Stimulant prescribing for the treatment of ADHD in Western Australia: socioeconomic and remoteness differences

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ABSTRACT

Objective: To identify whether the rate and average daily dose of stimulant prescribed for attention deficit hyperactivity disorder (ADHD) in Western Australia differed according to the geographical remoteness and socioeconomic status of the patient.

Design and data sources: Secondary analysis of population-based administrative pharmacy data from 2004, stratified by the Accessibility/Remoteness Index of Australia (ARIA+) categories and the Index of Relative Socio-Economic Disadvantage (IRSD) quintiles for WA (2001 Census).

Outcome measures: Rate ratios of stimulant prescription and mean average daily dose (in dex-equivalents) stratified by age (2–17, 18+ years), sex, ARIA+ category and IRSD quintile.

Results: The rate of stimulant prescription was 2.3 to 5.3 times greater in major cities in WA compared with remote and very remote parts of the state. The association between socioeconomic disadvantage and the rate of stimulant prescription was highly variable. Adults with the least socioeconomic disadvantage were significantly more likely to receive stimulants compared with their most disadvantaged counterparts; however, the reverse association was seen with children. The average daily dose of stimulant prescribed did not vary greatly across remoteness or socioeconomic categories.

Conclusion: Remoteness and socioeconomic disadvantage are significantly associated with rate of stimulant prescription for ADHD in WA, but not associated with average daily dose of stimulant prescribed. Further research is needed to understand why considerable variation exists in the use of prescribed stimulants for ADHD.

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Attention deficit hyperactivity disorder (ADHD) has been associated with a range of adverse outcomes throughout the lifespan, including impairments in educational attainment and interpersonal relationships, career difficulties, antisocial activities and the development of other comorbid conditions (eg, substance misuse, mood disorders).[1] However, diagnostic and historical heterogeneity has led to disparate findings,[2] and it remains unclear which ADHD symptom(s) are most predictive of future risk. Stimulants are the mainstay of ADHD therapy for both children and adults, although published studies support a multimodal treatment approach that incorporates psychosocial interventions individualised to suit personal needs.[3-5]

Little is known about the epidemiology of stimulant use at the patient level in Australia. With the exception of those from New South Wales and Western Australia,[6-8] most of the studies are based on aggregated consumption rates or survey data, or are restricted to children of certain ages.[9,10] There is an even smaller body of literature that focuses on differences in stimulant use across socioeconomic groups and remoteness areas. Buckmaster investigated jurisdictional variations and socioeconomic correlates of stimulant use in Australia.[11] However, this study was restricted to aggregated data about dexamphetamine sulfate (ie, it excluded methylphenidate hydrochloride), and it used very large and heterogeneous geographical boundaries (ie, federal electorates).[11]

The paucity of Australian studies on stimulant use is somewhat surprising given that in global comparative terms, the level of licit stimulant use in Australia is surpassed only by that in the United States and Canada.[9]

The aims of our population-based study were to identify whether the period-prevalence ratio (rate ratio) and average daily dose of prescribed stimulant used in the treatment of ADHD in WA differed according to the geographical remoteness and socioeconomic status of the patient.

METHODS

Population selection and data sources

The WA Department of Health provided anonymised, geocoded (using patient address) data about all people in WA aged 2 years and older who were notified to the Department of Health as receiving treatment with stimulant medicines for ADHD in the period 1 January to 31 December 2004. These data are maintained by the WA Department of Health on two population-based databases known as the Stimulant Notification Database and the Dispensed Stimulant Medication Database, which were introduced as part of the WA Stimulant Regulatory Scheme in August 2003.[8] This mandatory scheme restricts the prescription of stimulants to patients with specific conditions (ADHD, brain damage, narcolepsy or depression). Prescribers must hold specific specialist qualifications, apply to the WA Department of Health for a Stimulant Prescriber Number, and provide standardised documentation on each patient treated with stimulant medication (called Notification).

The Index of Relative Socio-Economic Disadvantage (IRSD) from the Socio-Economic Indexes for Areas (SEIFA) was used to construct five levels of socioeconomic disadvantage, with 20% of the population in each quintile. The IRSD represents the most general SEIFA measure and is based on answers to questions asked in the 2001 Census that indicate low income, low educational attainment, high unemployment, jobs in relatively unskilled occupations (eg, labourer, production, clerical, sales or service workers), and other indicators of disadvantage such as Indigenous status, public rental housing, and separated/divorced or single parent households.[12] The IRSD values were assigned to each patient's Stimulant Notification Record[8] using collection districts from the 2001 Census, or the statistical local area (SLA) if the collection district was not known. Collection districts each consist of about 220 households in urban areas (fewer in rural areas),[13] and thus minimise the risk of misclassification bias that results when IRSD values are assigned using larger geographical units such as postcodes or federal electorates.[14]

The Accessibility/Remoteness Index of Australia (ARIA+) was used to describe geographical disadvantage. ARIA+ measures access in terms of physical distance from services and opportunities for social interaction.[15] Designed as a continuous variable (values 0–15), ARIA+

1 Age- and sex-stratified rate ratio of stimulant prescribing for the treatment of attention deficit hyperactivity disorder by remoteness and socioeconomic quintile, Western Australia 2004. Data are rate ratio (95% CI)

	Child (2–17 years)		Adult (≥ 18 years)	
	Boys ($n = 7422$)	Girls ($n = 1828$)	Men ($n = 3621$)	Women ($n = 2164$)
Remoteness				
Major cities	2.3 (2.0–2.6)	2.6 (2.0–3.3)	5.3 (4.2–6.9)	4.8 (3.4–6.8)
Inner regional	2.5 (2.2–2.8)	2.4 (1.8–3.1)	3.3 (2.5–4.3)	3.3 (2.3–4.8)
Outer regional	1.5 (1.3–1.8)	1.6 (1.2–2.2)	2.0 (1.4–2.6)	2.3 (1.5–3.4)
Remote/very remote [period prevalence]*	1.0 [15.6]	1.0 [3.7]	1.0 [1.1]	1.0 [0.7]
χ^2 for trend	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$
Socioeconomic quintile				
Most disadvantaged [period prevalence]*	1.0 [37.2]	1.0 [9.9]	1.0 [4.0]	1.0 [2.6]
More disadvantaged	1.1 (1.0–1.1)	1.0 (0.9–1.2)	1.3 (1.1–1.4)	1.0 (0.9–1.2)
Average	0.8 (0.7–0.8)	0.7 (0.6–0.8)	1.0 (0.9–1.2)	0.9 (0.8–1.1)
Less disadvantaged	0.8 (0.7–0.9)	0.7 (0.6–0.8)	1.2 (1.1–1.4)	1.1 (1.0–1.3)
Least disadvantaged	0.9 (0.8–0.9)	0.9 (0.8–1.0)	1.7 (1.5–1.8)	1.5 (1.4–1.8)
χ^2 for trend	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$

*Period prevalence per 1000 population in the reference categories for remoteness (remote/very remote) and socioeconomic quintile (most disadvantaged). ◆

is often divided into the following five broad levels of remoteness for comparative statistical purposes: major cities of Australia, inner regional Australia, outer regional Australia, remote, and very remote.[15] This study combined the remote and very remote categories to improve the precision of the population estimates. As with the IRSD, the ARIA+ categories were assigned to patient records using collection districts, and gaps were filled with SLAs. It makes little difference in the population by ARIA+ whether the remoteness class is assigned by collection district or SLA.[16]

Population denominators for the period-prevalence estimates were based on the estimated resident population of WA at 30 June 2003,[17] minus people aged under 2 years. IRSD and ARIA+ data were aggregated using 2003 estimated resident population data, as the data for 2004 were not yet available at the collection district level. These data were supplied by the Epidemiology Branch, WA Department of Health.

The daily dose of stimulant medication prescribed was recorded on each patient's Stimulant Notification Record. In WA, patients are prescribed either methylphenidate hydrochloride (sustained release or immediate action) and/or dexamphetamine sulfate. In the case of patients with multiple Notification records over the study period (eg, due to a change in drug type or dose), an average daily prescribed dose for each drug type was calculated. As the outcome of interest was overall stimulant medication use, methylphenidate hydrochloride was converted to a dexamphetamine (dex)-equivalent dose by halving the daily dose ([mg/day]/2), whereas the dexamphetamine sulfate dose remained unchanged. The total daily dex-equivalent dose represented the sum of all dexamphetamine sulfate and/or dex-equivalent methylphenidate hydrochloride prescribed per day (mg/day).

Statistical analyses

Patient records that could not be geocoded to a collection district or SLA, and hence no IRSD or ARIA+ category could be assigned, were excluded from the analyses; χ^2 and independent samples t tests were used to examine whether these excluded patients differed from patients with a geocoded Stimulant Notification Record in terms of sex, age and average daily stimulant dose (in dex-equivalents).

The diagnosis of ADHD varies substantially by age and sex. Hence, we used Poisson regression to calculate age- (children, 2–17 years; adult, ≥ 18 years) and sex-stratified rate ratios (period-prevalence ratios) of stimulant prescribing by remoteness and socioeconomic quintiles separately (Box 1). The population denominators used in calculating the rate ratios were subdivided by the IRSD and ARIA+ categories. A more refined analysis of age was impossible without compromising the precision of the population estimates. The "remote/very remote" and "most disadvantaged" categories were used as the reference groups for remoteness and socioeconomic quintile, respectively. To determine whether there was a significant upward or downward trend in stimulant treatment across ARIA+ and IRSD categories, χ^2 linear tests of trend were performed within strata.

The mean daily stimulant dose (95% confidence interval) was calculated for each age and sex stratum (Box 2). Within each age stratum, generalised linear modelling was used to examine all pairwise least-squares mean differences (Tukey–Kramer adjustment) in the daily doses for ARIA+ and IRSD separately, adjusting for sex. We chose to adjust rather than stratify the analysis by sex because, unlike the rate ratios, we had no a priori knowledge that sex influenced daily dose. Stata version 9 (StataCorp, College Station, Tex, USA) and SAS version 9.1 (SAS Institute Inc, Cary, NC, USA) were used for the analyses.

RESULTS

WA ADHD population of prescribed stimulant users

The majority of the 15 690 records (95.8%) of eligible ADHD patients identified in WA during 2004 were geocoded with a collection district or SLA and hence were included in the analysis. There were two geocoded records that were assigned a remoteness category but no socioeconomic category; thus, the number of records analysed varied slightly ($n = 15\,035$ or 15 033). Patient records excluded from the analyses (4.2%) were not statistically different from those included in terms of age, sex or the total daily dose of stimulant prescribed.

Children (2–17 years) comprised most of the people with ADHD who were prescribed stimulants (61.5%). There were 2.8 times as many males as females (73.4% versus 26.6%). People from remote and very remote parts of WA comprised 3% of the ADHD population studied. People with ADHD living in major cities of WA were less likely to have high levels of socioeconomic disadvantage (most and more disadvantaged categories, 36.5%) compared with people living in inner regional (56.5%), outer regional (63.7%), and remote/very remote (65.0%) parts of the state.

There were more authorised prescribers treating patients in major cities ($n = 131$) compared with inner regional ($n = 80$), outer regional ($n = 65$) and remote/very remote parts

of WA ($n = 57$). There was less variability among socioeconomic categories where the number of prescribers treating patients from the two most disadvantaged categories ranged from 106 to 111, and 106 to 112 for the two least disadvantaged categories.

Rate ratio of stimulant prescription

There was a significant linear trend for ARIA+ across all strata, suggesting that the rate of stimulant treatment increased with decreasing remoteness. Adults with ADHD showed the greatest level of variation across remoteness areas, with the rate increasing over four- to fivefold for women and men, respectively, from the most remote to least remote areas. In children, the rate increased twofold from the most remote to least remote areas.

The association between socioeconomic quintile and stimulant prescription for ADHD was less uniform across age and sex strata (Box 1). The χ^2 tests for trend were highly significant for all strata. However, the rate ratios show that these trends were not linear and not in the same direction for each stratum. There were too few data points to determine the correct functional form of the trend. Men and women with the least socioeconomic disadvantage were significantly more likely to receive stimulants compared with their most disadvantaged counterparts; however, the reverse association was seen with children, although it did not achieve statistical significance for girls.

Average daily stimulant dose (mg/day in dex-equivalents)

The average daily stimulant dose prescribed across remoteness and socioeconomic categories is shown in Box 2. Children living in remote or very remote parts of WA had significantly lower daily doses than children living in less remote parts of the state, after adjustment for sex (range of least-squares mean differences, 2.3–3.3 mg/day). Children living in outer regional areas had significantly higher doses than children living in inner regional areas (least-squares mean difference, 1.3 mg/day; 95% CI, 1.1–1.5). Adults living in major cities and inner regional areas had higher daily doses than adults in outer regional areas (range of least-squares mean differences, 3.1–4.1 mg/day). Children with the highest and lowest levels of socioeconomic disadvantage had comparable daily doses that were significantly higher than children classified in the three intermediate socioeconomic groups, but the absolute differences were small (range of least-squares mean differences, 0.6–1.4 mg/day). There were no statistically significant differences in daily stimulant dose for adults in terms of socioeconomic disadvantage.

2 The effect of remoteness and socioeconomic status on the average daily stimulant dose (dex-equivalent mg/day) prescribed for the treatment of attention deficit hyperactivity disorder, Western Australia 2004. Data are unadjusted mean (95% CI)

	Child (2–17 years)		Adult (⩾ 18 years)	
	Boys ($n = 7422$)	Girls ($n = 1828$)	Men ($n = 3621$)	Women ($n = 2164$)
Overall	17.7 (17.5–17.9)	17.1 (16.7–17.5)	33.5 (33.0–34.0)	33.4 (32.8–34.1)
Remoteness				
Major cities (MC)	17.7 (17.4–17.9)	17.4 (16.9–17.8)	33.8 (33.3–34.2)	33.8 (33.1–34.6)
Inner regional (IR)	17.7 (17.2–18.2)	16.0 (15.0–16.9)	33.1 (31.7–34.6)	32.2 (30.3–34.1)
Outer regional (OR)	19.0 (18.3–19.8)	17.1 (15.9–18.3)	29.6 (27.7–31.6)	29.8 (27.1–32.4)
Remote/very remote (VR)	15.3 (14.3–16.2)	15.5 (12.9–18.2)	32.3 (28.5–36.2)	28.8 (24.2–33.4)
Significant pairwise differences	MC/OR*, MC/VR‡, IR/OR*, IR/VR*, OR/VR‡		MC/OR‡, IR/OR*	
Socioeconomic quintile				
Most disadvantaged (MS)	18.1 (17.6–18.5)	17.3 (16.4–18.2)	34.8 (33.7–36.0)	33.2 (31.6–34.7)
More disadvantaged (MR)	17.6 (17.2–18.0)	16.3 (15.6–17.1)	33.2 (32.2–34.1)	32.6 (31.1–34.0)
Average (AV)	17.2 (16.7–17.8)	16.4 (15.3–17.4)	32.9 (31.8–34.0)	33.0 (31.4–34.6)
Less disadvantaged (LS)	17.0 (16.5–17.4)	17.1 (16.2–18.1)	33.4 (32.4–34.4)	33.5 (32.1–34.9)
Least disadvantaged (LT)	18.4 (17.9–18.9)	18.2 (17.2–19.1)	33.4 (32.5–34.4)	34.3 (33.0–35.5)
Significant pairwise differences	MS/AV*, MS/LS*, MR/LT*, AV/LT†, LS/LT‡			

Total stimulant doses presented as combined dex-equivalent doses (ie, [dexamphetamine sulfate (mg/day)] + [methylphenidate hydrochloride (mg/day)]/2). *P* values for independent *t* tests of least-squares (sex-adjusted) mean differences: * $P < 0.05$; † $P < 0.001$; ‡ $P < 0.0001$. ◆

DISCUSSION

Our study found that the prescription of stimulants to treat ADHD in WA differs significantly according to geographical remoteness. Specifically, the rate of stimulant prescription was 2.3 to 5.3 times greater in major cities compared with remote and very remote parts of the state. Adults showed the largest rate ratios, possibly because the diagnosis of ADHD in adults remains controversial. That access to public mental health services in WA is severely restricted for adults with ADHD probably also contributed to their concentration in major cities (ie, where most private specialists practise). Inequities in the provision and accessibility of specialist mental health services in remote Australia have been recently summarised by Rajkumar and Hoolahan.[18] Equity of access problems have also been reported by expert witnesses in the WA Parliamentary Inquiry into ADHD (2004).[19]

Quite apart from access issues, it is possible that as yet unknown cultural aspects influence the diagnosis and treatment of ADHD in remote WA, particularly the tolerance and management of disruptive behaviour and the perceived importance of classroom compliance and academic performance. The high truancy in some remote WA communities (eg, Halls Creek) may also limit opportunities to detect ADHD. However, we cannot discount the possibility that the prevalence of ADHD does truly vary between remote and urban areas.

Unlike geographical remoteness, no consistent association between socioeconomic disad-

vantage and the rate of stimulant prescription emerged, with the exception that socioeconomically disadvantaged boys had a higher rate of stimulant use compared with their less disadvantaged counterparts, and the reverse association was found for adults. This is not surprising given that ADHD represents an extremely heterogeneous and complex developmental disorder.[20] Our study was further complicated by the fact that the WA Stimulant Regulatory Scheme does not require the subtype of ADHD, symptom severity, or the age of onset to be reported. Thus, the reduced richness of data may have masked real differences. In the absence of national practice guidelines for the treatment of ADHD, it is also possible that stimulant use was influenced by prescriber characteristics, as suggested by Buckmaster[11] and also found in the United Kingdom.[21]

We found few differences in the average daily dose of stimulant prescribed (dex-equivalent mg/day) across remoteness categories, with the exception that children in remote and very remote parts of WA received lower doses than their counterparts in less remote areas. We have subsequently found that these children weighed significantly less (mean body weight difference, 3.4 kg; 95% CI, 1.2 kg–5.5 kg), and hence the dosage differences are clinically insignificant when considered in conjunction with the Stimulant Regulatory Scheme guidelines for child dosages (1 mg/kg per day dex-equivalent dose). The lower doses for adults in outer regional areas may reflect patient characteristics or differences in the practice of individual practitioners. We found no clinically significant association between average daily stimulant dose and socioeconomic status.

Our study had limitations. Firstly, socioeconomic indices were ecological, based on Census data from 2001, rather than assigned at the individual level. Secondly, almost 10% of patient records could not be geocoded with a collection district. Wherever possible, the IRSD values for these records were assigned using the SLA, which may have introduced a misclassification bias. Thirdly, although the 5% of records excluded from the analyses were shown not to differ on the basis of age, sex or average daily dose (dex-equivalents), our study possibly underestimated the rate of stimulant use in remote and very remote parts of WA, as collection districts were commonly unknown for these areas. We did not have access to suburb names to confirm this view. Fourthly, the Stimulant Regulatory Guidelines do not distinguish incident from prevalent cases, and so we cannot examine different rates of diagnosis that may result in differences in patient management. Most importantly, the generalisability of our results to other Australian states may be limited, given that the rate of stimulant treatment in WA is 3.5 times greater than the national average.[11]

In summary, our study found that remoteness and socioeconomic disadvantage are significantly associated with the rate of stimulant prescription for the treatment of ADHD in WA, but not associated with the average daily dose of stimulant prescribed. As this is the first Australian study of this kind, replication is needed to validate the findings, and further research is needed to understand why considerable variation exists in the use of prescribed stimulants for ADHD across geographical locations and socioeconomic groups.

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COMPETING INTERESTS

None identified.

AUTHOR DETAILS

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REFERENCES

1 Willoughby M. Developmental course of ADHD symptomatology during the transition from childhood to adolescence: a review with recommendations. *J Child Psychol Psychiatry* 2003; 44: 88-106.
2 Lynam DK. Early identification of chronic offenders: who is a fledgling psychopath? *Psychol Bull* 1996; 120: 209-234.
3 Kutcher S, Aman M, Brooks S, et al. International consensus statement on attention-deficit/hyperactivity disorder (ADHD) and disruptive behavior disorders (DBDs): clinical implications and treatment practice suggestions [consensus statement]. *Eur Neuropsychopharmacol* 2004; 14: 11-28.
4 Stevenson C, Whitmont S, Bornholt L, et al. A cognitive remediation programme for adults with Attention Deficit Hyperactivity Disorder. *Aust N Z J Psychiatry* 2002; 36: 610-616.
5 Wender P. Attention deficit hyperactivity disorder in adults: a wide view of a widespread condition. *Psychiatr Ann* 1997; 27: 556-562.
6 Salmelainen P. Trends in the prescribing of stimulant medication for the treatment of attention deficit hyperactivity disorder in children and adolescents in NSW. Sydney: New South Wales Health Department, 2002.
7 Salmelainen P. Trends in the prescribing of stimulant medication for the treatment of attention deficit hyperactivity disorder in adults in NSW. Sydney: New South Wales Department of Health, 2004.
8 Western Australian Department of Health. Stimulant prescribing and usage patterns for the treatment of ADHD in Western Australia (1 August 2003 – 31 December 2004). Perth: Pharmaceutical Services Branch, WA Department of Health, 2005.
9 Berbatis C, Sunderland V, Bulsara M. Licit stimulant consumption in Australia, 1984–2000: international and jurisdictional comparison. *Med J Aust* 2002; 177: 539-543.
10 Sawyer M, Rey J, Graetz B, et al. Use of medication by young people with attention-deficit/hyperactivity disorder. *Med J Aust* 2002; 177: 21-25.
11 Buckmaster L. Medication for attention deficit/hyperactivity disorder (ADHD): an analysis by federal electorate (2001-03). Canberra: Parliamentary Library of Australia, 2004.
12 Australian Bureau of Statistics. Census of population and housing: socio-economic indexes for areas, Australia. Canberra: ABS, 2001. (Catalogue No. 2039.0.)
13 Australian Bureau of Statistics. Australian Standard Geographical Classification (ASGC) 2005. Canberra: ABS, 2005. (Catalogue No. 1216.0.)
14 Hyndman J, Holman C, Hockey R, et al. Misclassification of social disadvantage based on geographical areas: comparison of postcodes and collector's district analyses. *Int J Epidemiol* 1995; 24: 165-176.
15 Australian Bureau of Statistics. Outcomes of ABS views on remoteness consultation, Australia. Canberra: ABS, 2001. (Catalogue No. 1244.0.00.001.)
16 Glover J, Tennant S. Remote areas statistical geography in Australia: notes on the Accessibility/Remoteness Index for Australia (ARIA+ version). Working Papers Series No. 9. Adelaide: Public Health Information Development Unit, 2003.
17 Australian Bureau of Statistics. Australian historical population statistics – population, age and sex, WA, 1901 onwards. 2004. http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/Lookup/CA2568A90021A807CA256DB0000248A1/$File/3105065001_table30.xls (accessed Feb 2006). (Catalogue No. 3105.0.65.001.)
18 Rajkumar S, Hoolahan B. Remoteness and issues in mental health care: experience from rural Australia. *Epidemiol Psichiatr Soc* 2004; 13: 78-82.
19 Education and Health Standing Committee of the Western Australian Legislative Assembly. Attention deficit hyperactivity disorder in Western Australia. Perth: State Law Publisher, 2004.
20 Sonuga-Barke EJS, Sergeant J. The neuroscience of ADHD: multidisciplinary perspectives on a complex developmental disorder. *Dev Sci* 2005; 8: 103-104.
21 Salmon G, Kemp A. ADHD: a survey of psychiatric and paediatric practice. *Child Adolesc Ment Health* 2002; 7: 73-78.

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