



## Next Steps for Measures of Physical Activity During Pregnancy

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Published online: 21 January 2019

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We appreciate the recent Commentary by Guérin et al. (2018) which was designed to stimulate academic discussion among women's health researchers regarding how best to measure physical activity (PA) during pregnancy. This topic is particularly important in light of the recent 2018 Physical Activity Guidelines Advisory Committee Scientific Report (2018). In brief, while the committee found strong evidence that moderate-intensity PA reduces excessive gestational weight gain, gestational diabetes, and symptoms of postpartum depression, questions remain regarding the impact of PA on preeclampsia, gestational hypertension, and postpartum weight loss as well as quality of sleep, quality of life, and symptoms of anxiety and depression both during pregnancy and postpartum. The committee highlighted the importance of future studies designed to elucidate the impact of varying types (e.g., leisure-time, occupational, household, transportation), intensities, and doses of PA on maternal and fetal outcomes as critical in informing clinical and public health practice.

In their Commentary, Guérin et al. note discrepancies between PA estimates derived from self-report versus objective measures (Guérin et al. 2018). They argue that a more systematic use of accelerometry is necessary to improve validity and reliability of PA measurement and thereby ensure evidence-based recommendations for pregnant women. The authors premise their argument upon two motivating factors: (1) findings that many people inaccurately self-report their PA levels, and (2) the increasing availability of accelerometry.

In terms of their first point, the authors do not acknowledge that one of the highest priorities in designing a self-report PA questionnaire for epidemiologic practice is the ability of the questionnaire to rank individuals (i.e., to discriminate among individuals) according to their PA rather than to estimate their absolute energy expenditure. Therefore, in the development of questionnaires such as the Pregnancy Physical Activity Questionnaire (PPAQ) (Chasan-Taber et al. 2004), activities that were the most important contributors to between-person variation in pregnancy PA were selected for inclusion. This approach maximizes the ability of this questionnaire to correctly classify individuals into PA rankings thereby facilitating the ability of the questionnaire to predict maternal and fetal health outcomes. Such an approach is robust against systematic overestimation of PA by respondents from similar populations within which the items were developed. Indeed, prior studies have found that women ranked by questionnaires as least active were at statistically increased risk of excessive gestational weight gain (da Silva et al. 2017), gestational diabetes mellitus (Aune et al. 2016), and preeclampsia (Aune et al. 2014).

The authors' second point that the increasing availability of accelerometers should motivate their increased use appears to "put the cart before the horse". In other words, recommendations to rely upon accelerometer-assessed PA measures cannot come before calls for research to improve key aspects of these measurement tools. For example, pregnancy-specific metabolic equivalent values [e.g., modified obstetric METs [MOM-E] (Campbell et al. 2012)] are rarely available. Furthermore, procedures to analyze the data generated by hip- and wrist-based accelerometers need to be further refined and developed. Feasibility studies designed to increase compliance with monitor wear in pregnant women are largely lacking. Indeed, Guérin et al. rely upon studies conducted among nonpregnant women (Welk 2002) and young people (Kirby et al. 2012) to justify their assertion that accelerometers are easy to wear and do not interfere with normal daily activity among pregnant women. This overlooks important aspects unique to pregnancy, such as the impact of changing body girth on hip-worn

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accelerometry (DiNallo et al. 2012). Finally, the few studies which assessed the validity of accelerometers during pregnancy did so only at one or two time points or used a second PA measurement device as the criterion measure rather than indirect calorimetry. Similarly, few studies have assessed the reliability of accelerometry-assessed PA measures when worn during pregnancy (Conway et al. 2018).

In contrast to accelerometry, self-report measures provide information on the purpose, type, and context of PA, allowing investigators to identify and target discretionary behaviors that are amenable to change, critical for interventions designed to promote greater levels of PA. For example considering PA type or modality, studies evaluating risk of preterm birth generally find favorable associations for moderate intensity leisure-time PA (da Silva et al. 2017) but unfavorable associations for occupational PA (Bonzini et al. 2007). Additionally, self-report instruments may be favored for screening purposes, as well as to evaluate historical PA and PA based on relative intensity (Troiano et al. 2012). Indeed, self-reported PA assessments continue to be the most common method used in surveillance and epidemiological studies of pregnant women largely because these studies require a measure of habitual PA patterns for individuals, a large sample size, and due to the participant burden and cost of assessing PA with device-based sensors.

To improve the validity and measurement performance of self-report measures, consideration could be given to both the use of novel and innovative tools for questionnaire validation in free-living settings and the consideration of cognitive testing. For example, wearable cameras can capture a spectrum of behavior types as well as the context of accelerometer-defined episodes of PA in free-living conditions (Doherty et al. 2013). To improve the validity, usefulness, and measurement performance of accelerometry-based measures, consideration could be given to algorithms using the raw data and combining accelerometer data with metrics collected simultaneously (e.g., heart rate, location), or combining it with ecologic momentary assessment to obtain information on type of PA and with whom.

We can all agree that PA is a multi-dimensional behavior which is challenging to quantify. What has hampered research on PA is the lack of an accepted conceptual framework to convey what PA means and to inform the assessment of PA behaviors. The conceptual framework developed by Pettee Gabriel et al. is helpful to consider in this discussion (Pettee Gabriel et al. 2012). The authors define PA as “a behavior that involves human movement, resulting in physiologic attributes including increased energy expenditure and improved physical fitness” (p. S15) and provide study, population/individual, instrument, and activity considerations/characteristics that are essential to consider when assessing self-report or accelerometry-based PA behaviors. The authors acknowledge that no measurement is a perfect

assessment of PA, but rather encourage the researcher to consider what is most important to assess for their study question, how the measure will be interpreted, and what in the measure might be included or omitted.

In summary, instead of a wholesale shift to accelerometry, we suggest that device-based methods and self-report methods each provide unique information with neither method alone providing a complete picture (Troiano et al. 2012; Sternfeld and Goldman Rosas 2012). The decision on which, or both, measure to use should be driven by what dimensions of PA are desirable to assess (Troiano et al. 2012). This recommendation is consistent with the *Workshop on Measurement of Active and Sedentary Behaviors* (Bowles 2012) convened at the National Institutes of Health which concluded that the most comprehensive assessment of PA and sedentary behavior will ultimately rely upon complementary use of linked or integrated assessments using both device and self-report measures depending on the specific aims of the project.

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