Standing in the shadows: is standing a tonic or a toxin for cardiometabolic health?

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Need to put the health effects of standing in the research spotlight.

Since the turn of the century, the spotlight on the cardiometabolic risks of prolonged sitting has overshadowed the health effects of perhaps the greatest behavioural change in the transition from hunter-gatherers to modern humans: the remarkable increase in time spent standing.[1] As an example, figure 1 makes a comparison in device-measured time spent in various postures between middle-aged British adults[2] and Hadza adults in Tanzania[1] who still live a typical hunter-gatherer lifestyle. These data illustrate that in modern western society adults spend more than twice as much time in standing postures while stepping less, than typical hunter-gatherers. There are many differences between the populations which might confound these differences, but they indicate that globally, adults might have different compositions of physical behaviours depending on whether they are living in agricultural, industrial or information-based communities. A large portion of present-day adults spend a considerable amount of their day standing, with recent data from international adult cohorts showing that daily standing accounts for a staggering 3.1–4.6 hours/day or approximately 19%–29% of total waking times.[2 3]

While standing is very often portrayed as an accessible and feasible solution to outweigh the detrimental health effects of excessive sitting—for example, by introducing sit-stand tables to office workers[4]—the effects of standing on cardiometabolic health are barely researched. Therefore, there is little evidence to support the common narrative, that standing attenuates the potential negative (cardiovascular) health consequences of sitting—likely a leftover of the inaccurate 'sitting is the new smoking' axiom days.[5] This commentary presents a contemporary framework to consider the relationship of standing to cardiometabolic health.

IS STANDING HELPFUL OR HARMFUL?

Previous studies on the cardiometabolic consequences of prolonged standing have yielded conflicting results,[6 7] likely stemming from the inherent measurement imprecision of the self-reported methods used, including questionnaires or crude inferences from job titles.[7] However, recent advances in measurement techniques, such as thigh and wrist-worn accelerometers, now afford researchers the measurement precision needed to examine the cardiometabolic health effects of standing. For example, recent UK Biobank data in >83 000 adults wearing wrist accelerometers,[8] suggests that every additional 30 min/day of standing was associated with an 11% (5%–18%) higher risk for orthostatic circulatory disease while there were no beneficial or detrimental associations with risk of major cardiovascular disease (coronary heart disease and stroke) incidence. Moreover, replacing physical activity with standing was associated with worse cardiometabolic profiles in a recent pooled analysis of seven cohorts using thigh accelerometry.[3]

DEFINING RESEARCH HYPOTHESES ON STANDING

For future research to produce clinically relevant answers, we propose the following

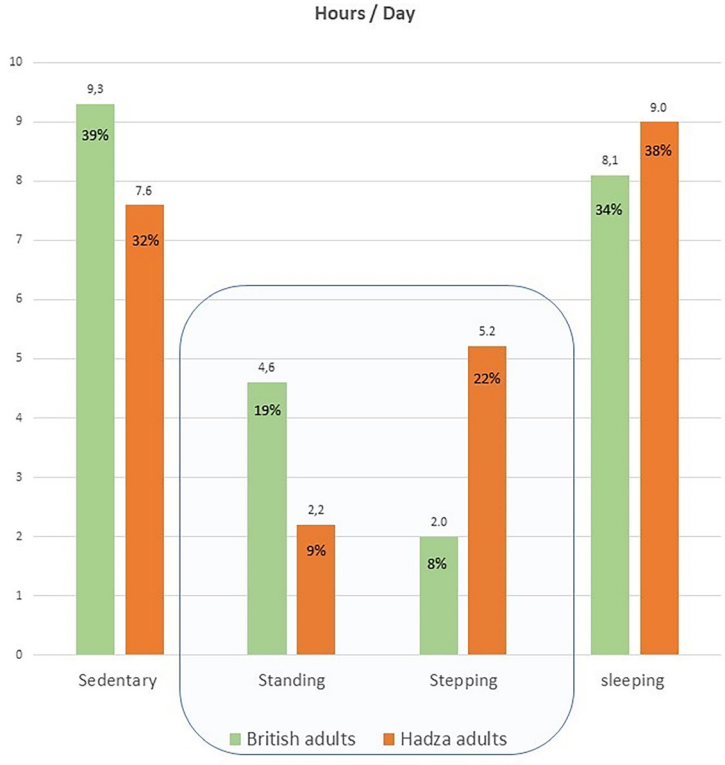

Figure 1 Comparison in device-measured posture and activity (sedentary, standing, stepping and sleeping) allocation between middle-aged British adults[2] (representing modern lifestyle) and Hadza adults in Tanzania[1] (representing hunter-gatherer lifestyle). Both studies used thigh-attached ActivPAL devices to measure posture and physical activity.

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priority hypotheses on standing being health detrimental (toxin) or health promoting (tonic). Each of the hypotheses lends itself to feasible research questions, whose answers may have significant consequences on the long-term health of the hundreds of millions of people (including workers) who stand a lot and the interventions aimed at countering the adverse effects of excessive sitting by replacing it withstanding.

1. Higher daily energy expenditure than sitting (tonic—metabolic mechanism): Standing contributes to higher daily energy expenditure compared with sitting, having beneficial effects on maintaining a healthy body weight and long-term cardiometabolic health.
2. Venous stasis (toxin—orthostatic mechanism): The gravitational pull and the absence of dynamic contractions during prolonged standing may lead to blood pooling in leg veins (venous stasis). Over time, this could manifest as varicose veins and possibly contribute to deep vein thrombosis, posing a potential risk to cardiometabolic health.
3. Glucose and lipid metabolism (tonic—metabolic mechanism): The transition from sitting to a standing posture and less so the maintenance of standing posture, involves activation of large leg muscles, which can improve lipid and glucose metabolism, insulin sensitivity and endothelial function and thus promote cardiometabolic health.
4. Increased heart rate and blood pressure (toxin—orthostatic mechanism): The heightened workload of the heart during standing, pumping against gravity, may result in elevated 24-hour heart rate and cardiac output. Prolonged exposure to these conditions could explain why standing may increase the risk of cardiometabolic disease.
5. Enhanced oxidative stress (toxin—inflammation mechanism): Prolonged standing may induce enhanced oxidative stress due to a maintained activation of leg muscles, known to contribute to cardiometabolic disease.
6. Fatigue and musculoskeletal pain (toxin—musculoskeletal mechanism): Extended periods of standing may induce fatigue and pain in the lower legs and back, acting as barriers to engaging in physical activities that promote cardiometabolic health.

MOVING FORWARD

The opportunities offered by wearable devices, for example, arm-worn accelerometer placement and continuous glucose and blood pressure monitoring and other state-of-the-art research technologies create excellent opportunities for more research into the health effects of daily standing. Moreover, standing is a diverse posture that in some cases involves upper body work and alterations with sitting postures. Therefore, research also should address the role of type (static vs dynamic), composition (with other physical behaviours), upper-body activities and time pattern (eg, bout duration) of standing on health effects, in the compositional context of 24 hour behaviours (including both sleep and wake movement). Shedding light on the potential health effects of standing postures for cardiometabolic health, as well as other relevant health outcomes such as musculoskeletal health, will add much needed nuance to future physical activity and workplace health and safety guidelines, and, in turn, potentially guide preventive interventions in the workplace and other life domains.

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Contributors AH wrote the first draft of the manuscript. All authors contributed to the content of the manuscript and accepted the submitted version of the manuscript. AH is the guarantor.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

OPEN ACCESS

ES and LS are joint senior authors.

To cite Holtermann A, Coenen P, N. Ahmadi M, *et al*. *Br J Sports Med* 2024;**58**:1173–1174.

Accepted 16 August 2024
Published Online First 5 September 2024

Br J Sports Med 2024;**58**:1173–1174.
doi:10.1136/bjsports-2024-108232

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REFERENCES

1 Raichlen DA, Pontzer H, Zderic TW, *et al*. Sitting, squatting, and the evolutionary biology of human inactivity. *Proc Natl Acad Sci U S A* 2020;117:7115–21.
2 Hamer M, Stamatakis E. The descriptive epidemiology of standing activity during free-living in 5412 middle-aged adults: the 1970 British Cohort Study. *J Epidemiol Community Health* 2020;74:757–60.
3 Blodgett JM, Ahmadi MN, Atkin AJ, *et al*. Device-measured physical activity and cardiometabolic health: the Prospective Physical Activity, Sitting, and Sleep (ProPASS) consortium. *Eur Heart J* 2024;45:458–71.
4 Shrestha N, Kukkonen-Harjula KT, Verbeek JH, *et al*. Workplace interventions for reducing sitting at work. *Cochrane Database Syst Rev* 2018;6.
5 Chau JY, Bonfiglioli C, Zhong A, *et al*. Sitting ducks face chronic disease: an analysis of newspaper coverage of sedentary behaviour as a health issue in Australia 2000-2012. *Health Promot J Austr* 2017;28:139–43.
6 van der Ploeg HP, Chey T, Ding D, *et al*. Standing time and all-cause mortality in a large cohort of Australian adults. *Prev Med* 2014;69:187–91.
7 Smith P, Ma H, Glazier RH, *et al*. The Relationship Between Occupational Standing and Sitting and Incident Heart Disease Over a 12-Year Period in Ontario, Canada. *Am J Epidemiol* 2018;187:27–33.
8 Ahmadi MN, Coenen P, Straker L, *et al*. Device-measured stationary behaviour and cardiovascular and orthostatic circulatory disease incidence: a population cohort study of 83,013 adults. *Epidemiology (Sunnyvale)* 2024.