Published in final edited form as:
Am J Epidemiol. 2010 May 15; 171(10): 1065–1068. doi:10.1093/aje/kwq068.

International physical activity comparisons: where to go from here?

Kirsten Corder and **Esther M. F. van Sluijs**
Medical Research Council Epidemiology Unit, Cambridge, UK

Physical activity is thought to be important for various health outcomes (1, 2) and even for reducing mortality risk (3, 4) in adults. Despite the widely publicized health benefits of physical activity, it is suspected that population levels are decreasing, however this has not been confirmed and as there are few large scale comparable data with which to assess temporal trends and between-population comparisons (5). There is also a lack of scientific evidence underpinning why physical activity levels are generally so low and why interventions to increase physical activity are generally unsuccessful (6). A possible reason why little is known about physical activity trends and differences between populations is at least partly due to difficulties in undertaking accurate large-scale assessments of physical activity (7). The measurement of body movement with accelerometry is becoming increasingly popular to assess overall physical activity in adults, and although resource limitations may prevent large-scale use, accelerometry is currently viewed as the minimum standard for physical activity assessment in epidemiological research. However, even despite this advancement in consensus about physical activity measurement, and the increased use of accelerometry in large studies of adults (8), there are still comparability issues due to the variety of monitors in use and variations in study protocols. Continued increases in the use of objective monitoring and longitudinal studies using objective measurement are needed along with more consistency in order to answer many questions currently pertinent to physical activity and public health.

Previous international comparisons of adult physical activity levels have mainly relied upon self-reported physical activity data (9-11) which by nature is susceptible to many forms of bias (12). While self-report data is essential for many aspects of epidemiological research, questionnaires have substantial limitations for the accurate quantification of physical activity levels, oftentimes showing contradictory evidence compared to objective measurements (13-15). The use of accelerometry in international studies theoretically allows the elimination of bias stemming from cultural differences, which may be especially problematic for questionnaire completion. Notwithstanding the necessary translation, cultural differences in activity profiles may result in certain physical activity questions on a self-report questionnaire becoming confusing or irrelevant in certain populations. Therefore, even a questionnaire specifically adapted for international use is likely to be susceptible to various forms of bias (16-18).

The current issue of the *American Journal of Epidemiology* includes a paper which is one of the first to undertake a large scale international comparison of objective physical activity data, using data collected in Swedish and US adults (13). The authors conclude that physical activity levels of US and Swedish men are similar, but show much lower physical activity levels for US women compared to Swedish women. The similar physical activity levels between US and Swedish men differ from previously published self-report data (9, 10) which tend to indicate that European adults are significantly more active than the US population. This is an interesting and timely comparison using an objective measurement method to compare data across countries, age groups and BMI categories.

Europe PMC Funders Author Manuscripts

There are few large scale studies objectively measuring population levels of physical activity in adults (8), highlighting the timeliness of the study by Hagstromer et al (13). Problems due to the scarcity of internationally comparable objective physical activity data in adults are augmented, at least partly, due to the lack of consistency in monitor use, often due to updates of commonly used monitor models which may not be comparable to previous versions (19-21). Although not susceptible to cultural biases to the same extent as self-report data, care should be taken when making decisions which are not reversible once data collection is complete, including the choice of epoch length (19, 22-25), monitor placement (25, 26), number of days of wear (22), whether weekdays and weekend days are required (22, 23) and monitor calibration (15). As more objective data is collected in adults, care should be taken to make data as comparable as possible to avoid some of the issues seen with accelerometry data comparability in studies in children (27) and self-report surveillance data in adults (5).

Despite the apparent comparability of these two datasets examined by Hagstromer et al., (13), uncertainties remain about the true extent of the differences between these two populations. Unfortunately, the authors were unable to statistically test differences in this paper, but nevertheless, there were some surprising results. Contrary to previous self-report data (9), and US and Swedish stereotypes, the men from both populations appear to have similar physical activity levels. It is possible that skiing during the winter and a higher cycling prevalence throughout the year in Sweden may result in greater accelerometry bias than in the US, potentially leading to an underestimation of Swedish physical activity levels, especially in men. This is partly supported by the higher mean US BMI in comparison to the Swedes, which may merit more exploration. Although this could indicate the relative importance of specific types and intensities of physical activity or could be due to a less healthy diet, it can at least be seen as an indication of lower energy expenditure. One must also consider that there may be other unexplored sources of bias which may mask true differences in physical activity between these populations, such as socio-economic status or other cultural differences.

Hagstomer et al., (13) show that, in contrast to the results in men, there is a substantial difference in physical activity levels between US and Swedish women, with the latter being substantially more active. Activity patterns also differed across SES groups in men, again in contrast to women, and physical activity differed across BMI groups in men and not women; both interesting observations which warrant further investigation. More information regarding the activity profiles of these women could help to determine whether this is due to differential accelerometer validity or whether it represents true international differences between men and women. Self-reported physical activity data in addition to the objective measure applied here may be helpful in this context. Physical activity was presented as an average over a full week, and it may be that cultural and socioeconomic differences could lead to large differences between weekday and weekend levels between the two countries. Although Hagstomer et al., (13) rightly state the greater validity of objective measures over self-report, it would have been very valuable to have both self-report and objective data available to help elucidate the observed population differences. This highlights the value of using both self-report and objective data in epidemiological research.

International physical activity recommendations still include reference to performing moderate-to-vigorous activity in bouts (28) and Hagstromer et al., (13) describe the physical activity levels of these populations largely in regards to bouts of moderate-to vigorous physical activity. However, there is no scientific consensus as to whether bouts of physical activity are more important for health than overall physical activity, and whether total physical activity, or activity of a pre-described intensity, is most beneficial for health (29). The inclusion of sedentary behavior in surveillance data is relatively novel. Comparatively

little information is available about the health risks of high sedentary behavior independent of physical activity levels and whether it may be more harmful for health than low levels of higher intensity physical activity (30-33). Additionally, preliminary data suggests that greater health risks are accrued with prolonged sedentary behavior, rather than that interrupted with bouts of higher intensity activity (34), but little is known about at what length of time these sedentary bouts become harmful. Longitudinal large scale studies using objective measurement of adult physical activity would be very helpful in further exploring and confirming these results.

The paper by Hagstromer et al (13) is a valuable addition to the current evidence on physical activity levels across countries. More similar work is needed, not only in Western countries but also in developing countries. Over 80% of the World's population lives outside of North America and Europe (35) and objective physical activity research is only gradually beginning in these areas (14, 36, 37). The accurate assessment of physical activity is valuable in these countries, firstly for the prevention of obesity and related metabolic disorders but also for the more precise estimation of energy requirements needed for the prevention of malnutrition in some areas of the World. Accelerometers have much potential for use in these countries as they may overcome the limitations of using self-reports in areas with low literacy levels and can also be used irrespective of many cultural and linguistic differences. Accurate validation work is however needed locally, in order to establish validity and to assess potential sources of bias particular to a population (14), something which may have influenced the results presented by Hagstromer et al (13). Assessing health behaviors and their association with health outcomes accurately Worldwide is important. Unfortunately, it is common for those of us in North America and Europe not to take adequate notice or to even disregard research from other parts of the World, but obesity and related metabolic disorders are a global problem, and it is therefore appropriate that the solution is similarly large scale in nature.

There is much scope for more international comparisons of physical activity levels using historically comparable measurement tools, as well as making current data available for reanalysis. The continued use of objective measurement tools with transparent research protocols and data reduction strategies would also be beneficial for future research. As it is not possible to determine temporal trends and cause and effect with cross-sectional data, large scale international prospective studies would also be very valuable. Prospective objective physical activity data across different countries would allow us to first learn which countries, if any, have been successful in maintaining or even increasing population physical activity levels so that we can create more successful strategies to improve population health elsewhere.

Acknowledgments

Kirsten Corder is supported by the Medical Research Council Epidemiology Unit, Cambridge, UK. Esther van Sluijs is supported by the Medical Research Council Epidemiology Unit and the Centre for Diet and Activity Research (CEDAR), Cambridge, UK.

References

1. Healy GN, Wijndaele K, Dunstan DW, et al. Objectively measured sedentary time, physical activity, and metabolic risk: the Australian Diabetes, Obesity and Lifestyle Study (AusDiab). Diabetes Care. 2008; 31:369–71. [PubMed: 18000181]
2. Huerta JM, Navarro C, Chirlaque MD, et al. Prospective study of physical activity and risk of primary adenocarcinomas of the oesophagus and stomach in the EPIC (European Prospective Investigation into Cancer and nutrition) cohort. Cancer Causes Control.

3. Besson H, Ekelund U, Brage S, et al. Relationship between subdomains of total physical activity and mortality. Med Sci Sports Exerc. 2008; 40:1909–15. [PubMed: 18845964]
4. Khaw K-T, Wareham N, Bingham S, Welch A, Luben R, Day N. Combined Impact of Health Behaviours and Mortality in Men and Women: The EPIC-Norfolk Prospective Population Study. PLoS Medicine. 2008; 5:e12. [PubMed: 18184033]
5. Carlson SA, Densmore D, Fulton JE, Yore MM, Kohl HW 3rd. Differences in physical activity prevalence and trends from 3 U.S. surveillance systems: NHIS, NHANES, and BRFSS. J Phys Act Health. 2009; 6(Suppl 1):S18–27. [PubMed: 19998846]
6. Lemmens VE, Oenema A, Klepp KI, Henriksen HB, Brug J. A systematic review of the evidence regarding efficacy of obesity prevention interventions among adults. Obes Rev. 2008; 9:446–55. [PubMed: 18298429]
7. Wareham N, Rennie K. The assessment of physical activity in individuals and populations: Why try to be more precise about how physical activity is assessed? International Journal of Obesity. 1998; 22:S30–S38. [PubMed: 9778094]
8. Troiano RP. Large-scale applications of accelerometers: new frontiers and new questions. Med Sci Sports Exerc. 2007; 39:1501. [PubMed: 17805080]
9. Sjöström M, Oja P, Hagströmer M, Smith B, Bauman A. Health-enhancing physical activity across European Union countries: the Eurobarometer study. J Public Health. 2006; 14:291–300.
10. Friedenreich CM, Courneya KS, Neilson HK, et al. Reliability and validity of the Past Year Total Physical Activity Questionnaire. Am J Epidemiol. 2006; 163:959–70. [PubMed: 16524954]
11. Besson H, Ekelund U, Luan J, et al. A cross-sectional analysis of physical activity and obesity indicators in European participants of the EPIC-PANACEA study. Int J Obes (Lond). 2009; 33:497–506. [PubMed: 19223851]
12. Corder K, Ogilvie D, van Sluijs EM. Invited Commentary: Physical Activity Over the Life Course--Whose Behavior Changes, When, and Why? Am J Epidemiol. 2009
13. Hagströmer M, Troiano R, Sjöström M, Berrigan D. Levels and patterns of objectively assessed physical activity - a comparison between Sweden and the United States. American Journal of Epidemiology. In press.
14. Corder K, Brage S, Wright A, et al. Physical activity energy expenditure of adolescents in India. Obesity. In press.
15. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc. 2008; 40:181–8. [PubMed: 18091006]
16. Craig CL, Marshall AL, Sjostrom M, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003; 35:1381–95. [PubMed: 12900694]
17. Bauman A, Ainsworth BE, Bull F, et al. Progress and pitfalls in the use of the International Physical Activity Questionnaire (IPAQ) for adult physical activity surveillance. J Phys Act Health. 2009; 6(Suppl 1):S5–8. [PubMed: 19998844]
18. Bauman A, Bull F, Chey T, et al. The International Prevalence Study on Physical Activity: results from 20 countries. Int J Behav Nutr Phys Act. 2009; 6:21. [PubMed: 19335883]
19. Corder K, Brage S, Ramachandran A, Snehalatha C, Wareham N, Ekelund U. Comparison of two Actigraph models for assessing free-living physical activity in Indian adolescents. Journal of Sports Sciences. 2007; 25:1607–1611. [PubMed: 17852668]
20. Rothney MP, Apker GA, Song Y, Chen KY. Comparing the performance of three generations of ActiGraph accelerometers. J Appl Physiol. 2008; 105:1091–7. [PubMed: 18635874]
21. John D, Tyo B, Bassett D. Comparison of Four Actigraph Accelerometers during Walking and Running. Med Sci Sports Exerc. In press.
22. Trost S, McIver K, Pate R. Conducting Accelerometer-Based Activity Assessments in Field-Based Research. Medicine and Science in Sports and Exercise. 2005; 37:531–543.
23. Trost S, Pate R, Freedson P, Sallis J, Taylor W. Using objective physical activity measures with youth: how many days of monitoring are needed? Medicine and Science in Sports and Exercise. 2000; 32:426–431. [PubMed: 10694127]

24. Corder K, Brage S, Ekelund U. Accelerometers-pedometers: methodology and clinical application. Current Opinion in Clinical Nutrition and Metabolic Care. 2007; 10:597–603. [PubMed: 17693743]
25. Nilsson A, Ekelund U, Yngve A, Sjostrom M. Assessing physical activity among children with accelerometers using different time sampling intervals and placements. Pediatric exercise Science. 2002; 14:75–84.
26. Yngve A, Nilsson A, Sjostrom M, Ekelund U. Effect of monitor placement and of actvity setting on the MTI accelerometer output. Med Sci Sports Exerc. 2003; 35:320–326. [PubMed: 12569223]
27. Mattocks C, Ness A, Leary S, et al. Use of Accelerometers in a Large Field-Based Study of Childen: Protocols, Design Issues, and Effects on Precision. Journal of Physical Activity and Health. 2008; 5:S98–S111. [PubMed: 18364528]
28. USDoHaHSH. Physical Activity Guidelines. 2008. http://www.health.gov/paguidelines
29. Metzger JS, Catellier DJ, Evenson KR, Treuth MS, Rosamond WD, Siega-Riz AM. Associations between patterns of objectively measured physical activity and risk factors for the metabolic syndrome. Am J Health Promot. 24:161–9. [PubMed: 20073381]
30. Ekelund U, Brage S, Griffin SJ, Wareham NJ. Objectively measured moderate- and vigorous-intensity physical activity but not sedentary time predicts insulin resistance in high-risk individuals. Diabetes Care. 2009; 32:1081–6. [PubMed: 19252168]
31. Helmerhorst HJ, Wijndaele K, Brage S, Wareham NJ, Ekelund U. Objectively measured sedentary time may predict insulin resistance independent of moderate- and vigorous-intensity physical activity. Diabetes. 2009; 58:1776–9. [PubMed: 19470610]
32. Perkins GM, Owen A, Kearney EM, Swaine IL. Biomarkers of cardiovascular disease risk in 40-65-year-old men performing recommended levels of physical activity, compared with sedentary men. Br J Sports Med. 2009; 43:136–41. [PubMed: 18308887]
33. Dunstan DW, Barr EL, Healy GN, et al. Television Viewing Time and Mortality. The Australian Diabetes, Obesity and Lifestyle Study (AusDiab). Circulation.
34. Healy GN, Dunstan DW, Salmon J, et al. Breaks in sedentary time: beneficial associations with metabolic risk. Diabetes Care. 2008; 31:661–6. [PubMed: 18252901]
35. PRB. World Population Data Sheet. 2009. 2009:www.prb.org
36. Assah FK, Ekelund U, Brage S, et al. Predicting Physical Activity Energy Expenditure Using Accelerometry in Adults From Sub-Sahara Africa. Obesity (Silver Spring). 2009
37. Krishnaveni GV, Veena SR, Kuriyan R, et al. Relationship between physical activity measured using accelerometers and energy expenditure measured using doubly labelled water in Indian children. Eur J Clin Nutr. 2009; 63:1313–9. [PubMed: 19690580]

Europe PMC Funders Author Manuscripts