

PSYCHOSOCIAL ISSUES

Association between Maximal Aerobic Capacity and Psychosocial Factors in Adults With Moderate-to-Severe Asthma

FELIPE A.R. MENDES, P.T., M.SC.,¹ ADRIANA C. LUNARDI, P.T., PH.D.,¹ RONALDO A. SILVA, P.T., M.SC.,¹
ALBERTO CUKIER, M.D., PH.D.,³ RAFAEL STELMACH, M.D., PH.D.,³ MILTON A. MARTINS, M.D., PH.D.,²
AND CELSO R.F. CARVALHO, P.T., PH.D.^{1,*}

¹Department of Physical Therapy, School of Medicine, University of Sao Paulo, Sao Paulo, Brazil.

²Department of Medicine, School of Medicine, University of Sao Paulo, Sao Paulo, Brazil.

³Department of Pulmonary Diseases, School of Medicine, University of Sao Paulo, Sao Paulo, Brazil.

Background. The symptoms of asthma impair health-related quality of life (HRQoL), increase anxiety and depression and may keep subjects from engaging in physical exercise. Physical inactivity has been related to poor asthma outcomes; however, the association between physical fitness and psychosocial disorders remains poorly understood. **Objective.** To verify the association between aerobic capacity, HRQoL, and psychological distress in adults with moderate or severe persistent asthma who were clinically stable. **Methods.** Eighty-eight participants (68 females) with either moderate or severe persistent asthma (age range, 20–60 years) who were under medical treatment for at least 6 months and considered clinically stable were studied. Participants were evaluated on two non-consecutive days. On the first day, the HRQoL, depression and anxiety levels and pulmonary function were assessed. On the second day, subjects underwent cardiopulmonary exercise testing. **Results.** Using the agglomerative cluster approach, two clusters were identified: 21 participants (24%) were grouped in Cluster 1, and 67 (76%) were grouped in Cluster 2. Asthmatic subjects from Cluster 1 exhibited increased aerobic capacity, better HRQoL and lower depression levels than did subjects in Cluster 2 ($p < .05$). No difference was observed between the clusters with respect to gender, age, body mass index (BMI) or pulmonary function ($p > .05$). The discriminant function model exhibits good accuracy ($R^2 = 0.79$) and predicted 93% of the case allocations. **Conclusion.** Our results suggest an association between reduced exercise capacity, low HRQoL and increases in depressive symptoms in clinically stable asthmatic subjects. These results suggest the need to assess physical fitness and psychosocial distress during asthma treatment and the importance of a multidisciplinary approach.

Keywords asthma, cluster, depression, fitness

INTRODUCTION

Asthma is a chronic inflammatory disorder of the airways that causes recurring episodes of wheezing, breathlessness, chest tightness and coughing (1). The burden of asthma leads to psychological distress, and asthmatic subjects are more likely to be depressed and anxious than those without asthma (2, 3). The symptoms of asthma exert a negative impact on daily life activities (4), and, as a result, those with asthma exhibit significantly compromised health-related quality of life (HRQL) (5, 6). Asthma symptoms experienced during daily physical activities or the fear to trigger such symptoms may keep asthmatic subjects from engaging in physical exercise (7), which often leads to a detrimental health cycle that includes an aversion to exercise practice, a low overall level of habitual activity and a reduction in physical fitness (8–10).

There is evidence suggesting that an increase in aerobic capacity improves asthma control and psychosocial factors (11–13); additionally, cross-sectional

studies observed that higher levels of physical activity in asthmatic subjects has been associated with a reduced number of exacerbations (14) and increased self-perceived health (15). Although these studies may suggest an association between physical fitness and asthma health outcomes (14, 15), physical activity was quantified using questionnaires that have limited reliability and validity compared with laboratory measurement of physical fitness (16).

The inverse association between physical capacity and psychosocial function has been extensively investigated in the general population (17, 18), elderly individuals (19) and patients with COPD (20, 21) and heart failure (22). However, little is known about the contribution of physical capacity to the HRQoL in asthmatic subjects. In addition, markers of disease severity in asthma are only modestly related to HRQoL scores (23, 24), suggesting that additional factors may be important. Thus, efforts should be directed at understanding the reasons responsible for the impairment of HRQoL in asthmatic subjects with more severe disease who have worse HRQoL (25). Based on this assumption, the aim of the present study was to verify the association between aerobic capacity, HRQoL, and psychological distress in adults with moderate or severe persistent asthma who were clinically stable.

Institution where the work was performed: Clinics Hospital, School of Medicine, University of São Paulo, São Paulo, Brazil.

*Corresponding author: Celso R. F. Carvalho, Department of Medicine, School of Medicine, University of Sao Paulo Av. Dr. Arnaldo 455–room 1210 01246–903–Sao Paulo – SP, Brazil; Tel: 55 11 3066 7317; Fax: 55 11 3085 0992 or 55 11 3091 7462; E-mail: cscarval@usp.br

METHODS

Participants

This study included 88 asthmatic outpatients (68 females) with moderate or severe persistent asthma aged 20–60 years from a tertiary university hospital. Asthma diagnoses were based on the Global Initiative for Asthma (1). All participants had been under medical treatment for ≥ 6 months, were considered clinically stable (i.e. no crises or changes in medication, for at least 30 days) and were not participating in any regular physical training program. Clinical stability was evaluated by a daily diary that quantified asthma symptoms, such as cough, diurnal or nocturnal dyspnea, wheezing and use of relief medication as previously described (12). Participants diagnosed with concurrent pathological conditions, such as cardiovascular, musculoskeletal or other pulmonary diseases, were excluded. The Clinics Hospital Ethics Committee approved the study (protocol number 0297/07), and subjects were evaluated only after they had signed informed consent.

Experimental Design

This cross-sectional study was conducted using participants from previous studies (12,13). Asthmatic subjects were evaluated over the course of two non-consecutive days. On the first day, participants' HRQoL, depression and anxiety levels, pulmonary function, and anthropometric data were evaluated. On the second day, subjects underwent cardiopulmonary exercise testing. Participants were not tested for exercise-induced asthma.

Assessments

Cardiopulmonary Exercise Testing. Participants were evaluated using a symptom-limited treadmill test on a digital computer-based exercise system (Sensormedics 229, USA) with breath-by-breath analysis according to the Balke-modified protocol (26). A bronchodilator (400 μ g salbutamol) was used 15 minutes prior to cardiopulmonary exercise testing to allow subjects to reach maximal oxygen consumption. All asthmatic subjects achieved physical exhaustion as determined by the following criteria: reaching the plateau or peak VO_2 independent of the increased workload; reaching the maximum predicted heart rate ($\pm 5\%$); or a respiratory coefficient ≥ 1.10 with the subject being unable to maintain the speed test (27). Aerobic capacity was classified according to the American Heart Association (28).

Asthma-Specific Health-Related Quality of Life (HRQoL). HRQoL was assessed by the QOL-EPM questionnaire (Asthma Quality of Life from Escola Paulista de Medicina) (29), which consists of four domains: physical limitation (11 questions), frequency of symptoms (2 questions), socioeconomic (11 questions) and psychosocial factors (7 questions), with maximal scores of 33, 6, 11, and 7 points, respectively. The total score was calculated as the average of the four domains. Every domain was converted to percentages, and lower scores represent better

HRQoL. This questionnaire exhibits good reliability (from 0.7 to 0.9).

Depression Level. Depression was evaluated by the Beck Depression Inventory (BDI) (30), which had been validated in Portuguese (31); all participants were Portuguese speakers. The BDI consists of 21 assertions scored from 1 to 3; the total score classifies the individual as not having depression (0–9) or depressed (>9).

Anxiety Level. Anxiety was evaluated using the State-Trait Anxiety Inventory (STAI) (32), which had been validated in Portuguese (31); all participants were Portuguese speakers. The STAI consists of two scales: “trait anxiety” (a transitory state of tension depending on the living condition) and “state anxiety” (the individual’s personality facing an acute threatening situation). Every scale is composed of 20 assertions, which are scored from 1 to 4. Every scale consists of 20 assertions scored on a scale of 1 to 4. Total scores <33 , from 33 to 49, and >49 indicate mild, moderate, and high levels of anxiety, respectively.

Lung Function. Lung function was assessed by spirometry (Sensormedics229, USA). The related technical procedures were performed as recommended by the American Thoracic Society/European Respiratory Society (33), and predicted normal values were those previously proposed (34). The parameters measured were as follows: Forced Vital Capacity (FVC), Forced Expiratory Volume in the First Second (FEV_1), Peak Expiratory Flow (PEF), Forced Expiratory Flow 25–75% ($\text{FEF}_{25-75\%}$) and the FEV_1/FVC ratio.

Anthropometric Measures. The body mass was measured by a balance (scale of 0.1 kg) with subjects wearing minimal clothing and no shoes, and height was measured with a stadiometer (Filizola, Sao Paulo, Brazil). Body mass index (BMI) was calculated by dividing the weight (in kilograms) by the square of the height (in meters).

Statistical Analysis

Normality was evaluated using the Kolmogorov–Smirnov test, and data are presented as the mean and standard deviation (SD). Uniform cluster analysis methodology was applied using an agglomerative two-step test and the log-likelihood method distance measure. The minor Schwarz’ Bayesian information criterion (BIC) was used to determine the number of clusters. This is an analytical technique that identifies subgroups of a sample according to their similarities to later determine which variables best discriminate these subgroups of the group *a priori* (35). The variables selected for cluster analysis were $\text{VO}_{2\text{max}}$ (% of predicted), all domains of HRQoL, BMI, age, and FEV_1 (% of predicted). To compare differences between clusters, Student’s *t*- and chi-squared tests were used for parametric continuous and categorical variables, respectively. Stepwise forward discriminant analysis using Wilks’ lambda and Fisher’s linear functions was performed. Discriminant analysis was applied to identify factors that discriminate independently pre-specified groups and determined whether the subjects assigned to one group were

TABLE 1.—Baseline characteristics and asthmatics stratified by cluster analysis.

	All patients	Cluster 1	Cluster 2	<i>p</i>
Number of patients	88	21	67	
Gender (F/M)	20/68	17/4	51/16	.77
Age (years old)	36.9 (8.5)	34.9 (8.2)	37.5 (8.5)	.21
BMI (kg/m ²)	24.2 (2.9)	4.1 (3.4)	24.3 (2.8)	.74
Aerobic capacity				
VO _{2max} (mLO ₂ /kg/min)	23.1 (5.1)	26.8 (5.6)	22.0 (4.3)*	<.001
(% predicted)	73.5 (14.5)	83.8(12.0)	70.3 (13.8)*	<.001
Lung function				
FEV ₁ (L/min)	2.3 (0.5)	2.3 (0.5)	2.3 (0.5)	.91
(% predicted)	81.0 (14)	80.1 (17.0)	81.2 (12.6)	.68
HRQoL domains (score)				
Physical limitation	60.4 (15)	44.7 (11.8)	65.1 (12.5)*	<.001
Symptoms frequency	68.2 (17.8)	56.0 (20.3)	71.8 (15.5)*	<.001
Economic social	69.0 (20.4)	50.2 (20.6)	74.7 (16.4)*	<.001
Psychosocial	55.6 (23.4)	32.0 (14.9)	63.0 (20.6)*	<.001
Total	62.1 (12.7)	48.0 (13.8)	66.6 (8.8)*	<.001
Psychological distress				
Depression (absent/depression)	27/61	12/9	14/53*	<.001
Trait anxiety (mild-to-moderate/severe)	59/85	11/10	51/16	.09
State anxiety (mild-to-moderate/severe)	16/72	9/12	44/23	.11

Notes: Legend: Data are presented as mean and standard deviation ($\pm$ SD) or absolute numbers; F = female; M = male; BMI = body mass index; VO_{2max} = maximum oxygen consumption; FEV₁ = forced expiratory volume during the first second; HRQoL = health-related quality of life; **p* < .05 compared with Cluster 1.

different from those assigned to another group (35). The equality of variance was assessed using BOX M (*p* > .05 represents equal variance). The dependent variable was cluster classification; independent variables were the same variables used in cluster analysis. The statistical significance level was set at 5% for all tests. The software package SPSS version 17.0 (SPSS, Inc., Chicago, Ill) was used for statistical analyses.

RESULTS

Participant Characteristics

All of the 88 asthmatic subjects successfully completed the protocol, and no adverse events were observed. Data regarding the asthmatics characteristics are presented in Table 1. Sixty-eight subjects (78%) were female, and 69 subjects were considered to have weak or very weak aerobic capacity according to the AHA. Seventy-six (83%) subjects were classified as having poor quality of life (a score of >50 points on the asthma-specific HRQoL questionnaire), and 47 (53%) subjects exhibited normal lung function (FEV₁ and FEV₁/FVC $\geq$ 80% of predicted). In addition, 61 (69%) subjects exhibited depressive symptoms, 85 (97%) exhibited “trait anxiety”, and 72 (82%) exhibited “state anxiety” symptoms.

Cluster Analysis

Using the agglomerative cluster approach, two clusters were identified. Twenty-one asthmatic subjects (24%) were grouped in Cluster 1, and 67 (76%) were grouped in Cluster 2. Asthmatic subjects from Cluster 1 exhibited higher aerobic capacity, better HRQoL, and lower levels of depression than did asthmatic subjects in Cluster 2

(Table 1; *p* < .05). No difference was observed between both clusters in terms of gender, age, BMI, pulmonary function, or anxiety levels (Table 1; *p* > .05).

Discriminant Analysis

In a multiple discriminant analysis, the significant determinants for the model were the percentage of predicted VO₂ (%) and three domains of the HRQoL questionnaire (physical limitations, socioeconomic, and psychosocial factors). The discriminant function model exhibits good accuracy ($R^2 = 0.79$) and predicted 93% of the case allocations. Pulmonary function (FEV₁ in % predicted), BMI, age, and the domains symptoms frequency of the HRQoL questionnaire were not significant determinants in the model.

DISCUSSION

The present study demonstrated that lower aerobic capacity was associated with reduced HRQoL and increased depression symptoms in asthmatic subjects independent of lung function, BMI, and age. It is noteworthy that although our subjects were clinically stable, most of them exhibited poor aerobic capacity. These results reinforce the idea that the burden of asthma leads to impairment in physical, functional, emotional, and social domains and underscores the necessity of an approach that extends beyond the simple treatment of a pulmonary disorder. These results are aligned with the GINA guidelines (1) recommending that, for proper asthma clinical control, limitations in daily life activities and physical exercise should be investigated.

In asthmatic subjects, higher levels of physical activity are related to a reduced number of exacerbations (14) and increased self-perceived health (15). Although this

association does not necessarily imply causality, there are some plausible reasons to explain why these factors can affect each other. For instance, the increase in overall physical capacity, especially cardiorespiratory endurance, can improve leisure and daily life physical activities, which improves social interaction, self-efficacy (an individual's ability to perform specific activities) and disease control over daily life (36). In addition, the relationship between physical capacity, HRQoL, and asthma control has been previously suggested in two distinct pathways: first, evidence exists that an improvement in aerobic capacity improves both HRQoL and asthma control (12, 37); second, subjects with uncontrolled asthma exhibit a higher risk for limitation in outdoor and physical activities (38) that can impair the cardiorespiratory system and psychosocial factors. Nevertheless, to the best of our knowledge, this is the first study to demonstrate a baseline association between aerobic capacity and psychosocial factors in asthmatic subjects despite disease control.

In our study, asthmatic subjects from both clusters exhibited similar FEV₁ values, suggesting that lung function was not a determining feature of aerobic capacity and HRQoL. FEV₁ is important to quantify the degree of lung impairment, asthma control, and disease severity (1) but may not represent the derangement of other body systems, which can affect aerobic capacity and quality of life (20). Moreover, a well-conducted systematic review observed that the improvement of physical capacity in asthmatic subjects did not change pulmonary function (10). However, our results do not exclude the importance of FEV₁ on HRQoL and cardiopulmonary capacity because our subjects were under optimized medical treatment and because their lung function was near normal predicted values.

Although our study was not designed to investigate the impairment of aerobic capacity in asthmatic subjects, this finding may be considered important because it reinforces the GINA guideline (1) recommendation that periodic assessment of the limitations in daily life activities and physical exercise is key to improving a patient's quality of life. Additionally, we are aware of only two studies investigating the maximal aerobic capacity in adults with asthma, and they yielded conflicting results. Clark and colleagues verified that adults with stable mild-to-moderate asthma are physically unfit compared with healthy subjects (8), while Garfinkel did not observe any difference between maximal aerobic capacity and predicted normal values in subjects with mild-to-moderate stable asthma (39). Comparison between our results and those of Clark and Garfinkel is difficult because our subjects exhibited worse disease severity (higher prevalence of moderate and severe asthma).

Certain limitations of this study should be noted. A bigger sample size could improve the association between psychosocial and aerobic capacity; however, to the best of our knowledge, our study included the largest number of asthmatic subjects evaluated with respect to maximal aerobic capacity and psychosocial distress. We used cardiopulmonary exercise testing, a gold standard tool to evaluate

maximal oxygen consumption, which certainly provides a more precise measurement of physical fitness. In addition, we included 10 subjects per variable, which is more than the minimum recommendation (five subjects per variable) for statistical analysis (35). The higher prevalence of women may also be considered a limitation for the external validation of our results; however, as previously quoted, it is widely known that asthma is more prevalent in adult women. Additionally, subjects enrolled in this study exhibited moderate or severe asthma; thus, these findings cannot be extrapolated for subjects with the milder form of the disease. Finally, it would be relevant to assess other outcomes that are clinically relevant in asthma, such as clinical control and exercise-induced asthma, to achieve a more clear understanding of the physical fitness limitation; however, this was not the main purpose of our study.

In conclusion, our results suggest that there is an association between reduced aerobic capacity, low HRQoL, and increased depressive symptoms in subjects with moderate or severe persistent asthma despite clinical stability. These results reinforce the importance of periodically assessing physical fitness and psychosocial distress even in asthmatic subjects who are clinically stable and may suggest the importance of a multidisciplinary approach in these subjects.

DECLARATION OF INTEREST

The authors of the present study do not have any conflicts of interest and there are not any relationships with companies/organizations whose products or services may be discussed in this article.

This work was supported by Fundação de Amparo à Pesquisa de São Paulo (FAPESP; Grants 02/08422-7 and 07/56937-0) and Conselho Nacional de Pesquisa (CNPq; Grants 480869/04-9).

REFERENCES

1. Global Initiative for Asthma (GINA) web site [internet]: Global Strategy for Asthma Management and Prevention. National Institutes of Health/ National Heart, Lung and Blood Institute of Health (updated 2009).
2. Goldney RD, Ruffin R, Fisher LJ, Wilson DH. Asthma symptoms associated with depression and lower quality of life: A population survey. *Med J Aust* 2003; 178(9):437-4.
3. Goodwin RD, Olsson M, Shea S, Lantigua RA, Carrasquillo O, Gameroff MJ, Weissman MM. Asthma and mental disorders in primary care. *Gen Hosp. Psychiatry* 2003; 25(6):479-483.
4. Baiardini I, Braidò F, Brandi S, Canonica GW. Allergic diseases and their impact on quality of life. *Ann Allergy Asthma Immunol* 2006; 97(4):419-428.
5. Juniper EF, Wisniewski ME, Cox FM, Emmett AH, Nielsen KE, O'Byrne PM. Relationship between quality of life and clinical status in asthma: A factor analysis. *Eur Respir J* 2004; 23(2):287-291.
6. Kalpaklioglu AF, Bağcıoğlu A. Evaluation of quality of life: Impact of allergic rhinitis on asthma. *J Invest Allergol Clin Immunol* 2008; 18(3):168-173.
7. Disabella V, Sherman C. Exercise for asthma patients: Little risk, big rewards. *Phys Sports Med* 1998; 26(6):75-85.
8. Clark CJ, Cochrane LM. Assessment of work performance in asthma for determination of cardiorespiratory fitness and training capacity. *Thorax* 1988; 43(10):745-749.

9. Villa F, Castro AP, Pastorino AC, Santarem JM, Martins MA, Jacob CM, Carvalho CR. Aerobic capacity and skeletal muscle function in children with asthma. *Arch Dis Child* 2011; 96(6):1–11.
10. Ram FSF, Robinson SM, Black PN, Picot J. Physical training for asthma (Cochrane Review). In: *The Cochrane Library*, Issue 1, 2009.
11. Fanelli A, Cabral ALB, Neder JA, Martins MA, Carvalho CR. Exercise training on disease control and quality of life in asthmatic children. *Med Sci Sports Exerc* 2007; 39(9):1474–1480.
12. Mendes FA, Gonçalves RC, Nunes MP, Saraiva-Romanholo BM, Cukier A, Stelmach R, Jacob-Filho W, Martins MA, Carvalho CR. Effects of aerobic training on psychosocial morbidity and symptoms in patients with asthma: A randomized clinical trial. *Chest* 2010; 138(2):331–337.
13. Mendes FAR, Mendes FA, Almeida FM, Cukier A, Stelmach R, Jacob-Filho W, Martins MA, Carvalho CR. Effects of aerobic training on airway inflammation in asthmatic patients. *Med Sci Sports Exerc* 2011; 43(2):197–203.
14. Garcia-Aymerich J, Varraso R, Antó JM, Camargo CA. Prospective study of physical activity and risk of asthma exacerbations in older women. *Am J Respir Crit Care Med* 2009; 179(11):999–1003.
15. Dogra S, Meisner BA, Baker J. Psychosocial predictors of physical activity in older aged asthmatics. *Age Ageing* 2008; 37(4):449–454.
16. Shephard RJ. Limits to the measurement of habitual physical activity by questionnaires. *Br J Sports Med* 2003; 37(3):197–206. discussion 206. Review. Jun.
17. De Moor MHM, Beem AL, Stubbe JH, Boomsma DI, De Geus EJC. Regular exercise, anxiety, depression and personality: A population-based study. *Prev Med* 2006; 42(4):273–279.
18. Dunn AL, Trivedi MH, O'Neal HA. Physical activity dose-response effects on outcomes of depression and anxiety. *Med Sci Sports Exerc* 2001; 33:S587–S597.
19. Spiriduso W, Cronin DL. Exercise dose-response effects on quality of life and independent living in older adults. *Med Sci Sports Exerc* 2001; 33:S598–S608.
20. Berry MJ, Adair NE, Rejeski WJ. Use of peak oxygen consumption in predicting physical function and quality of life in COPD patients. *Chest* 2006; 129(6):1516–1522.
21. Ketelaars CA, Schlösser MA, Mostert R, Huyer Abu-Saad H, Halfens RJ, Wouters EF. Determinants of health-related quality of life in patients with chronic obstructive pulmonary disease. *Thorax* 1996; 51(1):39–43.
22. Athanasopoulos LV, Dritsas A, Doll HA, Cokkinos DV. Comparative value of NYHA functional class and quality-of-life questionnaire scores in assessing heart failure. *J Cardiopulm Rehabil Prev* 2010; 30(2):101–105.
23. Carranza Rosenzweig JR, Edwards L, Lincourt W, Dorinsky P, ZuWallack RL. The relationship between health-related quality of life, lung function and daily symptoms in patients with persistent asthma. *Respir Med* 2004; 98(12):1157–1165.
24. Ehlers PO, Sundblad BM, Larsson K. Quality of life and inflammatory markers in mild asthma. *Chest* 2006; 129(3):624–631.
25. Gonzalez-Barcala FJ, de la Fuente-Cid R, Tafalla M, Nuevo J, Caamaño-Isorna F. Factors associated with health-related quality of life in adults with asthma. A cross-sectional study. *Multidiscip Resp Med* 2012; 7(1):32–42.
26. Sidney S, Haskell WL, Crow R, Sternfeld B, Oberman A, Armstrong MA, Cutter GR, Jacobs DR, Savage PJ, Van Horn L. Symptom limited graded treadmill exercise testing in young adults in the CARDIA study. *Med Sci Sports Exerc*. 1992; 24(2):177–183.
27. Wasserman K, Hansen J, Sue D, Casaburi R, Whipp B. *Principles of Exercise Testing and Interpretation*. Philadelphia, Pa: Lea & Febiger. 1999; 1142–1195.
28. Gibbons RJ, Balady GJ, Bricker JT, Chaitman BR, Fletcher GF, Froelicher VF, Mark DB, McCallister BD, Mooss AN, O'Reilly MG, Winters WL, Gibbons RJ, Antman EM, Alpert JS, Faxon DP, Fuster V, Gregoratos G, Hiratzka LF, Jacobs AK, Russell RO, Smith SC; American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Committee to Update the 1997 Exercise Testing Guidelines. ACC/AHA 2002 guideline update for exercise testing: Summary article: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1997 Exercise Testing Guidelines). *J Am Coll Cardiol* 2002; 40(8):1531–1540.
29. Oliveira MA, Barbieri A, Santos LA, Faresin SM, Godoy AL. Validation of a simplified quality of life questionnaire for a socioeconomic deprived asthma patients. *J Asthma* 2005; 42(1):41–44.
30. Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. *Arch Gen Psychiatry* 1961; 4:53–63.
31. Gorenstein C, Andrade L. Validation of a Portuguese version of the Beck Depression Inventory and the State-Trait Anxiety Inventory in Brazilian subjects. *Braz J Med Biol Res* 1996; 29(4):453–457.
32. Spielberger CD, Gorsuch RL, Lushene RE. *Manual for the State Trait Inventory*. Palo Alto: Consulting Psychologists Press, 1970.
33. ATS/ERS Task Force. Standardization of lung function testing: Standardization of spirometry. *Eur Respir J* 2005; 26:319–338.
34. Knudson RJ, Lebowitz MD, Holberg CJ, Burrows B. Changes in the normal expiratory flow-volume curve with growth and aging. *Am Rev Respir Dis* 1983; 127(6):725–734.
35. Hair JF, Black WC, Babin B, Anderson RE, Tatham RL. *Multivariate Data Analysis*. 6th edition. Upper Saddle River, NJ: Prentice Hall; 2006.
36. Ruuskanen JM, Ruoppila I. Physical activity and psychological well-being among people aged 65 to 84 years. *Age Ageing* 1995; 24(4):292–296.
37. Dogra S, Kuk JL, Baker J, Jamnik V. Exercise is associated with improved asthma control in adults. *Eur Respir J* 2011; 37(2):318–323.
38. Haselkorn T, Chen H, Miller DP, Fish JE, Peters SP, Weiss ST, Jones CA. Asthma control and activity limitations: Insights from the Real-world Evaluation of Asthma Control and Treatment (REACT) study. *Ann Allergy Asthma Immunol* 2010; 104(6):471–477.
39. Garfinkel SK, Kesten S, Chapman KR, Rebuck AS. Physiologic and nonphysiologic determinants of aerobic fitness in mild to moderate asthma. *Am Rev Respir Dis* 1992; 145(4):741–745.