Influence of Ambient Music on Perceived Exertion During a Pulmonary Rehabilitation Session: A Randomized Crossover Study

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BACKGROUND: Pulmonary rehabilitation is a key element in the treatment of COPD. Music has been shown to have a positive effect on parameters related to a decrease in exercise tolerance. The aim of this study was to evaluate the effect of listening to ambient music on perceived exertion during a pulmonary rehabilitation session for COPD subjects. METHODS: COPD subjects randomly performed a session of pulmonary rehabilitation with or without ambient music. Perceived exertion (Borg scales), anxiety (Hospital Anxiety and Depression Scale-Anxiety Subscale), dyspnea (visual analog scale), and cardiorespiratory parameters were compared at the end of both sessions. RESULTS: Forty-one subjects were analyzed. The characteristics of the COPD subjects were as follows: age, 70.5 ± 8.4 y; body mass index, 22.7 ± 3.9 kg/m^2; and FEV$_1$, 38.6 ± 12.5 % predicted. Perceived exertion was not modified by ambient music, but anxiety was improved (*P* = .02). Dyspnea, fatigue and cardiorespiratory parameters were not influenced by music during a typical session of the pulmonary rehabilitation program. CONCLUSIONS: This study demonstrates that perceived exertion during one pulmonary rehabilitation session was not influenced by ambient music. However, a positive effect on anxiety was observed. (ClinicalTrials.gov registration NCT01833260.) *Key words: exercise; chronic obstructive pulmonary disease; COPD; anxiety; fatigue; music.* [Respir Care 2015;60(5):711–717.

Introduction

After initial skepticism, pulmonary rehabilitation has been shown to result in clinically important improvements and effectiveness in patients with COPD. It is an evidence-based, multidisciplinary, and comprehensive program, including exercise training. Its main objectives are reducing symptoms and improving the quality of life and participation in daily life activities of patients. Pulmonary rehabilitation has become a key element in the treatment of patients with COPD. Adherence to exercise training in pulmonary rehabilitation programs is variable and related more to psychosocial than physiological impairment.[1,2] It can be negatively influenced by dyspnea, anxiety, and perceived exertion. In 2006, the American Thoracic Society and European Respiratory Society mentioned in their joint statement that all strategies to improve adherence need to be investigated.[3]

Dyspnea is a subjective breathing discomfort experienced by many patients with COPD[4] and results from expiratory flow limitation and lung hyperinflation. Dyspnea is experienced particularly during exercise, resulting in reduced exercise tolerance. Moreover, lower limb mus-

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cle dysfunction also contributes to dyspnea during exercise.[5] Although previous research explained the physiological mechanisms causing breathlessness in subjects with COPD, dyspnea possesses an important emotional component.

Patients with COPD present with anxiety[6,7] and fatigue[8] associated with the unpleasant perception of dyspnea and related to various psychological factors.[8] Even if there is no evidence of a relationship between failure to complete a rehabilitation program and level of anxiety,[9] this last factor is related to reduced exercise tolerance.[10] Although anxiety modification is not associated with change in quality of life,[11] literature suggests that anxiety can contribute to poor adherence to a pulmonary rehabilitation program.[12] The relationship between anxiety and level of daily life physical activities of patients with COPD has not been well evaluated.[13]

All these components could be positively influenced by distractive auditory stimuli such as music. By analogy, pain perception is improved by focusing attention away from the painful stimulus.[14] The effect of music on psychologically modulated factors (mood, emotion, dyspnea) was investigated previously[15] and was related to its tempo according to the type of exercise. A slow tempo will benefit an endurance exercise,[16] and a fast tempo will improve the work load during exercise.[17] Moreover, listening to music was demonstrated to be beneficial in various situations such as during physical exercise,[15,18] physiotherapy sessions for subjects with cystic fibrosis,[19] and rehabilitation of elderly subjects.[20] To our knowledge, its effect was not investigated during a group pulmonary rehabilitation session.

The aim of this study was to evaluate the influence of ambient music on (1) perceived exertion and (2) level of anxiety during a pulmonary rehabilitation session for COPD subjects.

QUICK LOOK

Current knowledge

Distractive auditory stimuli such as music is used in a number of scenarios to reduce the severity of perceived unpleasant procedures. Pain perception appears to be improved by focusing attention away from the painful external stimuli. The impact of distractive auditory stimuli on the sensation of dyspnea has not been studied.

What this paper contributes to our knowledge

The addition of distractive auditory stimuli in the form of music during a session of pulmonary rehabilitation reduced perceived anxiety in a group of subjects with COPD. The effect was immediate, but there was no effect on perceived level of exertion or dyspnea.

Methods

Subjects

Subjects with COPD were recruited from the pulmonary rehabilitation program of Cliniques Universitaires Saint-Luc. To be included, subjects had to participate in the program for at least 1 month after the initial medical investigation in at least 2 of 3 weekly sessions, be free of exacerbations for 1 month, and have maintained exactly the same program session for both evaluated sessions. An exacerbation was defined as follows: “two or more (increased or new-onset) respiratory symptoms such as cough, sputum, wheezing, dyspnea, or chest tightness, lasting at least 3 days, and requiring treatment with antibiotics and/or steroids, and/or hospitalization.”[21] Subjects demonstrating rheumatoid pulmonary disease, sarcoidosis, kyphoscoliosis, psychiatric disease, or any musculoskeletal or neurological condition that would limit exercise performance were excluded.

Subjects gave their written informed consent. This study was approved by the institutional medical ethics committee (B403201117655).

Study Design

This was a randomized crossover controlled study reported by the Consolidated Standards of Reporting Trials (CONSORT) (Fig. 1). Each subject served as his or her own control and participated randomly in 2 sessions of the pulmonary rehabilitation program under 2 different conditions: with or without a distractive auditory stimulus. The distractive auditory stimulus was a mix of music pieces at the same tempo (120 beats/min). Music was played by 2 speakers in the room at a sound level of 70 decibels (measured in the middle of the room). Randomization of the conditions was performed by a computer-generated random number list. Each subject performed an individualized routine program of exercises next to the other subjects (groups of 20 subjects). The program included aerobic exercise on a cycle ergometer (30 min of interval training: 2 min at 80% of peak power output and 3 min at 50% of peak power output), a rower (endurance for 10 min: fixed intensity based on a visual analog scale score of 5), and a treadmill (based on the average 6-min walk test speed) and strengthening of upper arm and lower leg muscle groups (3 sets of 10 repetitions at intensities of 85% of one repetition maximum). Sessions took place 3 times a week and lasted 1 h and 15 min. Subjects trained at the same load during the 2 consecutive investigated sessions

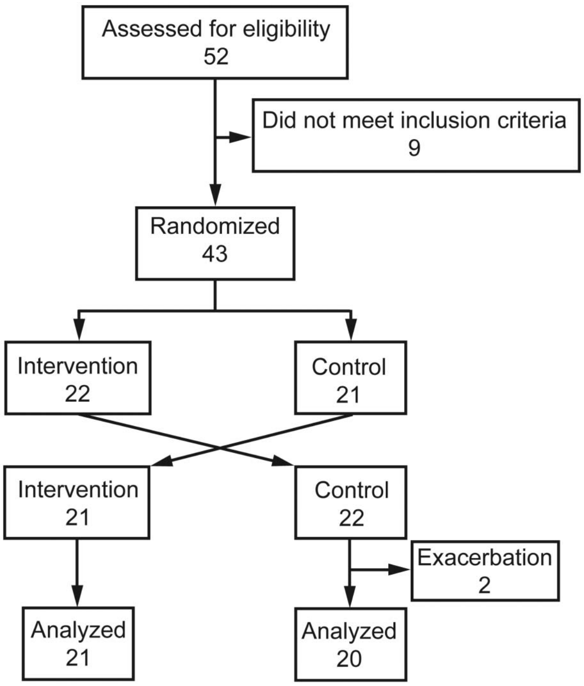

Fig. 1. Flow chart.

with or without the stimulus depending on its presence during the evaluation session. The interval between the investigated sessions varied from 1 to 6 d.

Outcomes

Perceived exertion was the main outcome. Heart rate, S_{pO_2}, and dyspnea intensity were measured at the beginning and end of each session. At the end of the exercise sessions, perceived exertion, fatigue, anxiety, and satisfaction regarding the session were quantified. Dyspnea intensity was measured by the visual analog scale (from zero [I am not at all short of breath] to 10 [The most short of breath I have ever been]).[22] Borg scales were used to rate perceived exertion and fatigue during the sessions.[23] Cardiorespiratory parameters (S_{pO_2} and heart rate) were measured by pulse oximetry (Onyx, Nonin, Plymouth, Minnesota). Anxiety was assessed by the Hospital Anxiety and Depression Scale-Anxiety Subscale (HADS-A). Level of satisfaction regarding the session was evaluated by a 10-point Likert scale.

Statistical Analyses

The sample size needed to detect the minimum clinically important difference on the Borg scale[4] with a power of 90 was determined (n = 37). Statistical analyses were performed using SPSS Statistics 21.0 (IBM, Armonk, New York). Cardiorespiratory parameters and dyspnea were expressed by the variation between the beginning and end of each session. The difference between the initial and final values was calculated and expressed as a percentage of the initial value (cardiorespiratory parameters) or as an absolute value (dyspnea). Normality of the distributions was verified by the Kolmogorov-Smirnov test. Results are expressed as mean ± SD and CI or as median with interquartile range depending on the normality of the distribution. Results were compared by the paired Student t test. Correlations were analyzed by the Pearson or Spearman correlation coefficient depending on the normality of the distribution. The significance level was set at .05.

Table 1. Demographic, Anthropometric, and Spirometric Data of Subjects With COPD

Parameter	Values
N	41
Males/females	38/3
Age (mean ± SD), y	70.5 ± 8.4
Height (mean ± SD), cm	171.7 ± 8.3
Weight (mean ± SD), kg	67.4 ± 14.3
BMI (mean ± SD), kg/m^2	22.7 ± 3.9
FVC (mean ± SD), % predicted	70.6 ± 13.8
FEV_1 (mean ± SD), % predicted	38.6 ± 12.5
TLC (mean ± SD), % predicted	112.5 ± 17.9
GOLD stage, n	
2	7
3	25
4	9

BMI = body mass index
TLC = total lung capacity
GOLD = Global Initiative for Chronic Obstructive Lung Disease

Results

The subjects' demographic, anthropometric, and spirometric data are summarized in Table 1. A total of 43 subjects were randomized, and 41 paired sessions were analyzed. Two subjects were excluded due to an exacerbation after the first session. Before each session, heart rate, S_{pO_2}, and dyspnea were similar ($P > .05$) (Table 2). Comparisons of outcomes obtained during sessions with or without music are presented in Tables 2 and 3. The results showed that listening to music during a typical session of a pulmonary rehabilitation program significantly decreased anxiety ($P = .02$) but did not modify perceived exertion, fatigue, dyspnea, or cardiorespiratory parameters. At the end of the sessions, dyspnea was similar for both conditions (4.9 ± 2.1 and 5.1 ± 2.3, respectively; $P = .47$).

When comparing paired sessions (with and without music), HADS-A, visual analog scale, and Borg scales were

Table 2. Outcomes Measured at the Beginning and End of Sessions Performed With and Without Ambient Music

Outcome	Beginning			End		
	With Music	Without Music	*P*	With Music	Without Music	*P*
Heart rate, beats/min	92.3 ± 16.1	93.1 ± 15.3	.71	101.4 ± 19.4	100.0 ± 7.5	.51
S_{pO_2}, %	91.7 ± 5.7	92.9 ± 4.3	.10	92.4 ± 4.7	92.5 ± 5.1	.90
Dyspnea intensity (visual analog scale), cm	4.6 ± 2.2	4.7 ± 2.0	.72	4.9 ± 2.1	5.1 ± 2.3	.46

Data are expressed as mean ± SD.

Table 3. Comparisons of Outcomes Measured During or After Sessions Performed With and Without Ambient Music

Outcome	Session With Music	Session Without Music	*P*
Heart rate variation (mean ± SD), %	11.15 ± 19.89 (95% CI 4.87–17.4)	8.24 ± 14.44 (95% CI 3.68–12.80)	.50
S_{pO_2} variation (mean ± SD), %	0.68 ± 4.27 (95% CI −0.67 to 2.03)	−0.39 ± 4.11 (95% CI −1.69 to 0.91)	.24
Dyspnea intensity variation (visual analog scale, mean ± SD), cm	0.32 ± 1.77 (95% CI −0.24 to 0.87)	0.41 ± 1.77 (95% CI −0.15 to 0.98)	.76
Anxiety (HADS-A), median (IQR)	8 (3)	8 (3)	.02
Perceived exertion (modified Borg scale), median (IQR)	5 (1)	4 (2)	.33
Fatigue (Borg scale), median (IQR)	13 (4)	13 (1)	.19
Satisfaction, median (IQR)	8 (3)	8 (2)	.75

HADS-A = Hospital Anxiety and Depression Scale-Anxiety Subscale
IQR = interquartile range

Table 4. Correlation Coefficients for Each Outcome Obtained During Sessions With and Without Ambient Music

Outcome	Correlation	
	r	*P*
Heart rate variation, %	−0.22	.17
S_{pO_2} variation, %	0.07	.69
Visual analog scale, cm	0.70	< .001
HADS-A	0.58	< .001
Modified Borg scale	0.33	.04
Borg scale	0.45	.003
Satisfaction	0.26	.17

HADS-A = Hospital Anxiety and Depression Scale-Anxiety Subscale

intercorrelated (Table 4), but there was no relationship for variations in cardiorespiratory parameters or satisfaction.

For both sessions, anxiety was significantly correlated with dyspnea (Fig. 2) but was not correlated with the other cardiorespiratory parameters. Fatigue was significantly correlated with perceived exertion (with music: r = 0.55, $P < .001$; without music: r = 0.42, $P = .006$). However, these scales were not correlated with dyspnea at the end of the session.

Discussion

To our knowledge, this is the first study to investigate the immediate effect of listening to ambient music during a pulmonary rehabilitation session. The results highlight an improvement in anxiety while listening to music without an effect on perceived exertion in subjects with COPD at the end of the pulmonary rehabilitation sessions. This was shown by an improvement in the HADS-A with a similar Borg scale score between the 2 conditions.

Music was demonstrated to positively influence sensations of endurance and fatigue by distracting subjects.[24,25] Moreover, Bauldoff et al[26] showed a positive effect of music on dyspnea during performance of daily life activities without modifying anxiety in subjects with COPD. In our study, we noted a decreased anxiety level when subjects listened to music during the exercise sessions. Moreover, a score of >8 points on the HADS-A is considered borderline for anxiety. We found such a mean score in the sessions without music, which was not the case for the sessions with music. The influence of music on anxiety could be considered, depending on the patient's level of anxiety.

Even if exercises are prescribed in the treatment of anxiety disorders,[27] in practice, these exercises can generate anxiety due to the exercise limitations of patients with

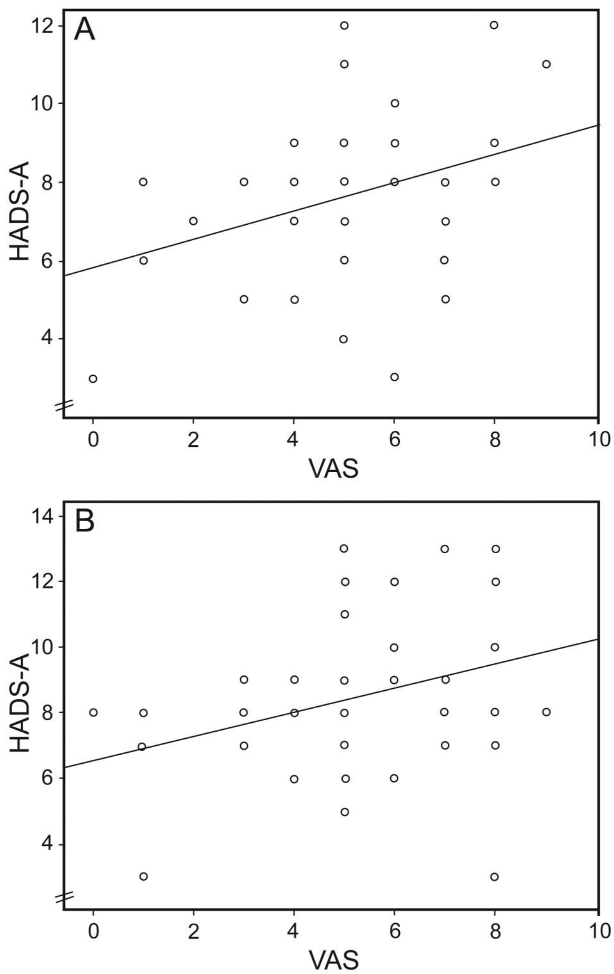

Fig. 2. Relationship between anxiety level (Hospital Anxiety and Depression Scale-Anxiety Subscale [HADS-A]) and dyspnea (visual analog scale [VAS]) measured at the end of the sessions. A: with music (r = 0.33, *P* = .033). B: Without music (r = 0.32, *P* = .039).

COPD.[10] It would be interesting to specify this influence related to the level of training, which is known to modify the anxiety response to exercise,[28] and type of music.[29] In our population, all subjects had already participated in the program for at least 1 month at the onset of the study, which excluded the influence of training level. The improvement in anxiety could also be related to the motivational environment that music can generate. Such an environment was demonstrated to significantly modify the psychological response with an increase in the stress-responsive hormone cortisol.[30]

Unlike numerous studies on healthy adults,[31-33] athletes,[34-36] and subjects with COPD,[15,18,37,38] perception of exertion, fatigue, and dyspnea was not influenced by music in our population. The absence of an effect on these parameters is surprising. It could be related to the intensity of the exercise even if the relationship between exercise intensity and benefit of music is not clear for low-to-moderate intensities.[15] In our study, exercise intensity was moderate following the pulmonary rehabilitation recommendation that the dyspnea level should not exceed 4–6 on the Borg scale. The mean value was 5 in our subjects at the end of the session. Moreover, dyspnea was significantly intercorrelated between both sessions, suggesting the same exercise intensity for the subjects during the sessions with and without music. The absence of effect on dyspnea is probably related to the measurement of the sensory dimension of dyspnea in our study. Only its affective dimension was demonstrated to be influenced by attentional distraction.[39,40]

The conditions of the sessions could also explain the absence of a music effect. In contrast to other studies on the effect of music on performance, our subjects were involved in a group program, and music was diffused in the room. When subjects wear headphones, such as in other studies, the distractive phenomenon is probably more important. Another explanation could be related to the style of music. One kind of music is not suitable for all subjects because differences were noted previously depending on personal preferences.[41] This hypothesis is reinforced by the absence of a correlation in satisfaction between subjects in both sessions. It highlights the heterogeneity in subject satisfaction. However, the choice of music was shown to have no influence on fatigue perception in healthy subjects.[24]

The concept of the minimum clinically important difference represents the smallest difference in the outcome of interest perceived by subjects as important and that may lead to a change. It is complementary to the statistical significance. The minimum clinically important difference was determined previously for the visual analog scale (1 cm),[42] Borg scale (1 point),[43] and HADS-A (1.5 points).[44] It is not surprisingly that this difference was not obtained between both sessions. This concept is poorly applicable to the design of our study because it was shown that the minimum clinically important difference for the HADS-A was not reached after a 6-week pulmonary rehabilitation program.[45] The minimum clinically important difference is probably more interesting for mid-term or long-term follow-up. It thus seems normal to remain below this level when comparing 2 close sessions as in our protocol.

Exercise tolerance, expressed by variation in heart rate and S_{pO_2} during an exercise training session, was similar in sessions with and without music. In contrast to studies showing a modified heart rate when listening to music during exercises,[17] we did not observe this modification. Based on dyspnea, the effort intensity was similar in both sessions. The variations in S_{pO_2} and heart rate during exercise were indeed identical and independent of the auditory stimulus. We did not observe an impact of music on exercise capacity, as was demonstrated previously.[38] Our results are similar to those of another study that evaluated the effect of listening to music in subjects with COPD during a 6-min walk test,[46] even though exercise duration was different. The design of our study, with a similar level of exercise in both sessions and an evaluation of only one session, did not permit us to observe this influence during a long-term period.

Standardization of methodological conditions is important to avoid some previously demonstrated external influences. Choice of music tempo is important. A tempo of 120 beats/min is the tempo spontaneously adopted by people during an exercise such as walking[47] or while performing usual daily activities.[48] On a treadmill, this tempo is optimal for slow walking.[47] Moreover, it is the more prevalent tempo in a sample of 74,042 pieces of modern music.[49] To avoid the demonstrated influence of loudness on treadmill exercise,[50] the sound level was fixed for all experiments. Moreover, some uncontrolled factors could have influenced the level of anxiety in our study. Indeed, anxiety symptoms were associated with sleep disturbances in the elderly[51] and with mood,[52] which could have presented day-to-day variations in our subjects.

Conclusions

In summary, listening to ambient music during a pulmonary rehabilitation session decreased the negative feelings experienced by subjects with COPD and improved anxiety levels. This effect was immediate. However, the level of perceived exertion was not influenced by this short-term intervention. In the future, we will consider introducing music during pulmonary rehabilitation sessions for patients with COPD. However, the benefits of music on a complete pulmonary rehabilitation program need to be evaluated.

REFERENCES

1. Keating A, Lee A, Holland AE. What prevents people with chronic obstructive pulmonary disease from attending pulmonary rehabilitation? A systematic review. Chron Respir Dis 2011;8(2):89-99.
2. Young P, Dewse M, Fergusson W, Kolbe J. Improvements in outcomes for chronic obstructive pulmonary disease (COPD) attributable to a hospital-based respiratory rehabilitation programme. Aust N Z J Med 1999;29(1):59-65.
3. Nici L, Donner C, Wouters E, Zuwallack R, Ambrosino N, Bourbeau J, et al. American Thoracic Society/European Respiratory Society statement on pulmonary rehabilitation. Am J Respir Crit Care Med 2006;173(12):1390-1413.
4. Glaab T, Vogelmeier C, Buhl R. Outcome measures in chronic obstructive pulmonary disease (COPD): strengths and limitations. Respir Res 2010;11:79-90.
5. Debigaré R, Maltais F. The major limitation to exercise performance in COPD is lower limb muscle dysfunction. J Appl Physiol 2008; 105(2):751-753; discussion 755-757.
6. Eisner MD, Blanc PD, Yelin EH, Katz PP, Sanchez G, Iribarren C, Omachi TA. Influence of anxiety on health outcomes in COPD. Thorax 2010;65(3):229-234.
7. Cooper CB. The connection between chronic obstructive pulmonary disease symptoms and hyperinflation and its impact on exercise and function. Am J Med 2006;119(10 Suppl 1):21-31.
8. Theander K, Unosson M. Fatigue in patients with chronic obstructive pulmonary disease. J Adv Nurs 2004;45(2):172-177.
9. Doyle C, Dunt D, Ames D, Selvarajah S. Managing mood disorders in patients attending pulmonary rehabilitation clinics. Int J Chron Obstruct Pulmon Dis 2013;8:15-20.
10. Giardino ND, Curtis JL, Andrei AC, Fan VS, Benditt JO, Lyubkin M, et al. Anxiety is associated with diminished exercise performance and quality of life in severe emphysema: a cross-sectional study. Respir Res 2010;11:29-30.
11. Pirraglia PA, Casserly B, Velasco R, Borgia ML, Nici L. Association of change in depression and anxiety symptoms with functional outcomes in pulmonary rehabilitation patients. J Psychosom Res 2011; 71(1):45-49.
12. Fan VS, Meek PM. Anxiety, depression, and cognitive impairment in patients with chronic respiratory disease. Clin Chest Med 2014; 35(2):399-409.
13. Nguyen HQ, Fan VS, Herting J, Lee J, Fu M, Chen Z, et al. Patients with COPD with higher levels of anxiety are more physically active. Chest 2013;144(1):145-151.
14. Villemure C, Bushnell MC. Cognitive modulation of pain: how do attention and emotion influence pain processing? Pain 2002;95(3): 195-199.
15. Karageorghis CI, Priest DL. Music in the exercise domain: a review and synthesis (Part I). Int Rev Sport Exerc Psychol 2012;5(1):44-66.
16. Copeland BL, Franks BD. Effects of types and intensities of background music on treadmill endurance. J Sports Med Phys Fitness 1991;31(1):100-103.
17. Waterhouse J, Hudson P, Edwards B. Effects of music tempo upon submaximal cycling performance. Scand J Med Sci Sports 2010; 20(4):662-669.
18. Karageorghis CI, Priest DL. Music in the exercise domain: a review and synthesis (Part II). Int Rev Sport Exerc Psychol 2012;5(1):67-84.
19. Grasso MC, Button BM, Allison DJ, Sawyer SM. Benefits of music therapy as an adjunct to chest physiotherapy in infants and toddlers with cystic fibrosis. Pediatr Pulmonol 2000;29(5):371-381.
20. Johnson G, Otto D, Clair AA. The effect of instrumental and vocal music on adherence to a physical rehabilitation exercise program with persons who are elderly. J Music Ther 2001;38(2):82-96.
21. Celli BR, MacNee W. Standards for the diagnosis and treatment of patients with COPD: a summary of the ATS/ERS position paper. Eur Respir J 2004;23(6):932-946.
22. Burdon JG, Juniper EF, Killian KJ, Hargreave FE, Campbell EJ. The perception of breathlessness in asthma. Am Rev Respir Dis 1982; 126(5):825-828.
23. Borg GA. Psychophysical bases of perceived exertion. Med Sci Sports Exerc 1982;14(5):377-381.
24. Potteiger JA, Schroeder JM, Goff KL. Influence of music on ratings of perceived exertion during 20 minutes of moderate intensity exercise. Percept Mot Skills 2000;91(3 Pt 1):848-854.
25. Yamashita S, Iwai K, Akimoto T, Sugawara J, Kono I. Effects of music during exercise on RPE, heart rate and the autonomic nervous system. J Sports Med Phys Fitness 2006;46(3):425-430.
26. Bauldoff GS, Hoffman LA, Zullo TG, Sciurba FC. Exercise maintenance following pulmonary rehabilitation: effect of distractive stimuli. Chest 2002;122(3):948-954.
27. Jayakody K, Gunadasa S, Hosker C. Exercise for anxiety disorders: systematic review. Br J Sports Med 2014;48(3):187-196.

28. Brownley KA, McMurray RG, Hackney AC. Effects of music on physiological and affective responses to graded treadmill exercise in trained and untrained runners. Int J Psychophysiol 1995;19(3):193-201.
29. Baldari C, Macone D, Bonavolontà V, Guidetti L. Effects of music during exercise in different training status. J Sports Med Phys Fitness 2010;50(3):281-287.
30. Hogue CM, Fry MD, Fry AC, Pressman SD. The influence of a motivational climate intervention on participants' salivary cortisol and psychological responses. J Sport Exerc Psychol 2013;35(1):85-97.
31. Simpson SD, Karageorghis CI. The effects of synchronous music on 400-m sprint performance. J Sports Sci 2006;24(10):1095-1102.
32. Styns F, van Noorden L, Moelants D, Leman M. Walking on music. Hum Mov Sci 2007;26(5):769-785.
33. Szabo A, Small A, Leigh M. The effects of slow- and fast-rhythm classical music on progressive cycling to voluntary physical exhaustion. J Sports Med Phys Fitness 1999;39(3):220-225.
34. Biagini MS, Brown LE, Coburn JW, Judelson DA, Statler TA, Bottaro M, et al. Effects of self-selected music on strength, explosiveness, and mood. J Strength Cond Res 2012;26(7):1934-1938.
35. Ferguson AR, Carbonneau MR, Chambliss C. Effects of positive and negative music on performance of a karate drill. Percept Mot Skills 1994;78(3 Pt 2):1217-1218.
36. Terry PC, Karageorghis CI, Saha AM, D'Auria S. Effects of synchronous music on treadmill running among elite triathletes. J Sci Med Sport 2012;15(1):52-57.
37. Szmedra L, Bacharach DW. Effect of music on perceived exertion, plasma lactate, norepinephrine and cardiovascular hemodynamics during treadmill running. Int J Sports Med 1998;19(1):32-37.
38. Thornby MA, Haas F, Axen K. Effect of distractive auditory stimuli on exercise tolerance in patients with COPD. Chest 1995;107(5):1213-1217.
39. von Leupoldt A, Dahme B. Differentiation between the sensory and affective dimension of dyspnea during resistive load breathing in normal subjects. Chest 2005;128(5):3345-3349.
40. von Leupoldt A, Taube K, Schubert-Heukeshoven S, Magnussen H, Dahme B. Distractive auditory stimuli reduce the unpleasantness of dyspnea during exercise in patients with COPD. Chest 2007;132(5):1506-1512.
41. Kopacz M. Personality and music preferences: the influence of personality traits on preferences regarding musical elements. J Music Ther 2005;42(3):216-239.
42. Ries AL. Minimally clinically important difference for the UCSD Shortness of Breath Questionnaire, Borg Scale, and Visual Analog Scale. COPD 2005;2(1):105-110.
43. Cazzola M, MacNee W, Martinez FJ, Rabe KF, Franciosi LG, Barnes PJ, et al. Outcomes for COPD pharmacological trials: from lung function to biomarkers. Eur Respir J 2008;31(2):416-469.
44. Puhan MA, Frey M, Büchi S, Schünemann HJ. The minimal important difference of the Hospital Anxiety and Depression Scale in patients with chronic obstructive pulmonary disease. Health Qual Life Outcomes 2008;6:46-52.
45. Griffiths TL, Burr ML, Campbell IA, Lewis-Jenkins V, Mullins J, Shiels K, et al. Results at 1 year of outpatient multidisciplinary pulmonary rehabilitation: a randomised controlled trial. Lancet 2000;355(9201):362-368.
46. Pfister T, Berrol C, Caplan C. Effects of music on exercise and perceived symptoms in patients with chronic obstructive pulmonary disease. J Cardiopulm Rehabil 1998;18(3):228-232.
47. Hirasaki E, Moore ST, Raphan T, Cohen B. Effects of walking velocity on vertical head and body movements during locomotion. Exp Brain Res 1999;127(2):117-130.
48. MacDougall HG, Moore ST. Marching to the beat of the same drummer: the spontaneous tempo of human locomotion. J Appl Physiol 2005;99(3):1164-1173.
49. Moelants D. Preferred tempo reconsidered. In: Stevens C, Burnham D, McPherson G, Schubert E. Renwick J, editors. Proceedings of the 7th International Conference on Music Perception and Cognition. Adelaide: Causal Productions; 2002:580-583.
50. Edworthy J, Waring H. The effects of music tempo and loudness level on treadmill exercise. Ergonomics 2006;49(15):1597-1610.
51. Spira AP, Friedman L, Flint A, Sheikh JI. Interaction of sleep disturbances and anxiety in later life: perspectives and recommendations for future research. J Geriatr Psychiatry Neurol 2005;18(2):109-115.
52. Yohannes AM, Alexopoulos GS. Depression and anxiety in patients with COPD. Eur Respir Rev 2014;23(133):345-349.