Self-report Pregnancy Physical Activity Questionnaire overestimates physical activity

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ABSTRACT

OBJECTIVES: Physical activity (PA) research during pregnancy relies heavily on indirect/subjective measures of PA, which may be less accurate than directly measured PA. We tested whether the Pregnancy Physical Activity Questionnaire (PPAQ) could accurately estimate PA by comparing PPAQ results to directly measured PA.

METHODS: In a sample of 29 women who completed the PPAQ, PA was directly measured in the second trimester of pregnancy using Actical® accelerometers (valid day = 10+ hours; 4–7 valid days). Activity variables from the PPAQ were calculated using all questions, and also by only considering the leisure time section. Women were classified as 'active' or 'non-active' using Canadian PA guidelines for adults (150 minutes moderate to vigorous PA (MVPA)/week, bouts of 10+ minutes). Bonferroni corrections were used to adjust for multiple comparisons. Data presented as mean ± standard deviation or median (interquartile range).

RESULTS: The PPAQ overestimated MVPA by 12.12 (14.34) hours/week in the combined sample, and the difference remained substantial when investigating the non-active [overestimate = 11.54 (10.10) hrs/wk] and the active women [overestimate = 16 ± 11 hrs/wk] separately. PPAQ-measured PA variables did not correlate with any of their respective Actical®-measured variables ($p > 0.008$). The leisure time PPAQ questions overestimated MVPA by 1 ± 3 hrs/wk, with a positive correlation between PPAQ-leisure time MVPA and Actical®-measured MVPA ($r = 0.565$, $p = 0.001$).

CONCLUSION: The PPAQ significantly overestimates MVPA and does not provide an accurate estimate of PA in pregnancy. While PPAQ leisure time questions may help distinguish trends in PA, data from subjective questionnaires may result in misinterpretation of relationships between prenatal PA and health outcomes.

KEY WORDS: Maternal health; accelerometry; quantitative evaluation; qualitative evaluation; physical activity

La traduction du résumé se trouve à la fin de l'article.

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Physical activity (PA) is an important component of a healthy pregnancy, for both the mother and her child.[1,2] Unfortunately, research exploring the impacts of prenatal PA continues to rely heavily on indirect and self-reported measures of PA, such as questionnaires or PA recalls, despite mounting evidence of the poor reliability of self-reported PA.[3,4] Many individuals unintentionally overestimate their PA (e.g., lack of understanding of intensity), and thus the use of self-reported prenatal PA may be less accurate and may lead to the misinterpretation of health outcomes related to prenatal PA. Numerous self-report PA questionnaires correlate poorly with directly measured PA during pregnancy, with questionnaires often overpredicting time spent in moderate intensity PA, and underpredicting time spent in light PA or sedentary time.[5–7] Despite this evidence, in the past year three papers were published on PA and gestational weight gain (GWG) that used self-reported estimates of PA,[8–10] and at least three studies were published using the Pregnancy and Physical Activity Questionnaire (PPAQ) to measure PA.[11–13] The original development and validation of the PPAQ reports weak to moderate correlations between the PPAQ and directly measured PA,[14] however, *p*-values were not reported. A second investigation reported moderate correlations between a French-translated PPAQ and directly measured light and moderate intensity PA, but not for sedentary or vigorous activity.[15] Furthermore, both previous studies used uniaxial Actigraphs, and neither study compared the amount of time spent at different PA intensities as measured by the two methods in order to determine whether the PPAQ was over- or underestimating PA. Since the PPAQ was designed to measure duration, frequency and intensity of activity,[14] it is important to evaluate whether it can accurately measure the time spent in different PA intensities.

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The purpose of this paper is to compare PPAQ-measured PA to directly measured PA using omniaxial Actical® accelerometers during the second trimester of pregnancy, with a focus on time spent at different PA intensities. Second, as it is suspected that women who are regularly physically active may have better comprehension of PA intensity and duration and thus may be more accurate in reporting PA, we aim to determine if there are any differences in the accuracy of the PPAQ in women who meet PA guidelines during pregnancy compared to those who do not meet PA guidelines. It is hypothesized that the PPAQ will overestimate PA in all women, and the differences between the two measures will be larger in the women who do not meet PA guidelines during pregnancy.

METHODS

Women from the Ottawa area between weeks 13 and 28 of pregnancy were recruited using flyers posted in medical facilities as part of a study examining the impact of PA on the placenta. This study was approved by the research ethics board (REB#0903E) and written informed consent was obtained from all participants. Women who smoked, as well as those with type 1, type 2 or gestational diabetes, fetal growth restriction or hypertensive diseases of pregnancy were excluded. Completion of the PA readiness medical examination (PARmed-X) for pregnancy was required to participate.[16] Maternal height was directly measured and pre-pregnancy weight was self-reported during participants' first visit. Prenatal PA was assessed via two methods: the PPAQ,[14] and an Actical® accelerometer.

PPAQ

The PPAQ is a self-administered questionnaire that asks respondents to report the time spent participating in 32 activities, including household/caregiving (13 activities), occupational (5 activities), sports/exercise (8 activities), transportation (3 activities) and inactivity (3 activities).[14] For each question, respondents select the option that best approximates the amount of time spent engaging in that activity during the current trimester. The PPAQ was completed between weeks 20–28, and women were asked to consider only the second trimester. Each question has six options, and possible time durations range from 0 to 6 or more hours per day and from 0 to 3 or more hours per week. The questionnaire includes an open-ended section that allows respondents to add up to two activities that are not included in the list.

The original PPAQ authors previously assigned each activity on the PPAQ to a specific metabolic equivalent (MET) value using field-based measurements in pregnant women[17] and the 2000 update to the compendium-based MET values (1 MET = 1 kcal/kg × hour).[18] These MET values were used to classify each activity by intensity: sedentary (<1.5 METs), light (1.5 ≤ 3.0 METs), moderate (3.0–6.0 METs) and vigorous (>6.0 METs). The duration of time spent per week at each relative intensity of PA was calculated by adding the amount of time spent at each activity within a given intensity level. In congruence with a recent comparison paper,[3] we excluded bicycling, swimming and weight training from the analysis of the PPAQ, as these activities are not well measured by accelerometry. PPAQ activity variables were calculated using two methods: using all questions, and only considering the leisure time section (8 of the 32 questions). We considered the leisure time (LT) section on its own because the authors who developed the PPAQ observed higher correlation coefficients between the LT section and the average Actical® counts per minute, compared to the other forms of activity.[14] Additionally, women may be better able to estimate time spent participating in sports/exercise, rather than household/caregiving or occupational activities.

Accelerometry

Free-living PA was assessed for 7 days with the omniaxial Actical® accelerometer (Mini Mitter Company, Inc., A Respironics Inc. Company, Blend, OR), which measures acceleration in all directions. Participants wore the accelerometer on an elastic waistband on the right hip during the day, except during bathing and aquatic activities. Participants kept daily logs to record when and why the Actical® was removed. Data reduction and analysis were harmonized with the Canadian Health Measures Survey, which has been used to measure PA in normal weight, overweight and obese adults.[19,20] In brief, accelerometry data were downloaded as 60-second epochs and signals were reported as counts per minute and translated into steps per minute. Data were processed using standardized quality control and data reduction procedures in SAS version 9.3 (SAS Institute, Cary, NC).[19] Respondents with 4 or more valid days (10+ hours of wear time) were retained for analyses.[20] Standard cut-points were used to measure time spent in various levels of movement intensity, including sedentary, light, moderate and vigorous.[20,21]

Adherence to the Canadian Society for Exercise Physiology's (CSEP) Canadian PA guidelines for adults was used to classify the women as 'active' or 'non-active'. These guidelines recommend 150 minutes of moderate to vigorous PA (MVPA) per week accumulated in 10-minute bouts, to maintain good health.[20,22] The more stringent, evidence-based PA guidelines for adults were used instead of pregnancy-specific guidelines in order to guarantee the selection of a very active population and because adherence to these guidelines has previously been measured using Actical® accelerometers.[19,20] Since not all participants completed 7 valid days, adherence to the guidelines was defined as an average daily MVPA > 21.43 minutes, which is equal to 150 mins divided by 7 days.

Analysis

We compared the PPAQ results to the Actical®-measured PA in the combined sample of all women and in the active and non-active women separately. We performed these PPAQ variable comparisons using two methods: i) using all questions, and ii) considering only the LT section.

Values greater than three standard deviations away from mean were excluded. Non-normally distributed variables were transformed using a logarithmic transformation. Despite transformation attempts, some variables remained non-normally distributed (*all women*: PPAQ-measured VPA, Actical®-measured VPA and MVPA; *non-active women*: PPAQ-measured VPA, Actical®-measured VPA) and non-parametric methods were employed. Paired sample *t*-tests and Wilcoxon signed-rank tests were used to test for potential differences in the PA variables between the PPAQ and the Actical® data. Effect sizes were

calculated for the normally distributed variables using the Cohen's *d*,[23] and for the non-normally distributed variables we used a modified *r* calculation followed by a conversion to Cohen's *d*.[24] Independent samples *t*-tests and Mann-Whitney U tests were used to test for possible differences between the active and the non-active women. Spearman and Pearson correlations tested potential relationships among minutes of light, moderate and vigorous PA, MVPA, and sedentary time, between the two measures of PA. For the descriptive characteristics, $p < 0.05$ was considered statistically significant. For the comparisons between methods and the correlations, a Bonferroni correction was used to correct for multiple comparisons, thus $p < 0.0083$ was considered significant. Statistical analyses were carried out using SPSS version 20.0 (SPSS Inc., Chicago, IL).

RESULTS

Characteristics of the women

All women had uncomplicated pregnancies and there were no between-group differences in demographic or anthropometric variables (Table 1). Of the 29 participants, 16 women had 7 valid days of Actical® wear time. The number of valid days of Actical® wear time for the remaining women was as follows: 6 days ($n = 7$), 5 days ($n = 4$) and 4 days ($n = 2$).

Relations between the measurement tools

The time spent in different intensities of PA (sedentary, light PA (LPA), moderate PA (MPA), vigorous PA (VPA), and MVPA) as measured by the PPAQ and the Actical® are shown in Table 2. Relative to the Actical®, the PPAQ significantly overpredicted the number of minutes spent engaging in LPA, MPA and MVPA, with very large effect sizes. Using only the PPAQ, LT questions still overpredicted MVPA by 1.1 (3.4) hrs/wk, but to a lesser extent compared to when using the whole PPAQ [12.1 (14.4) hrs/wk]. In some cases, the PPAQ reported implausibly high levels of activity; 5 women obtained more than 19 hrs/day of activity, with 2 participants' PPAQ results reporting >24 hrs of activity per day.

There are substantial differences between the methods with regard to the classification of the women as 'active' or 'non-active' (Table 3). The Actical® and the PPAQ agreed in 34.4% of the cases. When only considering the LT section of the PPAQ, a large proportion of the women were still misclassified as active, and the LT PPAQ agreed with the Actical® in 58.6% of cases.

The comparison of the PPAQ to the Actical® when investigating the active and the non-active women separately is shown in Table 4. In the active women, the PPAQ significantly overestimated LPA, MPA and MVPA with very large effect sizes. In the non-active women, the PPAQ significantly overestimated LPA, MPA and MVPA with large to very large effect sizes. When comparing Actical®-measured PA variables between groups, the active women accumulate significantly more minutes of MPA, VPA and MVPA, and have reduced sedentary time, compared to the non-active women. When comparing PPAQ-measured PA variables, the active women accumulated more minutes of VPA and LT-MVPA, but there was no difference in sedentary time, LPA, MPA or MVPA. The PPAQ overestimated Actical®-measured PA by similar amounts in both groups.

PPAQ variables did not correlate with their respective Actical® measures for sedentary time, LPA, MPA, VPA or MVPA (Table 5).

Table 1. Anthropometric and demographic characteristics of the women and their offspring

	Active ($n = 10$)	Non-active ($n = 19$)
Maternal age (years)	31 ± 3	32 ± 3
Maternal height (cm)	166.9 ± 6.1	166.2 ± 6
Married or living with partner	10 (100%)	19 (100%)
White	9 (90%)	19 (100%)
High school education	0 (0%)	1 (5%)
College or university graduate	10 (100%)	18 (95%)
Household income ≥$50,000	9 (90%)	19 (100%)
Household income <$50,000	1 (10%)	0 (0%)
Pre-pregnancy maternal weight (kg)	63.7 ± 8.5	69.0 ± 15.7
Pre-pregnancy BMI (kg/m^2)	23.0 ± 3.2	25.0 ± 5.8
Maternal weight at delivery (kg)	77.9 ± 7.6	84.4 ± 16.2
Gestational weight gain (kg)	15.0 ± 3.5	13.9 ± 5.0
Weeks of gestation of PPAQ assessment	24.8 ± 2.6	25.4 ± 1.9
PPAQ completed just prior to Actical®*	8 (80%)	13 (68%)
Weeks of gestation at Actical® assessment	25.0 ± 2.8	23.0 ± 4.5
Valid days of Actical® assessment†	6.9 ± 0.3	6.0 ± 1.0
Wear time on valid days of Actical® (hours)	13.0 ± 0.3	13.6 ± 1.5
Gestational age at delivery (weeks)	39.6 ± 1.4	39.1 ± 1.5
Birth weight (g)	3669.7 ± 353.0	3352.1 ± 466.4
Sex of infant (% female)	30%	53%

Notes: Data are presented as mean ± standard deviation or *n* (%). $p < 0.05$ was considered significant.

* In most cases, the Actical® was worn in the week following the completion of the PPAQ. In cases where the Actical® was worn before 20 weeks gestation, the PPAQ was administered in the following weeks (range 4 to 10 weeks after Actical®).

† Valid day of Actical® wear time = 10 or more hours of wear time.

Table 2. Comparison of the amount of time per week spent in different intensities of PA as measured by the Actical® and the PPAQ and how much the PPAQ overestimates the directly measured PA in all of the women

	PPAQ (mins/wk)	Actical® (mins/wk)	Effect size (*r*)	Overestimate (hrs/wk)
Sedentary	3570 (1418)	3045 (319)	0.51	8.6 (21.6)
LPA	1380 (1252)*	897 (304)	1.02	8.8 (17.4)
MPA	885 (893)*	150 (107)	1.76	12.5 (12.9)
VPA	15 (135)	24 (58)	−0.35	0.00 (1.8)
MVPA	885 (810)*	159 (154)	−1.57	12.1 (14.4)
LT-MVPA	255 (293)*	159 (154)	−0.80	1.1 (3.4)

Note: All data (normally and non-normally distributed variables) are presented as median (interquartile range) for ease of comparison.
The mean ± standard deviation of the normally distributed variables are as follows: Actical® Sedentary (3050 ± 235), sedentary overestimate (5.90 ± 17.35), Actical® MPA (155 ± 90), VPA overestimate (0.38 ± 1.24), PPAQ LT-MVPA (279 ± 176), and LT-MVPA overestimate (1.39 ± 2.65).

* $p < 0.0083$ was considered a significant difference between the methods.

Table 3. Classification of the women as active or non-active according to the Actical®, the whole PPAQ and the leisure time section of the PPAQ

	Active	Non-active
Actical®*	10	19
PPAQ	29	0
Leisure time PPAQ	22	7

* Active is considered >150 minutes of MVPA per wk. For the Actical®, as per standard methods, MVPA was accumulated in bouts of 10 mins or more.

Table 4. Comparison of the amount of time per week spent at different intensities of PA according to the PPAQ and the Actical® and how much the PPAQ overestimates different intensities of directly measured PA in the active and non-active women

	Active				Non-active			
	PPAQ (mins/wk)	Actical® (mins/wk)	Effect size	Overestimate (hrs/wk)	PPAQ (mins/wk)	Actical® (mins/wk)	Effect size	Overestimate (hrs/wk)
Sedentary	3045 (1968)	2966 (267)†	0.14	4.7 (36.1)	3570 (840)	3215 (332)†	0.64	8.6 (16.1)
LPA	1995 (1616)*	925 (184)*	1.17	17.7 (19.7)	1305 (630)*	890 (347)*	0.81	6.4 (15.6)
MPA	1193 (1073)*	233 (149)*,†	1.65	14.9 (17.8)	810 (450)*	98 (81)*,†	1.78	11.3 (9.6)
VPA	135 (146)‡	68 (87)†	0.26	0.72 (2.6)	0 (15)‡	0.9 (23.9)†	−0.19	0.00 (0.6)
MVPA	1200 (1208)*	347 (224)*,†	1.51	14.5 (22.1)	825 (465)*	111 (75)*,†	1.69	11.5 (10.1)
LT-MVPA	465 (251)‡	347 (224)†	0.41	1.6 (4.7)	180 (195)‡	111 (75)†	1.47	1.1 (2.3)

Note: All data (normally and non-normally distributed variables) are presented as median (interquartile range) for ease of comparison.
The mean ± standard deviation of the normally distributed variables are provided in supplemental file 1.
* $p < 0.0083$ was considered a significant difference between the methods within the women of the same group.
† $p < 0.0083$ was considered a significant difference in PA variables from the Actical® between the active and non-active women.
‡ $p < 0.0083$ was considered a significant difference in PA variables from the PPAQ between the active and non-active women.

Table 5. Correlations between the PPAQ and the Actical® measures for the different intensities of PA in all the women

	Correlation coefficient	*p*-value	*N*
Sedentary	−0.280	0.885	29
LPA	0.275	0.157	28
MPA	0.041	0.835	28
VPA	0.430	0.022	28
MVPA	0.021	0.914	28
LT-MVPA	0.565	0.001*	29

* $p < 0.0083$ significant correlation between the PPAQ and the Actical® measure of the same PA variable.

LT-MVPA and Actical®-measured MVPA were positively correlated. When analyzed separately as active and non-active women, there were no correlations between the PPAQ and the Actical® variables (data not shown, $p > 0.05$).

DISCUSSION

This analysis reveals discrepancies between Actical®-measured PA and the PPAQ. Our data indicate that the PPAQ is not an accurate proxy of PA: it drastically overestimates LPA, MPA and MVPA in all women, and PPAQ-measured PA variables did not correlate with the Actical® measures of sedentary time, LPA, MPA, VPA or MVPA. This suggests that women may have difficulties accurately recalling or quantifying the duration or intensity of their activities during their second trimester.

These results conflict with the previous publications that concluded that the PPAQ was a reasonably accurate tool for assessing prenatal PA.[14,15] The authors who developed the PPAQ only reported weak to moderate correlations when comparing the PPAQ to 3 different published cut-points for the Actigraph accelerometer [Spearman's r = 0.08–0.49 (n = 54)], but failed to report p-values. Thus, it is unknown whether these correlations are statistically significant. In addition, Chandonnet and colleagues tested a French-translated PPAQ in obese pregnant women and found that the PPAQ was correlated with Actigraph measures of light and moderate intensity PA [r = 0.46 for light, r = 0.40 for moderate, $p < 0.01$ (n = 49)] but not sedentary or vigorous activity.[15] Both previous studies used uniaxial Actigraphs rather than omniaxial Acticals®, and pooled women from the three trimesters, and these differences may have contributed to the different results observed in the current study. Furthermore, neither of the previous manuscripts directly compared the time spent in different PA intensities as measured by the two methods. Given that only moderate correlations were found between the methods,[14,15] it is unknown whether the PPAQ is under- or overpredicting PA or the magnitude of the difference. Based on our findings, and the missing p-values in the Chasan-Taber paper,[14] we do not believe that the PPAQ is a reliable tool to estimate time spent in different intensities of PA during pregnancy.

According to the Actical®-measured PA, only 10 of the 29 women met the PA guidelines, however according to the PPAQ, all 29 women met, if not vastly exceeded, these guidelines. Using the PPAQ and misclassifying a number of the non-active women as active is problematic, especially if this questionnaire were to be employed in research exploring the health effects of prenatal PA. A questionnaire that overestimates PA may increase the likelihood that spurious relationships will be observed. Using the PPAQ may cause relationships between PA and pregnancy outcomes to be missed if women who are not engaging in sufficient PA are grouped with the highly active women, thus diluting the actual level of PA in an active group of women.

This gross overestimation of PA and the lack of correlation between the PPAQ and the Actical®-measured PA call into question the findings from the recently published studies that used the PPAQ to measure PA during pregnancy.[11–13] Given our findings that the PPAQ significantly overestimates PA, it is possible that the conclusions from the previous studies may not represent true relationships. The use of directly measured PA would have provided more reliable measures for PA, potentially leading to different results and interpretations.

The overestimation of PA and the inaccuracies of the PPAQ are consistent with previous work comparing self-report PA to directly measured PA. Bell and colleagues compared two different PA questionnaires to directly measured PA and found that both questionnaires overestimated MVPA in lean and obese women and showed a poor ability to classify women as active or not (n = 59).[5] Additionally, the International Physical Activity Questionnaire (IPAQ) overpredicted MPA, but underpredicted LPA, with poor correlations between the IPAQ and accelerometer measures of PA during pregnancy (n = 30).[6] Furthermore, in overweight and obese pregnant women, the

self-report Activity Questionnaire for Adults and Adolescents overestimated Actigraph-measured MVPA and underestimated sedentary time (n = 55).[7] Unfortunately, the previous studies comparing the PPAQ to accelerometry data[14,15] only report correlation coefficients and do not directly compare PPAQ-measured and accelerometry-measured time spent in different intensities of PA. Thus, it is unknown how well the PPAQ predicted time spent at different PA intensities in those papers. Collectively, these findings strongly suggest that PA questionnaires are not accurate methods of assessing PA during pregnancy.

When investigating the active and the non-active women separately, by design the active women accumulated significantly more minutes of Actical®-measured MVPA. Contrary to our hypothesis, there was no difference in how much the PPAQ over- or underestimated any of the Actical®-measured PA variables between groups. Given that women who are regularly physically active might have a better understanding of the intensity and duration of PA, it was suspected that non-active women would be more likely to over-report their PA. However, when using the PPAQ, both groups over-reported their PA to the same extent.

When only the leisure time section of the PPAQ was considered, the PPAQ continued to overestimate MVPA in all women, but to a lesser extent compared to when using the whole questionnaire [1.1 (3.4) vs. 12.1 (14.4) hrs per wk]. When the group was divided into active and non-active women, there were no longer significant differences between LT-MVPA and Actical®-measured MVPA, which may have been the result of smaller sample sizes. LT-MVPA was significantly correlated with Actical®-measured MVPA, suggesting that using only the LT section of the PPAQ is a more reliable proxy for PA than using the whole questionnaire. It is possible that the women were better able to recall or estimate the intensity and time spent participating in leisure time PA rather than in all activities of daily living.

Limitations

One limitation is that the measurement collection periods differ. The Actical® was only worn for one week between weeks 14–28 of gestation, while the PPAQ reflects the entire second trimester. While both measures attempt to capture 'usual' levels of PA, it is possible that the women may have been experiencing unpleasant side effects of pregnancy during the week they were issued the Actical®, and may not have engaged in their usual level of PA. Comparatively, since the questionnaire covers the second trimester, during which time engaging in PA may become increasingly more difficult as gestation progresses, the women may have had trouble accurately averaging their PA across the trimester. In addition, since the PPAQ was completed between weeks 20 and 28, the period of time considered as the second trimester varied from 7 weeks to 15 weeks. Furthermore, given the implausibly high levels of activity reported in the results from some of the questionnaires, it is possible that some women were double-counting some activities, such as instances where two activities were performed simultaneously. The PPAQ does not include sleeping, eating or personal hygiene, so assuming that the women only slept for 6 hrs per day, the total number of hours of sedentary, LPA and MVPA combined should not be higher than 18 hrs per day. However, according to the PPAQ, 5 women accumulated more than 19 hrs per day of activity.

CONCLUSION

The PPAQ does not provide a reliable estimate of PA in pregnancy and we caution against the use of this questionnaire for research requiring an accurate measure of maternal energy expenditure during pregnancy. Although PPAQ leisure time questions may help distinguish trends in PA, data from subjective questionnaires may result in misinterpretation of relationships between prenatal PA with health and/or pregnancy outcomes.

REFERENCES

1. Ferraro ZM, Gaudet L, Adamo KB. The potential impact of physical activity during pregnancy on maternal and neonatal outcomes. *Obstet Gynecol Surv* 2012;67(2):99–110. PMID: 22325300. doi: 10.1097/OGX.0b013e318242030e.
2. Nascimento SL, Surita FG, Cecatti JG. Physical exercise during pregnancy: A systematic review. *Curr Opin Obstet Gynecol* 2012;24(6):387–94. PMID: 23014142. doi: 10.1097/GCO.0b013e328359f131.
3. Garriguet D, Colley RC. A comparison of self-reported leisure-time physical activity and measured moderate-to-vigorous physical activity in adolescents and adults. *Health Rep* 2014;25(7):3–11. PMID: 25029491.
4. Prince SA, Adamo KB, Hamel ME, Hardt J, Connor Gorber S, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: A systematic review. *Int J Behav Nutr Phys Act* 2008; 5(1):56–80. PMID: 18990237. doi: 10.1186/1479-5868-5-56.
5. Bell R, Tennant PW, McParlin C, Pearce MS, Adamson AJ, Rankin J, et al. Measuring physical activity in pregnancy: A comparison of accelerometry and self-completion questionnaires in overweight and obese women. *Eur J Obstet Gynecol Reprod Biol* 2013;170(1):90–95. PMID: 23849310. doi: 10.1016/j.ejogrb.2013.05.018.
6. Harrison CL, Thompson RG, Teede HJ, Lombard CB. Measuring physical activity during pregnancy. *Int J Behav Nutr Phys Act* 2011;8(19):114–21. PMID: 21418609. doi: 10.1186/1479-5868-8-19.
7. Oostdam N, van Mechelen W, van Poppel M. Validation and responsiveness of the AQuAA for measuring physical activity in overweight and obese pregnant women. *J Sci Med Sport* 2013;16(5):412–16. PMID: 23063355. doi: 10. 1016/j.jsams.2012.09.001.
8. Harris ST, Liu J, Wilcox S, Moran R, Gallagher A. Exercise during pregnancy and its association with gestational weight gain. *Matern Child Health J* 2015;19(3):528–37. PMID: 24912945. doi: 10.1007/s10995-014-1534-8.
9. Schlaff RA, Holzman C, Mudd LM, Pfeiffer K, Pivarnik JM. Body mass index is associated with appropriateness of weight gain but not leisure-time physical activity during pregnancy. *J Phys Act Health* 2014;11(8):1593–99. PMID: 24733294. doi: 10.1123/jpah.2013-0090.
10. Schlaff RA, Holzman C, Maier KS, Pfeiffer KA, Pivarnik JM. Associations among gestational weight gain, physical activity, and pre-pregnancy body size with varying estimates of pre-pregnancy weight. *Midwifery* 2014;30 (11):1124–31. PMID: 24780437. doi: 10.1016/j.midw.2014.03.014.
11. Chasan-Taber L, Silveira M, Pekow P, Braun B, Manson JE, Solomon CG, et al. Physical activity, sedentary behavior and risk of hypertensive disorders of pregnancy in Hispanic women. *Hypertens Pregnancy* 2015;34(1):1–16. PMID: 25121645. doi: 10.3109/10641955.2014.946616.
12. Harrod CS, Chasan-Taber L, Reynolds RM, Fingerlin TE, Glueck DH, Brinton JT, et al. Physical activity in pregnancy and neonatal body composition: The Healthy Start study. *Obstet Gynecol* 2014;124(2):257–64. PMID: 25004346. doi: 10.1097/AOG.0000000000000373.
13. Hawkins M, Chasan-Taber L, Marcus B, Stanek E, Braun B, Ciccolo J, et al. Impact of an exercise intervention on physical activity during pregnancy: The Behaviors Affecting Baby and You study. *Am J Public Health* 2014;104 (10):e74–81. PMID: 25122031. doi: 10.2105/AJPH.2014.302072.
14. Chasan-Taber L, Schmidt MD, Roberts DE, Hosmer D, Markenson G, Freedson PS. Development and validation of a pregnancy physical activity questionnaire. *Med Sci Sports Exerc* 2004;36(10):1750–60. PMID: 15595297.
15. Chandonnet N, Saey D, Almeras N, Marc I. French pregnancy physical activity questionnaire compared with an accelerometer cut point to classify physical activity among pregnant obese women. *PLoS One* 2012; 7(6):e38818. doi: 10.1371/journal.pone.0038818.
16. Canadian Society for Exercise Physiology. *Physical Activity Readiness Medical Examination (PARmed-X) for Pregnancy*. Ottawa, ON: Canadian Society for Exercise Physiology, 2013. Available at: http://www.csep.ca/cmfiles/publications/parq/parmed-xpreg.pdf (Accessed September 9, 2014).
17. Roberts DE, Fragala MS, Pober DL, Chasan-Taber L, Freedson PS. Energy cost of physical activities during pregnancy. *Med Sci Sports Exerc* 2002;34(5):S124.

18. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: An update of activity codes and MET intensities. *Med Sci Sports Exerc* 2000;32(Suppl. 9):S498–504. PMID: 10993420.
19. Colley RC, Gorber SC, Tremblay MS. Quality control and data reduction procedures for accelerometry-derived measures of physical activity. *Health Rep* 2010;21(1):63–69. PMID: 20426228.
20. Colley RC, Garriguet D, Janssen I, Craig CL, Clarke J, Tremblay MS. Physical activity of Canadian adults: Accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Rep* 2011;22(1):7–14. PMID: 21510585.
21. Wong SL, Colley R, Connor GS, Tremblay M. Actical accelerometer sedentary activity thresholds for adults. *J Phys Act Health* 2011;8(4):587–91. PMID: 21597132.
22. Tremblay MS, Warburton DE, Janssen I, Paterson DH, Latimer AE, Rhodes RE, et al. New Canadian physical activity guidelines. *Appl Physiol Nutr Metab* 2011;36(1):36–46. PMID: 21326376. doi: 10.1139/H11-009.
23. Rosenthal R. *Meta-analytic Procedures for Social Research*. Newbury Park, CA: Sage, 1991.
24. Fritz CO, Morris PE, Richler JJ. Effect size estimates: Current use, calculations, and interpretation. *J Exp Psychol Gen* 2012;141(1):2–18. PMID: 21823805. doi: 10.1037/a0024338.

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RÉSUMÉ

OBJECTIFS : La recherche sur l'activité physique (AP) durant la grossesse recourt largement aux indicateurs indirects/subjectifs de l'AP, lesquels peuvent être moins exacts que l'AP directement mesurée. Nous avons testé l'outil *Pregnancy Physical Activity Questionnaire* (PPAQ) pour voir s'il estime l'AP de façon exacte, en comparant les résultats du PPAQ aux résultats obtenus à partir de mesures directes de l'AP.

MÉTHODE : Dans un échantillon de 29 femmes ayant rempli le PPAQ, nous avons directement mesuré l'AP au deuxième trimestre de la grossesse à l'aide d'accéléromètres Actical® (jour admissible = 10+ heures; 4–7 jours admissibles). Les variables d'activité du PPAQ ont été calculées en utilisant toutes les questions, et aussi en ne tenant compte que de la section sur le temps libre. Les femmes ont été classées comme étant « actives » ou « non actives » selon les Directives canadiennes en matière d'AP à l'intention des adultes (150 minutes d'activité physique d'intensité modérée à élevée (APIME)/semaine, en épisodes de 10+ minutes). Nous avons appliqué la correction de Bonferroni pour permettre les comparaisons multiples. Les données ont été présentées sous forme de moyenne ± écart type ou de médiane (écart interquartile).

RÉSULTATS : Le PPAQ a surestimé l'APIME par 12,12 (14,34) heures/semaine dans l'échantillon combiné, et la différence est demeurée importante lorsque nous avons étudié séparément les femmes non actives [surestimation = 11,54 (10,10) h/sem] et les femmes actives [surestimation = 16 ± 11 h/sem]. Les variables d'AP mesurées selon le PPAQ n'étaient en corrélation avec aucune des variables correspondantes mesurées par Actical® ($p > 0{,}008$). Les questions du PPAQ (temps libre) surestimaient l'APIME de 1 ± 3 h/sem, avec une corrélation positive entre l'APIME mesurée selon les questions du PPAQ (temps libre) et l'APIME mesurée par Actical® ($r = 0{,}565$, $p = 0{,}001$).

CONCLUSION : Le PPAQ surestime l'APIME de façon significative et n'offre pas une estimation exacte de l'AP durant la grossesse. Les questions du PPAQ portant sur le temps libre peuvent aider à dégager des tendances dans l'AP, mais les données de questionnaires subjectifs peuvent entraîner une fausse interprétation des relations entre l'AP prénatale et les résultats de santé.

MOTS CLÉS : santé maternelle; accélérométrie; évaluation quantitative; évaluation qualitative; activité physique