

Letter to the Editor

Commentary on the article by Stevens G, Smart DR. The influence of wetsuit thickness (≥ 7 mm) on lung volumes in scuba divers

We read with interest the recent article by Stevens and Smart “*The influence of wetsuit stiffness on lung volumes*”.¹ The substantial number of participants and the diversity of their diving backgrounds allowed the authors to draw interesting comparisons of wetsuit effects between occupational and recreational divers, as well as between women and men. These add valuable data to the understanding of physiological demands in various diving conditions.

Since we have also investigated the side effects of wetsuits, we would like to offer some additional observations.

Wetsuits are designed to minimise water movement between the garment and the diver’s skin. To achieve a close fit without loose areas, they are made from elastic materials, predominantly neoprene. Such material can vary in thickness and stiffness, but in all cases its elastic properties generate a recoil force when stretched. Around cylindrical body segments such as the arms and legs, this recoil produces an inward centripetal pressure that can be measured with small flat balloons used as pressure transducers. In one study assessing the effects of wetsuits effect on fluid balance and urine flow, a 5 mm neoprene suit exerted a limb compression of approximately 25.8 mmHg, similar to class II-III 18 therapeutic stockings.² In another study, a custom-made neoprene suit comprising two layers (3.5 mm and 5.5 mm) for a total thickness of 9 mm produced a compression of 30 mmHg on the skin.³

This recoil pressure also applies on the thoracic and abdominal walls, tending to reduce circumferences and to limit the amplitude of ventilatory volume changes. During expiratory manoeuvres either slow or forced this elastic restriction facilitates exhalation. Accordingly, the greater reductions in forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1) observed with thicker suits appear to be a logical consequence of the higher pressure generated by thicker materials.¹ During immersion and diving, the hydrostatic pressure adds a fluid-redistributing effect to that of the wetsuit, as evidenced in the enhanced diuretic response.²

A reduction in lung compliance is an additional consequence of the decreased gaseous lung volume, which in turn makes lung inflation more difficult. In intensive care settings, patient positioning is known to influence regional lung ventilation and is a key factor in optimising ventilatory support.⁴ Hydrostatic pressure has been shown to produce similar effects during surface immersion in healthy individuals.⁵

Both the elastic restriction of lung volumes and the stiffness of the material therefore contribute to an increased inspiratory work of breathing and its associated cardiovascular consequences.^{6,7} An increase in the work of breathing can, by itself, provoke unpleasant dyspnoea,⁸ which may be hazardous during diving.⁹ On average, the work of breathing rises more rapidly in women than in men, due to smaller lung volumes and airway calibres. Moreover, increased inspiratory work is a key contributor to immersion pulmonary oedema, especially during exercise.^{7,10,11} Indeed a higher inspiratory work due to a reduced lung or thoracic wall compliance decreases the gaseous lung volume, lowers the inspiratory pleural and mediastinal pressure^{5,12} and concomitantly reinforces the preload⁷ and in turn the congestion of the pulmonary and bronchial vessels. Even a thin neoprene vest has been shown to aggravate dyspnoea and haemodynamic impairment during land-base cycling exercise.¹³

If the authors were to undertake a similar study under immersion, as they seem to suggest, we would respectfully propose that it would be of interest to measure the inspiratory capacity and the inspiratory pressures both during spontaneous breathing and during maximal inspiration, without a suit and with a suit, both on land and while immersed.

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