Potential impact of wearables on physical activity guidelines and interventions: opportunities and challenges

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Hundreds of millions of people own wearable devices capable of tracking their movement patterns.[1] Accelerometers are also increasingly the preferred tool to measure physical activity in research studies.[2] However, national and international physical activity guidelines, which recommend adults undertake at least 150–300 min of moderate intensity physical activity (MPA) or 75–150 min of vigorous intensity physical activity (VPA) per week, remain largely based on epidemiological studies in which physical activity was assessed using self-reported questionnaires. It is now known that such self-report measures generally overestimate moderate-to-vigorous physical activity (MVPA), are unlikely to accurately measure light intensity physical activity, and cannot capture very short bouts of incidental activity of any intensity.[3] These limitations impede the development of guidelines that reflect the true dose–response relationship between physical activity and health.

Recent prospective studies using wearable devices have started to transform our understanding of the association between physical activity and health outcomes. These suggest that the dose–response relationship between physical activity and health is steeper than self-report data suggest, with substantially smaller doses of device-measured MVPA (~40–80 min/week) associated with benefits similar to those from achieving the currently recommended levels (based on self-report), and an even greater benefit of being highly active than previously appreciated from self-reported data.[4 5] Such data have also demonstrated that just 3–4 min/day of device-measured intermittent VPA is associated with 30%–40% lower risk of all-cause and cardiovascular disease mortality, even in people who report no leisure-time physical activity,[6] and show benefits of engaging in light intensity activity, although minute-for-minute these are substantially smaller than engaging in MVPA.[4 5] Thus, current physical activity guidelines largely reflect the dose–response relationship between perceived—rather than actual—levels of physical activity and health outcomes, and the amount of device-measured physical activity needed for health benefits appears to be smaller than previously thought. This new evidence from wearable devices provides important opportunities and challenges for the development of future physical activity guidelines and for interventions to encourage physical activity.

DEVELOPMENT OF PHYSICAL ACTIVITY INTERVENTION APPROACHES

Mining of physical activity data from wearables has facilitated, and will continue to facilitate, new insights into how both dose and pattern of physical activity affect health outcomes, for example, demonstrating potential benefits of micropatterns of VPA,[6] and of breaking up periods of continuous sedentary time.[7] These observations provide opportunities to test the efficacy and long-term effectiveness of novel device-monitored intervention approaches, expanding the range of physical activity behaviour change options available, particularly for the most inactive who stand to gain most from increased activity even at low and/or intermittent levels.

RESEARCH-GRADE VERSUS CONSUMER WEARABLES

Most of the evidence about the dose–response relationships between activity behaviours and health outcomes has come from studies using research-grade accelerometers. However, individuals monitoring their own activity will typically use consumer devices with proprietary algorithms that do not necessarily measure activity in the same way or with the same accuracy. For example, it is unclear how a metric such as 'very active' minutes on a consumer device relates to definitions of MPA and VPA used in research. Greater understanding is needed of how activity metrics from consumer-based wearables: (1) relate to outputs from research-grade devices, and other models of consumer device and (2) relate to health outcomes. The recent data from the All of Us Research Program, demonstrating an association between step counts from individuals' personal wearable devices (Fitbit) and health outcomes, is an important first step in this direction,[8] but further studies with a more comprehensive range of activity metrics, in more diverse populations (including in historically underrepresented and marginalised groups), and with a wider range of devices are needed. In addition, there is potential to use consumer devices for long-term monitoring to provide insights into within-individual variability in physical activity levels and trends in activity patterns over time. However, using data from individuals' own devices presents challenges around data ownership and privacy, representativeness of the populations studied (users are likely to skew towards the more affluent and health-conscious), and alignment of activity metrics between different devices.

DEVICE-BASED ACTIVITY MONITORING

Self-report and wearables capture different constructs: questionnaires capture continuous blocks of time during which bouts of activity occur whereas

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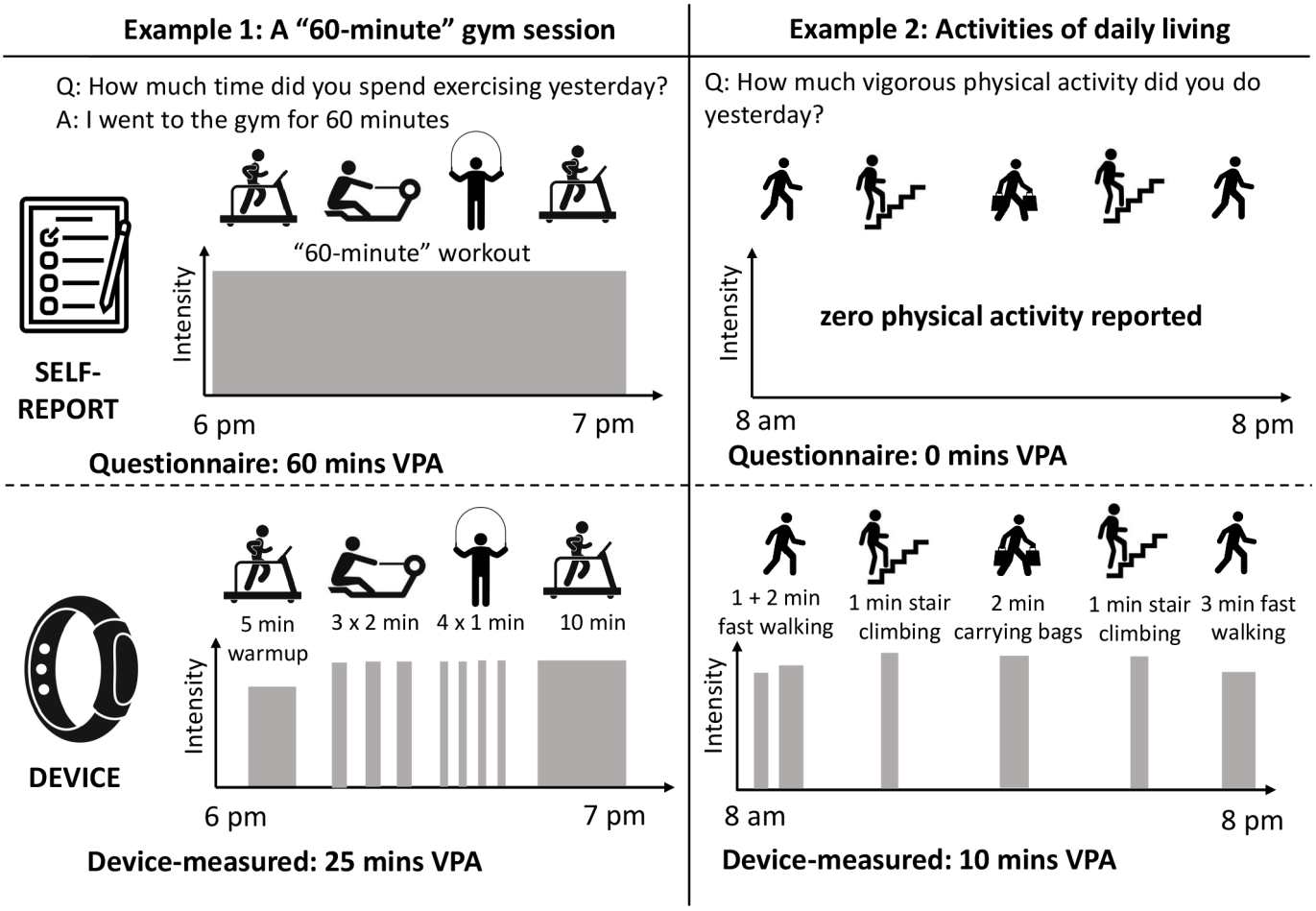

Figure 1 Physical activity captured by self-report questionnaire (top panels) and wearable device (bottom panels) in two different scenarios: a session in the gym (Example 1, left panels) and during intermittent activities of daily living (Example 2, right panels). Questionnaires overestimate physical activity in the former but underestimate physical activity in the latter. N.B. Simplified examples to illustrate the central point. VPA, vigorous physical activity.

devices capture actual physical activity bouts of any duration including those that occur intermittently (figure 1). It is, therefore, important that the methods used to generate the guidelines align with those used to monitor adherence. Using self-report to monitor adherence to a new device-based guideline would likely lead to overestimation of MVPA and underestimation of intermittent VPA and light activity. Thus, if guidelines were changed to reflect device-based data, monitoring of physical activity would also need to be performed by devices. The converse is true with respect to understanding adherence to existing guidelines. It will be important to ensure that changes to both guidelines and adherence monitoring methods are made through an equity lens, which can be iteratively reassessed as device costs decrease, mobile accessibility increases, and scalability and reach improve. As it unlikely that devices will become universally available in the foreseeable future, particularly in low-income and middle-income countries, additional innovative work is needed to understand how device-measured and self-reported physical activity can be aligned in cohort and monitoring studies.

In summary, wearable devices are already transforming how we research, prescribe and monitor physical activity. It is more important than ever for industry, academia and public health communities to work together to maximise the considerable potential that wearables offer to advance and translate our understanding of both how activity behaviours influence health and how to improve interventional approaches to increase physical activity.

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