

# Preventing the '24-hour Babel': the need for a consensus on a consistent terminology scheme for physical activity, sedentary behaviour and sleep

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Clear, concise, and consistent. These qualities (the 3Cs) are critical for effective scientific communication. Plain language enables easy comparisons between study findings, ensures construct uniformity, and enhances communication of scientific discoveries to audiences beyond academia.

Health research has a growing interest in the inter-relationships of physical activity (PA), sedentary behaviour (SB) and sleep. These behaviours occupy most of the 24-hour cycle and are associated with a plethora of health outcomes.<sup>1</sup> Consensus statements suggest how to analyse these behaviours.<sup>2</sup> Some PA/SB guidelines have incorporated sleep using mostly cross-sectional evidence.<sup>1</sup> However, these consensus statements and guidelines fail to acknowledge the interactive and reciprocal relationships between PA, SB and sleep.

As more scientists enter this field (figure 1), terminology is becoming inconsistent and confusing. Here, we outline the disparate vocabulary for the 24-hour cycle, and make the case for a consensus project to address how we collectively think about and refer to PA, SB and sleep using the 3Cs principle.

## TERMINOLOGY FOR THE 24-HOUR CYCLE

Health research has a well-defined vocabulary for behaviours which occupy most of the 24-hour cycle. PA is any bodily movement which increases energy expenditure above 1.5 metabolic

equivalents (METs).<sup>3</sup> SB is any behaviour performed from a seated/lying position that requires  $\leq 1.5$  METs.<sup>4</sup> Sleep is a recurring, reversible, neurobehavioural state of perceptual disengagement and unresponsiveness to the environment.<sup>5</sup> Sleep mechanisms are governed by homeostatic and circadian processes (ie, processes S and C, respectively) which interact continuously to regulate sleep.<sup>6</sup> Sleep is thus a complex physiological and psychological phenomenon, representing more than just a behaviour (ie, a biological state).

PA, SB and sleep are also linked to the 24-hour biological clock that regulates the sleep-wake cycle.<sup>7</sup> The 24-hour cycle can be further dichotomised into two types of behaviour that comprise both ends of the circadian cycle (ie, 'wake-based' and 'sleep-based' behaviour).

## CHANGING OUR PERSPECTIVE FROM INDIVIDUAL, ISOLATED BEHAVIOURS TO THE 24-HOUR CYCLE

Researchers often treat PA, SB and sleep as isolated behaviours. They are often considered outside the context of how people live each day (eg, poor sleep likely impacts PA and vice versa). This issue impedes our understanding of how these behaviours impact health and for developing interventions to promote a healthy lifestyle.

Fortunately, many now recognise that PA, SB and sleep share an interactive relationship behaviourally (ie, displacement of one with another) and synergistically affect health (ie, one unhealthy behaviour amplifies health risks of another).<sup>8</sup> As more researchers transition from using questionnaires to device-based measures (ie, wearables), we need to start conceptually integrating these behaviours. We think the time is now for a paradigm shift—consistent terminology is an essential first step.

## HEADING TOWARD A NEW BABEL: EXISTING TERMS TO COLLECTIVELY DEFINE THE 24-HOUR CYCLE

We need to have clear terminology to define the 24-hour cycle of activity. There are now at least five separate terms used to collectively describe PA, SB and sleep. The current Canadian 24-hour guidelines<sup>1</sup> refer to movement behaviours, where each behaviour reflects a certain amount (or lack) of movement. Bussman and Berg-Emons<sup>9</sup> coined the term physical behaviours to describe 'the behaviour of a person in terms of body postures, movements and/or daily activities in his/her own environment'. Pedišić<sup>10</sup> collectively branded PA, SB and sleep as time-use behaviours; our group suggested time-use activity behaviours.<sup>7</sup> Rosenberger *et al*<sup>8</sup> referred to these behaviours collectively as the 24-hour activity cycle.

There are benefits to using each term. Movement behaviours is used in national public health guidelines<sup>1</sup> and may be easily recognised by the public. Physical behaviours incorporates both body posture and movement into the definition; there is also a dedicated society, the International Society for the Measurement of Physical Behaviour, with a peer-reviewed journal. The label time-use (activity) behaviours—or the 24-hour activity cycle—is globally inclusive of all three behaviours and accounts for the complexity of sleep. There is also a network devoted to time-use behaviour epidemiology, the International Network of Time-Use Epidemiologists.

Concurrent or interchangeable use of these terms is incompatible with the 3Cs principle. A PubMed search of the published literature (2010–2020) shows >400 manuscripts that define PA, SB, and sleep using one of these terms; almost half these papers were published in the last 3 years. Interest in the 24-hour cycle's impact on health will continue to increase, which will amplify the confusion arising from the absence of formal agreement on terminology. This impedes synthesis of new knowledge about how PA, SB and sleep collectively impact health. Multiple terms describing similar concepts, or inconsistent terminology, will make it challenging to identify eligible articles for systematic reviews. Public health guidelines will be forced to continue using inconsistent terminology which will confuse the general public and reduce uptake of intended messages. We can only imagine the communications chaos if messages on COVID-19 used five (or more) different labels for the disease.

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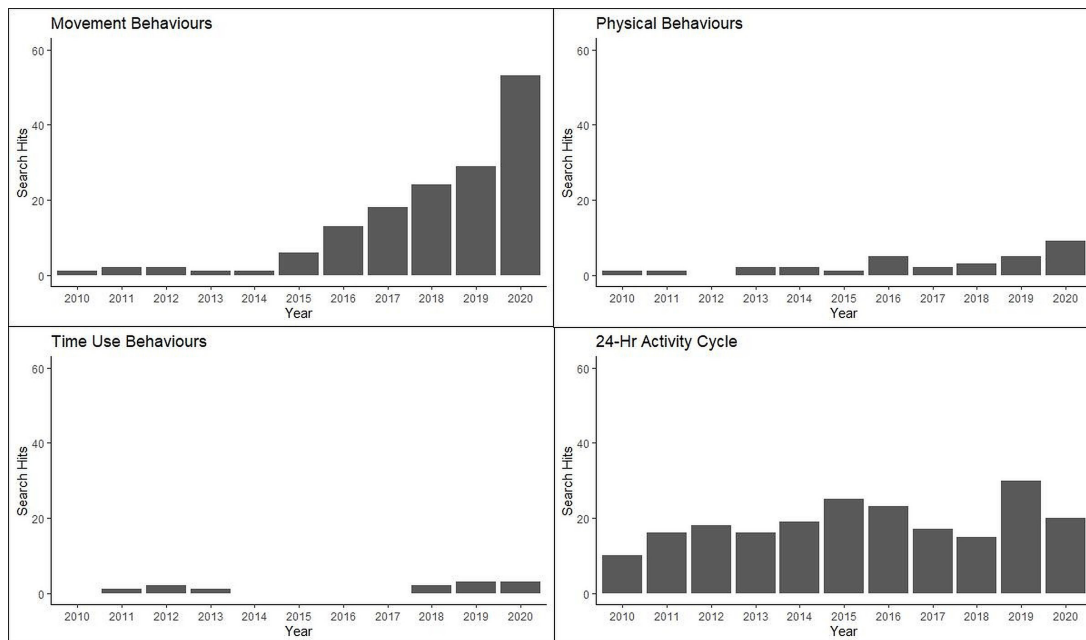


Figure 1 PubMed search hits from 2010 to 2020 for each term for collectively defining physical activity, sedentary behaviour and sleep.

**TOO MANY LABELS SPOIL THE MESSAGE**

The purpose of science is to build explanatory structures for natural phenomena using facts. However, our explanations for the collective impacts of PA, SB and sleep on health will crumble like the Tower of Babel if the language we use is not uniform.

Researchers need to prevent this looming ‘24-hour Babel’ by coming to agreement about how to collectively define PA, SB and sleep through an inclusive and systematic consensus process. We suggest that a 3Cs taxonomy of behaviours within the context of the 24-hour cycle is needed—as well as agreed on terminology which defines the 24-hour cycle. This could be similar to what was done to resolve the confusion in SB terminology.<sup>4</sup> Developing constructs and definitions using comprehensive, transparent and broad-based participatory processes will result in standardised terminology which is widely supported and adopted.

If integrated guidelines for these behaviours is the ultimate goal, it will be challenging to achieve—only a few studies have integrated them. Homogenous concepts and terminology which follow the 3Cs principle are an important first step to help advance future research, guidelines, policies and practices related to the 24-hour cycle.

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