Changes in Physical Activity Participation From 1985 to 2004 in a Statewide Survey of Australian Adolescents

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Objective: To examine changes in physical activity during a 19-year period between 2 representative cohorts of adolescents from New South Wales, Australia.

Design: Repeat cross-sectional study.

Setting: Randomly selected secondary schools from New South Wales, the most populous state in Australia.

Participants: One thousand fifty-five adolescents surveyed in May through October 1985 (with the Australian Health and Fitness Survey) and 1226 adolescents surveyed in March through April 2004 (with the New South Wales Schools Physical Activity and Nutrition Survey). Participants were aged 12 to 15 years.

Main Outcome Measures: The proportion meeting current guidelines for physical activity (60 min/d of moderate to vigorous physical activity) and time spent in moderate to vigorous physical activity assessed by self-reported participation in physical activity using the same questionnaire at both time points.

Results: All of the age and sex groups reported increases in both the prevalence of physical activity (mean increase range, 11.7%-20.0%) and in the minutes per week spent in moderate to vigorous physical activity (median increase range, 135-175 minutes). These findings remained the same after additional adjustment for age, socioeconomic status, and cultural background.

Conclusions: Physical activity participation has considerably increased during the past 19 years among adolescents in the state of New South Wales, Australia. These findings provide important information about trends in compliance with physical activity recommendations and in time spent in physical activity. They could help to explain what aspects may need to be promoted to maximize the role of physical activity in reducing the high and increasing rates of child and adolescent obesity.

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Regular participation in physical activity during adolescence is associated with several health benefits, including more favorable cardiovascular profiles, mental health, musculoskeletal health, and prevention of unhealthy weight gain.1 During the past decade, several countries have developed physical activity guidelines for children and adolescents.1,3 These recommend that school-aged youth participate in at least 60 min/d of moderate to vigorous physical activity (MVPA).

A reduction in habitual physical activity has been postulated as the major contributing factor in the increasing prevalence of child and adolescent obesity.4 However, reliable secular data on this issue are not available to our knowledge. Examining data prior to the genesis of the child obesity epidemic would be helpful in characterizing secular trends and in providing a better understanding of the contribution of physical activity to the increases in child obesity.

The purpose of this study was to examine changes in the prevalence of and time spent participating in physical activity across 2 representative samples of adolescents in New South Wales (NSW), Australia, during a nearly 20-year period.

METHODS

The Australian Health and Fitness Survey 1985 (AHFS 1985)5 was used to establish the fitness, health, and physical performance levels of children and adolescents in Australia. Random selection of schools was stratified by state and proportional to the number of students enrolled. Students aged 7 to 16 years were selected at random within schools. The final sample comprised 8484 students, of which secondary school questionnaire data (ages 12-15 years) for the state of NSW were extracted to allow comparison with the 2004 data. The methods of the AHFS 1985 have been reported in detail elsewhere.6
The NSW Schools Physical Activity and Nutrition Survey 2004 (SPANS 2004) was a representative population survey of primary and secondary students in grades kindergarten, 2, 4, 6, 8, and 10 in rural and urban NSW (n = 5402). Proportional stratified random sampling was used to select schools. A detailed description of the methods of the SPANS 2004 has been published. A subset of students in grade 8 (aged 12 and 13 years) and grade 10 (aged 14 and 15 years) completed the same questionnaire on physical activity participation that was used in the 1985 survey. The study was approved by the University of Sydney Human Research Ethics Committee and the State Education Research Approval Process of the NSW Department of Education and Training.

MEASURES

Assessment of Physical Activity

The same physical activity self-report questionnaire was used in both studies. Students were asked to think about only the previous week and to record the frequency and duration (on each occasion) of each of the following activities: (1) cycling to school, (2) walking to school, (3) physical education, (4) school sport, and (5) participation in any other physical activities (up to 4 different activities could be recorded).

Validity of the questionnaire was assessed by examining the relationship between time spent in MVPA and a measure of cardiorespiratory fitness, the 1.6-km run. This approach has been used in prior validation studies of self-reported physical activity among adolescents. The association of MVPA with time taken to complete the 1.6-km run (in seconds) was assessed by calculating the Spearman correlation coefficient, which was found to be -0.21 (P < .001).

Demographic Measures

Students were asked to report their date of birth, postal code of residence, and the language spoken most at home. The postal code was used as a proxy measure of socioeconomic status (SES), and students were categorized as having a low, middle, or high SES based on data collected in the population census most proximal to the survey date. Students' cultural background was assessed by the language spoken most at home and was used to categorize students as having speaking backgrounds of English or languages other than English.

PROCEDURES

In each study, trained assessors administered the same questionnaire using the same data collection procedures. Students were seated at individual desks and the instructions for completing the questionnaire were read from a prewritten script by 1 of the assessors. Students were encouraged to ask questions if required, and individual assistance was provided for any student with language or literacy difficulties.

STATISTICAL ANALYSIS

All of the analyses for this study were conducted between July 2005 and December 2006. Time spent in MVPA was calculated as follows. A rate of energy expenditure (metabolic equivalents [METs]; kilocalories per kilogram per minute) was assigned to each activity based on the Compendium of Physical Activities, and each physical activity was then categorized as light (< 3.0 METs), moderate (3.0-5.9 METs), or vigorous (≥ 6.0 METs) in intensity. Because only activities of at least moderate intensity are recommended in youth physical activity guidelines, activities with a MET value less than 3.0 were excluded. Also, with the exception of walking and cycling to school, activities for which the duration of participation was less than 10 minutes were not included. Where a student did not indicate the frequency or duration of physical education or school sport, the missing value was replaced with the median value reported by other students at his or her school. Missing values for nonschool activities were replaced with the median value reported by other students for that activity. For each activity, the average time per session was multiplied by the frequency of participation to give the total time spent in that activity. The times spent in all MVPAs were summed to give the total time in MVPA.

Prevalence of physical activity participation was defined in 2 ways: (1) accumulation of at least 420 minutes of MVPA (≥ 3.0 METs) over at least 7 sessions during the week (equivalent to an average of 60 min/d of MVPA), or (2) participation in at least 3 sessions of at least 20 minutes' duration of vigorous activity (≥ 6.0 METs) (60 min/wk of vigorous physical activity). The first definition (60 min/d of MVPA) reflects current physical activity recommendations in the United Kingdom, United States, and Australia for youth, and the second definition (60 min/wk of vigorous physical activity) reflects the vigorous recommendation from the physical activity guidelines for adolescents. It has been recently suggested that 90 min/d of MVPA might be necessary among adolescents to prevent clustering of cardiovascular disease risk factors. As such, we also classified adolescents based on participation in at least 90 min/d of MVPA.

Two age groups were constructed for the comparisons. The first comprised 12- and 13-year-olds and the second comprised 14- and 15-year-olds (as well as a very small number of 16-year-olds [< 5% in samples from both 1985 and 2004]). Separate analyses were conducted for each age group, stratified by sex, using SAS version 9.1 statistical software (SAS Institute, Inc, Cary, North Carolina). Analyses were conducted separately for 3 outcomes: (1) the proportion of students classified as physically active; (2) the proportion of students participating in at least 90 min/d of MVPA; and (3) time spent in MVPA. For the first 2 outcomes, the numbers and proportions of students who met the physical activity recommendation were tabulated for 1985 and 2004. Proportions meeting the guidelines were compared between 1985 and 2004 using logistic regression models. The SURVEYLOGISTIC procedure in SAS statistical software was used to allow for the stratified and clustered design of the surveys. Because the distribution of the third outcome, time spent in MVPA, was skewed, data were summarized with medians and interquartile ranges. Linear regression methods were used to analyze the log-transformed outcome, again adjusting for the stratified and clustered survey designs. The ratio of geometric means, which approximates the ratio of the medians (2004 vs 1985), is presented as the measure of effect. Because age, SES, and cultural background have been consistently reported as correlates of physical activity among adolescents, all of the analyses were conducted with and without adjustment for these variables.

RESULTS

The participation rates for the adolescent questionnaire component of the AHFS 1985 and this substudy of the SPANS 2004 were 62% and 58%, respectively. The main reasons for nonresponse were absenteeism (sickness) and failure to return a consent form. Because active parental consent was required, it was not possible to distinguish between refusal to participate and failure to remember to return the consent form. We found no difference in body mass index
between students who did and did not complete the physical activity questionnaire in the AHFS 1985 (t = 0.16; P = .87).

As height and weight were not assessed in this sample of students in the SPANS 2004, it was not possible to determine whether there were differences in body mass index between those who completed the questionnaire and those who did not. We did, however, test whether there was a response bias with respect to body mass index between participants and nonparticipants in the main sample of the SPANS 2004 and found that the differences between these groups in the prevalence of overweight and obesity were all less than 1 percentage point.16

Table 1 shows the demographic characteristics of both samples. Students in the SPANS 2004 were slightly older than those in the AHFS 1985 (mean age difference, 0.3 years), but the narrow confidence intervals meant that these differences were statistically significant (P < .001). There were no differences in SES or languages other than English.16

Table 2 shows the prevalence in physical activity participation according to current guidelines and median time spent in MVPA for each survey year and the change between surveys. Physical activity participation was higher among boys for each age group and survey year. The proportion of boys who met current guidelines increased between 1985 and 2004 by approximately 12% to 15%. The proportion of girls who spent more than 90 min/d in MVPA doubled between survey periods.

Table 2 also shows the change in physical activity participation from 1985 to 2004, unadjusted and adjusted

### Table 1. Characteristics of Participants in the Australian Health and Fitness Survey 1985 and the Schools Physical Activity and Nutrition Survey 2004

| Characteristic | Participants Aged 12 and 13 y | | | Participants Aged 14 and 15 y | | |
|----------------|------------------------------|----------|-------------------|---------------------|------------------|
|                | 1985 (n=245) | 2004 (n=307) | 1985 (n=241) | 2004 (n=331) | 1985 (n=449) | 2004 (n=309) |
| Age, mean (95% CI), y | 13.1 (13.0-13.2) | 13.4 (13.3-13.4) | 13.1 (13.0-13.1) | 13.4 (13.3-13.4) | 15.0 (14.9-15.0) | 15.4 (15.3-15.4) |
| SEIFA score, mean (95% CI) | 1003.4 (971.4-1035.5) | 991.7 (971.9-1011.6) | 1008.5 (976.9-1040.1) | 997.8 (969.6-1026.1) | 1004.7 (973.8-1035.7) | 989.4 (969.5-1009.2) |
| LOTE spoken at home, % (95% CI) | 11.6 (2.3-21.0) | 11.4 (4.8-18.0) | 6.0 (1.5-10.6) | 6.9 (3.2-10.7) | 16.4 (4.1-28.8) | 10.2 (3.4-17.0) |

Abbreviations: CI, confidence interval; LOTE, language other than English; SEIFA, Socioeconomic Indicator for Areas.

### Table 2. Changes in Physical Activity Between 1985 and 2004

<table>
<thead>
<tr>
<th>Outcome</th>
<th>1985</th>
<th>2004</th>
<th>2004 vs 1985 Unadjusted Ratio (95% CI)b</th>
<th>2004 vs 1985 Adjusted Ratio (95% CI)b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence of physical activity, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aged 12-13 y</td>
<td>Boys</td>
<td>61.6</td>
<td>73.3</td>
<td>1.80 (1.13-2.87)</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>44.4</td>
<td>64.4</td>
<td>2.29 (1.49-3.53)</td>
</tr>
<tr>
<td>Aged 14-15 y</td>
<td>Boys</td>
<td>58.6</td>
<td>73.5</td>
<td>1.97 (1.20-3.22)</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>46.0</td>
<td>64.7</td>
<td>2.15 (1.32-3.49)</td>
</tr>
<tr>
<td>Prevalence of ≥ 90 min/d of MVPA, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aged 12-13 y</td>
<td>Boys</td>
<td>23.7</td>
<td>47.6</td>
<td>3.07 (1.92-4.91)</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>16.6</td>
<td>31.4</td>
<td>2.28 (1.29-4.01)</td>
</tr>
<tr>
<td>Aged 14-15 y</td>
<td>Boys</td>
<td>23.4</td>
<td>44.0</td>
<td>2.55 (1.57-4.15)</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>15.5</td>
<td>28.8</td>
<td>2.16 (1.23-3.81)</td>
</tr>
<tr>
<td>Time spent in MVPA, median (IQR), min/d</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aged 12-13 y</td>
<td>Boys</td>
<td>430 (250-680)</td>
<td>605 (345-900)</td>
<td>1.38 (1.18-1.61)</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>355 (195-550)</td>
<td>490 (300-715)</td>
<td>1.38 (1.15-1.66)</td>
</tr>
<tr>
<td>Aged 14-15 y</td>
<td>Boys</td>
<td>420 (260-665)</td>
<td>590 (420-885)</td>
<td>1.39 (1.18-1.63)</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>330 (215-540)</td>
<td>465 (315-705)</td>
<td>1.33 (1.09-1.61)</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; IQR, interquartile range; MVPA, moderate to vigorous physical activity.

a Ratios for prevalence of physical activity and prevalence of more than 90 min/d of MVPA are expressed as odds ratios. Ratios for time spent in MVPA are expressed as ratios of geometric means, which approximate ratios of medians.

b Adjusted for age, socioeconomic status, and cultural background.
for age, SES, and cultural background. Large and statistically significant increases were consistently found for all of the 4 groups for all of the 3 outcomes. Additional modeling controlling for age, SES, and cultural background made no difference in these results.

**COMMENT**

The prevalence of meeting current physical activity recommendations, the prevalence of participating for 90 min/d or longer, and the time spent in MVPA markedly increased among 12- to 15-year-old adolescents from NSW during the period of 1985 to 2004.

**STRENGTHS AND LIMITATIONS**

Both studies used representative population samples. The same instrument administered with the same procedures and analyzed with the same physical activity criteria was used in both studies. Limitations are that self-report is prone to recall bias and overestimation among adolescents, although this bias would be present for both studies. Self-reports do not capture incidental or light-intensity activities very well, which means that walking and cycling for pleasure or transportation and unorganized play are probably not captured and that the total time spent in physical activity may be underestimated. The months of testing were different for both studies. The AHFS 1985 was conducted in May through October (late fall through mid spring in the southern hemisphere) and the SPANS 2004 data for this study were collected in March and April (early to mid fall). To determine whether season may be related to physical activity, we compared the prevalence of physical activity participation and time spent in MVPA reported on the AHFS 1985 by students surveyed in the winter and those surveyed in the fall and in the spring. No significant differences were found for either (P = .20 and P = .62, respectively).

**COMPARISONS WITH OTHER STUDIES**

Previous studies in the United Kingdom, greater Europe, Canada, and the United States have reported changes in self-reported participation in physical activity among adolescents. In the United Kingdom, the prevalence of participating in at least 3 sessions of vigorous physical activity had increased from approximately 28% to 42% among 12- to 15-year-olds from 1995 to 2003. A more recent study of 7 European countries found that the proportion of adolescents who reported regular vigorous physical activity increased or remained stable from 1986 to 2002. In Canada, data from 3 national health and fitness surveys showed that the proportion of adolescents who met recommended levels of leisure-time MVPA of 25.1 kJ/kg/d doubled from 10% to 20% among boys and girls aged 12 to 14 years and among boys aged 15 to 19 years from 1981 to 1998. In the United States, data from the Youth Risk Behavior Surveillance survey showed that the prevalence of participation in vigorous physical activity has remained stable among students in grades 9 to 12 from 1993 to 2003.

**EXPLANATION OF FINDINGS**

Several explanations are possible for the findings described here. First, self-report instruments predominantly capture structured MVPA (such as organized sports) among adolescents. Conversely, incidental and light-intensity activities (walking, chores, moving around) are not well captured by self-report measures, so changes in participation in these types of activities may not have been identified. Because these activities make up the largest proportion of overall daily energy expenditure, our results must be interpreted with caution and cannot explain trends in overall physical activity participation.

At a community level, the increase in the availability of organized sports and in sporting club registrations among young people in recent years may have contributed to the increase in participation rates. This has been supported at a policy level in Australia by the release of documents such as *Backing Australia’s Sporting Ability: A More Active Australia* that provided a framework for increasing youth participation in organized sports, especially at a club or youth league level.

There have also been changes in education policies in NSW during this period. A comprehensive elementary school physical and health education syllabus and a support document were released as drafts in 1992 and formally in 1999. Concurrent to this was the release of the support document *Physical Activity for Health and Fitness* in 1997. These documents stressed the responsibility of elementary schools for promoting physical activity and providing regular and frequent opportunities for students to be active. Additionally, in 1998, all elementary schools in NSW were formally recommended to allocate a minimum of 120 min/wk of planned physical activity in every school grade from kindergarten to grade 6. These developments in elementary schools in NSW in the 1990s would have had a subsequent flow-on effect into high schools, which may partly explain the increase in physical activity among adolescents during this time.

Also, adolescents may have been more savvy about the term *physical activity* in 2004 compared with 1985; for example, activities such as walking and cycling for fun and dancing for pleasure perhaps were not thought to be physical activity in 1985 but were in 2004. Related to this is the possibility of social desirability influencing the results in 2004. Because physical activity has been given more attention in the past decade, adolescents may feel some “evaluation apprehension” that could lead to overreporting their activity levels. However, even the hypothesized changes in incidental physical activity that may have occurred could not by themselves explain the large differences in overall physical activity participation.

Tangential to this is that because fewer adolescents are walking and cycling to school, because neighborhoods are perceived as less safe for active play, and because the size of safe play areas such as backyards is decreasing, parents and adolescents themselves are turning to other, perceived safer options such as organized sports and activities. Also, because self-reports more accurately capture these activities (very little active neighborhood, backyard, or street play is captured in self-reports owing to the unstructured nature), it is not...
IMPLICATIONS FOR PUBLIC HEALTH

Our results, which show an increase in physical activity participation among adolescents, are encouraging as MVPA has the strongest association with health benefits. It is also encouraging that this is occurring against the backdrop of an increase in the prevalence of adolescent overweight and obesity, and it may have an effect on the magnitude of such increases. If organized sports and activities are increasing in popularity, then policy makers and communities should look for ways to promote such activities. One such way in Australia is the Active After-school Communities Program, which targets participation in organized physical activity by inactive children and currently involves more than 1700 schools and 90 000 primary school–aged children (http://www.ausport.gov.au/aasc). However, it must be remembered that there is a decline in participation in organized sports from adolescence to adulthood,25 and as such, other popular types of adult physical activity (walking, exercise or fitness classes) need to also be promoted to older adolescents.

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Author Contributions: Dr Okely had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Okely, Booth, Hardy, and Denney-Wilson. Acquisition of data: Okely, Hardy, and Denney-Wilson. Analysis and interpretation of data: Okely, Booth, Hardy, Dobbins, and Denney-Wilson. Drafting of the manuscript: Okely and Dobbins. Critical revision of the manuscript for important intellectual content: Okely, Booth, Hardy, Dobbins, and Denney-Wilson. Statistical analysis: Dobbins. Obtained funding: Booth. Administrative, technical, and material support: Hardy and Denney-Wilson. Study supervision: Booth and Hardy.

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REFERENCES

2. Department of Health and Ageing. Australia’s Physical Activity Recommenda-


thority; 1998.
6. Dwyer T, Gibbons LE. The Australian Schools Health and Fitness Survey: physi-

284-292.
8. Booth ML, Okely AD. Chey T, Baum A. The reliability and validity of the Ado-

economic Indices for Areas: Catalogue No. 2912.0. Canberra, Australia: Austra-
11. Brownson RC, Jones DA, Pratt M, Blanton C. Heath GW. Measuring physical ac-

tralia: NSW Dept of Health; 2006.
18. School Health Education Unit. Trends: Young People and Physical Activity: At-
20. Eisenmann JC, Katzmarzyk PT, Tremblay MS, Leisure-time physical activity lev-

154-162.
22. Pratt M, Macera CA, Blanton C. Levels of physical activity and inactivity in chil-
23. Kohl HW, Fulton JE, Caspersen CJ. Assessment of physical activity among chil-

Information Paper: 1991 Census Socio-
economic Indices for Areas: Catalogue No. 2912.0. Canberra, Australia: Austra-