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EFFECT OF LAUGHTER YOGA ON PULMONARY REHABILITATION IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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Abstract
Objective : To evaluate the clinical usefulness of laughter yoga for patients with chronic obstructive pulmonary disease (COPD) in a pulmonary rehabilitation setting.
Design : Pilot study, with randomization of participants.
Setting: This study was conducted by the Yoshino-cho National Health Insurance Yoshino Hospital Department of Internal Medicine.
Participants : Stable outpatients with COPD (7 men and 1 woman, age 64 to 84 years) participated in the pulmonary rehabilitation program during a 2-week period.
Intervention : The patients were divided into two groups based on a sealed envelope randomization method. The laughter yoga group had a 10-min laughter yoga session before exercise training. Patients in both groups had exercise training, educational programs, lung physiotherapy, and nutrition counseling.
Outcome Measures : Health-related quality of life using the St. George's Respiratory Questionnaire (SGRQ) and the Medical Research Council (MRC) Health Survey Short Form 36-item (SF-36), depression scores using the Self-rating Depression Scale (SDS), anxiety scores using State-Trait Anxiety Inventory (STAI), and spirometry, the 6-minute walk test and mMRC dyspnea scale results were evaluated before and at 2 weeks after the program in both groups.
Results : There were significant improvements in the SGRQ impacts domain and the SF-36 general health domain in the laughter yoga group, while the SF-36 physical functioning domain significantly improved in the control group. SDS and STAI result did not significantly change in either group. Spirometry, the 6-minute walk test, and MRC dyspnea scale results did not significantly change in either group.
Conclusion : Laughter yoga may improve the psychological quality of life in patients with COPD.

Key words : chronic obstructive pulmonary disease, pulmonary rehabilitation, laughter yoga, psychological quality of life, depression, anxiety

Introduction

Chronic obstructive pulmonary disease (COPD) is a worldwide clinical burden[1)2)]. It is associated with high mortality[3)] and deterioration of quality of life[4)]. COPD is a disease with multiple comorbidities, and the updated Global Initiative for Chronic Obstructive Lung Disease (GOLD 2015) stresses the importance of treating comorbidities in patients with COPD[1)]. Two of the most common and least-treated comorbidities of COPD are anxiety and depression[5)], but only a few prospective studies have addressed the diagnosis and management of anxiety and depression, or have determined their impacts on health status among patients with COPD. Furthermore, only a very small number of studies have evaluated therapeutic approaches to anxiety and depression in COPD patients[6)7)].

Laughter is a behavior commonly related to positive emotion in human beings. Laughter is thought to be good for health, but the clinical application of laughter is challenging. Laughter yoga is an exercise that combines laughter with yoga breathing. It has become a worldwide health movement, with more than 10000 laughter clubs spread throughout numerous countries[8)]. Laughter yoga originated with Dr. Madan Kataria, in 1995, in Mumbai, India. It does not require any specific inducer for laughter. Instead, participants may begin by feigning laughter until they begin to laugh mirthfully. We believed that laughter yoga might help to relieve the anxiety or depressive symptoms associated with COPD. Therefore, we performed a small, randomized pilot study to investigate the effect of laughter yoga during a pulmonary rehabilitation program in patients with COPD.

To our knowledge, this is the first report of preliminary prospective randomized study of laughter yoga for COPD patients.

Materials and Methods

Participant: The participants were stable COPD patients from our outpatient clinic. The patients were enrolled in a pulmonary rehabilitation program. All patients who participated in the study gave written informed consent. Inclusion criteria were forced expiratory volume in 1 second % predictive value ($FEV_1\%$) < 0.7 and $FEV_1\%pred$ < 0.8, which are the GOLD 2 criteria. Patients with severe heart disease, neuromuscular disease, or dementia were excluded. The study participants were divided randomly using a sealed-envelope method into two groups: the laughter yoga (LY) group and control group, which consisted of patients who participated in pulmonary rehabilitation without laughter yoga. All participants were enrolled in the pulmonary rehabilitation program for 2 weeks. There were 5 patients in the LY group and 3 in the control group. The clinical trial was approved by the Yoshino-cho National Health Insurance Yoshino Hospital ethics committee.

Assessment instruments: Base-line characteristics were assessed through a detailed questionnaire analysis of symptoms, age, smoking history, and diet. Height and body weight were measured. Spirometric analysis (MINATO Autospiro AS 507) was used to assess slow vital capacity (VC), forced vital capacity (FVC), and forced expiratory volume in one

second (FEV_1) using the Japanese Respiration Society (JRS) standard technique [9]. Depressive symptoms were assessed by Self-rating Depression Scale (SDS) [10] and anxiety symptoms were assessed by the State-Trait Anxiety Inventory (STAI) [11] for anxiety. The STAI measures two aspects of anxiety: state anxiety is short term anxiety induced after a precipitating event and, trait anxiety is characteristic anxiety by nature. Health-related quality of life (QOL) was assessed by the Medical Research Council Health Survey Short Form 36-item (SF-36) [12)-14)], and the St. George's Respiratory Questionnaire (SGRQ) [15]. The SF-36 is a generic instrument for QOL surveys, and the SGRQ is a disease-specific instrument for respiratory failure.

Exercise capacity assessment was done on the basis of the 6-minute walk test (6MD) according to the manual for respiratory rehabilitation of the Japanese Society for Respiratory Care and Rehabilitation [16].

Intervention: All participants underwent comprehensive pulmonary rehabilitation (PR), which included a PR conference once a week. The exercise intensity was low to medium. There were five patient education sessions provided by a nurse using video lectures in a 2-week PR period. Drug education or nutritional education was offered when necessary. The patients in the LY group had 10 min of laughter yoga before a standard PR exercise training session. The laughter yoga sessions involved the following steps:

・Deep breathing (expiration-inspiration-expiration), 3 times. After inspiration a 3-second breath-hold, followed by expiration with laughter.

・Parallel hand clapping with full expanded finger-to-finger and palm-to-palm contact; Kataria has explained that this stage stimulates acupressure points in the hands to increase energy levels. This clapping is carried out rhythmically, i.e., 1-2, 1-2-3.

・Laughter activities such as hand-shake laughter, wherein participants are to shake each other's hands and laugh together. An important point of this step is eye contact; the participants are encouraged to maintain eye contact and laugh together.

・The leader signals the end of the laughing activity by clapping and calling HO-HO HA-HA-HA, and the participants stop their laughter.

・The session covers 3 to 5 activities held over about 10 minutes.

・Cool down at the end of these session by deep breathing.

Data analysis: The data were analyzed using Stat View version 5.0 (SAS Institute Inc.) for Windows. Descriptive statistics were reported in tables and as mean ± standard deviation or frequency and percentage values. Main outcomes were presented as box plot graphs. Analyses of pre-post comparisons were performed using in Student's t-test and p-values of ≤ 0.05 were considered significant.

Results

Patients characteristics are shown in Table 1. There were 5 patients in the LY group and 3 patients in the control group. There were no significant differences in age, body mass index (BMI), VC, FEV_1, 6MD, and modified MRC dyspnea scale between the two groups.

Table 1. Patient characteristics in 8 COPD patients

	Participants (n=8)	Laughter yoga group (n=5)	Control group (n=3)	p value
Age [yr]	75.5±6.4	74.6±6.7	77.0±7.0	ns
Male/Female	7/1	5/0	2/1	
BMI [kg/m^2]	21.0±4.8	21.7±1.7	19.8±8.5	ns
VC [L]	2.54±0.59	2.58±0.30	2.47±1.00	ns
FEV1 [L]	1.03±0.48	0.93±0.20	1.20±0.81	ns
6MD [m]	325.4±90.3	336.4±113.6	307.0±44.3	ns
mMRC	2.86±0.69	2.75±0.5	3.00±1.0	ns

【Table 1 abbreviation】
BMI: Body mass index, VC: vital capacity, FEV1: forced expiratory volume in one second
6MD: 6-minute walk test, mMRC: modified Medical Research Council dyspnea scale

Table 2. Questionnaire data before and after intervention

	Laughter yoga group		Control group		p-value
	Pre-Rehab	Post-Rehab	Pre-Rehab	Post-Rehab	
SGRQ symptom	52.7±11.4	44.4±15.9	61.0±10.6	59.3±16.2	ns/ns
SGRQ activity	70.6±18.9	68.0±20.6	70.7±8.1	58.7±7.2	ns/ns
SGRQ impacts	37.3±14.7	28.6±9.5*	42.7±6.4	41.3±9.0	0.023/ns
SGRQ total	49.8±13.4	43.3±10.5	54.0±4.4	49.7±6.8	ns/ns
SF-36 PF	45.0±31.4	53.3±29.2	41.1±12.1	46.7±11.5*	ns/0.010
SF-36 RP	15.0±33.5	30.0±41.1	8.3±14.4	0.0±0.0	/ns
SF-36 BP	64.2±27.5	55.4±25.3	54.7±15.8	55.7±24.5	ns/ns
SF-36 GH	39.4±8.9	52.2±8.7*	40.7±9.8	44.0±9.6	0.016/ns
SF-36 VT	51.0±18.2	62.0±14.8	50.0±8.7	54.5±15.0	ns/ns
SF-36 SF	65.0±38.9	79.9±28.9	75.0±21.7	66.7±38.2	ns/ns
SF-36 RE	20.0±44.7	20.0±44.7	0.0±0.0	0.0±0.0	ns/ns
SF-36 MH	56.0±26.8	72.0±16.5	54.7±8.3	67.3±21.9	ns/ns
SDS	40.0±4.8	38.8±9.9	40.7±9.5*	43.3±8.6	ns/ns
STAI (State anxiety)	38.6±12.4	35.0±10.4	44.3±11.7	36.7±6.1	ns/ns
STAI (Trait anxiety)	33.8±5.4	31.2±8.6	41.0±13.0	34.3±2.9	ns/ns

* : p<0.05

【Table 2 abbreviation】
PF: physical functioning, RP: role-physical, BP: bodily pain, GH: general health, VT: vitality, SF: social functioning, RF: role-emotional, MH: mental health.

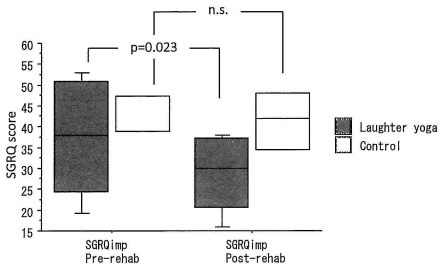

Fig. 1. QOL (SGRQ impacts domain) change before and after intervention. LY group improved significantly, compared to the control group.

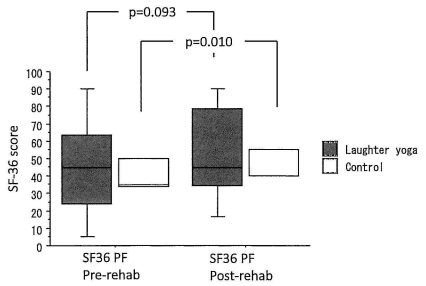

Fig. 2. QOL (SF-36 PF domain) change before and after intervention. Control group improved significantly, compared to the LY group. The QOL of the control group was not different from that of the LY group.

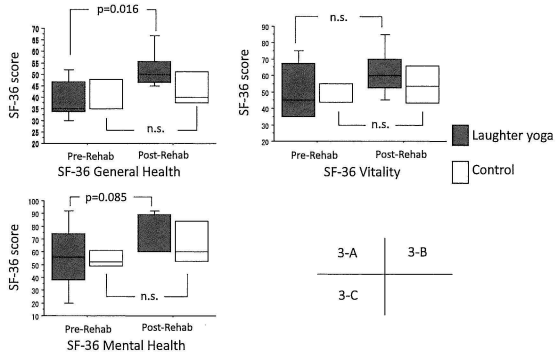

Fig. 3. Change in psychological QOL domains before and after intervention for 3-A, SF-36 General Health, 3-B. SF-36 Vitality, 3-C. SF-36 Mental Health. In 3-A, only GH is significantly improved in the LY group.

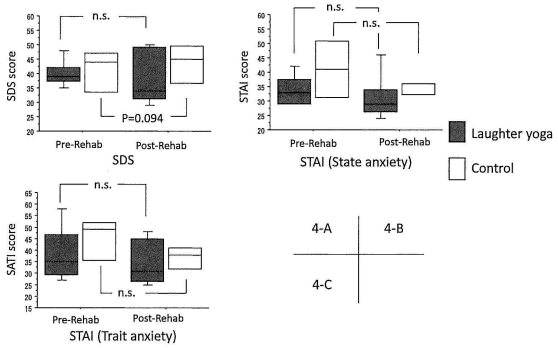

Fig. 4. Depressive state and anxiety before and after intervention for 4-A. SDS score, 4-B. STAI (State anxiety) score, 4-C. STAI (Trait anxiety) score. There is no significant change in any data pre and post intervention.

The questionnaire data before and after intervention for each group are shown in Table 2. There was significant improvement in the SGRQ impacts domain in the LY group (37.3 ± 14.7 to 28.6 ± 9.5, p = 0.023) (Fig. 1), but no significant change was noted in the control group. The SF-36 general health domain also improved significantly in the LY group (39.4 ± 8.9 to 52.2 ± 8.7, p = 0.016), but not in the control group (Fig. 3-A). The SF-36 physical functioning domain showed an improvement in both groups, but the change did not reach statistical significance in the LY group (45.0 ± 31.4 to 53.3 ± 29.2, p = 0.093, vs. 41.1 ± 12.1 to 46.7 ± 11.5, control group, p = 0.010)(Fig. 2).

There were no significant changes in SDS and STAI outcomes from baseline to post-rehabilitation (Fig. 4) in either group.

Pre- and post-intervention, respiratory function, activity, and dyspnea scales are shown in Table 3. VC and FEV_1 data did not change significantly in either group, and there were no significant changes in 6MD in either group, although the improvement in the control group was somewhat larger than that in the LY group. The dyspnea scale had a tendency of improvement

Table 3. Respiratory function, activity, and dyspnea scale before and after intervention

	Laughter yoga group		Control group		p-value
	Pre-Rehab	Post-Rehab	Pre-Rehab	Post-Rehab	
VC [L]	2.58±0.30	2.59±0.28	2.47±1.01	3.06±0.09	ns/ns
FEV1 [L]	0.93±0.20	0.88±0.22	1.20±0.81	1.69±0.52	ns/ns
IC [L]	1.79±0.16	1.99±0.47	1.71±0.84	1.97±0.50	ns/ns
6MD [m]	336.4±113.6	339.6±128.1	307.0±44.2	337.7±23.7	ns/ns
mMRC	2.75±0.50	2.00±0.0	3.00±1.00	2.67±0.58	ns/ns

【Table 3 abbreviation】
VC: vital capacity, FEV1: forced expiratory volume in one second, IC: inspiratory capacity, 6MD: 6-minute walk test, mMRC: modified Medical Research Council dyspnea scale

in both groups, particularly in the LY group (2.75 ± 0.50 to 2.00 ± 0.0, p = 0.057).

Discussion

In recent years, more attention has been focused on the many comorbid conditions in patients with COPD[1]. The GOLD 2015 and other guidelines emphasize the importance of the treatment for these comorbid diseases. Among the comorbidities, depression and anxiety are especially difficult to treat[5]. Depression is reported in 5.5 to 44.4% of patients with COPD[17)-23)]. The GOLD 2015 recommends standard medical therapies for depression and anxiety in patients with COPD, but this therapy is often not effective for these patients. Yohannes et al.[6] reported a trial of fluoxetine in depressive patients with COPD. They found that patient compliance with the antidepressants was poor. There were 7 out of 57 patients (12%) who completed a 6-week course of fluoxetine, and 4 (7%) were fluoxetine responders. It was also reported in another study comparing COPD and non-COPD patients that 52.8% of the COPD patients were able to complete a 3-month course of antidepressants, vs. 63.2% of non-COPD patients [7], and Jordan et al. [24] have reported that there was no significant improvement in hospitalization and in all-cause mortality in COPD patients treated for depression in accordance with guideline recommendations.

On the other hand, it is widely known that pulmonary rehabilitation is effective to relieve depression and anxiety for patients with COPD [25), 26)]. However depressed COPD patients may avoid attending pulmonary rehabilitation or have a greater tendency to drop out [27)]. It is possible that by enhancing the impression of these programs as a good life event, patients with depression and anxiety might be more likely to continue.

The old proverb "laughter is the best medicine" had gained empirical support in various fields of medicine and health care. Norman Cousins, a well-known journalist in the US, published an article in the New England Journal of Medicine describing his successful pain relief for ankylosing spondylarthritis, wherein he reported that 10 minutes of laughter give him at least two hours of pain-free sleep [28)], and more recently it was determined that laughter could activate NK activity in various situations [29)].

Meanwhile, Surwit et al. have reported that negative emotion is associated with increased blood sugar levels [30)], while Hayashi et al. have reported that laughter lowered postprandial

blood glucose levels in patients with type 2 diabetes mellitus after 40 min of watching Manzai, a Japanese cross-talk comedy [31]. Other studies have also indicated that laughter is effective in ameliorating type 2 diabetes mellitus [32, 33].

It has also been well-established that negative emotional states increase the risk for cardiovascular disease, and Sugawara et al. [34] have suggested that mirthful laughter had a beneficial effect on carotid arterial compliance, and that the effect was sustainable for 24 hours.

Although all of these reports suggest the benefits of laughter or positive emotions, almost all studies concerning laughter have relied on comedy videos induce laughter in the test patients. In routine clinical practice, it can be difficult to accumulate a sufficient variety of comedy videos to maintain the interest of the patients.

As noted, Madan Kataria introduced laughter yoga in 1995, while he was practicing as a family physician in Munbai, India. Laughter yoga combines laughter with a yoga breathing method. An advantage of laughter yoga is that it does not require an outside stimulate to induce laughter. Laughter yoga has recently been mentioned in several reports. Shahidi et al. found that the benefits of laughter yoga were equivalent to those of a group exercise program for elderly depressed women [35], and laughter yoga has also been credited as beneficial for moderating heart rate variability, mood, and long-term anxiety among outpatients awaiting organ transplantation [36].

In this pilot study, laughter yoga provided significant improvements in the SGRQ impacts domain and the SF-36 general health domain among COPD patients in a pulmonary rehabilitation program. We believe that our finding that the SF-36 physical functioning domain was significantly improved only in the control group was due to the fact that the LY group had slightly higher baseline scores for this parameter, which may have influenced the extent of the difference in the change between the two groups before and after intervention.

Our results showed a worsening tendency in the SDS score among the control patients, while there was a small (non-significant) decrease in these scores among the LY patients, and state anxiety decreased in both groups, but not significantly. There was no significant change in VC, FEV_1, or 6MD in either group. Since it is generally known that an effective duration for a pulmonary rehabilitation program is over 6 weeks [37], the short study period in this report probably influenced these results. Taking this into account, our new 6-week COPD outpatients PR trial is under way. (Data was not shown in this paper.)

The key to treating depression and anxiety in COPD patients remains elusive. If laughter yoga can provide improved psychological QOL, it will be a useful addition to pulmonary rehabilitation for COPD patients.

We know that this study has several limitations. First, the number of patients is very small. We recently introduced an action plan for our pulmonary rehabilitation program that would have forced the study protocol to change, so we stopped entry into this study.

Second, the SDS and STAI scores did not change significantly, and this may be because among the enrolled patients, who came from our general COPD outpatient population, the baseline levels of depression and anxiety were lower than they would have been if we had focused enrollment on COPD patients with known depression and anxiety. Laughter yoga is very easy to perform, and may be beneficial for COPD patients with depression and anxiety.

Further studies with longer trial periods and greater numbers of COPD patients with known depression or anxiety should be encouraged.

Conclusions

The findings from this study reveal that laughter yoga may improve the psychological quality of life in patients with COPD. More studies need for establishing clinical usefulness of laughter yoga. We are very keen to improve the quality of life of patients with COPD using pulmonary rehabilitation with laughter yoga.

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Conflict of interest

The authors have no conflict of interest to be reported in relation to this study.

References

1) Decramer M, Vestbo J, Vestbo J et al. The Global Strategy for the Diagnosis, Management and Prevention of COPD, Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2015, http://www.goldcopd.org/. April, 29, 2015.
2) Lopez AD, Shibuya K, Rao C, et al. Chronic obstructive pulmonary disease: current burden and future projections. Eur Respir J 2006; 27: 397-412, 2006.
3) Mathers CD and Loncar D. Projections of Global mortality and burden of disease from 2002 to 2030. PLoS Med 2006; 3: e442.
4) Peruzza S, Sergi G, Vianello A, et al. Chronic obstructive pulmonary disease (COPD) in elderly subjects: impact on functional status and quality of life. Respir Med 2003; 97: 612-617.
5) Maurer J, Rebbapragada V, Borson S, et al. Anxiety and depression in COPD. Chest 2008; 134: 43S-56S.
6) Yohannes AM, Connolly MJ, Baldwin RC. A feasibility study of antidepressant drug therapy in depressed elderly patients with chronic obstructive pulmonary disease. Int J Geriatr Psychiatry 2001; 16: 451-454.
7) Pirraglia PA, Charbonneau A, Kader B, et al. Adequate initial antidepressant treatment among patients with chronic obstructive pulmonary disease in a cohort of depressed veterans. Prim Care Companion J Clin Psychiatry 2006; 8: 71-76.
8) Laughter yoga Global Movement for health, Joy & World peace, http://www.laghteryoga.org/. April, 29, 2015.
9) Japanese Respiration Society, eds. Guideline for lung function test –spirometry, flow-volume curve, diffusion capacity of the lung-. Medical Review, pp2, 2004.
10) Zung WWK. A self-rating depression scale. Arch Gen Psychiatry 1965; 12: 63-70.

11) Spielberger CD. Theory and research on anxiety: Anxiety and behavior. New York, Academic Press, 1966.
12) Fukuhara S, Bito S, Green J et al. Translation, adaptation, and validation of the SF-36 health survey for use in Japan. J Clin Epidemiol 1998; 51: 1037-1044.
13) Fukuhara S, Ware JE, Kosinski M et al. Psychometric and clinical tests of validity of the Japanese SF-36 Health Survey. J Clin Epidemiol 1998; 51: 1045-10533.
14) Fukuhara S, Suzukamo Y, Bito S et al. Manual of SF-36 Japanese version 1.2: Public Health Research Foundation, Tokyo, 2001.
15) Jones PW, Quirk FH, Baveystock CM, Littelejohns P. A self-complete measure for chronic airflow limitation : the St. George's Respiratory Questionnaire. Am Rev Respir Dis 1992; 145: 1321-1327.
16) Japanese society for respiratory care and rehabilitation, eds. Manual for respiratory rehabilitation –Exercise therapy – . Shorinsha, pp76, 2003.
17) Tze-Pin Ng, Mathew Niti, Wan-Cheng Tan, et al. Depressive symptoms and chronic obstructive pulmonary disease. Effect on Mortality, Hospital Readmission, Symptom Burden, Functional Status, and Quality of Life. Arch Intern Med 2007;167:60-67.
18) Schane RE, Woodruff PG, Dinno A, et al. Prevalence and risk factors for depressive symptoms in persons with chronic obstructive pulmonary disease. J Gen Intern Med 2008; 23:1757-62.
19) Bert LVD, Schemer T, Bor H, et al. The risk for depression comorbidity in patients with COPD. Chest 2009; 135: 108-114.
20) De Voogd JN, Wempe JB, Koeter GH, et al. Depression symptoms as predictors of mortality in patients with COPD. Chest 2009; 135: 619-625.
21) Omachi TA, Katz PP, Yelin EH. Depression and health-related quality of life in chronic obstructive pulmonary disease. Am J Med 2009; 122: 778.e9-778.e15.
22) Hayashi Y, Senjyu H, Iguchi A, et al. Prevalence of depressive symptoms in Japanese male patients with chronic obstructive pulmonary disease. Psychiatry and clinical Neurosciences 2011; 65: 82-88.
23) Schnell K, Weiss CO, Lee T, et al. The prevalence of clinically-relevant comorbid conditions in patients with physician-diagnosed COPD: a cross-sectional study using data from NHANES 1999-2008. BMC pulmonary Med 2012; 12: 26.
24) Jordan N, Lee TA, Valenstein M, et al. Effect of depression care on outcome in COPD patients with depression. Chest 2009; 135:626-632.
25) Garuti G, Cilione C, Dell'Orso D, et al. Impact of comprehensive pulmonary rehabilitation on anxiety and depression in hospitalized COPD patients. Monaldi Arch Chest Dis 2003; 59: 56-61.
26) Paz-Diez H, Montes de Oca M, Lopez JM, et al : Pulmonary rehabilitation improves depression, anxiety, dyspnea and health status in patients with COPD. Am J Phys Med Rehabil 2006; 86: 30-36.
27) Keating A, Lee A and Holland AE. What prevents people with chronic obstructive pulmonary disease from attending pulmonary rehabilitation? A systematic review. Chr Respir Dis 2011; 8: 89-99.
28) Norman Causins. Anatomy of an illness (As perceived by the patient). New Engl J Med 1976; 296: 1458-1463.
29) Bennett MP, Zeller JM, Rosenberg L, et al. The effect of mirthful laughter on stress and natural killer cell activity. Altern Ther Health Med. 2003; 9: 38-43.
30) Surwit RS and Sreatchneider MS. Role of stress in the etiology and treatment of diabetes mellitus. Psychosomatic Medicine 1993; 55: 380-393.
31) Hayashi K, Hayashi T, Iwanaga S, et al. Laughter lowered the increase in postprandial blood glucose. Diabetes Care 2003; 26: 1651-1652.

32) Hayashi T, Urayama O, Kawai K, et al. Laughter regulates gene expression in patients with type 2 diabetes. Psychother Psychosom 2006; 75: 62-65.

33) Hayashi T, Tsujii S, Iburi T, et al. Laughter up-regulates the genes related to NK cell activity in diabetes. Biomedical Research 2007; 28: 281-285.

34) Sugawara J, Tarumi T and Tanaka H. Effect of mirthful laughter on vascular function. Am J Cardiol 2010; 106: 856-859.

35) Shahidi M, Mojtahed A, Modabbernia A, et al. Laughter yoga versus group exercise program in elderly depressed women: a randomized controlled trial. Int J Geriatr Psychiatry 2011; 26: 322-327.

36) Dolgoff-Kaspar R, Baldwin A, Scott Johnson M, et al. Effect of laughter yoga on mood and heart rate variability in patients awaiting organ transplantation: a pilot study. Altern Ther Health Med 2012; 18: 53-58.

37) Japanese society for respiratory care and rehabilitation, eds. Manual for respiratory rehabilitation –Exercise therapy – 2nd edition. Shorinsha, pp42, 2012.