Postural Control Is Impaired in People with COPD: An Observational Study

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ABSTRACT

Purpose: We investigated deficits in postural control and fall risk in people with chronic obstructive pulmonary disease (COPD).

Method: Twenty people with moderate to severe COPD (mean age 72.3 years, standard deviation [SD] 6.7 years) with a mean forced expiratory volume in 1 second (FEV₁) of 46.7% (SD 13%) and 20 people (mean age 68.2 years, SD 8.1) who served as a comparison group were tested for postural control using the Sensory Organization Test (SOT). A score of zero in any trial of the SOT was registered as a fall. On the basis of the SOT results, participants were categorized as frequent fallers (two or more falls) or as fallers (one fall). To explore the potential influence of muscle weakness on postural control, knee extensors concentric muscle torque was assessed with an isokinetic dynamometer. Physical activity level was assessed with the Physical Activity Scale for the Elderly.

Results: People with COPD showed a 10.8% lower score on the SOT ($p = 0.016$) and experienced more falls (40) than the comparison group (12). The proportion of frequent fallers and fallers during the SOT was greater ($p = 0.021$) in the COPD group (four of 10) than in the comparison group (two of seven). People with COPD showed deficits in knee extensors muscle strength ($p = 0.01$) and a modest trend toward reduced physical activity level. However, neither of these factors explained the deficits in postural control observed in the COPD group.

Conclusions: People with COPD show deficits in postural control and increased risk of falls as measured by the SOT. The deficits in postural control appear to be independent of muscle weakness and level of physical activity. Postural control interventions and fall risk strategies in the pulmonary rehabilitation of COPD are recommended.

Key Words: falls, accidental; muscle strength; balance, postural; proprioception; pulmonary disease; chronic obstructive.

RÉSUMÉ

Objectif : Étudier les déficits dans le contrôle postural et les risques de chute chez les personnes souffrant de maladie pulmonaire obstructive chronique (MPOC).

Méthode : Un échantillon de 20 personnes souffrant de MPOC modérée à sévère ($72,3 \pm 6,7$ ans) avec volume expiratoire maximal par seconde (FEV₁) de $46,7 \pm 13\%$ et de 20 personnes ($68,2 \pm 8,1$ ans) qui ont servi de groupe de référence ont subi un SOT (test d'organisation sensorielle) afin d'évaluer leur contrôle postural. Un pointage de zéro (0) à n'importe quel test du SOT était considéré comme une « chute ». En fonction des résultats du SOT, les participants ont été classés « personnes faisant des chutes fréquentes » (2 « chutes » ou plus), ou comme « personnes faisant des chutes » (1 « chute »). Dans le but d'explorer l'influence potentielle de la faiblesse musculaire sur le contrôle postural, la force du muscle concentrique des extenseurs du genou a été évaluée à l'aide d'un dynamomètre isocinétique. Le degré d'activité physique a été évalué avec une échelle d'activité physique adaptée aux aînés.

Résultats : Au SOT, les personnes souffrant de MPOC ont obtenu un pointage de 10,8 % moindre que celui du groupe de référence ($p = 0,016$) et ont subi plus de « chutes » (40) que les personnes du groupe de référence (12). La proportion de « personnes faisant des chutes fréquentes » et « personnes faisant des chutes » au cours du SOT était plus élevée ($p = 0,021$) au sein du groupe de personnes avec MPOC (10/4) qu'au sein du groupe de référence (2/7). Les personnes avec MPOC montraient des déficits de force des muscles extenseurs du genou ($p = 0,01$) et une tendance modérée à réduire leur degré d'activité physique. Toutefois, aucun de ces facteurs ne peut expliquer les déficits en contrôle postural observé au sein du groupe avec MPOC.

Conclusions : Les personnes avec MPOC ont démontré des déficits de contrôle postural et un risque de « chutes » accru, comme l'a révélé le SOT. Les déficits dans le contrôle postural semblent être indépendants de la faiblesse musculaire et du degré d'activité physique. Des interventions en contrôle postural et des stratégies relatives aux risques de chute dans le cadre de la réadaptation pulmonaire en MPOC sont recommandées.

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Postural control (i.e., postural stability) is critical in preventing older people from falling.¹ A meta-analysis identified deficits in postural control as the second most important individual risk factor for falls in older adults after muscle weakness.² Results from previous studies have suggested that people with chronic obstructive pulmonary disease (COPD) may experience deficits in postural stability^{3–6} and an increased risk of falling.^{7,8} However, most studies investigating postural control in COPD have used functional measures of balance such as the Functional Reach Test^{5,6} or the Community Balance and Mobility Scale,⁷ which, although useful for assessing overall deficits in postural stability, are not appropriate to elucidate the contribution of the sensory and motor systems to postural control. In addition, although balance tests such as the Berg Balance Scale have been successfully used to identify people with COPD with a previous history of falls,⁷ the relationship between postural instability and fall incidence in these individuals has yet to be formally established.⁸

Postural control is regulated by the interaction of the vestibular, somatosensory, and visual sensory systems⁹; however, it is unclear whether impairments of postural stability in people with COPD are produced by deficits in one or more of these sensory systems. We used computerized dynamic posturography to assess postural control with the Sensory Organization Test (SOT), a balance test designed to assess postural sway while exploring the contributions of each sensory system to stability when standing.¹⁰ Our primary objective was to compare postural control and fall risk between people with COPD and a comparison group. We also investigated the contribution of each sensory system to the control of postural sway. Moreover, because muscle weakness (e.g., knee extensors) is also known to increase postural sway in older adults,¹¹ we tested knee extensors muscle strength to explore the potential influence of muscle weakness on postural control in people with COPD.

METHODS

Design

We conducted an observational (cross-sectional) study. A sample of convenience was recruited from the local community from October 2008 to June 2009. Flyers for the study were distributed in waiting rooms of hospitals and at seniors' centres. To confirm the severity of COPD or to rule out pulmonary disease, people with COPD and healthy participants, respectively, underwent spirometry according to international guidelines,¹² using a portable spirometer (CPFS/D spirometer, Medi Graphics Corp., St. Paul, MN).

Participants

The inclusion criterion for people with COPD was the presence of moderate to severe disease (stage II or III)

diagnosed by a physician on the basis of the Global Initiative for Obstructive Lung Disease.¹³ Exclusion criteria were (1) an acute exacerbation¹⁴ within the 3 months before the study; (2) regular participation in a formal exercise rehabilitation program during the 1 year period before the study; (3) current smoking;¹⁵ (4) comorbid cardiovascular or neurological disease or lower extremity musculoskeletal problems that would interfere with or cause undue risk during the performance of study testing; (5) visual or vestibular deficits that could affect postural control; (6) use of supplemental oxygen on a continuous basis; or (7) α -1 antitrypsin deficiency without a significant smoking history.

The inclusion criterion for participants in the comparison group was a sedentary lifestyle. *Sedentary* was defined as "only performs activities with low metabolic cost, including light activities such as slow walking or cooking."^{16(p.174)} Exclusion criteria for people in the comparison group were (1) regular participation in a formal exercise program during the 1 year period before the study; (2) current smoking; (3) respiratory, cardiovascular, or neurological disease or lower-extremity musculoskeletal problems that could interfere with or cause undue risk during the performance of a study test; (4) visual or vestibular problems that could affect postural control; or (5) spirometry values indicative of ventilatory impairment.¹³ The University of British Columbia clinical research ethics board approved the study, and all participants gave written informed consent before participation.

Outcome Measures

Postural Control

Postural control was assessed with the SOT on an EquiTest system (NeuroCom International Inc., Clackamas, OR), an instrument designed to assess postural sway under increasingly challenging conditions (see Figure 1). The SOT, whose reliability¹⁷ and validity¹⁸ are well established, consists of six conditions that manipulate visual, somatosensory, and vestibular inputs to challenge postural control.¹⁹ A detailed description of each SOT condition is provided in Box 1. Depending on which SOT condition is used, the EquiTest system modifies the support surface (by tilting the force plate in the sagittal plane) or the visual surround (by moving the background in the sagittal plane) to alter somatosensory and visual inputs, respectively.¹⁹ The vestibular system is specifically challenged in conditions 5 and 6, when the support surface is altered while visual input is eliminated (i.e., participants' eyes are closed) or when both the support surface and the visual surround are altered simultaneously (see Box 1).

The sway gain of the EquiTest system was set at 1, meaning that the support surface or visual surround follows the individual's sway exactly. We calculated the equilibrium scores (based on an individual's postural sway) for each SOT condition by determining the maxi-

Figure 1 Participant performing the Sensory Organization Test on the EquiTest system.

mum and minimum anterior–posterior (AP) sway angles. (The AP sway angle is the angle between a line projecting vertically from the centre of foot support and a line from the centre of foot support to the centre of gravity; see Figure 2.)¹⁹ We then calculated a composite equilibrium score from the six SOT conditions. A detailed description of the equations used to calculate the composite equilibrium score is available elsewhere.¹⁹ A composite equilibrium score of 100 represents no postural sway; lower scores indicate increasingly poor balance or increasing postural instability.

While standing with shoes on the force plates, participants were instructed to maintain an upright posture while looking straight ahead with arms at their sides. Before testing, participants were allowed to familiarize themselves with the SOT by practicing the six conditions in a progressive order of difficulty (1–6). Provided that participants were not at risk, we did not use a safety harness, because the first two participants in the COPD group indicated that the harness was uncomfortable and increased breathing discomfort during testing. During the SOT, three trials of each condition were randomly administered. Each trial lasted either 20 seconds or until the participant required a step to regain balance or touched the visual surround for support. In the latter case, the trial received an equilibrium score of zero and was registered as a fall. To explore fall susceptibility between groups, participants were categorized as frequent fallers (two or more falls) or fallers (one fall).²⁰ We used this classification, rather than faller (one or more falls) versus non-faller (no fall), to discriminate between occasional fallers and frequent fallers during the SOT.²¹

Sensory Analysis

Because each condition of the SOT targets specific sensory systems that contribute to postural balance (see Table 1), we performed sensory analyses to explore the potential contributions of somatosensory, visual, and vestibular inputs to postural control. Briefly, calculating the ratio of the equilibrium scores of condition 2 to condition 1, we assessed the participant's ability to use the somatosensory system to maintain postural balance. Similarly, we used the ratios of condition 4 to condition 1 and condition 5 to condition 1 to assess participants' ability to use information from the visual and vestibular systems, respectively, to maintain balance. To determine the degree to which the participant relied on visual information to maintain balance (i.e., visual preference), the sum of the average scores for conditions 3 and 6 was divided by the sum of the average scores for conditions 2 and 5. A more detailed description of these sensory ratios and their functional relevance is provided elsewhere.¹⁰

Box 1 Description of the Six Conditions of the Sensory Organization Test

Condition	Description	Sensory systems altered	Sensory systems targeted
1	Eyes open, fixed surface, and visual surround	None	All
2	Eyes closed, fixed surface	None	Somatosensory and vestibular
3	Eyes open, fixed surface, sway-referenced visual surround	Visual	Somatosensory and vestibular
4	Eyes open, sway-referenced surface, fixed visual surround	Somatosensory	Visual and vestibular
5	Eyes closed, sway-referenced surface	Somatosensory	Vestibular
6	Eyes open, sway-referenced surface, and visual surround	Visual and somatosensory	Vestibular

Figure 2 The anterior–posterior (AP) sway angle is the angle between a line projecting vertically from the centre of foot support and a line from the centre of foot support to the centre of gravity (COG) position on the body (55% of person's height).

Knee Extensors Muscle Strength

We assessed concentric average peak torque of the knee extensors of the dominant leg on the KinCom dynamometer version 5.30 (Chattanooga Group Inc., Vista, TN). We chose this muscle group because it is independently associated with postural sway in healthy older adults.¹¹ Three maximal trials were recorded, interspersed with 2-minute rest intervals. Details of the protocol used have been described elsewhere.²²

Physical Activity

To determine whether level of physical activity was associated with postural control, we assessed physical activity with the Physical Activity Scale for the Elderly

(PASE),^{23,24} which has been validated by comparison to physical activity levels measured by portable accelerometers.²⁵ The PASE is a 12-item self-administered questionnaire that measures physical activity levels. Scores range from 0 to 400, with higher scores indicating greater physical activity.

Data Analysis

We explored assumptions for normality of data distribution through inspection of histograms and normality plots²⁶ and confirmed them with the Shapiro–Wilk test. Differences in participants' characteristics, including physical activity level, were assessed with Student's *t* test. Individual scores for conditions 2–6 were normalized by the scores for condition 1 to reduce between-group differences at baseline.¹⁹ We used the Mann–Whitney *U* test to assess differences between groups in condition 1, normalized individual scores for conditions 2–6, composite equilibrium score, and sensory ratios. Differences in knee extensors muscle torque were assessed using a *t*-test. We used the χ^2 test to determine differences between groups in the ratio of frequent fallers (two or more falls) and fallers (one fall). A zero score in any of the trials during the SOT was registered as a fall. The odds ratio of having frequent falls was calculated by dividing the ratios of frequent fallers and fallers for each group.²⁷ We used Spearman's correlations to explore relationships of muscle torque and physical activity with each (non-normalized) individual SOT condition, composite equilibrium score, and sensory system in both groups. The strength of each correlation was categorized as low (0–0.25), moderate (>0.25–0.50), strong (>0.50–0.75), or very strong (>0.75).²⁷ Data are presented as means and standard deviations with 95% CI or as medians with percentiles (P_{25} , P_{75}). We performed all analyses using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL) using two-tailed probability tests with the level of significance set at $p < 0.05$.

RESULTS

Participants

Twenty non–oxygen-dependent, clinically stable people (10 men and 10 women) with moderate to severe COPD and 20 sedentary controls matched for age, sex, and body mass participated in the study (see Table 1). From the results of a previous study using a similar balance test,³ we estimated that this sample size would be sufficient to detect differences in postural control between people with COPD and healthy control participants. People with COPD were slightly older and showed a modest trend toward reduced physical activity level (mean difference -31.1 ; 95% CI, -76.9 to 14.8). Relative to the control group, people with COPD showed moderate to severe levels of airflow limitation.

Table 1 Characteristics of the Study Participants

Characteristics	Group; mean and (SD); range	
	Healthy; <i>n</i> = 20	COPD; <i>n</i> = 20
Age, y	68.2 (8.1); 53–85	72.3 (6.7); 62–85
Height, m	1.7 (0.1); 1.4–1.8	1.6 (0.1); 1.5–1.8
Weight, kg	71.5 (12.6); 47–104	70.5 (10.4); 48.3–103.4
BMI, kg/m ²	25.5 (4); 20–36	25.7 (4.4); 20.1–38.4
PASE score	140.4 (73.9); 32–271.5	109.3 (69.2); 27.2–307.3
FEV ₁ , % predicted	98.6 (12); 76–114	46.7 (13);* 32–72
FVC, % predicted	109.1 (20.5); 67–141	81.8 (14.8);* 42–102
FEV ₁ /FVC, % predicted	68.9 (7.4); 57–85	50 (14.6);* 27–71

*Indicates significant difference between groups at $p < 0.05$.

COPD = chronic obstructive pulmonary disease; BMI = body mass index; PASE = Physical Activity Scale for the Elderly; FEV₁ = forced expiratory volume in 1 second; FVC = forced vital capacity.

Figure 3 Differences in equilibrium scores between people with chronic obstructive pulmonary disease (COPD) (filled bars) and healthy control participants (white bars) in conditions (COND) 2 to 6 of the Sensory Organization Test (SOT).

Postural Control

People with COPD showed lower equilibrium scores in (non-normalized) condition 1 ($p = 0.008$); the median (P_{25} , P_{75}) was 92.8 (90.3–93.6) for the control group and 89.8 (87.7–91.8) for the COPD group. The analysis of differences between groups in normalized SOT conditions 2–6 revealed only a trend toward lower performance in the group with COPD in conditions 5 ($p = 0.07$) and 6 ($p = 0.06$) (see Figure 3). People with COPD demonstrated a 10.8% significantly ($p = 0.014$) lower composite equilibrium score compared with participants in the control group (see Table 2). Chi-square tests showed a significant difference between groups in the ratio of frequent fallers to fallers (odds ratio [OR] = 9; $p = 0.021$). The group with COPD had 10 frequent fallers and four fallers, and the control group had two frequent fallers and seven fallers. The group with COPD had 40 falls (11.2% of all trials), and the control group had 12 falls (3.4% of all trials). In the group with COPD, most of the falls occurred in conditions 5 (32.5%) and 6 (62.5%); in the control group, all falls were evenly distributed between conditions 5 (50%) and 6 (50%).

Sensory Analysis

Sensory ratios did not reveal significant differences between groups in any specific sensory system (i.e., somatosensory, visual, vestibular) that could entirely explain the deficits in postural control among people with COPD (see Table 2).

Associations of Knee Extensors Muscle Strength and Physical Activity with Postural Control

People with COPD showed 29.6% lower values than the control group in knee extensors concentric strength ($p = 0.01$). The COPD group had a mean peak torque of 57.3 Nm (SD 23.9), whereas the control group's mean peak torque was 81.4 Nm (SD 31.9; mean difference 24.1 Nm; 95% CI, 42.1–5.9). Spearman's correlations showed no significant associations between measures of knee extensors muscle strength and individual SOT conditions, composite equilibrium scores, or specific sensory systems in the group with COPD. Healthy control participants showed a strong association ($r = 0.68$; $p = 0.001$) between knee extensors strength and postural control in SOT condition 4. Level of physical activity was not associated with measures of postural control in any of the groups.

DISCUSSION

Our main finding was that, compared with participants in the comparison group, people with COPD showed marked deficits in postural control (i.e., composite equilibrium scores). More interesting, deficits in postural stability were accompanied by a higher rate of falls (i.e., zero scores) during the SOT trials in the group with COPD. The odds of having frequent falls during the

Table 2 Differences in Composite Equilibrium Scores and Sensory Analysis (Ratios) between People with COPD and Healthy Participants

	Group; medians with percentiles (P ₂₅ , P ₇₅)		
Parameter	Healthy; <i>n</i> = 20	COPD; <i>n</i> = 20	<i>p</i> -value
<i>Postural balance</i>			
Composite equilibrium score	72 (66.2–75)	62.5 (54.2–71)	0.014*
<i>Sensory ratios</i>			
Somatosensory	93 (90.1–97.3)	93 (89.6–95.1)	0.552
Visual	88.5 (81–92)	90 (77.9–93.5)	0.978
Vestibular	59.4 (44.8–72.8)	54.6 (26.1–67.5)	0.117
Preference	96.2 (87.4–108.6)	99.9 (78.8–113.6)	0.607

*Indicates significant difference between groups at $p < 0.05$.

Note: Preference indicates the degree to which participant relies on visual information to maintain balance. See Methods section for details on how sensory ratios are calculated.

SOT for people with COPD were approximately nine times as high as those for control participants. The sensory analysis did not reveal significant differences between groups (see Table 3). Although lower levels of strength and a modest tendency toward lower physical activity levels were observed in the group with COPD, neither of these two factors was associated with measures of postural control.

The deficits in postural control reported in this study are consistent with previous reports that used functional balance tests to confirm that postural control is impaired in people with COPD. Eisner and colleagues⁶ found lower scores in the Functional Reach Test (9%; $p < 0.0017$) when a group with COPD ($n = 1,202$) with a mean FEV₁ of 62% (SD 23%) was compared with a control group ($n = 302$). Another study³ showed lower scores ($p < 0.05$) in the Community Balance and Mobility Scale in two groups of people with moderate (FEV₁ = 45.7% predicted, SD 3.7% predicted) and severe (FEV₁ = 29.9% predicted, SD 3.7% predicted) COPD compared with a healthy control group. The latter study,³ however, did not reveal significant differences among groups in postural sway measured through posturography. The fact that we found differences between groups could be attributed to the manipulation of sensory information during the SOT, which, compared with conventional posturography, increases the difficulty of the balance task. However, our preliminary analysis showed significant differences ($p = 0.008$) in the median equilibrium scores for condition 1 between the two groups, suggesting that alterations in postural control in people with COPD are present even in unchallenged situations of relative postural stability. The use of different balance testing protocols may well explain these conflicting findings.

Perhaps the most striking finding of this study was the high rate of zero scores, registered as falls, in the group with COPD during the SOT. In a recent prospective cohort study,²⁸ we found that 101 people with COPD had an annual incidence rate of 1.2 falls per person-year, substantially higher than the rate of 0.24 reported in elderly people.²⁹ The higher rate of falls in this study is thus consistent with these findings and supports recent studies underlining a potential association between postural instability and fall risk in people with COPD.^{4,7} Despite these results, it is important to reiterate that a fall during the SOT represents a zero score in a specific trial, not an actual fall. In addition, 95% of falls in people with COPD in this study occurred during the most challenging SOT conditions (5 and 6), in which sensory information was dramatically altered. These challenging situations are different from likely conditions during activities of daily living, and, therefore, extrapolation of our findings to real-life situations should be done with extreme caution. Nevertheless, these results reinforce the potential association between fall history and deficits in balance described previously in COPD.⁷ More longitudinal studies are required to confirm the direct implications of postural control deficits for fall incidence in people with COPD.

Another finding of this study concerns the analysis of sensory ratios. The novelty of this analysis consisted of exploring whether deficits in postural control in people with COPD were catalyzed by specific alterations in the somatosensory, visual, or vestibular domains of postural stability. Sensory ratios did not reveal significant differences between groups, although differences in postural balance between groups seemed to originate mainly from deficits specific to the vestibular control of balance (i.e., conditions 5 and 6) in the COPD group (see Figure 3). It has been postulated that chronic hypoxemia may alter audio-vestibular function; however, the existing literature pertaining to vestibular impairments in COPD is equivocal. For example, El-Kady and colleagues³⁰ investigated audio-vestibular function in people with COPD having hypoxemia ($PO_2 < 75$ mm Hg) compared with a control group; although they observed poorer general audio-vestibular function in the group with COPD, the differences were not significant. In a previous study, Nakano and colleagues³¹ used brain stem auditory evoked potentials to investigate the influence of oxygen deficits on audio-vestibular function in people with chronic hypoxemia ($PO_2 = 58.2$ mm Hg); their results indicated that chronic hypoxemia does not alter audio-vestibular function. Hence, more studies are required to investigate potential vestibular deficits and their contribution to postural control and fall risk in people with COPD.

Previous reports have indicated that postural deficits in older adults are associated with muscle weakness, especially during the most demanding balance tasks.¹¹ Thus, a possible explanation for the preferential deficits

during SOT conditions 5 and 6 in people with COPD may be a result of the confounding effect of muscle weakness (see Box 1). However, our correlational analysis showed no significant association between knee extensors muscle strength and the vestibular component of balance in the COPD group. More important, when knee extensors strength was correlated with the results of each individual SOT condition for the COPD group, we did not observe any association with conditions 5 or 6 to support a potential confounding effect of muscle weakness in explaining deficits in postural control during such conditions. These findings conflict with those of a previous study¹⁹ that used the SOT to investigate the contribution of muscle strength to deficits in postural stability in people with stroke ($n = 40$) and a control group ($n = 40$). The researchers found that the strength of some muscle groups (i.e., paretic knee extensors) in the stroke group was correlated with postural sway only in the most challenging SOT conditions (i.e., conditions 5 and 6), supporting the notion that strength plays an important role in situations of maximal instability,¹¹ particularly when the vestibular system is targeted during the SOT. Because the strength values of the stroke group in that study are similar to the values obtained from people with COPD in our study, it is unlikely that the level of muscle strength in the group with COPD was too high for our analysis to detect any significant association with measures of postural control. Disease-specific mechanisms (e.g., spasticity) may partly explain the different associations between muscle strength and postural control observed in the two studies.

On the basis of the existing literature, we expected somatosensory deficits to play a role in explaining the impaired postural control observed in the COPD group. Indeed, proprioception of the lower limbs appears as a primary somatosensory measure associated with postural sway assessed on a firm surface in older adults.¹¹ The fact that postural sway was significantly greater in people with COPD during condition 1 ($p = 0.008$), therefore, is suggestive of proprioceptive deficits in this group. Previous studies have shown nerve conduction abnormalities^{32,33} and signs of peripheral neuropathy (i.e., smaller amplitude potentials, increased latency, decreased conduction velocity), especially in the sensory nerves, in people with COPD.³⁴ Peripheral neuropathy, which can be present even in people with moderate COPD,³³ may have led to somatosensory deficits,³⁵ alterations in postural balance, and increased fall risk³⁶ in our COPD group. However, none of the participants with COPD had been formally diagnosed with peripheral neuropathy. More important, the sensory analysis did not reveal specific alterations in the somatosensory control of balance (see Table 2). In spite of these findings, however, the potential implications of proprioceptive deficits in the regulation of postural control in people with COPD should not be overlooked. The strong association

of strength with condition 4 in the healthy control group ($r = 0.68$, $p = 0.001$), in addition to the lack of correlation in the group with COPD, suggests that differences may exist in the integration of sensory information and in the motor response to postural instability between healthy people and individuals with COPD.

This study has several limitations that need to be considered when results are interpreted. First, although the relatively small convenience sample used in the study was sufficient to detect between-group differences in postural control (i.e., composite equilibrium scores) and the proportion of fallers and frequent fallers during the SOT, a larger sample size would be required to establish more reliable correlations between measures of strength and different aspects of postural control. Second, the fact that people with COPD were moderately older than participants in the control group may have contributed to the deficits in postural control observed in this group. Third, on the basis of previous literature,¹¹ we targeted knee extensors as a muscle group potentially associated with postural sway. However, the assessment of ankle muscles (e.g., gastrocnemius and tibialis) might perhaps be more appropriate to detect correlations between muscle weakness and AP postural sway.³⁷ Last, comorbidities³⁸ and medications³⁹ are important factors contributing to altered postural control and fall risk in older adults; although our exclusion criteria reduced potential confounding factors from other comorbidities that could affect postural control, we cannot rule out the possibility that medications affected postural control in the group with COPD.

CONCLUSION

Postural control is impaired in people with moderate to severe COPD. In our study, deficits in postural control resulted in a greater number of falls during the SOT, as well as a higher proportion of frequent fallers, in the group with COPD. Deficits in postural control in the group with COPD were not associated with muscle weakness of knee extensors or with reduced physical activity level, which suggests that postural instability in people with COPD is not solely attributable to muscle weakness and a sedentary lifestyle. Taken together, these findings underscore the importance of targeting deficits in postural control and fall prevention strategies in rehabilitation programs for people with COPD.

KEY MESSAGES

What Is Already Known on This Topic

People with COPD show deficits in postural control assessed with functional tests of balance. Deficits in postural control in people with COPD appear to be associated with previous fall history. Among elderly people, muscle weakness contributes to deficits in postural control.

What This Study Adds

People with COPD show deficits in postural control assessed with dynamic posturography. These deficits are accompanied by an increased risk of falls during the SOT. In this study, deficits in postural control were not associated with muscle weakness in people with COPD.

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