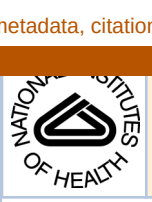

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Review of Self-reported Physical Activity Assessments for Pregnancy: Summary of the Evidence for Validity and Reliability

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Abstract

Background—Epidemiologic studies and surveillance systems of pregnant women often rely collection of physical activity through self-report. This systematic review identified and summarized self-reported physical activity assessments with evidence for validity and reliability among pregnant women.

Methods—Peer-reviewed articles published through 2011 were included if they assessed validity and/or reliability of an interviewer- or self-administered physical activity questionnaire or diary among pregnant women.

Results—We identified 15 studies, including 12 studies that assessed questionnaires and 4 studies that assessed diaries, conducted in Australia, Finland, Norway, United Kingdom, United States, and Vietnam. For questionnaires, 92% (11/12) assessed mode, all assessed frequency and/or duration, and 58% (7/12) collected information on perceived intensity. All but one study (92%) assessed validity of the questionnaires. Questionnaires compared to objective measures (accelerometers, pedometers) ranged from slight to fair agreement, while comparison to other self-reported measures ranged from substantial to almost perfect agreement. Five studies (42%) assessed test-retest reliability of the questionnaires, ranging from substantial to almost perfect agreement. The four studies on diaries were all assessed for validity against objective measures, ranging from slight to substantial agreement.

Conclusions—Selection of valid and reliable physical activity measures that collect information on dose (type, frequency, duration, intensity) is recommended to increase precision and accuracy in detecting associations of physical activity with maternal and fetal outcomes.

Keywords

diary; measurement; physical activity; pregnancy; questionnaire; reliability; review; validity

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Introduction

Physical activity during pregnancy may be associated with improved maternal psychological well-being[1-3] and a reduced risk of gestational diabetes mellitus,[2-4] preeclampsia,[2-4] preterm birth,[3] and excessive gestational weight gain.[4, 5] These research findings help support guidelines for pregnant women to engage in 30 minutes or more of daily moderate intensity exercise in the absence of medical/obstetric complications issued by the American Congress of Obstetricians and Gynecologists (ACOG).[6] Guidelines pertaining to physical activity during pregnancy also exist from the United States (US) government,[3] and from other countries (for example the United Kingdom[7] and Canada[8]).

To determine if pregnant women are meeting physical activity guidelines, self-reported assessment is the most common method used in surveillance studies.[9, 10] In addition, epidemiologic studies of the impact of physical activity before and during pregnancy on birth outcomes typically rely on self-report due to their large sample size and need for cost-effectiveness. For these same reasons, epidemiologic studies designed to identify the predictors of participation in or cessation of physical activity with pregnancy have also relied on self-report assessments. Because these studies are used to inform interventions designed to increase physical activity during pregnancy, it is critical that their findings be both valid and reliable.

An earlier review of the scientific literature through 2005 found that epidemiologic studies of recreational activity (a specific type of physical activity) and two birth outcomes (birthweight and length of gestation) all relied on questionnaires.[11] Most of these questionnaires did not consistently assess type, frequency, intensity, and duration of recreational activity. Moreover, none of the reviewed studies included questionnaires that had been assessed for validity or reliability among pregnant women. To date, there has been no systematic review of self-reported physical activity assessments, including either recreational activity or other modes of physical activity, with evidence for validity and/or reliability among pregnant women.

Self-reported assessments include self- or interviewer-administered questionnaires and diaries, also called logs or records. Self-report assessments can collect mode or type of activity and perceived exertion, two components of physical activity that are not typically ascertained by current objective measures. In contrast, objective measures, such as accelerometers or pedometers, are not subject to self-report error but also have several limitations. Some of these tools are unable to accurately measure physical activities involving upper body movement, pushing or carrying a load, and stationary exercise such as bicycling, weight lifting, and water activities. The inability of some of these tools to discriminate between different modes of physical activity precludes an assessment of the relationship between type of physical activity and pregnancy outcomes. Also of importance, cutpoints necessary to translate accelerometer data into specific intensity categories (i.e., light, moderate, and vigorous) have not been developed for pregnant women.

The purpose of this systematic review was to identify and summarize self-reported physical activity questionnaires and diaries with evidence of validity or reliability among pregnant women from the scientific literature. Our review included studies that assessed all types or modes of physical activity published through the year 2011, in contrast to the earlier review that focused on recreational activity as it related to specific birth outcomes.[11] The ultimate goal was to help researchers select self-reported physical activity measures with evidence for validity and reliability in order to increase precision and accuracy in detecting associations between physical activity and maternal and fetal outcomes.

Methods

We conducted a systematic review of the literature through the year 2011 in the following electronic databases: PubMed, CINAHL, SportDISCUS, Embase, ERIC, Psych Info, and ISI Web of Science. Search terms are defined in the Appendix. Only published peer-reviewed journal articles in the English language were included which reported evidence for validity or reliability on self-reported assessments (questionnaire or diary) of physical activity among pregnant women. We excluded articles that did not report any agreement statistics between the self-reported and criterion or comparison measure; report of means or medians was not sufficient to be included. We did not report results on non-pregnant or postpartum women, but extracted only results on pregnant women even if present within the same article.

From each study, we extracted descriptive information on the sample, characteristics of the assessment tool, and results from validity and reliability testing. We abstracted agreement statistics (e.g., kappa coefficients, percent agreement, correlation coefficients, sensitivity, specificity) between the questionnaire or diary and the comparison method, even when the study's primary purpose may not have been to assess validity. As a guide, we assigned the ratings suggested by Landis and Koch[12] for the abstracted agreement statistics: <0 poor, 0-0.20 slight, 0.21-0.40 fair, 0.41-0.60 moderate, 0.61-0.80 substantial, and 0.81-1.00 almost perfect. We contacted the authors when available to obtain missing information from our abstraction form.

Results

Questionnaire Assessment

We identified 12 studies that assessed the measurement properties of physical activity questionnaires among pregnant women (Table 1). The following questionnaires were assessed: Pregnancy Physical Activity Questionnaire,[13, 14] International Physical Activity Questionnaire,[15, 16] 7-day physical activity recall,[17, 18] occupational questionnaire,[19] modified Kaiser Physical Activity Survey,[20] Norwegian Mother and Child Cohort Study Survey,[21] Leisure-time Exercise Questionnaire,[22] third Pregnancy Infection and Nutrition (PIN3) Study physical activity questionnaire,[23] and STORK physical activity and pregnancy questionnaire.[24] Studies were conducted in Australia,[16] Finland,[15] Norway,[21, 24] United Kingdom,[18] US,[13, 17, 19, 20, 22, 23] and Vietnam.[14] Four questionnaires were interviewer-administered[17, 18, 20, 23] and eight were self-administered.[13-16, 19, 21, 22, 24] Three studies conducted repeat assessments,[17, 18, 22] while the majority assessed only one time during pregnancy.

Recall periods for the assessment included the past week,[16-18, 22, 23] the past two weeks,[15] the current trimester,[13, 14, 20, 24] since becoming pregnant,[21] and since their last menstrual period.[19] All but one questionnaire[17] assessed mode of physical activity. Frequency or duration, sometimes in combination, was assessed in all studies. Relative or perceived intensity was collected in seven questionnaires.[15-18, 22-24]

All but the earliest study[19] included assessment of validity using an objective measure of physical activity (Table 2). The sample sizes for the validity assessment ranged from 12 to 177 pregnant women. The objective assessments included accelerometers[13, 16-18, 20, 21, 23, 24] or pedometers[14-16, 22] to compare to the questionnaire. The results of the comparison ranged widely from poor to substantial agreement. Additionally, five studies included assessment of validity using another self-reported measure of physical activity to compare against the questionnaire, including a clinical

interview,[19] a 7-day diary[15, 17, 23] and the Pregnancy Physical Activity Questionnaire.[20] The results ranged from fair to almost perfect.

Five studies included assessment of test-retest reliability,[13-15, 20, 23] with the sample size ranging from 49 to 109 (Table 3). The time between assessments ranged from 1-2 days to 2 weeks. Most assessments were conducted such that the same time period was recalled. From the five studies, reliability estimates ranged from substantial to almost perfect.

Diary Assessment

We identified four studies that assessed the measurement properties of physical activity diaries among pregnant women (Table 4).[23, 25-27] Two additional studies reported on diaries as a comparison to questionnaires; however, they lacked evidence for validity or reliability of the diary method and therefore were not reviewed here.[15, 17] All four studies were conducted in the US, relied on paper administration, and captured time spent in physical activity. The recording period ranged from 2 days[26] or 3 days[25] to one week.[26, 27] Each diary collected physical activity in different ways. One diary collected activities within given intensity levels on an hourly basis,[26] one collected exercise and sleep,[25] one collected any activity that was at least fairly light in intensity,[23] and one captured all activities including sleep.[27] Three of the four diaries captured relative intensity,[23, 26, 27] with the most detail by Smith et al.[27] using the Borg rating of perceived exertion.[28]

All four diaries reported on evidence for validity by comparing results to objective measures including an accelerometer,[23, 27] Caltrac monitor,[26] pedometer,[25] or a heart rate monitor[26] (Table 4), with sample sizes ranging from 28 to 177. For the Stein et al.[26] study, comparing the heart rate monitor to the diary for total energy expenditure ranged from slight to moderate agreement, while the comparison of the Caltrac to the diary ranged from fair to substantial agreement. For the Lindseth et al.[25] study, agreement between the pedometer and exercise reported on the diary was moderate. For the Evenson et al.[23] study, agreement between the ActiGraph and the diary ranged from slight agreement for moderate activity to fair agreement for vigorous activity. Lastly, the Smith et al.[27] study developed a reference standard, defined as three 30-minute sessions of moderate to vigorous physical activity per week determined by interview and compared to the diary and the SenseWear® device. They found that the highest sensitivity and specificity came from combining the diary with the SenseWear® device to detect the reference standard definition. Only the study by Lindseth et al.[25] examined reliability of the diary by comparing data collected at 14 weeks' to 28 weeks' gestation, with substantial agreement.

Discussion

Self-reported assessments of physical activity continue to be the most common method used in epidemiologic studies of pregnant women. Our review identified 12 studies that assessed questionnaires and 4 studies that assessed diaries for either or both validity and reliability among pregnant women. Since there is no one accepted gold standard measure for physical activity, studies used a range of choices for comparison to evaluate validity (i.e., accelerometer, pedometer, heart rate monitor). For the 4 diary assessments, evidence for validity ranged from slight to substantial against objective measures. For the 12 studies on questionnaires, evidence for validity compared to objective measures ranged from poor to substantial agreement, while comparison to other self-reported measures (i.e., previously explored questionnaires or diaries) ranged from fair to almost perfect agreement.

The finding that agreement was higher when self-reported assessments were used as a criterion as compared to the use of objective assessments is likely due to correlated errors between the two self-reported tools, resulting in inflated estimates of validity. This finding

should be considered when interpreting the validation results. However, there are also concerns when using an objective measure as the criterion, including errors in the objective measure itself. For example, when an accelerometer is worn on the hip, error may result from the inability of the device to accurately measure activities involving upper body movement, pushing or carrying a load, stationary exercise (e.g., cycling), and weight-lifting. Newer versions of these monitors overcome some of these limitations. However, hip-worn monitors may still be affected by other factors specific to pregnant women, such as changes in body girth, placement site, and monitor tilt.[29]

The choice of the length of time the monitor is worn will also impact agreement with self-reported measures, given that the objective assessment tool is typically worn for a period ranging from 3 to 10 days. The consensus is that the number of days needed to reliably estimate habitual physical activity with objective devices varies depending on the precision required, the accuracy of the criterion method, and the intra-individual variation in physical activity.[30, 31]

Another concern with the use of accelerometry as the criterion measure is that cutpoints from calibration studies are needed to determine the threshold to categorize counts into differing levels of intensity for an activity.[32] At least four different cutpoints for moderate to vigorous physical activity were used among the reviewed studies of pregnant women.[33-36] These cut points differ substantially, have not been substantiated in pregnant populations, and their varied use has resulted in discrepant estimates of validity, as evidenced from this review. The use of total counts from the accelerometer moves away from the dependence on cutpoints, but represents total physical activity and not specific time in a given intensity. In the future, other options to interpret objectively assessed physical activity should be available as an alternative to the dependence on cutpoints.

Finally, wearing an activity monitor or keeping a diary during the interval between administrations of the questionnaires may lead to a heightened awareness of physical activity among participants, thereby affecting the self-assessment tool results leading to a potentially biased estimate of validity. Given that neither the objective nor self-reported comparison method is perfect, it is critical that the errors inherent in each method be as independent as possible, as correlated errors will result in spuriously high validity coefficients.[37]

This review identified the use of agreement statistics to report on evidence of validity, often using correlation coefficients. Many times these results were not presented with confidence intervals, which did not allow for the interpretation of precision of the reported estimates. Moreover, only some of the studies used Bland-Altman plots in their assessment.[14-16, 23, 24] Improvement in future validity studies could include expanding the analysis to incorporate confidence intervals around the agreement statistics and the use of Bland-Altman plots, as suggested by others,[38] to better quantify the comparison and indicate the direction of mismeasurement between the two assessment tools.

Only one study assessed reliability of the diary,[25] with substantial agreement, and five studies assessed reliability of the questionnaires (Table 3), ranging from substantial to almost perfect agreement. In one of the five studies,[15] the recall of physical activity during the second questionnaire administration was not during the same time period as the first questionnaire administration, which may have reduced reliability estimates if physical activity behavior truly changed during that period. The time between questionnaire administration of the test and retest versions ranged from 1-2 days to 2 weeks. Reliability estimates can be overestimated by choosing too short a time period between administrations, such that participants are simply recalling their responses to the first questionnaire. In

contrast, the only diary that assessed reliability allowed 14 weeks between administration.[25] For longer time between administrations, the concern is that physical activity behavior may have truly changed between the two time points. Reliability assessment should be conducted to minimize changes in physical activity between the two time periods. In particular, this choice will also depend on the recall period of the instrument being used, with shorter recall periods needing shorter time between the two administrations if the same time periods will be recalled.

Several questions, summarized in Table 5, could be considered when choosing a questionnaire or diary to assess physical activity among pregnant women. Other resources, summarized elsewhere,[39] can also help supplement these points.

Conclusion

Among pregnant women, self-reported physical activity measures are the most common assessment method used for surveillance, intervention, and epidemiologic studies. This review of self-reported physical activity instruments was conducted to assist researchers in selecting valid and reliable physical activity measures for studies of pregnant women. Ideally these measures should collect information on dose of activity (e.g., frequency, duration, and intensity),be useful for a wide range of physical activity modes and intensities, and ultimately increase precision and accuracy in detecting associations between physical activity and maternal and fetal outcomes.

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Appendix

The literature review search strategy using both medical subject headings (MeSH) and text words (tw)

(pregnancy (MeSH) OR pregnancy (tw) OR maternity (tw))

AND (exercise (MeSH) OR motor activity (MeSH) OR physical activity (tw) OR exercise/physiology (MeSH) OR motion (MeSH))

AND (self disclosure (MeSH) OR self report (MeSH) OR questionnaires (MeSH) OR physiology/instrumentation (MeSH) OR metabolic equivalent (MeSH) OR questionnaire* (tw) OR diary (tw) OR self report (tw))

Note: Several articles were reviewed in full and excluded because they did not meet the inclusion criteria, including those referenced herein[53,55,62-64].

References

1. Poudevigne M, O'Connor P. A review of physical activity patterns in pregnant women and their relationship to psychological health. Sports Medicine. 2006; 36:19–38. [PubMed: 16445309]

2. Pivarnik JM, Chambliss H, Clapp J III, Dugan S, Hatch M, Lovelady C, et al. Impact of physical activity during pregnancy and postpartum on chronic disease risk. Medicine and Science in Sports and Exercise. 2006; 38:989–1006. [PubMed: 16672855]
3. U.S. Department of Health and Human Services. Physical Activity Guidelines for Americans. Washington, D.C.: 2008. ODPHP Publication No. U0036at http://www.health.gov/paguidelines/ 2008
4. Symons Downs D, Chasen-Taber L, Evenson K, Leiferman J, Yeo S. Physical activity and pregnancy: Past and present evidence and future recommendations. Research Quarterly for Exercise Sport. 2012 in press.
5. Institute of Medicine. National Research Council. , editor. Weight gain during pregnancy: Reexamining the guidelines. National Academies Press; Washington, D.C.: 2009.
6. ACOG. Exercise during pregnancy and the postpartum period. Obstet Gynecol. 2002; 99:171–173. ACOG Committee Opinion No. 267. [PubMed: 11777528]
7. Royal College of Obstetricians and Gynaecologists. [Accessed September 1, 2009] Exercise in pregnancy. 2006. RCOG Statement No. 4 - January 2006at http://www.rcog.org.uk/files/rcog-corp/uploaded-files/ RCOGStatement4ExercisePregnancy2006.pdf
8. Davies G, Wolfe L, Mottola M, MacKinnon C. Joint SOGC/CSEP clinical practice guideline: Exercise in pregnancy and the postpartum period. Canadian Journal of Applied Physiology. 2003; 28:330–341. [PubMed: 12955862]
9. Evenson K, Wen F. National trends in self-reported physical activity and sedentary behaviors among pregnant women: NHANES 1999-2006. Preventive Medicine. 2010; 50:123–128. [PubMed: 20053370]
10. Bovbjerg ML, Siega-Riz AM. Exercise during pregnancy and cesarean delivery: North Carolina PRAMS, 2004-2005. Birth. 2009; 36:200–207. [PubMed: 19747266]
11. Chasan-Taber L, Evenson KR, Sternfeld B, Kengeri S. Assessment of recreational physical activity during pregnancy in epidemiologic studies of birthweight and length of gestation: methodologic aspects. Women Health. 2007; 45:85–107. [PubMed: 18032169]
12. Landis J, Koch G. The measurement of observer agreement for categorical data. Biometrics. 1977; 33:159–174. [PubMed: 843571]
13. Chasan-Taber L, Schmidt M, Roberts D, Hosmer D, Markenson G, Freedson P. Development and validation of a pregnancy physical activity questionnaire. Medicine and Science in Sports and Exercise. 2004; 36:1750–1760. [PubMed: 15595297]
14. Ota E, Haruna M, Yanai H, Suzuki M, Anh DD, Matsuzaki M, et al. Reliability and validity of the Vietnamese version of the Pregnancy Physical Activity Questionnaire (PPAQ). Southeast Asian Journal of Tropical Medicine and Public Health. 2008; 39:562–570. [PubMed: 18564699]
15. Aittasalo M, Pasanen M, Fogelholm M, Ojala K. Validity and repeatability of a short pregnancy leisure time physical activity questionnaire. Journal of Physical Activity and Health. 2010; 7:109–118. [PubMed: 20231762]
16. Harrison CL, Thompson RG, Teede HJ, Lombard CB. Measuring physical activity during pregnancy. International Journal of Behavioral Nutrition and Physical Activity. 2011; 8:19. Available at http://www.ijbnpa.org/content/8/1/19/. [PubMed: 21418609]
17. Poudevigne MS, O'Connor PJ. Physical activity and mood during pregnancy. Medicine and Science in Sports and Exercise. 2005; 37:1374–1380. [PubMed: 16118585]
18. Rousham E, Clarke P, Gross H. Significant changes in physical activity among pregnant women in the UK as assessed by accelerometry and self-reported activity. European Journal of Clinical Nutrition. 2005; 60:393–400. [PubMed: 16306930]
19. Eskenazi B, Pearson K. Validation of a self-administered questionnaire for assessing occupational and environmental exposures of pregnant women. American Journal of Epidemiology. 1988; 128:1117–1129. [PubMed: 3189285]
20. Schmidt MD, Freedson PS, Pekow P, Roberts D, Sternfeld B, Chasan-Taber L. Validation of the Kaiser Physical Activity Survey in pregnant women. Medicine and Science in Sports and Exercise. 2006; 38:42–50. [PubMed: 16394952]

21. Brantsaeter AL, Owe KM, Haugen M, Alexander J, Meltzer HM, Longnecker MP. Validation of self-reported recreational exercise in pregnant women in the Norwegian Mother and Child Cohort Study. Scandinavian Journal of Medicine and Science in Sports. 2010; 20:e48–e55. [PubMed: 19486481]
22. Symons Downs D, LeMasurier G, DiNallo J. Baby steps: pedometer-determined and self-reported leisure-time exercise behaviors of pregnant women. Journal of Physical Activity and Health. 2009; 6:63–72. [PubMed: 19211959]
23. Evenson KR, Wen F. Measuring physical activity in pregnant women using a structured one-week recall questionnaire: evidence for validity and reliability. International Journal of Behavioral Nutrition and Physical Activity. 2010; 7:21. Available at http://www.ijbnpa.org/content/27/21/21. [PubMed: 20302668]
24. Haakstad LA, Gundersen I, Bo K. Self-reporting compared to motion monitor in the measurement of physical activity during pregnancy. Acta Obstetricia et Gynecologica Scandinavica. 2010; 89:749–756. [PubMed: 20450260]
25. Lindseth G, Vari P. Measuring physical activity during pregnancy. Western Journal of Nursing Research. 2005; 27:722–734. [PubMed: 16157944]
26. Stein A, Rivera J, Pivarnik J. Measuring energy expenditure in habitually active and sedentary pregnant women. Medicine and Science in Sports and Exercise. 2003; 35:1441–1446. [PubMed: 12900702]
27. Smith KM, Foster RC, Campbell CG. Accuracy of physical activity assessment during pregnancy: an observational study. BMC Pregnancy and Childbirth. 2011; 11:86. Available at http://www.biomedcentral.com/1471-2393/11/86. [PubMed: 22039863]
28. Borg G, Linderholm H. Perceived exertion and pulse rate during graded exercise in various age groups. Acta Medica Scandinavica. 1974; 472:194–206.
29. DiNallo J, Symons Downs D, Le Masurier G. Objectively assessing treadmill walking during the second and third pregnancy trimesters. Journal of Physical Activity and Health. 2012; 9:21–28. [PubMed: 22232501]
30. Corder K, Brage S, Ekelund E. Accelerometers and pedometers: methodology and clinical application. Current Opinion in Clinical Nutrition and Metabolic Care. 2007; 10:597–603. [PubMed: 17693743]
31. Trost S, McIver K, Pate R. Conducting accelerometer-based activity assessments in field-based research. Medicine and Science in Sports and Exercise. 2005; 37:S531–S543. [PubMed: 16294116]
32. Matthews C. Calibration of accelerometer output for adults. Medicine and Science in Sports and Exercise. 2005; 37:S512–S522. [PubMed: 16294114]
33. Freedson P, Melanson E, Sirard J. Calibration of the Computer Science and Applications, Inc. accelerometer. Medicine and Science in Sports and Exercise. 1998; 30:777–781. [PubMed: 9588623]
34. Swartz A, Strath S, Bassett D Jr. O'Brien W, King G, Ainsworth B. Estimation of energy expenditure using CSA accelerometers at hip and wrist sites. Medicine and Science in Sports and Exercise. 2000; 32:S450–456. [PubMed: 10993414]
35. Troiano R, Berrigan D, Dodd K, Masse L, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. Medicine and Science in Sports and Exercise. 2008; 40:181–188. [PubMed: 18091006]
36. Hendelman D, Miller K, Baggett C, Debold E, Freedson P. Validity of accelerometry for the assessment of moderate intensity physical activity in the field. Medicine and Science in Sports and Exercise. 2000; 32:S442–449. [PubMed: 10993413]
37. Nusser SM, Beyler NK, Welk GJ, Carriquiry AL, Fuller WA, King BM. Modeling errors in physical activity recall data. Journal of Physical Activity and Health. 2012; 9(Suppl 1):S56–67. [PubMed: 22287449]
38. Schmidt ME, Steindorf K. Statistical methods for the validation of questionnaires--discrepancy between theory and practice. Methods of Information in Medicine. 2006; 45:409–413. [PubMed: 16964357]

39. Bowles HR. Measurement of active and sedentary behaviors: closing the gaps in self-report methods. Journal of Physical Activity and Health. 2012; 9(Suppl 1):S1–S4. [PubMed: 22287442]
40. Sternfeld B, Jiang SF, Picchi T, Chasan-Taber L, Ainsworth B, Quesenberry CP Jr. Evaluation of a cell phone-based physical activity diary. Medicine and Science in Sports and Exercise. 2012; 44(3):487–495. [PubMed: 21857369]
41. Intille SS, Lester J, Sallis JF, Duncan G. New horizons in sensor development. Medicine and Science in Sports and Exercise. 2012; 44:S24–31. [PubMed: 22157771]
42. Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DR Jr. Tudor-Locke C, et al. 2011 Compendium of Physical Activities: A Second Update of Codes and MET Values. Medicine and Science in Sports and Exercise. 2011; 43:1575–1581. [PubMed: 21681120]
43. Lof M. Physical activity pattern and activity energy expenditure in healthy pregnant and non-pregnant Swedish women. European Journal of Clinical Nutrition. 2011; 65:1295–1301. [PubMed: 21792212]
44. Giles-Corti B, Timperio A, Cutt H, Pikora T, Bull F, Knuiman M, et al. Development of a reliable measure of walking within and outside the local neighborhood: RESIDE's Neighborhood Physical Activity Questionnaire. Preventive Medicine. 2006; 42:455–459. [PubMed: 16574208]
45. Kuo J, Schmitz KH, Evenson KR, McKenzie TL, Jobe JB, Rung AL, et al. Physical and social contexts of physical activities among adolescent girls. Journal of Physical Activity and Health. 2009; 6:144–152. [PubMed: 19420391]
46. Krenn PJ, Titze S, Oja P, Jones A, Ogilvie D. Use of global positioning systems to study physical activity and the environment: a systematic review. American Journal of Preventive Medicine. 2011; 41:508–515. [PubMed: 22011423]
47. Owen N, Sugiyama T, Eakin EE, Gardiner PA, Tremblay MS, Sallis JF. Adults' sedentary behavior determinants and interventions. American Journal of Preventive Medicine. 2011; 41:189–196. [PubMed: 21767727]
48. Clark BK, Thorp AA, Winkler EA, Gardiner PA, Healy GN, Owen N, et al. Validity of self-reported measures of workplace sitting time and breaks in sitting time. Medicine and Science in Sports and Exercise. 2012; 43:1907–1912. [PubMed: 21926535]
49. Kozey-Keadle S, Libertine A, Lyden K, Staudenmayer J, Freedson PS. Validation of wearable monitors for assessing sedentary behavior. Medicine and Science in Sports and Exercise. 2011; 43:1561–1567. [PubMed: 21233777]
50. Mackay LM, Schofield GM, Oliver M. Measuring physical activity and sedentary behaviors in women with young children: a systematic review. Women and Health. 2011; 51:400–421.
51. Castillo-Retamal M, Hinckson EA. Measuring physical activity and sedentary behaviour at work: a review. Work. 2011; 40:345–357. [PubMed: 22130052]
52. Arredondo EM, Mendelson T, Holub C, Espinoza N, Marshall S. Cultural adaptation of physical activity self-report instruments. Journal of Physical Activity and Health. 2012; 9(Suppl 1):S37–43. [PubMed: 22287446]
53. Matsuzaki M, Haruna M, Ota E, Yeo S, Murayama R, Murashima S. Translation and cross-cultural adaptation of the Pregnancy Physical Activity Questionnaire (PPAQ) to Japanese. Bioscience Trends. 2010; 4:170–177. [PubMed: 20811136]
54. Troiano RP, Pettee Gabriel KK, Welk GJ, Owen N, Sternfeld B. Reported physical activity and sedentary behavior: why do you ask? Journal of Physical Activity and Health. 2012; 9(Suppl 1):S68–75. [PubMed: 22287450]
55. McParlin C, Robson SC, Tennant PW, Besson H, Rankin J, Adamson AJ, et al. Objectively measured physical activity during pregnancy: a study in obese and overweight women. BMC Pregnancy and Childbirth. 2010; 10:76. Available at http://www.biomedcentral.com/1471-2393/10/76. [PubMed: 21114834]
56. Evenson K, Wen F. National prevalence and correlates of objectively measured physical activity and sedentary behaviors among pregnant women. Preventive Medicine. 2011; 53:39–43. [PubMed: 21575654]
57. Allied Dunbar Assurance Plc, Council HEAaS. Allied Dunbar National Fitness Survey. Sports Council and Health Education Authority; London: 1992.

58. Blair SN, Haskell WL, Ho P, Paffenbarger RS Jr. Vranizan KM, Farquhar JW, et al. Assessment of habitual physical activity by a seven-day recall in a community survey and controlled experiments. American Journal of Epidemiology. 1985; 122:794–804. [PubMed: 3876763]

59. Ainsworth B, Sternfeld B, Richardson M, Jackson K. Evaluation of the Kaiser Physical Activity Survey in women. Medicine and Science in Sports and Exercise. 2000; 32:1327–1338. [PubMed: 10912901]

60. Jacobs D Jr. Ainsworth B, Hartman T, Leon A. A simultaneous evaluation of 10 commonly used physical activity questionnaires. Medicine and Science in Sports and Exercise. 1993; 25:81–91. [PubMed: 8423759]

61. Craig C, Marshall A, Sjostrom M, Bauman A, Booth M, Ainsworth B, et al. International physical activity questionnaire: 12-country reliability and validity. Medicine and Science in Sports and Exercise. 2003; 35:1381–1395. [PubMed: 12900694]

62. Wildschut HI, Harker LM, Riddoch CJ. The potential value of a short self-completion questionnaire for the assessment of habitual physical activity in pregnancy. Journal of Psychosomatic Obstetrics and Gynecology. 1993; 14:17–29. [PubMed: 8358520]

63. Lof M, Forsum E. Activity pattern and energy expenditure due to physical activity before and during pregnancy in healthy Swedish women. British Journal of Nutrition. 2006; 95:296–302. [PubMed: 16469145]

64. Bauer PW, Pivarnik JM, Feltz DL, Paneth N, Womack CJ. Validation of an historical physical activity recall tool in postpartum women. Journal of Physical Activity and Health. 2011; 7:658–661. [PubMed: 20864762]

Table 1

Description of physical activity questionnaires of pregnant women, by publication year through 2011*

	Eskenazi and Pearson, 1988[19]	Chasan-Taber, et al., 2004[13]	Rousham, et al., 2005[18]	Poudevigne and O'Connor, 2005[17]	Schmidt, et al., 2006[20]	Ota, et al., 2008 [14]	Brantsaeter, et al., 2010[21]	Symons Downs, et al., 2009[22]	Aittasalo, et al., 2010[15]	Evenson and Wen, 2010[23]	Haakstad, et al., 2010[24]	Harrison, et al., 2011[16]
Questionnaire	University of California - San Francisco questionnaire on occupational and environmental exposures	Pregnancy Physical Activity Questionnaire	7-day physical activity recall	7-day physical activity recall	modified Kaiser Physical Activity Survey	Pregnancy Physical Activity Questionnaire, Vietnamese version	Norweigan Mother and Child Cohort Study physical activity questionnaire	Leisure-time Exercise Questionnaire	modified International Physical Activity Questionnaire, short version	Third Pregnancy Infection and Nutrition Study (PIN3) Physical Activity Questionnaire	STORK physical activity and pregnancy questionnaire	International Physical Activity Questionnaire, long version
Modification or reference of original version	N/A	developed for this study	adapted from the Allied Dunbar National Fitness Survey (Allied Dunbar Assurance Plc, 1992)[57]	(Blair, et al.1985)[58]	adapted from the Kaiser Physical Activity Survey (Ainsworth, et al., 2000)[59]	adapted from English version of the Pregnancy Physical Activity Questionnaire (Chasan-Taber, et al., 2004)[13]	N/A	Leisure-time Exercise Questionnaire (Jacobs Jr., et al., 1993)[60]	adapted from the International Physical Activity Questionnaire (Craig, et al., 2003)[61]; "walking" was changed to "household chores indoors and outdoors"	developed for this study	N/A	(Craig, et al., 2003)[61]
Administration delivery	self-administered	self-administered	interviewer administered	interviewer administered	interviewer administered	self-administered	self-administered	self-administered	self-administered	interviewer administered	self-administered	self-administered
Administration time during pregnancy	mean 27 weeks' gestation	30% first trimester, 31% second trimester, 39% third trimester	12, 16, 25, 34, and 38 weeks' gestation	12, 16, 20, 24, 28, 32, and 36 weeks' gestation	30% first trimester, 31% second trimester, 39% third trimester	38% first trimester, 35% second trimester, 27% third trimester	15-17 weeks' gestation	study 2: 20 and 32 weeks' gestation	<=33 weeks' gestation	mean 19 weeks' gestation for reliability and mean 21 weeks' gestation for validity	mean 34.7 weeks' gestation	26-28 weeks' gestation
Recall period	since their last menstrual period	current trimester	past week	past week before laboratory session	current trimester	current trimester	during this pregnancy	past week	past 2 weeks	past week	current trimester	past week
Data collection years	1986	2002-03	1998-99	2003-04	2002-03	2007	2003-04	2007-08	2007	2002-04	2007-08	2009-10
Assessment of:												
Mode	yes; exercise (not reported on in this publication) and work	yes; household, sport, transportation, work, inactivity	yes; household, recreation, work, sleep	no	yes; active living, household, sport, work	yes; household, sport, transportation, work, inactivity	yes; 14 recreational activities	yes; exercise	yes; household, recreation	yes; any activity that was at least fairly light in intensity	yes; household/ child care, exercise, sport, transportation, work	yes; household, recreation, transportation, work, sitting
Frequency	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
Duration	yes	yes	yes	yes	yes	yes	no (only in a preliminary	yes	yes	yes	yes	yes

	Eskenazi and Pearson, 1988[19]	Chasan-Taber, et al., 2004[13]	Rousham, et al., 2005[18]	Poudevigne and O'Connor, 2005[17]	Schmidt, et al., 2006[20]	Ota, et al., 2008 [14]	Brantsaeter, et al., 2010[21]	Symons Downs, et al., 2009[22]	Aittasalo, et al., 2010[15]	Evenson and Wen, 2010[23]	Haakstad, et al., 2010[24]	Harrison, et al., 2011[16]
							version)					
Relative/perceived intensity	no	no	yes	yes; moderate, hard, very hard	no	no	no	yes; mild, moderate, strenuous	yes; none, some, strong	yes; fairly light, somewhat hard, hard/very hard	yes; inactivity, low, moderate, high	yes; moderate, vigorous

N/A=not applicable

*Some information not found in the article was obtained directly from the authors.

Table 2

Physical activity questionnaires for pregnant women that reported evidence for validity, by publication year through 2011*

	Eskenazi and Pearson, 1988[19]	Chasan-Taber, et al., 2004[13]	Rousham, et al., 2005[18]	Poudevigne and O'Connor, 2005[17]	Schmidt, et al., 2006[20]	Ota, et al., 2008[14]	Brantsaeter, et al., 2010[21]	Symons Downs, et al., 2009[22]	Aittasalo, et al., 2010[15]	Evenson and Wen, 2010[23]	Haakstad, et al., 2010[24]	Harrison, et al., 2011[16]
Questionnaire	University of California - San Francisco questionnaire on occupational and environmental exposures	Pregnancy Physical Activity Questionnaire	7-day physical activity recall	7-day physical activity recall	modified Kaiser Physical Activity Survey	Pregnancy Physical Activity Questionnaire, Vietnamese version	Norweigan Mother and Child Cohort Study physical activity questionnaire	leisure-time exercise questionnaire	modified International Physical Activity Questionnaire, short version	Third Pregnancy Infection and Nutrition Study (PIN3) Physical Activity Questionnaire	STORK physical activity and pregnancy questionnaire	International Physical Activity Questionnaire, long version
Validity analysis sample of pregnant women; location	n=57; California, US	n=54; Massachusetts, US	n=57; United Kingdom	n=12 first trimester; Georgia, US	n=54; Massachusetts, US	n=59; Vietnam	n=112; Norway	n=23 study 2; Pennsylvania, US	n=45 for accelerometer; n=47 logbook; Finland	n=177; central North Carolina, US	n=77; Norway	n=30 with body mass index 25-<46 kg/m2 participating in a randomized clinical trial; Australia
Objective Measures												
Measure	none	ActiGraph 7164 accelerometer for 7 days using 1-minute epochs; worn on hip	Actiwatch AW2 for 3 days (1 weekend and 2 weekdays) using 1-minute epochs; worn on ankle	ActiGraph 7164 for 3 days (2 weekdays and 1 weekend day) using 1-minute epochs; worn on hip	ActiGraph 7164 accelerometer for 7 days using 1-minute epochs; worn on hip	Digiwalker SW-200 Yamax pedometer; measured as 10-day averages; worn on hip	ActiReg accelerometer for 4 days using 1-minute epochs; attached to the chest and the front of the thigh	Yamax Digiwalker SW-701 pedometer for 3 days; worn on hip	Omron HJ-113 pedometer for 7 days; worn on hip	ActiGraph 7164 accelerometer for 7 days using 1-minute epochs; worn on hip	ActiReg accelerometer for 7 days using 1-minute epochs; attached to the chest and front of the thigh	Digiwalker SW-700 Yamax pedometer and ActiGraph GT1M for 5-7 days using 1-minute epochs; worn on hip
Recall exact same period of time	N/A	yes	no	yes	yes	no	no	no	no	yes	no	yes
Results **	N/A	SCC (MVPA accelerometer to total activity from the questionnaire) 0.08 Freedson, 0.32 Swartz, 0.43 Hendelman; SCC (average counts/minute accelerometer to questionnaire) 0.27	PCC (MVPA using Hendelman on accelerometer to questionnaire) 12/16/25/34/38 weeks: 0.33/-0.13/-0.10/-0.10/0.16; low intensity: 0.78/-0.14/0.23/0.13/0.14	SCC (accelerometer counts to 7 day recall) 0.23	SCC (MVPA accelerometer to total activity from questionnaire): 0.59 Freedson, 0.49 Swartz, 0.55 Hendelman; SCC (average counts/minute accelerometer to questionnaire) 0.52	PCC (overall steps to questionnaire): 0.29	PCC (total EE accelerometer to all weekly exercise on questionnaire): unadjusted 0.17, adjusted 0.27; PCC (physical activity EE to questionnaire): unadjusted 0.26, adjusted 0.26	PCC (mean pedometer steps/day to total minutes in exercise on the questionnaire) 0.24 at 20 weeks and 0.00 at 32 weeks	SCC (pedometer to average weekly leisure activity on questionnaire) 0.16 frequency, -0.18 duration	SCC (questionnaire in MET-hours/week to accelerometer using 3 different cutpoints) ranged from 0.04 to 0.08 for moderate (4.8-7.1 METS), 0.29 to 0.31 for vigorous	SCC (accelerometer to questionnaire) 0.20 light, 0.15 moderate, 0.59 vigorous	SCC (accelerometer to questionnaire) total 0.18, light 0.07, moderate 0.54; SCC (pedometer steps to mean daily MET-minutes from the

	Eskenazi and Pearson, 1988[19]	Chasan-Taber, et al., 2004[13]	Rousham, et al., 2005[18]	Poudevigne and O'Connor, 2005[17]	Schmidt, et al., 2006[20]	Ota, et al., 2008[14]	Brantsaeter, et al., 2010[21]	Symons Downs, et al., 2009[22]	Aittasalo, et al., 2010[15]	Evenson and Wen, 2010[23]	Haakstad, et al., 2010[24]	Harrison, et al., 2011[16]
										(>7.1 METS), and 0.18-0.21 for MVPA; SCC (questionnaire in hours/week to accelerometer using 3 different cutpoints) ranged from 0.25 to 0.33 for moderate, 0.26 to 0.32 for vigorous, and 0.28-0.34 for MVPA		questionnaire) 0.30
Self-report Measures												
Measure	clinical interview	none	none	7-day physical activity diary	Pregnancy Physical Activity Questionnaire (Chasan-Taber, et al., 2004)	none	none	none	leisure activity logbook that recorded mode, duration, and intensity for one week	Third Pregnancy Infection and Nutrition Study (PIN3) structured diary	none	none
Recall exact same period of time	yes			7 days before laboratory session	yes				no	yes		
Results **	PCC (questionnaire to interview) sitting at work 0.78; stooping/bending 0.76; flights of stairs climbed 0.91			7-day recall significantly under estimated EE by a mean of 37 kcal/kg-week; SCC (not accounting for repeated measures) 0.41	SCC 0.37 total physical activity; SCC 0.51 total physical activity with weighted domains				SCC (logbook to average weekly leisure activity on questionnaire) 0.27 frequency, 0.47 duration	SCC (questionnaire to diary, both in MET-hours/ week) 0.61 moderate, 0.47 vigorous, and 0.69 MVPA; SCC (questionnaire to diary, both in hours/week) 0.63 moderate, 0.68 vigorous, and 0.66 MVPA		

EE=energy expenditure, MET=metabolic equivalent; MVPA=moderate to vigorous physical activity, N/A not applicable; PCC=Pearson correlation coeffient; SCC=Spearman correlation coefficients; US=United States

* Some information not found in the article was obtained directly from the authors.

** Other agreement statistics can be found in the manuscript referenced.

Table 3

Physical activity questionnaires for pregnant women that reported evidence for reliability, by publication year through 2011*

	Chasan-Taber, et al., 2004[13]	Schmidt, et al., 2006[20]	Ota, et al., 2008 [14]	Aittasalo, et al., 2010[15]	Evenson and Wen, 2010[23]
Questionnaire	Pregnancy Physical Activity Questionnaire	modified Kaiser Physical Activity Survey	Pregnancy Physical Activity Questionnaire, Vietnamese version	modified International Physical Activity Questionnaire, short version	Third Pregnancy Infection and Nutrition Study (PIN3) Physical Activity Questionnaire
Reliability analysis sample of pregnant women; location	n=54; Massachusetts, US	n=54; Massachusetts, US	n=60; Vietnam	n=49; Finland	n=109; North Carolina, US
Time between test and retest	7 days	7 days	2 weeks	2 weeks	1-2 days
Recall same period of time	yes, if still in same trimester 1 week later	yes, if still in same trimester 1 week later	yes, if still in same trimester 2 weeks later	no	yes
Results **	ICC: 0.78 total physical activity; 0.79 sedentary; 0.78 light; 0.82 moderate; 0.81 vigorous	ICC: 0.84 total physical activity	ICC 0.88 total activity, 0.94 sedentary, 0.88 light, 0.90 moderate, 0.87 vigorous	weekly leisure activity: change in mean frequency of sessions -0.7; change in geometric mean duration 0.9	ICC (MET-hours/week absolute intensity) 0.72 moderate (4.8-7.1 METS), 0.73 vigorous (>7.1 METS), and 0.74 MVPA; ICC total hours/week using perceived intensity 0.84

ICC=intraclass correlation coefficient; MET=metabolic equivalent; MVPA=moderate to vigorous physical activity; US=United States

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**Other agreement statistics can be found in the manuscript referenced.

Table 4

Physical activity diaries of pregnant women that reported evidence for validity, in order by year of publication through 2011*

	Stein, et al., 2003[26]	Lindseth and Vari, 2005[25]	Evenson and Wen, 2010[23]	Smith, et al., 2011[27]
Diary	physical activity record	exercise diary	Third Pregnancy Infection and Nutrition Study (PIN3) structured diary	physical activity record
Modification or reference of original version	N/A	based on the University of Minnesota modified self-reported food and activity diary	developed for this study; access to the diary available through the reference	N/A
Mode of delivery	self-administered, paper	self-administered, paper	self-administered, paper	self-administered, paper
Administration time during pregnancy	20 and 32 weeks' gestation	14 and 28 weeks' gestation	mean 21 weeks' gestation	18 weeks' gestation
Recording period	hourly record for all waking hours over 2 days	record that day over 3 days	record that day over one week	record over one week
Data collection years	1996-98	1996-2000	2002-04	2009-10
Assessment of:				
Mode	no	yes; exercise, sleeping/resting	yes; any that was at least fairly light in intensity	yes; all including sleep
Time	yes; on an hourly basis	yes; on a daily basis	yes; on a daily basis	yes; start and end time of every activity
Relative/perceived intensity	yes; sedentary, light, moderate, hard, very hard	no	yes; fairly light, somewhat hard, hard/very hard	yes; used Borg rating of perceived exertion scale
Validity analysis sample of pregnant women; location	n=28 who were "habitual exercisers" and n=28 who were "habitually sedentary" (middle group excluded); Michigan, US	n=94; midwestern US	n=177; North Carolina, US	n=52; Iowa, US
Objective measures used	Caltrac and Polar heart rate monitor for 2 days; Caltrac worn on hip	Accu-split pedometer for 3 days (1 weekend and 2 weekdays); worn on hip	ActiGraph 7164 accelerometer for 7 days using 1-minute epochs; worn on hip	SenseWear® Mini Armband; worn on upper arm
Recall exact same period of time	yes	yes	yes	yes
Results **	PCC (standarized to a 14-hour day) kilocalories for habitual exercisers/sedentary participants (heart rate to diary) 0.27/0.47 at 20 weeks and 0.14/0.07 at 32 weeks;	PCC (3-day pedometer to diary) 0.49	SCC (diary in MET-hours/week to accelerometer using 3 different cutpoints) ranged from 0.12 to 0.13 for moderate (4.8-7.1 METS), 0.23 to 0.29 for vigorous (>7.1 METS), and 0.16 to 0.18 for	The reference standard was 3 30-minute sessions of MVPA/week determined by interview, the physical activity record, and/or a heart rate monitor. The physical activity record and

	Stein, et al., 2003[26]	Lindseth and Vari, 2005[25]	Evenson and Wen, 2010[23]	Smith, et al., 2011[27]
	(Caltrac to diary) 0.74/0.23 at 20 weeks and 0.30/0.36 at 32 weeks		MVPA	SenseWear® device over estimated the reference standard; the combination of the two measures provided the most favorable sensitivity and specificity to detect the reference standard.

MET=metabolic equivalent; MVPA=moderate to vigorous physical activity; N/A=not applicable; PCC=Pearson correlation coefficient; SCC=Spearman correlation coefficients; US=United States

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Table 5

Questions to consider when choosing a questionnaire or diary physical activity assessment for pregnant women

Question	Discussion
How will the assessment be delivered?	Each of the self-administered questionnaires and diaries in this review were collected on paper. Future assessments of physical activity could consider new technologies to help enhance recall of physical activity, with the supposition that this method might enable more frequent and accurate recall.[40, 41] These new technologies could include telephones, text messaging, email, or an interactive website. With the newer technologies, the burden of increasing assessment and the possibility of participants simply recalling their responses to the first questionnaire will need to be evaluated.
What is the appropriate length of the recall period?	The recall period from questionnaires under review ranged from the past week to the time since they became pregnant (with the study asking women this at a mean of 27 weeks' gestation1[19]). The diaries, by nature, had shorter recall periods. Of the 4 diaries, one[27] incorporated event-contingent recording, defined as recording directly after the physical activity. The other diaries used interval-contingent recording, by asking women to record at the end of the hour or the day. Consideration should be given to the balance of accuracy, using shorter recall periods to enhance memory of physical activity, and to the length of administration. A more detailed questionnaire will be more difficult to answer if the recall period covers long periods of time. Another consideration is the etiologically relevant time period for the impact of physical activity on maternal and fetal outcomes. For example, for a particular maternal or fetal outcome there may be a particular period of susceptibility during gestation whereby physical activity can have the greatest influence on risk suggesting that a physical activity assessment tool which can be targeted to that pregnancy time period may be most useful.
Are the major components of physical activity assessed?	The major components of physical activity include mode, frequency, duration, and intensity. Regarding mode, if specific activities are collected, then it would be prudent to verify that they represent typical tasks that pregnant women would engage in. The development of the Pregnancy Physical Activity Questionnaire[13] excelled in this aspect, by examining the relative contribution of different types of physical activities from three 24-hour recalls administered to a population of prenatal care patients. The authors selected the 32 activities that explained the most between-person variation in total energy expenditure for inclusion on their questionnaire.For assignment of intensity, the Compendium of physical activities can be used to assign metabolic equivalent (MET) values to each type of physical activity without reliance on the woman's self-report.[42] However, a moderate to vigorous physical activity may be perceived at a different intensity over the course of pregnancy. The activity may also be modified to compensate for the physical changes taking place in pregnancy[43] The Compendium values do not account for the physical changes that occur with pregnancy and many values are derived from activities performed in the laboratory, as accurate metabolic measurements in the field have been difficult to obtain. This limitation could lead to nondifferential misclassification, attenuate observed associations towards the null, and cause a failure to observe associations when they exist. Thus, it is valuable when possible to also collect perceived intensity of the activity.
Is it important to know where or with whom the activity occurred?	Consideration could be given to whether the physical and social context is important to collect, assessed by asking where and with whom the physical activity was performed. This would be particularly important, for example, among intervention studies trying to increase social support or increase awareness of places to walk. To our knowledge, none of the questionnaires or diaries we reviewed included assessment of these characteristics. There are questionnaires developed to assess the physical and social contexts,[44, 45] and other studies incorporating global positioning systems (GPS) to determine where physical activity occurred rather than relying on self-report.[46] However, we are not aware of any published studies using these assessments in pregnancy.
Can the method assess current and future recommendations for physical activity?	The assessment of whether women are meeting recommendations for physical activity is often of interest in epidemiologic studies of pregnancy. However, the level of detail required to assess this, and consideration to which pregnancy-related physical activity guidelines are important to compare against, should be considered. For example, the ACOG[6] guidelines recommend 30 minutes or more of moderate exercise a day on most, if not all, days of the week for women without complications. To determine this, the assessment method must include specificity with regards to mode, by collecting activities considered "exercise" (i.e., a form of physical activity that is structured, planned, repetitive, and performed with the goal of improving health or fitness[3]). It must also distinguish whether the exercise is of moderate intensity, as well as collect the number of days per week and daily duration that exercise is performed. In contrast, one of the recommendations from the US "Physical Activity Guidelines for Americans"[3] is that pregnant women should engage in at least 150 minutes/week of moderate intensity aerobic activity, preferably spread throughout the week. To determine this, assessments should include aerobic activities, intensity of activity, and the time spent each week on these activities. To determine if the aerobic activity is spread throughout the week, the duration each day would also be ascertained. These two examples show the nuances and challenges in determining whether physical activity guidelines for pregnant women are being met.

Question	Discussion
Does the assessment evaluate sedentary behavior?	Sedentary behavior is characterized predominately by sitting and associated with low levels of energy expenditure.[47] Particularly for pregnant women, it can be influenced by bedrest, often prescribed to treat symptoms of clinical complications of pregnancy such as pregnancy-induced hypertension. Only some of the assessments we evaluated ascertained sedentary behaviors.[13, 14, 16, 18] Future assessments for pregnant women should consider measuring sedentary behavior to provide a more accurate estimate of the full range of behaviors that women engage in during pregnancy. Other assessments focusing specifically on sedentary behaviors among adults have been developed and the time spent in sedentary behavior can be evaluated (i.e., accelerometers, activPAL, GENEA (Gravity Estimator of Normal Everyday Activity), or the SenseWear® Armband).[48-51]
Was assessment of validity and reliability conducted in a population that is generalizable, and is the assessment appropriate for my population?	Consideration should be given to whether the sample upon which validity and reliability testing was done is representative of the ultimate study population among which the assessment will be used, particularly with respect to level of physical activity, gestational age, race/ethnicity, education, age, and socioeconomic status. For example, Stein et al.[26] included pregnant women at the highest and lowest levels of physical activity (defined in terms of exercise and occupation), while excluding the moderate-level group when assessing validity; thus, their findings would not necessarily be extended to those in the moderate-level group. Cultural adaptation of the physical activity assessment may need to be considered.[52] For example, the Pregnancy Physical Activity Questionnaire developed in the US was translated and culturally adapted for pregnant women in Japan[53] and Vietnam.[14] As part of this process, in Japan several specific items that were not relevant to their population were modified. For example, the description of “a gallon of milk” was modified to “a 3 kilogram bag of rice”. The goal of cultural adaptation of the physical activity assessment would be to yield the most valid and reliable results for pregnant women under study.
Should objective assessments of physical activity be considered?	Objective measures of physical activity offer a complementary method or alternative to self-reported measures.[54] In the studies reviewed, these assessments included heart rate monitoring, pedometers, and accelerometers. However, objective measures may not be appropriate for longer-term monitoring, with evidence of a decline in compliance with later stages of pregnancy.[18, 55] Objective measures are dependent on the participant wearing the monitor daily, with findings from national surveillance data indicating that compliance among pregnant women was lower than the general population.[56] Another consideration is to combine self-report with objective measures. In particular, the Smith et al. study[27] found the combination of self-report and objective measures yielded the highest sensitivity and specificity to the criterion reference standard of meeting physical activity guidelines.