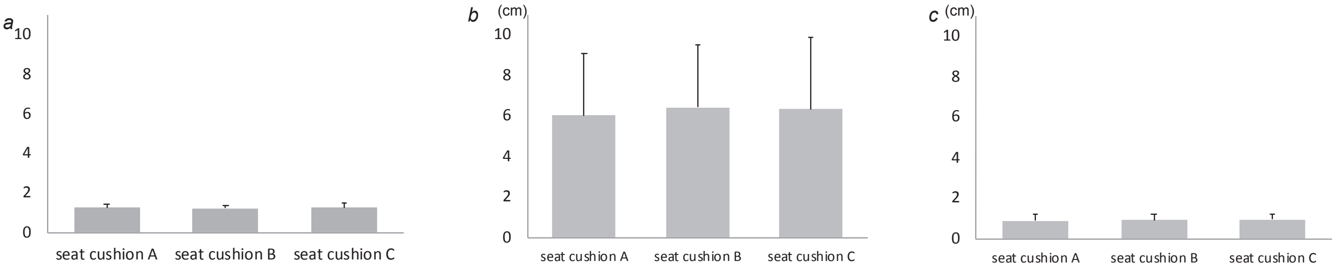

Fig. 2. Mean SR, AP, and ML displacements of COP in healthy adults.
(a) Mean SR, (b) Mean AP displacements, (c) Mean ML displacements
No significant deferences were odserved between the cushions.
※ SR: straight rate, AP: anterior/posterior, ML: medial/lateral, COP: center of pressure
※ seat cushion; A: low urethane, B: high urethane, C: silicone

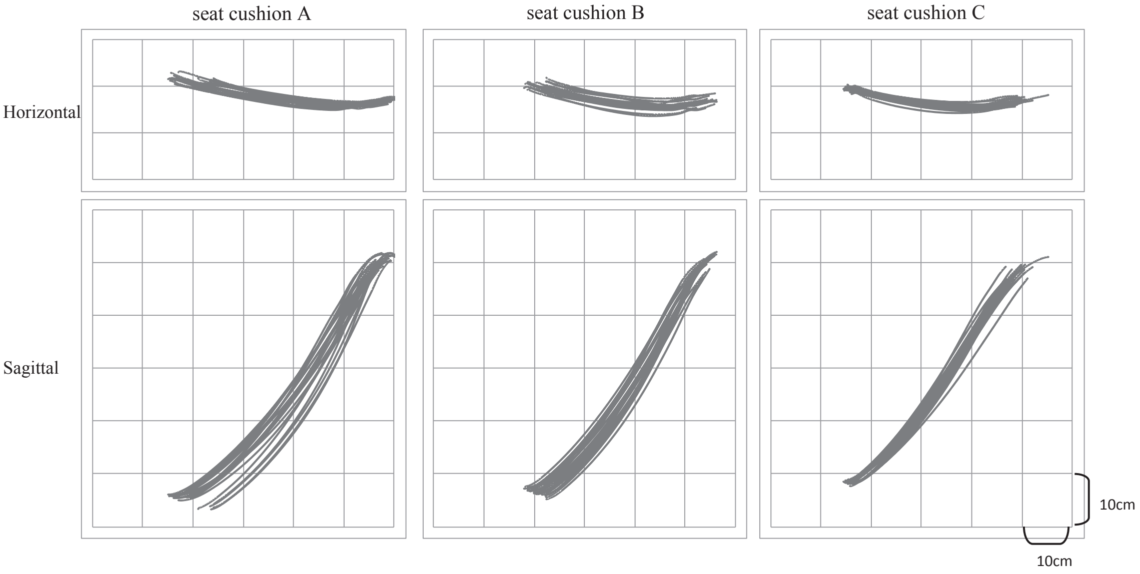

Fig. 3. The trajectory of the wrist joint motion inheathy adults.
Upper graph showed the horizontal plane. *Lower graph* showed the sagittal plane.
Left graph is seat cushion A, *Center graph* is seat cushion B, *Right graph* is seat cushion C.
In each trace, the left side is the start of movement, and the right side is the completion of the reach.
The trajectory of the reach motion from completion of one reaching movement back to the start position was excluded.
Each curve represents a trace from a single trial, and each graph contains all trial.
※ seat cushion; A: low urethane, B: high urethane, C: silicone

III. Results

1) Healthy adults

(1) MT

All healthy adults successfully performed the repeated reaching task. The means MT for seat cushions A, B, and C were 2.61 ± 0.02, 2.62 ± 0.05, and 2.62 ± 0.02 s, respectively. There were no significant differences between seat cushions ($F_{2,18} = 0.114$, $p = 0.894$).

(2) Measurement of body pressure

Figure 2 presents the means of COP for healthy adults. No significant differences in SR, AP, or ML were observed among cushions. Therefore, the standard values in this study were SR, 1.60; AP, 12.45; and ML, 1.49.

(3) Trajectory of the hand marker

Subjects were consistently able to reach straightly to the target from the initial position (Fig. 3). No difference was observed among seat cushions.

(4) Movement onset of each joint

Figure 4 shows the timing of the movement onset in each joint. The graph depicts the start time lag (s) of

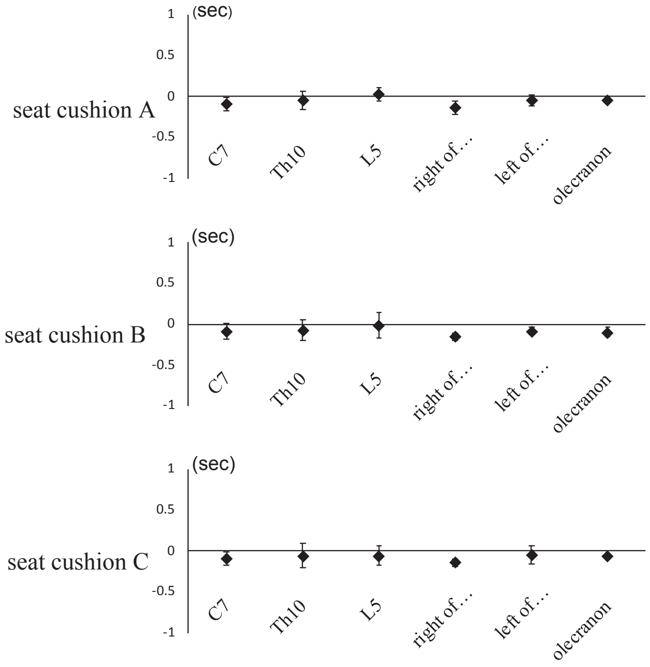

Fig. 4. Mean the timing of the movement onset in each joint in healthy adults.
The timing of the movement onset depicts the start time lag (s) of other markers with respect to the hand marker when the movement onset of the hand marker was set to 0.
※ seat cushion; A: low urethane, B: high urethane, C: silicone

other markers with respect to the hand marker when the movement onset of the hand marker was set to 0. In all cushions, all markers on the trunk started movement earlier than the hand marker.

2) Individuals with CP

(1) Number of reaches

Subjects with CP were able to reach the target 10 or more times using seat cushion C. By contrast, they were unable to reach the target 10 times using the two urethane seat cushions (Fig. 5). In particular, the fewest reaches were observed using the high-rebounding cushion (cushion B).

(2) Pressure (Fig. 6)

The SR of seat cushion C was almost 1 or smaller than the standard value. The mean AP was smaller than the standard value in every seat cushion. ML was greater than the standard values in all subjects regardless of the seat cushion used. CP1 and CP3 subjects demonstrated the smallest disturbance in ML on seat cushion C.

(3) Trajectory of the hand marker

Figure 7 illustrates the trajectories of movement. Traces were more linear and consistent with seat cushion C than the other seat cushions.

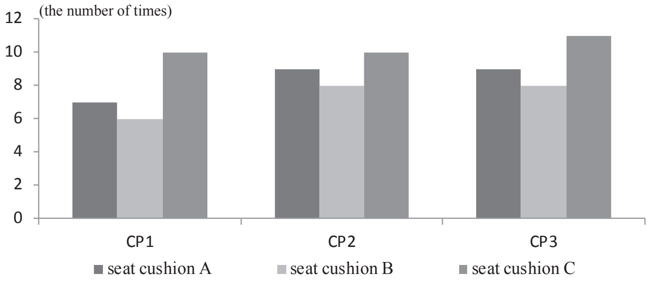

Fig. 5. Number of successful reaches in subjects with cerebral palsy.
※ seat cushion; A: low urethane, B: high urethane, C: silicone

(4) Movement onset of each joint

Figure 8 shows the timing of movement onset in each joint. Using seat cushions, A and B, almost all trunk markers started moving after the hand marker. By contrast, in the seat cushion C, trunk markers, in particular the acromion, started moving earlier than hand marker.

IV. Discussion

1) Effects of seat cushions in healthy adults

Healthy adults were able to perform the task at the prescribed pace and number of times. The speed control of arm motion varies when the movement speed slows down [14]; therefore. the task was designed with a constant rhythm. As a result, there was no difference in movement velocity among the seat cushions. In addition, the SR, AP, and ML values of the COP were not significantly different among seat cushions. The healthy subjects' proficient posture adjustability can be considered a factor in their high performance regardless of the seat cushion material used as a base of support.

Movement analysis supported this hypothesis, indicating the right acromion began moving earliest with all cushions and that the trunk moved prior to peripheral parts. This timing is due to anticipatory postural adjustment (APA) [15, 16]. APA is a postural adjustment function that stabilizes posture during disturbance caused by voluntary movement and is largely related to developmental processes [2, 17]. Various investigations into APA have been conducted since it was first reported in 1967 by Belen'kiĭ [18]; however, in healthy adults with mature motor function, APA is thought to function by increasing the efficiency of a movement. In other words, by stabilizing the trunk, the center of the body, during a movement and reducing shaking, APA helps exercise the pectoral girdle, a moving segment, more efficiently and improves the accuracy of a movement [14].

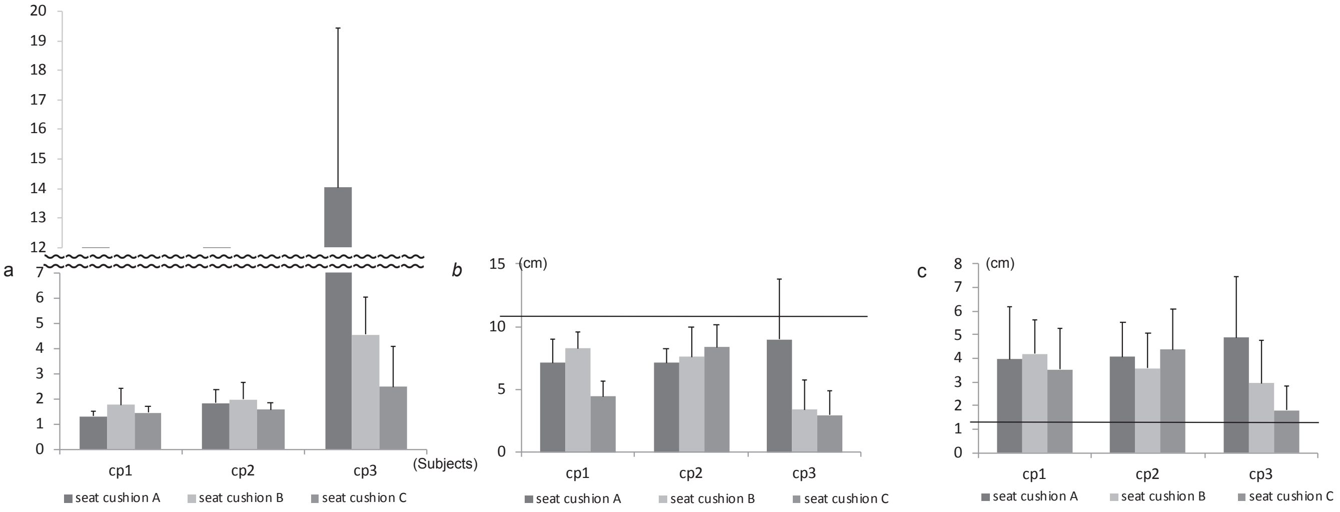

Fig. 6. Mean SR, AP and ML displacements of COP in subjects with cerebral palsy.
The horizontal line indicates the mean value of healthy adults plus 2SD
(a) Mean SR, (b) Mean AP displacement, (c) Mean ML displacement
No significant diference was observed between seat cushions.
SR: straight rate, AP: anterior/posterior, ML: medial/lateral, COP: center of pressure
※ seat cushion; A: low urethane, B: high urethane, C: silicone

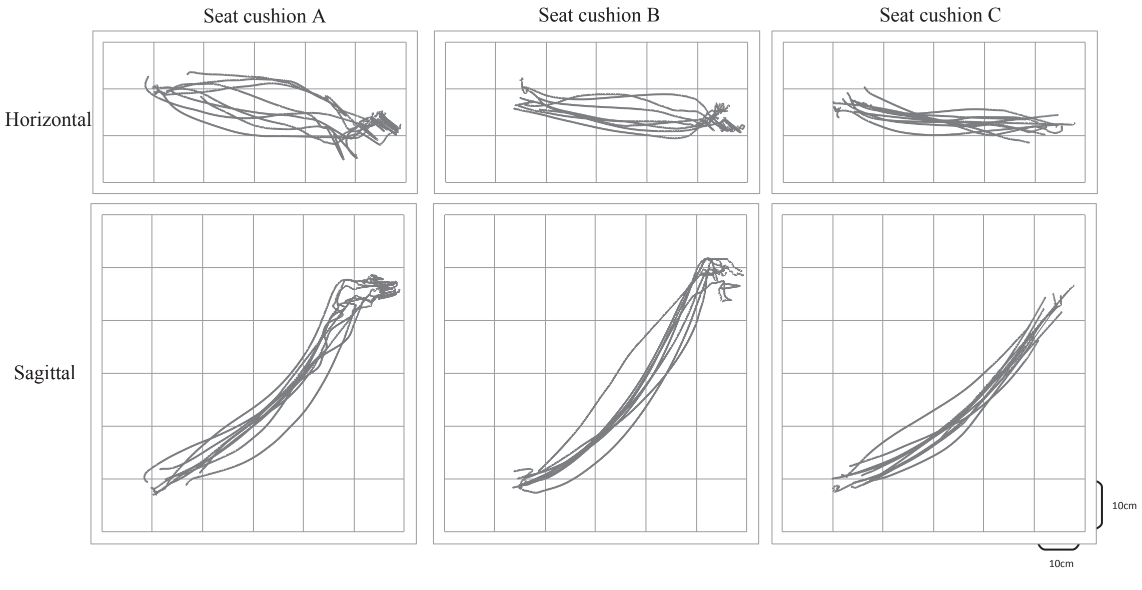

Fig. 7. Trajectory of wrist joint motion in subjects with cerebral palsy.
Upper graph showed the horizontal plane. *Lower graph* showed the sagittal plane.
Left graph is seat cushion A, *Center graph* is seat cushion B, *right graph* is seat cushion C.
In each trace, the left side is the start of movement, and the right side is the completion of the reach.
The trajectory of the reach motion from completion of one reaching movement back to the start position was excluded.
Each curve represents a trace from a single trial, and each graph contains all trial.
※ seat cushion; A: low urethane, B: high urethane, C: silicone

As the reaching task was designed to require a reach longer than arm length, forward movement of the trunk was required, and movement of the center preceded that of the periphery for more efficient movements. Previous studies also reported that the center begins moving earlier than the arm and suggest a connection between the movements of the center and arm [11]. Therefore, it can be presumed that healthy adults use this strategy for efficient movement wherein they stabilize their center to move closer to an object.

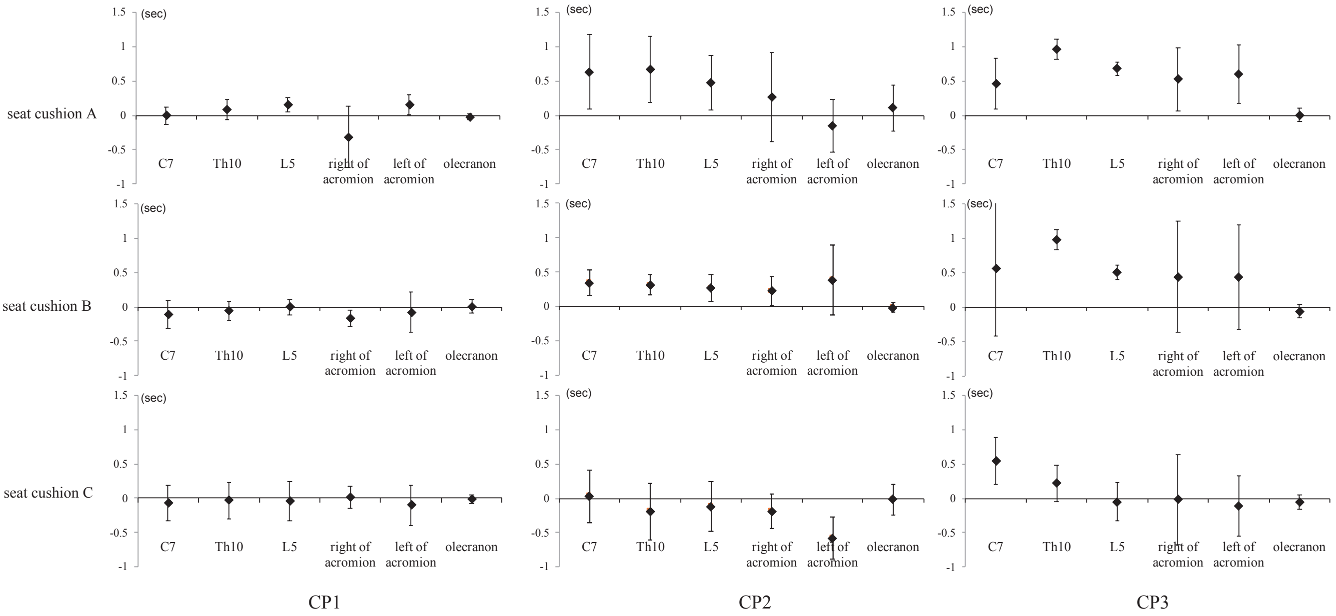

Fig. 8. Mean the timing of the movement onset in subjects with cerebral palsy.
The timing of the movement onset depicts the start time lag (s) of other markers with respect to the hand marker when the movement onset of the hand marker was set to 0.
※ seat cushion; A: low urethane, B: high urethane, C: silicone

2) Effects of seat cushions in individuals with CP

Individuals with CP completed fewer reaches than healthy adults, because individuals with CP who have a disability in postural adjustment experience difficulty maintaining postural stability and moving the upper limbs independently. This was apparent in the results for all seat cushions. However, the number of reaches performed by individuals with CP differed among seat cushions, with the silicone cushion, resulting in the most successful reaches.

Corroborating these observed differences in task performance, we confirmed that on the urethane seat cushions, subjects tended to increase the SR of the COP to at least the same extent as that for the silicone seat cushion, which affected their periphery, with the upper limb initiating the movement followed by the movement of the trunk. The task used in this study required moving the center of gravity of the trunk during reaching; this may have been difficult to accomplish without increasing the tension of the trunk muscles and then moving forward. A urethane seat cushion tends to sink with forward movement because of its material properties. Therefore, the trunk leans forward. At this time, hypotonic CP patients must maintain their posture more consciously, making it difficult for them to perform a smooth reaching movement. Therefore, their performance of the reaching task can be considered to involve first increasing trunk muscle tension, then raising the upper limbs, and finally leaning forward.

According to a previous report, in a reaching task requiring greater posture adjustment such as circumnutation of the trunk, CP patients prioritized the stability of the center rather than the motion efficiency of the periphery; thus, the movement of the peripheral controlling part tended to be unstable [13]. The results of the present study also demonstrate that the motion trajectory of the wrist joint was extended on a more unstable seat cushion, requiring posture stabilization. By contrast, all subjects had a stable motion trajectory, and their motion start time was similar to the motion pattern of healthy adults on the silicone seat surface. Therefore, we hypothesize that the improvement of trunk support enabled the forward movement of the trunk, leading to improvements in task performance and stability of the motion trajectory compared to those on the urethane seat surface.

The cause of the improvement in trunk support with the silicone seat cushion might be the sensory feedback exerted from each silicone tube, supplying the posture control mechanism of the trunk with more information. CP patients cannot gain adequate sensory feedback because of somatosensory system dysfunction and may have difficulty controlling their posture [7, 19], which can result in increased shaking during balancing in the standing position [7]. As this study confirms the effects of the silicone seat cushion specifically in subjects whose trunks were hypotonic, it demonstrates the possibility that the postural control of such subjects can be promoted by environmental factors such as seat surface material to help them exercise more efficiently.

V. Conclusion

The findings of this study indicate that the use of a silicone seat cushion increases the number of reaches, efficiency of COP displacement, and stability of the trajectory of peripheral movement in individuals with CP who have hypotonic trunk muscles. Therefore, seat cushion design may improve movement in individuals with cerebral palsy who have postural control disabilities. However, further larger studies considering multiple clinical conditions are needed. In addition to the current reaching task, the use of a silicone cushion should be investigated in many reaching and manipulation tasks resembling activities of daily living.

Acknowledgements: The authors would like to express their sincere thanks to the study participants with cerebral palsy. The study was partially supported by the Fukushimura Hokkaido Social Welfare Corporation, Japan.

References

[1] van der Heide JC, Begeer C, Fock JM, Otten B, Stremmelaar E, van Eykern LA, *et al*. Postural control during reaching in preterm children with cerebral palsy. Dev Med Child Neurol. 2004; 46(4): 253–66.

[2] van der Heide JC, Otten B, van Eykern LA, Hadders-Algra M. Development of postural adjustments during reaching in sitting children. Exp Brain Res. 2003; 151(1): 32–45.

[3] Hadders-Algra M, van der Heide JC, Fock JM, Stremmelaar E, van Eykern LA, Otten B. Effect of seat surface inclination on postural control during reaching in preterm children with cerebral palsy. Phys Ther. 2007; 87(7): 861–71.

[4] Cherng RJ, Lin HC, Ju YH, Ho CS. Effect of seat surface inclination on postural stability and forward reaching efficiency in children with spastic cerebral palsy. Res Dev Disabil. 2009; 30(6): 1420–7.

[5] van der Heide JC, Fock JM, Otten B, Stremmelaar E, Hadders-Algra M. Kinematic characteristics of postural control during reaching in preterm children with cerebral palsy. Pediatr Res. 2005; 58(3): 586–93.

[6] Garber SL, Dyerly LR. Wheelchair cushions for persons with spinal cord injury: an update. Am J Occup Ther. 1991; 45(6): 550–4.

[7] Cherng RJ, Su FC, Chen JJ, Kuan TS. Performance of static standing balance in children with spastic diplegic cerebral palsy under altered sensory environments. Am J Phys Med Rehabil. 1999; 78(4): 336–43.

[8] Aissaoui R, Boucher C, Bourbonnais D, Lacoste M, Dansereau J. Effect of seat cushion on dynamic stability in sitting during a reaching task in wheelchair users with paraplegia. Arch Phys Med Rehabil. 2001; 82(2): 274–81.

[9] Kyvelidou A, Harbourne RT, Shostrom VK, Stergiou N. Reliability of center of pressure measures for assessing the development of sitting postural control in infants with or at risk of cerebral palsy. Arch Phys Med Rehabil. 2010; 91(10): 1593–601.

[10] Kodama T, Nakamura Y, Nakajima S, Kamoshita K, Sengoku Y. The effect of the seat cushion during upper limb task. Presented at the 16th International Congress of the World Federation of Occupational Therapists. Yokohama, Japan. June 18–21.

[11] Dean C, Shepherd R, Adams R. Sitting balance I: trunk-arm coordination and the contribution of the lower limbs during self-paced reaching in sitting. Gait Posture. 1999; 10(2): 135–46.

[12] Palisono R, Rosenbaum P, Walter S, Russell D, Wood E, Galuppi B. Development and reliability of a system to classify gross motor function in children with cerebral palsy. Dev Med Child Neurol. 1997; 39(4): 214–23.

[13] Ju YH, You JY, Cherng RJ. Effect of task constraint on reaching performance in children with spastic diplegic cerebral palsy. Res Dev Disabil. 2010; 31(5); 1076–82.

[14] Messier J, Adamovich S, Berkinblit M, Tunik E, Poizner H. Influence of movement speed on accuracy and coordination of reaching movements to memorized targets in three-dimensional space in a deafferented subject. Exp Brain Res. 2003; 150(4): 399–416.

[15] Massion J. Postural control system. Curr Opin Neurobiol. 1994; 4(6): 877–87.

[16] Bruttini C, Esposti R, Bolzoni F, Vanotti A, Mariotti C, Cavallari P. Temporal disruption of upper-limb anticipatory postural adjustments in cerebellar ataxic patients. Exp Brain Res. 2014; 233(1): 197–203.

[17] Hadders-Algra M, van der Fits IB, Stremmelaar EF, Touwen BC. Development of postural adjustments during reaching in infants with CP. Dev Med Child Neurol. 1999; 41(11): 766–76.

[18] Belen'kiĭ VE, Gurfinkel' VS, Pal'tsev E. Control elements of voluntary movements. Biofizika. 1967; 12(1): 135–41.

[19] Teflioudi EP, Zafeiriou DI, Vargiami E, Kontopoulos E, Tsikoulas I. Somatosensory evoked potentials in children with bilateral spastic cerebral palsy. Pediatr Neurol. 2011; 44(3): 177–82.

CASE REPORT

Effect of Combining the Canadian Occupational Performance Measure with Cognitive Behavioral Therapy to Enable Occupation in a Client with Depression: A Case Study in Home-Visiting Support

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Abstract: Introduction: Few reports describe interventions combining the Canadian Occupational Performance Measure (COPM) with cognitive behavioral therapy (CBT) although both are important in enabling occupation for a client with depression. We outline the therapy process conducted by an occupational therapist combining the COPM with CBT to enable occupation for a client with depression.
Methods: A single-system research design was implemented. The intervention was based on behavioral activation, and the cognitive restructuring was divided into three phases: baseline (Phase I), intervention 1 (Phase II), and intervention 2 (Phase III). Baseline consisted of behavioral activation only. In intervention 1, the COPM was used in addition to the baseline action. In intervention 2, cognitive restructuring was conducted in addition to intervention 1.
Results: There was no significant difference in the client's frequency per week of going out in Phase II compared with Phase I ($p = 0.062$), but the rate increased significantly in Phase III compared with Phase II by binomial test ($p = 0.002$). As assessed by the COPM, the performance and satisfaction scores for going out were 4 and 3 at the 5th week, but they improved to 7 and 6 at the 17th week.
Conclusion: Combining the COPM with CBT significantly increased the frequency of going out that a client with depression hoped to attain. The present intervention might facilitate enabling occupation for clients with depression. Our findings suggested that in clients with depressive symptoms, enabling occupation is possible by combining the COPM with CBT.

Keywords: enabling occupation, COPM, cognitive behavioral therapy, depression, single system design

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Introduction

It is important to focus on an individual's occupation and to select appropriate interventions for enabling occupation in a client with depression. The Canadian Occupational Performance Measure (COPM) is an useful method for focusing on the occupation of a client [1]. Schindler [2] showed that an occupation-based practice increased client scores on satisfaction and performance of occupational performance problems identified on the COPM in psychiatric disorders.

Cognitive behavioral therapy (CBT) is one effective intervention for depression [3, 4]. When appropriately self-assessing themselves, clients with depression tend to have difficulty in recognizing positive results.

Although the self-assessment of positive changes in daily activity by using the COPM might promote the effect of CBT, few studies in depression show the effect of combining the COPM with CBT.

The purpose of this study was to outline the therapy process conducted by combining the COPM with CBT for enabling occupation of a client with depression. Signed informed consent for this study was obtained from the client.

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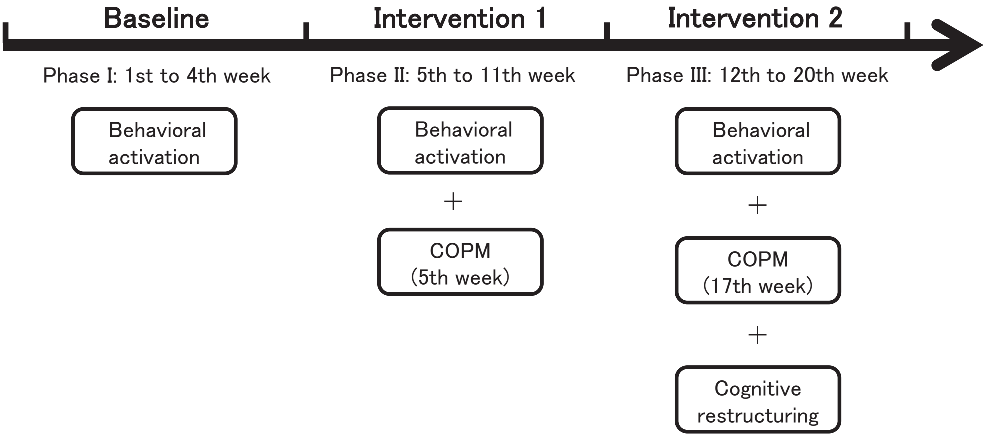

Fig. 1. The experimental procedure.
Baseline therapy consisted of behavioral activation only. In intervention 1, the Canadian Occupational Performance Measure (COPM) was used in addition to the baseline action. In intervention 2, cognitive restructuring was carried out in addition to intervention 1.

Subject

The client was a woman in her 40s with depression. She lives with her husband and daughter and is a housewife. Her symptoms of depression such as anxiety and sleeplessness first appeared 10 years ago, and she was diagnosed as having anxiety disorder. After that, her symptoms worsened from one year ago, and she was diagnosed as having depression. Her symptoms were mainly anxiety that often worsened when she did nothing during the day. Although she had hoped to go out shopping and eat in restaurants, she was unable to act with her own intention and was in a double bind due to the influence of her symptoms.

We adopted “behavioral activation” using a table of her self-recorded daily activities to enhance behavior that reduced her anxiety by visualizing the relationship between her behavior and mood. Behavioral activation is a technique of CBT that promotes engagement with activities and focuses on increasing pleasure and productive experiences [5, 6].

“Cognitive restructuring” was also adopted to allow her to behave in a manner that would reduce her anxiety after stressful events. Cognitive restructuring is a CBT technique that focuses on automatic thoughts, cognitive distortion, and decreasing feelings such as depression and anxiety, and corrects non-adaptive behaviors [7].

Method

Therapy process

The interventions based on the COPM, behavioral activation, and cognitive restructuring were divided into three phases and were carried out via home-visiting support once a week (Fig. 1). The only services used by our client were outpatient treatment and home-visiting support.

Phase I (baseline: 1st to 4th week)

As an intervention based on behavioral activation, performance of daily activities and changes in her anxiety were self-recorded by the client. In addition, activities that would decrease her anxiety were checked, and an executable daily schedule was planned collaboratively.

Phase II (intervention 1: 5th to 11th week)

Assessment with the COPM for the purpose of focusing on her occupations was added to the interventions in Phase I. In addition, the use of COPM was proposed to promote the client’s self-awareness of satisfaction and occupational performance of going out. Therefore, the presentation of the COPM score to compare with the current situation were conducted in the interview.

Phase III (intervention 2: 12th to 20th week)

Cognitive restructuring was added to the interventions in Phase II, and her tendency to grasp ideas, automatic thoughts, and cognitive biases generated by stressful events were confirmed. Moreover, the adjustive thoughts and behaviors that reduced her anxiety were examined collaboratively.

Procedure

A single-system research design comprising three target outcomes was conducted to clarify the effect of intervention for the client (Fig. 1).

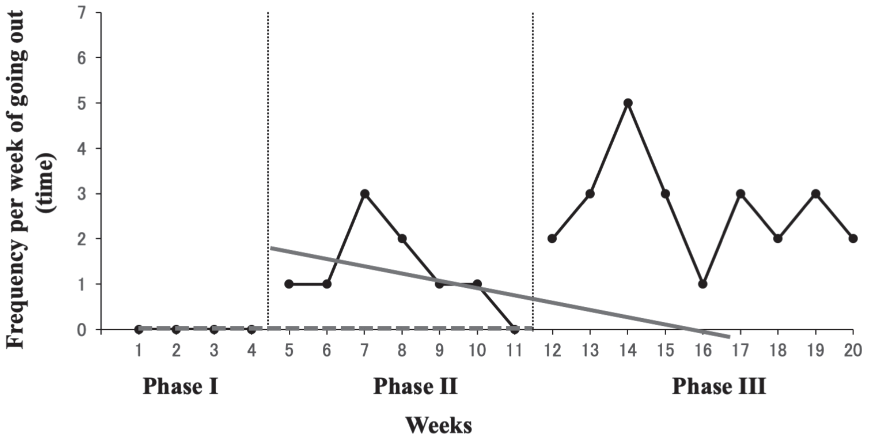

Fig. 2. Frequency per week of going out.
Going out indicates that the client hoped for it. The broken grey line shows the celeration line in Phase I. The solid grey line shows the celeration line in Phase II. Going out was not done in Phase I. Visual observation was found to increase in Phase II compared with Phase I, and it increased significantly in Phase III compared with Phase II by the binomial test ($p = 0.002$). Phase I = 1st to 4th week; Phase II = 5th to 11th week; Phase III = 12th to 20th week.

1) Frequency of going out

The target behavior was the frequency per week of going out that she hoped to achieve. “Going out” was defined as eating at restaurants and going shopping.

2) COPM performance and satisfaction scores

We conducted COPM assessment to determine the occupation “Going out” that she hoped to achieve and analyzed changes in COPM performance and satisfaction scores in Phases II and III.

3) Degree of anxiety

The changes in her degree of anxiety (range, 0 to 100) for each hour of every day that she self-scored were monitored.

Data analysis

Visual analysis, the split-middle technique, and the binomial test were adopted to compare the frequency per week of going out, which was counted in each phase. A p value < 0.05 was considered to indicate statistical significance.

Results

The average frequency per week of going out in each phase is shown in Fig. 2 and Table 1. There was no significant difference in the client’s frequency per week of going out in Phase II compared with Phase I ($p = 0.062$), but the rate increased significantly in Phase III compared with Phase II by binomial test ($p = 0.002$).

As assessed by the COPM, the performance and satisfaction scores for going out were 4 and 3 at the 5th week, but they improved to 7 and 6 at the 17th week (Table 1). The client recognized that she went out for mandatory and rehabilitative activities to help reduce her anxiety in Phase I. The number of destinations she visited in Phase II had increased, but she still had no confidence in going shopping. In Phase III, she began to experience the feeling of leisure when she went out. However, her average degree of anxiety did not change during each phase (Table 1).

Discussion

Identifying factors inhibiting occupational performance and selecting appropriate interventions are important roles of occupational therapists in the practice of enabling occupation [8]. The present results show that the behavior of our client with depression was difficult to change with either COPM or CBT alone. A combination of prompt self-monitoring and other techniques is effective in initiating behavioral changes [9]. The combination of COPM and several CBT techniques was an appropriate method for addressing the factors that inhibited her occupational performance. Therefore, her COPM scores improved, and she began to understand the meaning of leisure and to achieve enabling occupation via the present interventions without exacerbating her anxiety.

Depressive symptoms have a negative effect on the quality of life. However, the process of changing one’s attitudes, goals, and skills to live a satisfying life by overcoming the limitations caused by mental disease is important [10]. Visualization of the behaviors and anxiety based on CBT and focusing on meaningful oc-

Table 1. Changes in target outcomes in each phase.

	Phase I	Phase II	Phase III
Frequency per week of going out (times)	0 ± 0	1.3 ± 0.8	2.7 ± 1.0
Number of destinations visited	1	2	4
Reason for visiting destination	• Mandatory visit	• Mandatory visit • Eating out at restaurants	• Mandatory visit • Eating out at restaurants • Visiting town • Shopping
COPM			
Performance score (range: 1−10)	—	4	7
Satisfaction score (range: 1−10)	—	3	6
Degree of anxiety (range: 1−100)	41.8 ± 20.1	40.9 ± 17.5	41.6 ± 17.9

Notes. Phase I = 1st to 4th week; Phase II = 5th to 11th week; Phase III = 12th to 20th week; COPM = The Canadian Occupational Performance Measure. Values are mean ± SD, n, or score.

cupation based on performance and satisfaction scores of the COPM prompted the client to positive thought for enabling occupation. Therefore, our findings suggested that if enabling occupation of clients with depression is difficult to achieve due to their symptoms, an intervention combining the COPM with CBT might be effective in home-visiting support. Further research and increase of sample size are required to validate the effectiveness of combining the COPM and CBT.

Conclusions

An intervention combining the COPM with CBT was sufficiently appropriate to facilitate the enabling occupation of a community-dwelling client with depression.

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References

[1] Law MC, Baptiste S, Carswell A, McColl MA, Polatajko H, Pollock N. The Canadian Occupational Performance Measure (ed 3). Ottawa, ON: CAOT Publications, 1998.

[2] Schindler VP. A client-centred, occupation-based occupational therapy programme for adults with psychiatric diagnoses. Occup Ther Int. 2010; 17(3): 105–12.

[3] Beck JS. Cognitive behavior therapy: Basics and beyond. New York: Guilford Press, 2011.

[4] Hofmann SG, Asnaani A, Vonk IJ, Sawyer AT, Fang A. The efficacy of cognitive behavioral therapy: A review of meta-analyses. Cognit Ther Res. 2012; 36(5): 427–40.

[5] Barlow DH, editor. Clinical handbook of psychological disorders: A step-by-step treatment manual, (5th ed.). New York: Guilford Publications, 2014.

[6] Dimidjian S, Hollon SD, Dobson KS, Schmaling KB, Kohlenberg RJ, Addis ME, *et al.* Randomized trial of behavioral activation, cognitive therapy, and antidepressant medication in the acute treatment of adults with major depression. J Consult Clin Psychol. 2006; 74(4): 658–70.

[7] Hope DA, Burns JA, Hayes SA, Herbert JD, Warner MD. Automatic thoughts and cognitive restructuring in cognitive behavioral group therapy for social anxiety disorder. Cognit Ther Res. 2010; 34(1): 1–12.

[8] Law M, Cooper B, Strong S, Stewart D, Rigby P, Letts L. The person-environment-occupation model: A transactive approach to occupational performance. Can J Occup Ther. 1996; 63(1): 9–23.

[9] Michie S, Abraham C, Whittington C, McAteer J, Gupta S. Effective techniques in healthy eating and physical activity interventions: a meta-regression. Health Psychol. 2009; 28: 690–701.

[10] Anthony WA. Recovery from mental illness: the guiding vision of the mental health service system in the 1990s. Psychosocial Rehabilitation Journal. 1993; 16(4): 11–23.