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Original Article

Comparison of respiratory function, physical function, and activities of daily living among community-dwelling patients with respiratory and non-respiratory disease

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Abstract. [Purpose] The purpose of this study was to investigate the differences in respiratory function, physical function, and Activities of Daily Living (ADL) between respiratory and non-respiratory patients using community-based home rehabilitation. [Participations and Methods] Maximum Phonation Time (MPT), upper and lower limb muscle strength, and ADL were compared in two groups: a respiratory disease group including respiratory patients and those with respiratory comorbidities, and a non-respiratory disease group. Cutoff values were determined for items that showed significant differences between groups. [Results] There were no significant differences between the two groups in assessments other than MPT. MPT was significantly lower in the respiratory disease group, with an MPT cutoff value of 10.1 sec and an area under the curve of 0.74. [Conclusion] Use of the MPT cutoff value may help to determine whether respiratory function is impaired in patients with respiratory disease.
Key words: Maximum phonation time, Respiration disorders, Community-based rehabilitation

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INTRODUCTION

It has been reported that respiratory diseases, such as chronic obstructive pulmonary disease (COPD) and asthma, increase mortality in the elderly through acute exacerbation and complication of other respiratory diseases[1, 2)], and that it is difficult to recognize the severity of these diseases[3)]. It has been reported that approximately 10% of elderly people living in the community have decreased respiratory function[4)]. In order to reduce mortality and prevent acute exacerbation, it is important to assess respiratory function in community-dwelling elderly people, especially in those with respiratory disease.

Respiratory rehabilitation is a means of maintaining and improving respiratory function. However, respiratory rehabilitation practice is not currently sufficiently widespread[5)]. It has been reported that the recurrence rate of pneumonia is higher in patients with pneumonia and chronic lung disease[6)], and that respiratory muscle weakness is associated with an increased risk of pneumonia and other respiratory infections, due to impaired airway clearance[7)].

Respiratory disease has been shown to be a factor that inhibits patients from continuing to live at home[8)]. Home visit respiratory rehabilitation is often the first choice for community-dwelling patients. Therefore, it is necessary to evaluate the

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status of respiratory function, physical function, and Activities of Daily Living (ADL) for risk management of these patients. However, it is not easy to perform detailed respiratory function tests using spirometers and other devices in the home visit context. Therefore, it is necessary to investigate whether the presence or absence of respiratory disease makes a difference in physical function and ADL, in addition to examining indicators that can easily identify respiratory status and decline in respiratory function.

The purpose of this study was to investigate the differences in respiratory function, physical function, and ADL between patients with respiratory diseases and non-respiratory diseases who use community-based home rehabilitation.

PARTICIPANTS AND METHODS

This was a cross-sectional study of 383 patients who used the home visit rehabilitation services of Itabashi Rehabilitation Nurse Station and Nishinasuno General Home Care Center. Background data included: age, gender, term of home visit rehabilitation, main disease, presence of respiratory comorbidities. We excluded persons declined to participate, those who found it difficult to participate in the research due to rapport formation or mental instability, etc., persons who have difficulty entering verbal instructions or speaking due to diseases such as dementia, use of a ventilator, or stroke, and those whose condition worsened.

As an alternative assessment of respiratory function tests, we used the Maximum Phonation Time (MPT), which has relative and absolute reliability[9] and a proven relationship with pulmonary function[10]. Patients were asked to vocalize the "a" sound for as long as possible at normal volume[11]. The duration of the vocalization was measured.

Upper limb muscle strength was evaluated by measuring by hand grip strength in the left and right limbs; the maximum value was adopted. Lower limb muscle strength was evaluated using the 30-second chair stand test (CS-30s)[12]. Patients were instructed to repeat standing and sitting as many times as possible in 30 sec; the number of times the patients stood was measured. ADL was evaluated using the Functional Independence Measure (FIM)[13]. Each sub-item of this measure is rated on a scale of 1–7, with a higher score indicating a higher degree of independence. FIM motor items, FIM cognitive items, and FIM total score were measured. Life-space Assessment (LSA)[14] was used to assess physical activity in the living space. In this assessment, scores are derived based on: range of activity, frequency of activity, and degree of independence over the past month. The score range is 0–120 points; a higher score implies greater physical activity in the living space.

Patients were classified into two groups: 1) respiratory patients and those with respiratory comorbidities (respiratory disease group), and 2) others (non-respiratory disease group). The basic attributes of age, gender, and duration of home visit rehabilitation were statistically analyzed using the χ^2 test, t-test, and Mann–Whitney U test. Analysis of covariance, with age and gender as covariates, was used for statistical analysis of each measure. Receiver operating characteristic (ROC) curves were calculated for all items that showed significant differences between groups. An MPT cutoff value for the presence of respiratory disease was calculated using the Youden index[15], positive and negative predictive values were also calculated.

All data were analyzed using IBM SPSS version 27.0 (IBM, Armonk, NY, USA). The significance level was set at 5%.

The study was approved by the Ethics Committee of the International University of Health and Welfare Graduate School (Approval Number: 19-Io-237). All patients provided written and oral informed consent, and this study was conducted according to the principles of the Declaration of Helsinki.

RESULTS

One hundred and fifteen patients were included in the final analysis (Fig. 1). There were nineteen patients in the respiratory disease group and 96 patients in the non-respiratory disease group. The prevalence of respiratory disease was 16.5%.

In the analysis of covariance, MPT was significantly shorter in the respiratory disease group than in the non-respiratory disease group. There were no significant differences in grip strength, CS-30s, FIM motor items, FIM cognitive items, FIM total, and LSA between the two groups (Table 1).

The ROC curve for MPT was calculated using the presence or absence of respiratory disease as a status variable. The Area Under the Curve; (AUC) was 0.74—a significant value. The MPT cutoff value for decreased respiratory function was 10.1 sec, with sensitivity of 78.9% and specificity of 65.6% (Fig. 2). The positive and negative predictive values were 31.2% and 83.5%, respectively (Table 2).

DISCUSSION

This study investigated whether the presence or absence of respiratory disease in community-dwelling home visit rehabilitation patients was associated with differences in respiratory function, physical function, and ADL. The mean age of patients was 76.5 years. The mean MPT was 8.9 sec in the respiratory disease group and 13.5 sec in the non-respiratory disease group, which was lower than the mean values of 16.8 sec in people in their 70 year-old group and 15.9 sec in people in their 80 year-old group reported in previous studies of healthy elderly people[16]. It has been reported that respiratory function in elderly people living in the community often declines, even if they have not been diagnosed with a respiratory disease[17]. This study suggests that respiratory function in community-dwelling home visit rehabilitation patients may decline.

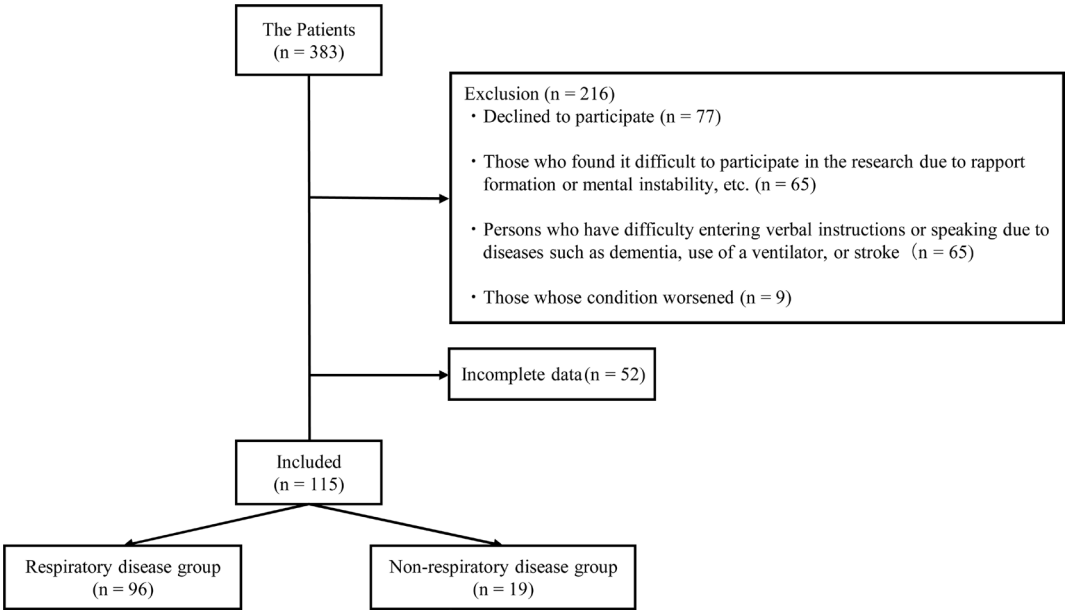

Fig. 1. Details of the participant criteria.

Table 1. Attributes of the participants

		All participants	Respiratory disease group	Non-respiratory disease group
		n=115	n=19	n=96
Age (years)*		76.5 ± 11.4	83.3 ± 6.5	75.2 ± 11.7
Gender (n)*	Males	66 (57.4%)	16 (84.2%)	50 (52.1%)
	Females	49 (42.6%)	3 (15.8%)	46 (47.9%)
Duration of home-visit rehabilitation (months)		33.3 ± 32.9	28.0 ± 24.9	34.3 ± 34.2
Main disease (n)	Cerebrovascular disease	34 (36.9%)	4 (21.1%)	30 (31.3%)
	Musculoskeletal disease	31 (33.6%)	3 (15.8%)	28 (29.2%)
	Neuromuscular disease	21 (22.8%)	1 (5.3%)	20 (20.8%)
	Cardiovascular disease	5 (5.4%)	2 (10.5%)	3 (3.1%)
	Respiratory disease	6 (6.5%)	6 (31.6%)	0 (0%)
	Cancer	4 (4.3%)	2 (10.5%)	2 (2.1%)
	Others	14 (15.2%)	1 (5.3%)	13 (13.5%)
Comorbidity of respiratory disease (n)	Bronchial asthma	5 (4.3%)	5 (26.3%)	
	Interstitial pneumonia	1 (0.9%)	1 (5.3%)	
	Chronic obstructive pulmonary disease	6 (5.2%)	6 (31.6%)	
	Bronchitis	2 (1.7%)	2 (10.5%)	
	Chronic respiratory insufficiency	2 (1.7%)	2 (10.5%)	
	Lung cancer	2 (1.7%)	2 (10.5%)	
	Chronic cough	1 (0.9%)	1 (5.3%)	
MPT (sec)*		12.8 ± 6.9	8.9 ± 5.7	13.5 ± 6.8
Hand grip (kg)		20.5 ± 8.4	18.4 ± 7.5	20.9 ± 8.6
CS-30 (times)		4.4 ± 5.5	3.9 ± 5.9	4.5 ± 5.4
Motor FIM (points)		72.4 ± 14.6	69.8 ± 16.5	72.9 ± 14.2
Cogenitive FIM (points)		32.5 ± 4.4	31.2 ± 6.0	32.7 ± 4.1
Total FIM (points)		104.8 ± 17.0	101.0 ± 21.4	105.6 ± 16.1
LSA (points)		30.7 ± 16.0	26.3 ± 22.5	31.5 ± 14.4

Values are presented as mean ± standard deviation or number (%).
*$p<0.05$, statistically significant.
MPT: Maximum Phonation Time; CS-30: 30-seconds Chair-Stand test; FIM: Functional Independence Measure; LSA: Life Space Assessment.

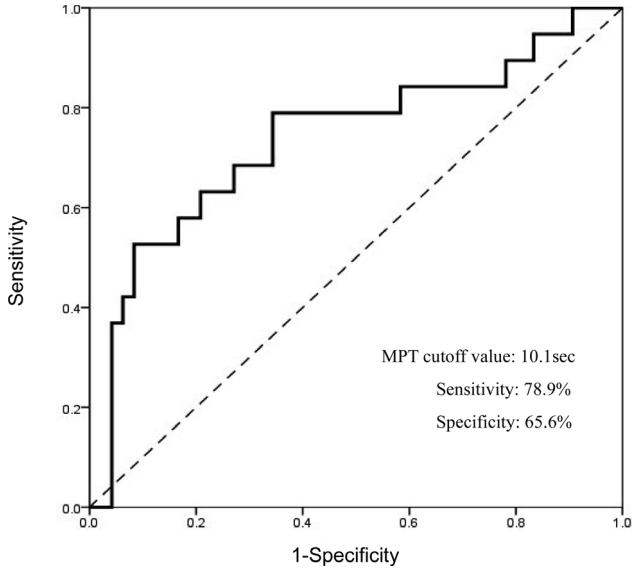

Fig. 2. Receiver operating characteristics curve of maximum phonation time.
The MPT cutoff value for the presence of respiratory disease was calculated using the Youden index.

Table 2. Details of each group at maximum phonation time cutoff

	Respiratory disease group n=19	Non-respiratory disease group n=96	Total (n)
<10.1 sec (n)	15	33	48
>10.1 sec (n)	4	63	67
Total (n)	19	96	115

In the comparison between the two groups, the respiratory disease group had significantly lower MPT, a surrogate for the assessment of respiratory function, than the non-respiratory disease group, and there was no difference in physical function or ADL. Elderly people with respiratory diseases are considered to be at high risk of developing pneumonia[18]. It has been suggested that it is important for risk management to investigate respiratory function, especially in community-dwelling home visit rehabilitation patients with respiratory disease.

In this study, the MPT cutoff for the presence or absence of respiratory disease was calculated to be 10.1 sec. The AUC was found to be 0.74, indicating moderate discriminative ability; the positive predictive value was 31.3% and the negative predictive value was 83.5%. When the MPT was less than 10.1, the probability of the patient having respiratory disease was found to be 31.3%. If the MPT is greater than 10.1 sec, the probability of not having respiratory disease is found to be 83.5%. The prevalence of respiratory disease was 16.5%, which may have resulted in low sensitivity and high specificity. Previous studies have shown that the prevalence of COPD in patients older than 80 years is greater than in patients younger than that age, suggesting the need for screening of respiratory function[4]. The use of an MPT cutoff value may help to determine whether respiratory function is impaired, even in those with respiratory disease. Moreover, it could be used in combination with auscultation and other vital signs for risk management in home visit rehabilitation, as well as for determining the effectiveness of improving respiratory function during home visit rehabilitation. In the future, it is necessary to investigate the utility of using MPT as a criterion for judging the effectiveness of rehabilitation and for clarifying the importance of respiratory rehabilitation.

There were some limitations to this study. First, the study does not account for the effects of disease diversity. Second, the study was biased by unmeasured confounders (height and weight, nutritional status, vocal cord function, etc.). Third, the study had a small number of patients with respiratory diseases. There was a variation in the number of people between the two groups. In the future, it will be necessary to increase the number of study participants, evaluate the effect of each disease separately, and adjust for confounders.

Since the implementation rate of respiratory rehabilitation has been declining and the number of patients with respiratory diseases receiving home rehabilitation was small, the number of patients receiving home rehabilitation for respiratory diseases included in this study was also small. As the implementation of home visit respiratory rehabilitation becomes more widespread, we believe it is important to objectively show the effects of its implementation.

Conflict of interest

The authors declare no conflict of interest.

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