3 Perry J. Normal and pathological gait. *In*: Hsu JD, Michael JW, Fisk JR, eds. AAOS Atlas of Orthoses and Assistive Devices. Philadelphia, Mosby Elsevier, 2008; pp. 61–82.
4 Esquenazi A, Talaty M. Gait analysis: technology and clinical applications. *In*: Braddon RL, ed. Physical Medicine and Rehabilitation 3rd Edn. Saunders Elsevier, 2008; pp. 99–116.
5 Saunders JB, Inman VT, Eberhart HD. The major determinants in normal and pathological gait. *J Bone Joint Surg Am* 1953; 35-A: 543–558.
6 Mayer N, Keenan M, Esquenazi A. Limbs with restricted or excessive motion after traumatic brain injury. *In*: Rosenthal M, Griffith ER, Kreutzer GS, eds. Rehabilitation of the adult and child with traumatic brain injury. 3rd Edn. Philadelphia, Fa Davis, 1990; pp. 503–535.
7 Tom FN. Orthoses for cerebral palsy. *In*: Hsu JD, Michael JW, Fisk JR, eds. AAOS Atlas of Orthoses and Assistive Devices. Philadelphia, Mosby Elsevier, 2008; pp. 487–497.
8 Eyring EJ, Murray WR. The effect of joint position on the pressure of intra articular effusion. *J Bone Joint Surg Am* 1964; 46: 1235–1241.
9 Calverley PM. Respiratory failure in chronic obstructive pulmonary disease. *Eur Respir J* 2003; 22: Suppl. 47, 26s–30s.
10 Sorond FA, Galica A, Serrador JM, *et al.* Cerebrovascular hemodynamics, gait and falls in an elderly population. *Neurology* 2010; 74: 1627–1633.

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*From the authors:*

We thank De and Bhuniya for their interesting comments on our study that investigated gait patterns in chronic obstructive pulmonary disease (COPD) [1]. We measured 30 gait parameters during normal walking, turning and tandem walking in 1500 persons (mean age 74 years), and summarised these parameters into seven independent gait domains. Importantly, only the gait domain Rhythm (reflecting how quickly steps are taken) was significantly impaired in persons with COPD [1, 2]. We fully support the call to investigate the causes of this disturbed Rhythm in COPD thoroughly and to elucidate why fallers with COPD exhibit especially worse Rhythm.

De and Bhuniya suggest four interesting probable causes for the disturbed Rhythm that we observed in persons with COPD: an abnormal base of support, joint instability, problems in limb clearance and musculoskeletal pain. However, abnormal base of support, joint instability or problems in limb clearance are more likely to affect gait domains such as Base of Support, Variability or Phases (reflecting double support time). Although we did hypothesise that both spatiotemporal and balance aspects of gait would be worse in COPD subjects compared with persons with normal lung function, we only observed disturbances in the temporal aspect of gait, Rhythm. This sole finding of an association for COPD with Rhythm reduces the probability that base of support, joint instability and problems in limb clearance are the cause or an intermediate of the associations found. The fourth suggested cause, musculoskeletal pain, may be more likely, since we observed that among participants of the Rotterdam Study, leg pain was found to associate significantly with worse Rhythm, independent from osteoarthritis [3].

Gait variability is a well-established risk factor for falls in elderly subjects and patients with neurodegenerative diseases [4]. In persons with COPD, lower limb muscle weakness and impaired activities of daily living predict falls, though little was known on the influence of gait deficits [5]. Our study added to the field that fallers with COPD exhibit worse Rhythm, while Rhythm did not discriminate fallers in persons without COPD. In addition, adjusting for cognitive status hardly changed associations between COPD and gait. These observations rather suggest that gait deficits in patients with COPD are different from natural ageing or common neurodegenerative diseases.

Finally, hypercapnia is not expected to be the principal cause of the slower Rhythm in our study as the COPD subjects mainly had mild to moderate disease (mean forced expiratory volume in 1 s 81% predicted, diffusing capacity of the lung for carbon monoxide 89% and 12% frequent exacerbators), generally visited our research centre in a stable phase and were not persuaded to perform the test if they felt physically too poor to walk (explaining the overall exclusion of 152 participants due to physical inability). Nevertheless, since COPD severity correlated with poorer Rhythm and more gait deficits (including smaller steps), we fully support the call for more pathophysiological studies to elucidate the role of hypoxaemia, hypercapnia and potential underlying neuromuscular disorders.

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**Musculoskeletal pain may contribute to worse Rhythm in gait analysis of COPD patients**
http://ow.ly/RWtMF

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## References

1 Lahousse L, Verlinden VJ, van der Geest JN, *et al.* Gait patterns in COPD: the Rotterdam Study. *Eur Respir J* 2015; 46: 88–95.
2 Verlinden VJ, van der Geest JN, Hoogendam YY, *et al.* Gait patterns in a community-dwelling population aged 50 years and older. *Gait Posture* 2012; 37: 500–505.
3 de Kruijf M, Verlinden VJ, Huygen FJ, *et al.* Chronic joint pain in the lower body is associated with gait differences independent from radiographic osteoarthritis. *Gait Posture* 2015 [In press DOI: 10.1016/j.gaitpost.2015.06.193].
4 Schniepp R, Wuehr M, Schlick C, *et al.* Increased gait variability is associated with the history of falls in patients with cerebellar ataxia. *J Neurol* 2014; 261: 213–223.
5 Roig M, Eng JJ, Road JD, *et al.* Falls in patients with chronic obstructive pulmonary disease: a call for further research. *Respir Med* 2009; 103: 1257–1269.

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