In the United States, the most widely used treatment for children with attention-deficit/hyperactivity disorder (ADHD) is psychostimulant medication (Greenhill, 1992). Between 75% and 90% of children who have received medical diagnoses of ADHD will also receive psychostimulants for at least some period (Angold et al., 2000; LeFever et al., 1999; Reid et al., 1994; Wolraich et al., 1990). Recent studies have served to underscore the effectiveness of psychostimulants (Crenshaw et al., 1999). When used under optimal circumstances, psychostimulants can dramatically reduce teacher and parent ratings of symptom severity (MTA Cooperative Group, 1999).

Estimating the number of children receiving psychostimulant medication is difficult, because neither national studies (Hoagwood et al., 2000) nor state-by-state comparisons have been conducted (Hoagwood et al., 2000; Safer and Zito, 2000). This last consideration is important, because research suggests that there is a high degree of variability in psychostimulant use across various regions and states (Morrow et al., 1998; U.S. Drug Enforcement Agency, 2000).

Findings from studies addressing psychostimulant rates at the state and community level have ranged widely. The lowest estimates include 0.4% among 3- to 17-year-olds in one rural county in New York (Sherman and Hertzig, 1991); 1.3% across sites in Georgia, New Haven, New York, and Puerto Rico based on data collected in 1992 (Jensen et al., 1999); and 1.1% among 5- to 14-year-olds in a health maintenance organization population from the northwestern United States (Zito et al., 1998). The highest estimate reported overall rates of approximately 8% in two large Virginia school districts, with rates of approximately 17% among 7- to 10-year-old white males (LeFever et al., 1999). Angold and colleagues also reported high prevalence rates, with 7.3% of a sample of 4,964 children from western North Carolina receiving medication at some point in the course of a 4-year study (Angold et al., 2000). Other estimates are more reflective of the 3% to 5% rate at which ADHD is thought to occur.

Use of Psychostimulant Medication for ADHD in South Australia

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ABSTRACT

Objective: A retrospective analysis of archival data on psychostimulant prescriptions from South Australia for the period 1990 to 2000 for 5,189 youths from birth to age 18 years was conducted. Method: A person-based data set was used to assess (1) rate of new prescriptions by age group, (2) demographic characteristics (age of psychostimulant start, male-to-female ratio), (3) duration of psychostimulant use, and (4) geographic variation in psychostimulant prescription. Results: Four major findings were observed: (1) the rate of new prescriptions increased dramatically until 1995 but is now declining; (2) demographic characteristics and changes over time mirror those observed in the United States; (3) median duration of psychostimulant use (for a subset of 1,688 children) was approximately 2.5 years; and (4) there was a significant correlation between geographic location and prescription rate. Conclusions: The patterns of psychostimulant use in Australia closely parallel U.S. patterns. Physicians’ prescribing practices may be extremely volatile. Duration of medication treatment should receive increased attention. There is pronounced geographic variability in prescription rates which may be related to socioeconomic status. J. Am. Acad. Child Adolesc. Psychiatry, 2002, 41(8):000–000. Key Words: psychostimulants, attention-deficit/hyperactivity disorder, pharmacotherapy, socioeconomic status.
Rappley and colleagues (1995) reported a prevalence of 1.9% in males from birth to 19 years of age and a 4.3% rate in males aged 10 to 11 years. Wolraich and colleagues (1996) found a rate of approximately 3% among kindergarten to fifth-grade students in a Tennessee county. Finally, in a series of studies during the course of the 1990s, Safer and colleagues documented a rise in psychostimulant use among elementary public school children in Maryland from 2.46% in 1991 to 5.76% in 1997. A similar pattern was reported for middle school students, whose rate increased from 2.47% in 1991 to 5.64% in 1997.

A number of factors may influence the variability in rates of psychostimulant use. The subject selection and time of data collection varied widely across studies. For example, the high prevalence rates reported by both Angold et al. (2000) and Lefever et al. (1999) may be due in part to the fact that the age range of participants corresponds to the peak age of ADHD diagnosis. The use of school-based versus clinical samples may also affect results (Safer and Zito, 2000). Schools may not be aware of children who receive psychostimulants only in the home. The lower rates reported by Jensen et al. (1999) and Zito et al. (1998) may be because the data were collected in the early 1990s and thus may not be reflective of current rates.

Although the general outlines of the increase are well established, there is less information about specific aspects of children receiving psychostimulants such as the rate of use by age levels, the age when children begin treatment, and treatment duration. Data from two large-scale studies with 32,608 individuals (Rappley et al., 1995) and 2,186 youths (Zito et al., 1997) both showed consistent patterns of use by age levels. Psychostimulant rates are relatively low for children aged 5 and younger. At age 6, the percentage of children begins to increase markedly, peaking at around ages 9 and 10. Rates then begin to decelerate quickly. This is consistent with other data on peak ages for ADHD symptoms (Szatmari et al., 1989). There is little information available on the age at which children begin psychostimulant treatment and the duration of treatment. Safer and Krager (1994) suggested that children most frequently begin psychostimulant treatment at around ages 7 or 8 years. This estimate is consistent with data reported by Rappley et al. (1995) and Zito et al. (1997).

Significantly more males than females receive psychostimulants. Safer and Zito (2000) reported that in 1980 the male-to-female ratio for Baltimore County was 6:1. However, the ratio dropped to 4:1 in 1990, with changes due to increased numbers of females. Safer and Krager (1988) reported that duration of psychostimulant treatment for children in Baltimore County Public Schools averaged 7 to 8 years for high school students, 4 to 5 years for middle school students, and 1 to 2 years for elementary school students. Angold et al. (2000) reported an average duration of treatment of just over 4 years.

Information on the age at which medication begins and the duration of treatment has potentially important ramifications for treatment of children with ADHD. Psychostimulants are a mainstay of most physicians' treatment regimens, and there is little indication that nonpharmacological treatments are widely used (Wolraich et al., 1990). This is not inappropriate given current research. The results of the recent MTA Cooperative Group study (1999) support the use of psychostimulants as a major component of treatment. However, other approaches (e.g., behavior modification, environmental modifications) have also demonstrated effectiveness (Pfiffner and Barkley, 1998) and may be useful in their own right or provide additive effects (Conners et al., 2001). If medication is the sole treatment component, then after medication treatment ceases children may be left without sufficient resources to progress or function effectively.

Safer and Zito (2000) suggested that large, community-based samples are useful in estimating medication prevalence because they provide stable estimates that are reliable across geographic locales and patient subgroups and reflect the actual variation that exists in practice. Comparison between studies could allow for isolation of factors which are directly related to differences in the rate of medication or geographic variations. International comparisons may also be useful because they would allow for comparisons across different health care systems and populations. Australia is one of the few countries to have experienced an increase in psychostimulant use comparable with that of the United States (Prosser and Reid, 1999); thus it provides a potentially useful source of comparison. The purpose of this study is twofold. First, we present descriptive statistics on children who were prescribed psychostimulant medication and provide information on changes over time. Second, we analyze the data for differences in psychostimulant use across geographic areas within the Adelaide metropolitan area. We hypothesized that (1) demographic characteristics of children in our sample would be consistent with those in the United States, (2) there would be a steady increase in new cases over time, and (3) there would be considerable variation across geographic areas.
METHOD

Data used for this study were archival records of children who received prescriptions for psychostimulants (either methylphenidate or dextroamphetamine). Dextroamphetamine is available to any child through national health insurance free of charge. All data were collected in South Australia by the South Australian Health Commission (SAHC). Both methylphenidate and dextroamphetamine are classified as “drugs of dependence” by the SAHC. Because of this, all medical practitioners in South Australia are required to obtain an authorization from the SAHC to treat a patient with psychostimulants for any period longer than 2 months. Therefore, this data set represents all children from birth to age 18 who have been authorized to receive psychostimulants. Data for 5,189 cases were collected. Data span the period 1990 to 2000. Both drugs are approved for the treatment of narcolepsy. Because the prevalence of narcolepsy is estimated at 4 to 10 per 10,000 (Stoore, 1999), all but a fraction of cases should be ADHD. The cases reported on in this study come from the city of Adelaide, which is the major population center in South Australia. Metropolitan Adelaide (population 1,079,112) comprises 73% of the total population of South Australia. Metropolitan Adelaide extends almost 90 km from north to south and 30 km from east to west.

Data provided by the SAHC include gender, date of birth, date psychostimulants were authorized, date of last contact (which indicates when authorization ceased), postcode (analogous to zip code), and status. Status was defined by the SAHC as either “active” (i.e., the child was still authorized to receive psychostimulants) or “ceased” (i.e., the child was no longer authorized to receive psychostimulants). From these data we calculated the start age (date psychostimulants were authorized minus birthdate), duration of treatment (date of last contact minus date psychostimulants were authorized), and the number of children beginning psychostimulant treatment per year. Postcode was used as a geographic marker. The postcode is a useful spatial unit because it covers a small and fairly homogeneous population grouping. There are 125 postcodes in the metropolitan area of Adelaide. A total of eight postcodes which cut across the metropolitan Adelaide boundary, which cover a very small population, or which are located primarily outside of metropolitan Adelaide were excluded. Population figures on postcodes were available from the Australian Bureau of Statistics based on the latest census data from 1996 and estimates for the previous and ensuing years. The mean population of the postcodes was 8,607 (SD = 1,960).

Data were analyzed for differences across postcodes and for patterns related to geographic location. To test for a relation between location and psychostimulants, each postcode’s distance from the city center was estimated and correlated with a standardized medication ratio (SMR) for the postcode. Distance from the city center for 117 postcodes was computed by calculating the distance from each postcode’s centroid to the centroid of the city-center postcode. SMRs for each postcode were computed by using indirect standardization. The ratio of observed counts to expected counts for each postcode were derived by calculating age-sex stratum–specific proportions (using the entire Adelaide population as the reference) and multiplying these proportions with the stratum-specific populations and summing the product. The SMR for each postcode was calculated by dividing the observed number of children with prescriptions by the expected number. Thus an SMR of greater than 1 indicates more cases were observed than would be expected. To calculate Pearson product moment correlations we weighted for population size, and both the postcode and distance data were normalized (normalized SMR = 1/sqrt SMR, normalized distance = sqrt distance). A Spearman ρ correlation between SMRs and distance was also calculated. The Spearman correlation was used as an additional check and to attenuate the possible effects of any outliers. We also collected data on socioeconomic status (SES) for each postcode. The Index of Relative Socioeconomic Disadvantage (IRSD), which is compiled by the Australian Bureau of Statistics, was used as a measure of SES. The IRSD considers factors such as educational levels, income, and unemployment. A high score suggests that a postcode has more higher-income families and more trained and educated people. A low score suggests the opposite.

The status category, used by the SAHC to indicate whether a child was authorized to receive psychostimulants, changed midway through the 1990s. Until 1994, practitioners were required to reauthorize treatments on a yearly basis. Because of the increase in the number of authorizations that occurred early in the 1990s, the SAHC was no longer able to handle the volume of requests on a yearly basis. This demand resulted in a change in policy. After 1994 physicians were no longer required to request yearly reauthorizations. Instead, the initial authorization was valid until the child reached the age of 18. Physicians were asked to report voluntarily to the SAHC when a child ceased psychostimulant treatment. It is highly unlikely that all physicians who ceased psychostimulant treatment actually reported this to the SAHC. Thus the number of children currently active is likely to be an overcount. For this reason we report duration data only for those who were reported to have ceased psychostimulant treatment.

RESULTS

Prescriptions by Age Group

Figure 1 shows the number of children beginning psychostimulant treatment for the period 1990–2000 broken down by age group. The number of children receiving psychostimulant increased markedly over the decade. The most dramatic increase came in the span of a single year from 1991–1992. The increase in the rate of new authorizations for the 5- to 9-year age group was greater than 10-fold. The rate at which new children were authorized to receive psychostimulants continued to increase until 1995–1996, after which it began to decline noticeably. The bulk of the increase (and decrease) was due to changes in the number of males receiving prescriptions. Females showed a slow increase and did not decrease as steeply as males. It is interesting that in 2000 the number of new authorizations approximated the numbers starting psychostimulants in 1992.

As expected, the 5- to 9-year-olds received the bulk of the new prescriptions, followed closely by the 10- to 14-year-olds. The overall male-to-female ratio was 5.4:1. Over the period 1990–2000 there was a marked increase in the number of females receiving psychostimulants and a corresponding decrease in the ratio of males to females. From 1992 to 2000 the male-to-female ratio exhibited an overall decelerating trend. It decreased from a high of 7.7:1 in 1993 to a low of 4.3:1 in 1998. The changes were statistically significant over the period 1992–2000 (χ2 = 22.63, p = .003) (the years 1990 and 1991 were excluded because
of low numbers). The highest male-to-female ratio was found for the 10- to 14-year age group. The birth to 4-year and 15- to 18-year age groups had the lowest male-to-female ratios. The data suggest a general trend toward lower male-to-female ratios over time across all age groups.

Start Age

Figure 2 shows a histogram of the ages at which children began psychostimulant treatment for the period 1990–2000. The average age at which children started psychostimulants was 9.35 years (SD = 3.25). The median age was 8.97. The distribution is skewed because a disproportionate number of children began in their teens. The average start ages for males and females, respectively, were 9.41 (SD = 3.21) and 9.02 (SD = 3.39). The difference between the two was significant ($F_{1,5188} = 10.32, p = .001$). Regression analysis indicated that there was a slight but statistically significant trend toward a younger start age over the period 1992–2000 ($t = –3.50, p < .001, B = –0.065$). This translated into a decrease in the average start age of approximately 6 months over a 9-year period.

Duration of Psychostimulant Treatment

Of 5,189 cases (over the years 1990–2000), 1,688 (1,410 males and 278 females) were no longer being prescribed psychostimulants. Of these cases, 945 (56%) were from the period 1990–1994 and 743 (44%) were from 1995–2000, which is after the reporting procedure changed. Figure 3 shows a histogram of treatment duration for those reported as having ceased medication. There was no difference between the proportions of males and females who ceased psychostimulant treatment and those who were still reported as active ($\chi^2_1 = 0.04, p = .84$). For those reported as having ceased treatment, the mean durations of treatment for males and females, respectively, were 2.87 (SD = 1.94) and 2.85 (SD = 1.75) years. There was no significant difference between males and females in treatment duration. The median duration of treatment was 2.47 years. The modal period of treatment was 1 year. Approximately 25% of cases received psychostimulants for 1 year or less. Children whose duration was 0 are those who were reported as starting and stopping psychostimulants in the same month. These are likely children who either could not tolerate psychostimulants or refused treatment. The mean duration of treatment (and standard deviations) for the age groups was 0 to 4 years = 2.60 years (SD = 1.64); 5 to 9 = 2.88 years (SD = 1.93); 10 to 14 = 3.05 years (SD = 2.01); and 15 to 18 = 2.22 years (SD = 1.31). Again, the modal duration of treatment was 1 year across all age groups.

Geographic Variation

The SMRs of observed versus expected rates by postcode ranged from 0.49, indicating that only half as many children as expected had received prescriptions, to 3.42, indicating more than 3 times as many as would be expected. The discrepancy between observed and expected rates was significant for 33 of the postcodes. Of these, 17 had
significantly lower rates ($p < .05$) than expected and 16 had significantly higher rates than expected ($p < .05$). The Pearson correlation between SMR and distance was significant ($r = -0.69$, $p < .0001$). The Spearman correlation was also significant ($\rho = 0.56$, $p = .001$). Thus both tests indicated that the likelihood of a child’s receiving psychostimulants increased with distance from the city center. The Pearson correlation between SMR and IRSD was significant ($r = 0.46$, $p = .01$). The Spearman correlation was also significant ($\rho = -0.28$, $p = .002$). The results of both tests suggest that lower SES is associated with increased likelihood of children receiving psychostimulants. Note that the SMR normalization process affects the sign of the Pearson correlation.

**DISCUSSION**

The results of this study are quite consistent with those of previous studies in that the demographic characteristics of children receiving psychostimulants in the United States are similar to those of Australian children. The age at which psychostimulants were started was nearly iden-

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**Fig. 2** Age psychostimulants started (years) for 1990–2000.

**Fig. 3** Duration of treatment in years ($n = 1,688$) for 1990–2000.
tional with that found in previous studies (Rappley et al., 1995; Zito et al., 1997). The same increase with age, which peaked between ages 9 and 10 years, was observed. One slight difference was in the number of patients in whom psychostimulant treatment was started in the teen years. Here the rate was higher. These cases may be the result of the extremely low rates of prescription in the previous decade. The ratio of males to females was also quite consistent with other studies. There was an overall decrease in the proportion of males to females, with the number of females increasing and maintaining over the 1990–2000 period. This finding from an Australian sample suggests that both the peak age of treatment and the increased numbers of females receiving psychostimulants are very consistent, even across disparate settings. The difference in start ages between males and females was surprising: females would receive psychostimulants on average 4 to 5 months earlier than males. One possible explanation for this difference is that females with ADHD may need to exhibit more serious problems than males in order to receive a diagnosis (Eme, 1992; Seidman et al., 1997). However, the effect was small and statistical power is extremely high. Whether this finding is clinically significant is uncertain. The overall trend toward decreased start age was also unexpected. The change appears to be due to the increased rate at which young children received psychostimulants in combination with decreases in the 5- to 9- and 10- to 14-year-old groups which occurred after 1995. Increases in the rate of psychostimulant prescription for young children have been previously noted (Zito et al., 2000). Again, however, the change in age at which psychostimulants were started was small—around 6 months—and power is high. Whether this result is clinically significant remains to be determined.

One of the most interesting aspects of the data were the changes in the number of new cases per year. The decrease in number of new cases after 1995 is puzzling. Because of the attention that the ADHD diagnosis has received, we expected an increase. The volatility observed was also unexpected, both in terms of the rapidity of the increase in new cases and the equally abrupt decline. Large increases have been previously documented. For example, Safer and Zito (2000) reported a fivefold increase in medication prevalence for the Baltimore County Public Schools. However, this change was much more gradual, occurring over a 25-year period, and rather than decreasing, rates appeared to plateau. There are no obvious explanations for the changes observed in the present study.

One possible explanation for the rapid increases in the period from 1992 to 1996 is that the rate of psychostimulant authorization for the decade prior to 1992 was essentially negligible. Thus many children, who should have received psychostimulant treatment earlier, could have been included in this period, which would contribute to the rapid rise. After these children had been accounted for, the rate would then decrease because of saturation (i.e., the treatment population had been identified and treated). Saturation has previously been suggested as a factor in medication rates (Safer and Zito, 2000). The rapidity of the change, however, was striking. It suggests that physicians’ prescribing practices can change markedly in a relatively brief period.

Our duration results are consistent with Safer and Krager’s (1994) examination of school medication records from Baltimore County, a large suburban school district with 670,000 students. Their data, collected over the period 1971–1993, showed that the duration for elementary school students—who constituted the vast majority of children starting psychostimulant treatment—was only 2 years and had been stable since 1983. However, Safer and Krager did not note whether the 2-year duration figure was based on children who had ceased medication. Thus the results may not be directly comparable with the results in the present study. If the present sample is even somewhat representative, however, there are important implications for practice. More than half the children in the subset reported as having ceased medication received psychostimulant treatment for less than 3 years. Because children were most likely to start psychostimulants between ages 6 and 9 years, many children would be off psychostimulants for most of the years they would spend in school. This is an aspect of treatment that should be addressed by future research. There are few data on psychostimulant treatment duration, why children discontinue psychostimulants, and the effects of cessation on outcomes. In part this may be due to the fact that assessing the duration of medication treatment is difficult because of the longitudinal nature of the data. Whether to assess duration based on children who have ceased medication or who are currently active is another issue. Generalization is also a potential problem, because duration of medication treatment may well be a “moving target” which changes over time. Thus, in this study, it is uncertain how well the duration data are representative of current practice.

Previous studies have shown distinct differences across regions in the rate of psychostimulant use (Rappley et al.,
As expected, the SMR data showed a high degree of variation across postcodes. The difference from the highest to lowest SMR was nearly sevenfold. There was no apparent trend toward over- or underprescription. The significant correlation between SES and SMR was consistent with previous research with Australian samples that found differences in psychostimulant rates across income levels (Prosser and Reid, 1999). In our data the highest SMRs tended to be located in the northern and southern suburbs. These areas are predominantly of lower SES, with high unemployment. SES has previously been suggested as a risk factor for ADHD (Biederman et al., 1995). There are several reasons why low SES might be associated with an increased incidence of ADHD. Low SES may be associated with other risk factors, such as severe marital discord, foster care placement, or increased exposure to environmental or psychosocial stressors. Assessment bias also may be a factor. Stevens (1981) found that children described as low SES received significantly higher hyperactivity ratings.

The results of our study are contrary to suggestions that psychostimulant use is more likely among the middle to upper middle class (Diller, 1998). However, generalizations across countries are risky. First, health care systems differ. In Australia all children are covered by a national health plan that covers 100% of the cost of psychostimulant medication, but other forms of treatment, such as child psychologists, are not covered. Second, there may be changes in the relationship between medication use and SES over time. Safer and Krager (1988) found that in Maryland medication patterns across low and mid to high SES changed from the 1970s to the 1980s. Finally, differences between the makeup of lower SES groups across countries also make comparisons difficult. For example, the medication rate for African Americans in the United States is significantly lower than for whites (Zito et al., 1998).

**Limitations**

The data on duration must be interpreted very cautiously. First, because of the changes in authorization procedures that occurred in 1994, there was no way to determine the number of children who actually ceased psychostimulant treatment after 1995. The number of children reported as having ceased treatment decreased markedly after 1994; however, whether this indicates a trend in increased psychostimulant use or simply that physicians were not reporting children who ceased treatment cannot be determined. Thus it is not possible to generalize the data from the subset of children who were reported as having ceased psychostimulant treatment to the entire sample. Second, these data almost certainly include nonresponders or children who could not tolerate psychostimulants. Third, children who ceased psychostimulant treatment may have been switched to other medications (e.g., antidepressants) which would not be reflected in these data. Fourth, there may be differences among physicians who reported when a child ceased psychostimulant treatment versus those who did not report. Finally, the changes in the rate of new cases per year indicated that physicians’ practice can change rapidly. Thus the extent to which the cases reported are representative of current practice is uncertain.

**Clinical Implications**

Much time and effort have gone toward comparisons of medication versus other forms of treatment. However, if medication is not administered, comparisons are moot. Our data suggest this may be a concern. Unless there are other supports in place (e.g., educational accommodation, behavior modification, counseling), children would be untreated and could be at increased risk for adverse outcomes. If medication is to be the mainstay of a treatment program, children must be maintained on an appropriate (and properly monitored) course of medication. However, these data suggest that there is a relatively high turnover rate.

In sum, the results of this study suggest that the demographic characteristics of children receiving psychostimulants in Australia are similar to those in the United States. Although the magnitude of psychostimulant use was smaller, the overall patterns of use across age and gender were consistent. Even though overall psychostimulant consumption was increasing, the rate of new cases was actually decreasing. Duration of treatment has received relatively little attention, however, and it may be an important aspect of treatment planning. Why children cease psychostimulant treatment, how transitions are planned and supported, and the success of outcomes would be useful information. Finally, SES as a risk factor may be a concern that should receive increased attention.

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