The Decline in Physical Activity Among Adolescent Students

A Cross-national Comparison

Kenneth R. Allison, PhD[1]
Edward M. Adlaf, PhD[2]
John J.M. Dwyer, PhD[3]
Daria C. Lysy, MA[1]
Hyacinth M. Irving, MA[1]

ABSTRACT

Background: The decline in physical activity during adolescence is a key public health concern. This comparative study assesses whether the age-related decline in physical activity among high school students occurs similarly in the United States (US) and Ontario, whether the decline in physical activity is steady throughout the age range, or whether any declines are age-specific.

Methods: Data are based on self-reports of 9th- to 12th-graders derived from the 2001 Youth Risk Behavior Survey (n=13,503) and the 2001 Ontario Student Drug Use Survey (n=1,322). Physical activity is measured by the number of days of vigorous physical activity during the past 7 days.

Results: In both samples, there was a dominant and steady decline in physical activity between ages 14 and 18 years. The number of activity days was higher in the US than in Ontario holding constant age and sex. However, a significant sample-by-age interaction showed that the decline in the percentage of US students reporting 3 or more physical activity days was greater than it was in Ontario.

Conclusions: While the pattern of decline was shown to be similar, the decline was stronger among US adolescents. Future research should examine additional factors influencing the decline in activity and the optimal timing of programs to reduce the decline.

MeSH terms: Adolescent behaviour; exercise; comparative study

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

1. Physical Activity Research Program, Department of Public Health Sciences, Faculty of Medicine, University of Toronto, Toronto, ON
2. Centre for Addiction and Mental Health, Toronto, and the Department of Public Health Sciences, Faculty of Medicine, University of Toronto
3. Department of Family Relations and Applied Nutrition, College of Social and Applied Human Sciences, University of Guelph, Guelph, ON, and the Public Health Research, Education and Development Program, Public Health and Community Services, Hamilton, ON

Correspondence and reprint requests: Kenneth R. Allison, Department of Public Health Sciences, 6th Floor, Health Sciences Building, University of Toronto, 155 College Street, Toronto, ON M5T 3M7, Tel: 416-978-5869, Fax: 416-978-8299, E-mail: k.allison@utoronto.ca

Acknowledgements: This research is supported by the Heart and Stroke Foundation of Ontario (HBR4860). The Ontario Student Drug Use Survey is sponsored by the Centre for Addiction and Mental Health, Toronto, Ontario.

In both the United States (US) and Canada, physical inactivity is recognized as a major public health concern, primarily because it is associated with the leading causes of death, illness and disability, such as coronary heart disease, colon cancer, breast cancer, stroke, respiratory disease, and diabetes.[1,2] In the US, for example, approximately 250,000 premature deaths are attributed annually to physical inactivity,[1] and in Canada the comparable figure is about 21,000.[3] The direct medical costs of treating physical inactivity-related diseases in the US and Canada are estimated at $24.3 billion[4] and $2.1 billion,[3] respectively, representing 2.4%[4] and 2.5%,[3] respectively, of the total indirect health care costs. Both the US and Canada seek to reduce the mortality and economic costs associated with physical inactivity by promoting physical activity for the entire population, including children and adolescents.[2,5,6]

However, increasing physical activity among adolescents to a level that meets health-related physical activity guidelines is a major public health challenge. Studies consistently show that physical activity declines sharply during adolescence.[7-18] Declines are reported with both self-report,[9,13-18] and objective measures of physical activity.[10-12] Similarly, declines are documented in cross-sectional,[9,12-14,17] and longitudinal studies.[10,11,15,16,18] Age-related declines in physical activity are also reported in several countries, including the US[9-12,17,18] Canada,[13,14] Finland,[15] and in Amsterdam (Netherlands).[16]

Although there is consensus in the literature that physical activity declines markedly during adolescence, the results are mixed concerning the timing of the decline. Among American adolescents, physical activity declines steeply from ages 15-18,[9] while among Canadian adolescents, the decline has been reported to be from age 14-16.[13] For Finnish youth,[15] the ages of greatest decline are 12-15 or 15-18, and for Dutch youth, 13-16.[16]

Results are also mixed concerning the relationship between gender and the age-related decline in physical activity among adolescents. Some studies report an interaction between gender and age, indicating greater declines in female compared to male youth.[7,13] Other studies find greater declines among male compared to female youth.[9,15,16] A more recent study suggests

that physical activity declines at the same rate for both female and male adolescents.[14]

Methodological differences might explain the divergent results regarding the timing of the age-related declines and the relationship between gender and the age-related decline. In this study, we take advantage of the youth public health surveillance surveys conducted in the US and Canada that use similar sample designs and instruments to evaluate the decline in physical activity among high school students. We assess whether the age-related decline in physical activity among high school students occurs similarly in the US and Ontario. We also examine whether the decline in physical activity is steady throughout the age range, or whether any declines are age-specific. By analyzing American and Canadian data in the same study, we provide an added dimension to the comparison between countries by assessing differences and similarities based on analyses of original data rather than that based on existing published results.

METHODS

Our pooled sample consisted of 9th- through 12th-graders: 13,503 derived from the 2001 Youth Risk Behavior Survey (YRBS) in the United States, and 1,322 from the 2001 Ontario Student Drug Use Survey (OSDUS) in Canada. The design features of both surveys were incorporated into the pooled data set, resulting in 17 strata (13 in YRBS and 4 in OSDUS) and 116 high schools (53 in YRBS, 63 in OSDUS).

The 2001 YRBS data employed a three-stage cluster sample design (degree of urbanization/percentage of blacks and Hispanics, school enrollment size, and classes of a required subject such as English or social studies) to produce a nationally representative sample of students in grades 9-12. The student completion rate was 63%. Students responded to the survey during school time.[19]

The OSDUS data were derived to correspond to the YRBS, specifically, 9th- to 12th-graders. Also, because the physical activity items in the OSDUS were asked of a random half sample, the effective sample size was 1,322. The OSDUS employs a two-stage cluster design (i.e., random selection of both school and class). Staff from the Institute for Social Research, York University, administered the questionnaires to students in classrooms. The student completion rate was 71%. Conducted every two years since 1977, OSDUS is funded by the Centre for Addiction and Mental Health and is the longest ongoing school study of adolescents in Canada.[20] For several reasons, the OSDUS is most suited for such a comparison. First, unlike in the United States, there is no ongoing national school survey in Canada. Second, the Ontario population of youth represents 40% of all Canadian students.[21] Finally, surveys typically show Ontario estimates of physical activity are similar to the national average.[22] The two samples showed no significant sex (F=1.71, p=0.194) or grade difference (F=0.54, p=0.633), although the YRBS sample was slightly older.

TABLE I

Vigorous Physical Activity Days by Sample (weighted percentage and 95% CI)

	USA n=12,924	ONTARIO n=1296
Days of Vigorous Physical Activity Per Week		
0	15.7 [14.7,16.8]	14.4 [11.5,17.8]
1	9.3 [8.6,10.1]	12.3 [10.1,15.0]
2	10.2 [9.6,10.9]	10.5 [8.7,12.7]
3	12.0 [11.3,12.7]	15.2 [13.2,17.5]
4	9.2 [8.6,9.9]	13.4 [11.0,16.2]
5	13.9 [12.9,14.8]	12.7 [10.8,15.0]
6	7.4 [6.6,8.2]	7.6 [6.1,9.5]
7	22.3 [20.9,23.8]	13.9 [11.4,16.8]
Mean	3.72 (3.64, 3.81)	3.39 (3.19, 3.58)
Frequency of Vigorous Physical Activity Per Week		
<3 days/week	35.3 [33.8,36.8]	37.2 [33.3,41.3]
3+ days/week	64.7 [63.2,66.3]	62.8 [58.7,66.7]

TABLE II

Observed and Predicted Mean Activity Days by Sample and Age

	YRBS		OSDUS	
Year of Age	Observed	Predicted	Observed	Predicted
14	4.07	4.17	3.46	3.65
15	4.13	3.90	3.66	3.51
16	3.69	3.63	3.42	3.37
17	3.44	3.36	2.94	3.22
18	3.24	3.09	3.26	3.08

Predicted values based on model including age, sex and sample.

TABLE III

Regression Predicting Vigorous Physical Activity Among Total Sample (n=14,120)

	PA7		Activity (3+)			
Predictors	b	p	Odds Ratio	95% CI		p
Age Linear Model						
Sample	-0.41	0.000	0.18	0.04	0.91	0.038
Age	-0.16	0.020	0.82	0.79	0.85	0.000
Sex	-0.90	0.000	0.46	0.43	0.49	0.000
Sample X Age	–	–	1.11	1.00	1.23	0.040
Age Difference Model						
Sample	-0.40	0.000	0.87	0.71	1.07	0.181
14 to 15	-0.22	0.336	1.10	0.73	1.65	0.652
15 to 16	0.23	0.232	0.84	0.58	1.23	0.374
16 to 17	0.47	0.013	1.50	1.03	2.18	0.035
17 to 18	-0.15	0.596	0.98	0.54	1.80	0.951
Sex	-0.90	0.000	0.49	0.37	0.64	0.000

Measures

We compare two outcomes: past 7-day participation in vigorous physical activity (number of days), and past 7-day participation in vigorous physical activity (3+ days). The outcomes were based on the following question, "On how many of the last 7 days did you exercise or participate in sports activities for at least 20 minutes that made you sweat and breathe hard? Please include activities such as basketball, jogging, fast dancing, swimming laps, tennis, fast bicycling, or similar aerobic activities (include both school and non-school activities)." Responses indicated the number of days between 0 and 7.

Data analysis

To assess the decline in physical activity with age, we evaluated two models. The first assesses the linear age effect with sex, sample, and the 2-way interactions sample-by-age, sample-by-sex, sex-by-age and sample-by-sex-by-age. In order to more clearly delineate the precise age-related decline in physical activity, the second model employed sequential age-differenced contrasts (e.g., age 14 vs. 15, age 15 vs. 16, etc.) with the same independent variables above. All estimates were weighted and variance and statistical tests have been corrected for the complex sample design using Taylor series methods available in Stata.[23]

RESULTS AND DISCUSSION

Although we see in Table I some variation in the distribution in 7-day physical activity by sample (Wald [6, 552] = 7.74, $p<0.001$), and a mean difference (3.72 in the YRBS vs. 3.39 in the OSDUS, $p=0.003$)), there is no significant variation in physical activity participation in relation to the standard 3+ days cut-off (64.7% in the US vs. 62.8% in Ontario, $p>0.05$).

Table II shows the mean number of activity days, both observed and predicted, by age and by sample. These data show two features: first, there is a general downward movement in both observed and predicted activity for both YRBS and OSDUS; second, American 14 and 15 year olds have greater activity days compared to Ontario, but this difference disappears by age 18.

Table III shows regression results based on the pooled data. Beginning with the number of physical activity days, we see that neither the age-linear nor age-differenced models showed significant interactions. Age was significantly related in both the linear and differenced models. The age-linear model shows that physical activity declines by .16 days with each increase in age, while the age-differenced model shows that the first and only significant decline occurs between 16 and 17 years of age. Specifically, the number of physical activity days is .47 days higher among 16 year olds compared to 17 year olds. Also notable, holding constant age and sex, the number of physical activity days is significantly lower in Ontario than in the US (-0.41 in the age-linear and -0.40 in the age-differenced models).

The age-linear logistic regression predicting 3+ physical activity days shows a significant sample-by-age interaction. An examination of the predicted values showed steeper age declines in physical activity in the YRBS (from .72 among 14 year olds to .54 among 18 year olds, effect size=.38) than in the OSDUS (from .68 to .59, effect size=.19-data not shown). The age-differenced model for 3+ physical activity days generally replicated findings for the physical activity days models, namely, a significant decline between 16 and 17 year olds. The exception in this model is the non-significant sample effect, indicating that although the number of physical activity days is significantly higher in the US than in Ontario, this difference does not translate into the 3+ physical activity target behaviour.

In both samples and for both males and females, there was a steady decline in vigorous physical activity between ages 14 and 18 years. This general pattern of decline replicates and supports findings from previous studies conducted both in North America and several other countries.[9-18] As this pattern is consistent across settings, it suggests that the decline may be normative during adolescence.[24] To use a life course explanation for the decline, as youth get older they develop new interests and pursuits, and experience additional pressures specific to this stage, and many of these changes, getting a driver's license or beginning to date, for example, reduce the time available for physical activity.

While the pattern of decline is steady in both samples, the decline is stronger in the US than in Ontario. One possible explanation for this finding relates to potential differences in the composition of the adolescent populations reflected by the two samples. For example, in relation to race, we know that blacks in the US are less active than other groups,[25] and that they represent a greater proportion of the population of the US than in Canada. While race was included as a variable in the YRBS study, it was not included in OSDUS. Thus the possibility that greater decline in the US is explainable by differences in race between the two samples cannot be empirically tested here. Another explanation for the comparative difference in the decline includes potential differences in opportunities, programs, and facilities between the US and Canada.

Sample differences in the number of activity days, showing higher levels in the United States compared to Ontario, do not translate into differences in the standard of 3+ days per week of vigorous physical activity recommended by health professionals.[25] That is, there are no significant differences between YRBS and OSDUS samples in the amount of vigorous physical activity considered as sufficient.

Previous studies of the decline in adolescent physical activity have not conclusively identified a "turning point" at a particular age. Although our study did find a significant decline in activity between 16 and 17 years for both samples, the decline is linear throughout the age period from 14 to 18 years.

There are a number of limitations in the current study. In analyzing cross-sectional data, we frequently cannot substantiate the temporal ordering in the relationships. One could argue that chronological age precedes physical activity level. But while age precedes physical activity, it cannot be said to cause it. Thus, age can be seen as representing a number of additional factors and events which make participation in physical activity less likely to occur. The data analyzed in this study were also based on self-reports, as opposed to direct measures, which are seen as being more robust.[26] While physical activity could have been over- or under-estimated by study participants, there is no reason to believe that any potential bias due to self-reports would have been age-related. Also, the YRBS, from which the measures of physical activity used in the study (in both samples) was derived, has been shown to be a reliable instrument in surveys of adolescents.[27]

Future research should examine the role of additional factors potentially influencing the decline in physical activity, such as socio-economic status, ethnicity, urban versus rural school setting, and school size.

The importance of consistently lower levels of physical activity on the part of female, as compared to male, adolescents is well documented. However, the findings here suggest that the age-related decline among adolescents (in both samples) holds for both females and males. This finding has implications for policies and programs directed to adolescents. Likewise, the findings from the current study raise future

research questions concerning the appropriate age for, and optimal timing of, policy and program interventions to reduce the decline in physical activity during adolescence.

REFERENCES

1. Booth F, Chakravarthy M. Cost and consequences of sedentary living: New battleground for an old enemy. Washington, DC: President's Council on Physical Fitness and Sports Research Digest, 2002.
2. Romanow RJ. Building on Values: The Future of Health Care in Canada. Ottawa, ON: Commission on the Future of Health Care in Canada, 2002.
3. Katzmarzyk PT, Gledhill N, Shephard RJ. The economic burden of physical inactivity in Canada. *CMAJ* 2000;163:1435-40.
4. Colditz GA. Economic costs of obesity and inactivity. *Med Sci Sports Exerc* 1999;31:S663-S667.
5. US Department of Health and Human Services. Physical activity and health - A report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 1996.
6. Federal-Provincial-Territorial Advisory Committee on Fitness and Recreation: Physical Inactivity. A Framework for Action. Ottawa: Health Canada, 1997.
7. Sallis JF. Epidemiology of physical activity and fitness in children and adolescents. *Crit Rev Food Sci Nutr* 1993;33:403-8.
8. Sallis JF. Age-related decline in physical activity: A synthesis of human and animal studies. *Med Sci Sports Exerc* 2000;32:1598-600.
9. Caspersen CJ, Pereira MA, Curran KM. Changes in physical activity patterns in the United States, by sex and cross-sectional age. *Med Sci Sports Exerc* 2000;32:1601-9.
10. Kimm SY, Glynn NW, Kriska AM, Barton BA, Kronsberg SS, Daniels SR, et al. Decline in physical activity in black girls and white girls during adolescence. *N Engl J Med* 2002;347:709-15.
11. Kimm SY, Glynn NW, Kriska AM, Fitzgerald SL, Aaron DJ, Similo SL, et al. Longitudinal changes in physical activity in a biracial cohort during adolescence. *Med Sci Sports Exerc* 2000;32:1445-54.
12. Trost SG, Pate RR, Sallis JF, Freedson PS, Taylor WC, Dowda M, et al. Age and gender differences in objectively measured physical activity in youth. *Med Sci Sports Exerc* 2002;34:350-55.
13. Allison KR, Adlaf EM. Age and sex differences in physical inactivity among Ontario teenagers. *Can J Public Health* 1997;88:177-80.
14. Thompson AM, Baxter-Jones AD, Mirwald RL, Bailey DA. Comparison of physical activity in male and female children: Does maturation matter? *Med Sci Sports Exerc* 2003;35:1684-90.
15. Telama R, Yang X. Decline of physical activity from youth to young adulthood in Finland. *Med Sci Sports Exerc* 2000;32:1617-22.
16. van Mechelen W, Twisk JW, Post GB, Snel J, Kemper HC. Physical activity of young people: The Amsterdam Longitudinal Growth and Health Study. *Med Sci Sports Exerc* 2000;32:1610-16.
17. Nelson MC, Gordon-Larsen P, Adair LS, Popkin BM. Adolescent physical activity and sedentary behavior: Patterning and long-term maintenance. *Am J Prev Med* 2005;28:259-66.
18. McMurray RG, Harrell JS, Bangdiwala SI, Hu J. Tracking of physical activity and aerobic power from childhood through adolescence. *Med Sci Sports Exerc* 2003;35:1914-22.
19. Grunbaum JA, Kann L, Kinchen SA, Williams B, Ross JG, Lowry R, et al. Youth risk behavior surveillance—United States, 2001. *J Sch Health* 2002;72:313-28.
20. Adlaf EM, Paglia A. Drug Use Among Ontario Students, 1977-2001: Findings from the OSDUS. Toronto, ON: Centre for Addiction and Mental Health, 2001.
21. Statistics Canada. Population by sex and age group, in CANSIM II, table 051-0001, 2004.
22. Stephens T. Leisure-Time Physical Activity, in Canada's Health Promotion Survey 1990: Technical Report. Edited by Stephens T, Fowler Graham D. Ottawa: Health and Welfare Canada, 1993;139-50.
23. StataCorp. Stata Statistical Software: Release 8.0. College Station, TX: Stata Corporation, 2003.
24. Clausen J. *The Life Course: A Sociological Perspective.* Englewood Cliffs, NJ: Prentice-Hall, 1986.
25. Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Med Sci Sports Exerc* 2000;32:963-75.
26. Tremblay M. The need for directly measured health data in Canada. *Can J Public Health* 2004;95:165-66.
27. Brener ND, Kann L, McManus T, Kinchen S, Sundberg EC, Ross JG. Reliability of the 1999 Youth Risk Behavior Survey questionnaire. *J Adolesc Health* 2002;31:336-42.

Received: December 6, 2005
Accepted: July 14, 2006

RÉSUMÉ

Contexte : La diminution de l'activité physique pendant l'adolescence est un problème de santé publique fondamental. Par cette étude comparative, nous avons cherché à déterminer si la diminution liée à l'âge dans les niveaux d'activité physique des élèves du secondaire est semblable aux États-Unis et en Ontario, et si la diminution de l'activité physique est soutenue dans toute la plage d'âge ou si certaines diminutions surviennent à certains âges.

Méthode : Nos données proviennent des déclarations d'élèves de la 9e à la 12e année tirées de l'enquête états-unienne Youth Risk Behavior Survey de 2001 (n=13 503) et du Sondage sur la consommation de drogues parmi les élèves de l'Ontario de 2001 (n=1 322). L'activité physique est calculée selon le nombre de jours où l'on a pratiqué une activité physique vigoureuse au cours des sept jours précédents.

Résultats : Dans les deux échantillons, on observe une diminution prédominante et soutenue de l'activité physique entre 14 et 18 ans. Le nombre de jours d'activité était plus élevé aux É.-U. qu'en Ontario, en tenant compte de l'âge et du sexe. Cependant, une interaction significative selon l'âge montre que la diminution du pourcentage d'élèves états-uniens ayant pratiqué trois jours d'activité physique ou plus était plus importante qu'en Ontario.

Conclusion : La tendance générale à la baisse était semblable, mais la diminution était plus prononcée chez les adolescents états-uniens. Les études futures devraient porter sur les autres facteurs qui influencent la diminution de l'activité physique et sur l'âge optimal auquel il faudrait offrir des programmes pour contrer cette diminution.