Anabolic-Androgenic Steroid Use and Involvement in Violent Behavior in a Nationally Representative Sample of Young Adult Males in the United States

Kevin M. Beaver, PhD, Michael G. Vaughn, PhD, Matt DeLisi, PhD, and John Paul Wright, PhD

We examined the effects of anabolic-androgenic steroid use on serious violent behavior. Multivariate models based on data from the National Longitudinal Study of Adolescent Health (N=6823) were used to examine the association between lifetime and past-year self-reported anabolic-androgenic steroid use and involvement in violent acts. Compared with individuals who did not use steroids, young adult males who used anabolic-androgenic steroids reported greater involvement in violent behaviors after we controlled for the effects of key demographic variables, previous violent behavior, and polydrug use. (*Am J Public Health.* 2008;98:2185–2187. doi: 10.2105/AJPH.2008.137018)

Anabolic-androgenic steroids are muscle-building synthetic compounds closely related to male sex hormones and legally available only by prescription. Although attention has focused on professional athletes, evidence from national surveys indicates that adolescents and young adults also are using these substances.[1] The dramatic physical changes and resultant consequences of anabolic-androgenic steroid use are well documented; however, the behavioral and emotional effects of steroid use, although of interest,[2–6] have not been as thoroughly researched. Elevations in testosterone stemming from anabolic-androgenic steroid abuse have led researchers to examine purported links to aggressive and violent behaviors, and several studies have shown an association between anabolic-androgenic steroid use and increased aggression and violence[4,5,7–12] including homicide.[13] Some reports, however, have failed to identify links to aggressive behavior.[14–16]

We examined the empirical relation between anabolic-androgenic steroid use and involvement in different types of violent behavior (e.g., shooting or stabbing someone) in a nationally representative sample of young adult males. We hypothesized that respondents who used anabolic-androgenic steroids would self-report greater involvement in a variety of violent acts after we controlled for substance use and demographic factors.

METHODS

We analyzed data from the National Longitudinal Study of Adolescent Health (Add Health). Detailed information about the Add Health data and the sampling design is available elsewhere.[17,18] Briefly, the Add Health is a nationally representative sample of American students who were enrolled in 7th through 12th grade in 1994. Three waves of data were collected (2 in adolescence and 1 in early adulthood) on more than 20000 participants. In total, the data span nearly 7 years of human development.

We measured anabolic-androgenic steroid use in 2 ways. First, during wave 3 interviews, respondents were asked whether they had ever used anabolic-androgenic steroids during their life (0=no; 1=yes). Second, during wave 3 interviews, respondents were asked whether they had used anabolic-androgenic steroids or other performance-enhancing drugs during the previous 12 months (0=no; 1=yes). Overall, 2.6% of the males had used anabolic-androgenic steroids at least once in their life, and 2.3% had used anabolic-androgenic steroids in the previous year. The prevalence rates were much lower for females (0.9% for lifetime use and 0.4% for previous year); thus, we restricted the analyses to males only.

The dependent variable was self-reported violent behavior assessed through 8 questions asked at wave 3. This scale is similar to violence measures used previously[19] and captures involvement in acts of serious violence, such as physical fighting (α=.67). Three sets of control variables were also included. First, a 7-item wave-2 violent behavior scale (α=.74) was included to help control for underlying antisocial propensities. Second, a wave-3 polydrug-use scale was included to help isolate the effect of steroids from that of other drugs (α=.61). Third, models also were adjusted for age (measured in years) and race (0=White; 1=minority).

We examined the association between anabolic-androgenic steroid use and violent delinquency by estimating negative binomial regression equations to take into account the severe skewness of the dependent variable (skewness statistic=4.56).

TABLE 1—Effect of Lifetime Anabolic-Androgenic Steroid Use on Violent Behavior Among Young Adult Males: National Longitudinal Study of Adolescent Health, United States, 1994–2002

	Model 1 (n=6823)		Model 2 (n=5158)		Model 3 (n=6789)		Model 4 (n=5134)	
	b (SE)	z	b (SE)	z	b (SE)	z	b (SE)	z
Lifetime steroid user	1.12* (0.16)	6.96	1.19* (0.17)	6.91	0.87* (0.16)	5.58	0.98* (0.17)	5.86
Age	-0.15* (0.02)	-9.72	-0.15* (0.02)	-7.99	-0.13* (0.02)	-8.21	-0.13* (0.02)	-7.19
Race	0.20* (0.06)	3.39	0.15 (0.05)	2.30	0.36* (0.06)	6.31	0.31* (0.06)	4.79
Previous violent behavior			0.17* (0.01)	12.51			0.15* (0.01)	11.72
Polydrug use					0.35* (0.02)	14.80	0.29* (0.03)	11.15

Note. Model 1 estimated the baseline effect that steroid use has on wave-3 violence. Model 2 introduced a measure of previous violent behavior (measured at wave 2) as a statistical control. Model 3 introduced a measure of polydrug use as a statistical control. Model 4 estimated the effect of steroid use on wave-3 violence after we controlled for both previous violent behavior (measured at wave 2) and polydrug use.
* $P \leq .001$.

TABLE 2—Effect of Past-Year Anabolic-Androgenic Steroid Use on Violent Behavior Among Young Adult Males: National Longitudinal Study of Adolescent Health, United States, 1994–2002

	Model 1 (n = 6822)		Model 2 (n = 5157)		Model 3 (n = 6788)		Model 4 (n = 5133)	
	b (SE)	z	b (SE)	z	b (SE)	z	b (SE)	z
Past-year steroid user	1.25* (0.17)	7.27	1.19* (0.19)	6.31	0.93* (0.17)	5.55	0.91* (0.19)	4.90
Age	−0.15* (0.02)	−9.53	−0.15* (0.02)	−8.21	−0.13* (0.02)	−8.52	−0.14* (0.02)	−7.35
Race	0.19* (0.06)	3.27	0.14 (0.06)	2.20	0.36* (0.06)	6.21	0.30* (0.06)	4.69
Previous violent behavior			0.16* (0.01)	12.32			0.15* (0.01)	11.55
Polydrug use					0.35* (0.02)	14.55	0.29* (0.03)	11.06

Note. Model 1 estimated the baseline effect that steroid use has on wave-3 violence. Model 2 introduced a measure of previous violent behavior (measured at wave 2) as a statistical control. Model 3 introduced a measure of polydrug use as a statistical control. Model 4 estimated the effect of steroid use on wave-3 violence after we controlled for both previous violent behavior (measured at wave 2) and polydrug use.
* $P \leq .001$.

RESULTS

Table 1 provides estimates of the relation between lifetime anabolic-androgenic steroid use and violence. Model 1 shows that males who had used anabolic-androgenic steroids at least once in their life reported greater involvement in violent behavior compared with males who reported never using anabolic-androgenic steroids. This association remained even after we controlled for violence at wave 2 (model 2), polydrug use at wave 3 (model 3), and the combined effect of both measures (model 4).

Table 2 provides estimates of the relation between past-year anabolic-androgenic steroid use and violence. Males who used anabolic-androgenic steroids in the previous year scored significantly higher on the violence scale in comparison with males who had not used anabolic-androgenic steroids in the previous year, after the effects of wave-2 violence (model 2), polydrug use at wave 3 (model 3), and the combined effect of both measures (model 4) were controlled.

DISCUSSION

Our results suggest that the use of anabolic-androgenic steroids is related to heightened levels of violent behaviors. However, limitations must be considered. First, the measures of anabolic-androgenic steroid use were based on self-reports, not on direct measures as have been used by previous researchers.[8] Another limitation of our study was that the measures of violent behavior were drawn from self-reports, which necessarily raises the question of whether the reports were reliable and accurate. With these limitations in mind, the current research suggests that the media attention and public concern surrounding anabolic-androgenic steroid use may be justified given its association with violence among males in the United States. ■

About the Authors

Kevin M. Beaver is with the College of Criminology and Criminal Justice, Florida State University, Tallahassee. Michael G. Vaughn is with the School of Social Work and Departments of Public Policy and Epidemiology, Saint Louis University, St Louis, MO. Matt DeLisi is with the Department of Sociology, Iowa State University, Ames. John Paul Wright is with the Division of Criminal Justice, University of Cincinnati, Cincinnati, OH.

Requests for reprints should be sent to Kevin M. Beaver, PhD, College of Criminology and Criminal Justice, Florida State University, 634 W Call St, Tallahassee, FL 32306-1127 (e-mail: kbeaver@fsu.edu).

This brief was accepted May 1, 2008.

Contributors

K. M. Beaver conceptualized the study, analyzed the data, interpreted the findings, and wrote the brief. M. G. Vaughn and M. DeLisi helped interpret the findings and write the brief. J. P. Wright provided comments on drafts of the brief. All authors contributed to the editing of the final draft.

Acknowledgments

This research used data from National Longitudinal Study of Adolescent Health (Add Health), a program project designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris and funded by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (grant P01-HD31921), with cooperative funding from 17 other agencies. Special acknowledgment is due to Ronald R. Rindfuss and Barbara Entwisle for assistance in the original design. No direct support was received from grant P01-HD31921 for this analysis.

Human Participant Protection

The use and analysis of the data were approved by Florida State University's institutional review board.

References

1. Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE. Overall, illicit drug use by American teens continues gradual decline in 2007 [press release]. Ann Arbor: University of Michigan News Service; December 11, 2007.
2. Bahrke MS. Psychological and behavioral effects of anabolic-androgenic steroids. *Int J Sp Exerc Psychol.* 2005;4:428–445.
3. Pagonis TA, Angelopoulos NV, Koukoulis GN, Hadjichristodoulou CS. Psychiatric side effects induced by supraphysiological doses of combinations of anabolic steroids correlate to the severity of abuse. *Eur Psychiatry.* 2006;21:551–562.
4. Skarberg K, Engstrom I. Troubled social background of male anabolic-androgenic steroid abusers in treatment. *Subst Abuse Treat Prev Policy.* 2007;2:20.
5. Trenton AJ, Currier GW. Behavioural manifestations of anabolic steroid use. *CNS Drugs.* 2005;19:571–595.
6. Wood RI. Anabolic-androgenic steroid dependence? Insights from animals and humans. *Front Neuroendocrinol.* Published online January 3, 2008. doi:10.1016/j.yfrne.2007.12.002.
7. Conacher GN, Workman DG. Violent crime possibly associated with anabolic steroid use. *Am J Psychiatry.* 1989;146:679.
8. Klötz F, Garle M, Granath F, Thiblin I. Criminality among individuals testing positive for the presence of anabolic androgenic steroids. *Arch Gen Psychiatry.* 2006;63:1274–1279.
9. Pope HG, Katz DL. Affective and psychotic symptoms associated with anabolic steroid use. *Am J Psychiatry.* 1988;145:487–490.
10. Schulte HM, Hall MJ, Boyer M. Domestic violence associated with anabolic steroid abuse. *Am J Psychiatry.* 1993;150:348.
11. Thiblin I, Kristiansson M, Rajs J. Anabolic androgenic steroids and behavioral patterns among violent offenders. *J Forensic Psychiatry.* 1997;8:299–310.
12. Thiblin I, Parlklo T. Anabolic androgenic steroids and violence. *Acta Psychiatr Scand.* 2002;412:125–128.
13. Pope HG, Katz DL. Homicide and near-homicide by anabolic steroid users. *J Clin Psychiatry.* 1990;51:28–31.
14. Bahsin S, Storer TW, Berman N, et al. The effects of supraphysiologic doses of testosterone on muscle size and strength in normal men. *N Engl J Med.* 1996;335:1–7.
15. Yates WR, Perry PJ, MacIndoe J, et al. Psychosexual effects of three doses of testosterone cycling in normal men: a controlled personality study. *Biol Psychiatry.* 1999;45:254–260.
16. Pope HG, Kouri EM, Hudson JI. Effects of supraphysiologic doses of testosterone on mood and aggression in normal men: a randomized controlled trial. *Arch Gen Psychiatry.* 2000;57:133–140.

17. Harris KM, Florey F, Tabor J, et al. The National Longitudinal Study of Adolescent Health: study design. Available at: http://www.cpc.unc.edu/projects/addhealth/design. Accessed March 1, 2007.

18. Resnick MD, Bearman PS, Blum RW, et al. Protecting adolescents from harm: findings from the National Longitudinal Study of Adolescent Health. *JAMA.* 1997;278:823–832.

19. Guo G, Roettger ME, Shih JC. Contributions of the DAT1 and DRD2 genes to serious and violent delinquency among adolescents and young adults. *Hum Genet.* 2007;121:125–136.

Examining the Lag Time Between State-Level Income Inequality and Individual Disabilities: A Multilevel Analysis

Tahany M. Gadalla, PhD, MMath, and Esme Fuller-Thomson, PhD, MSW

State-level income inequality has been found to have an effect on individual health outcomes, even when controlled for important individual-level variables such as income, education, age, and gender. The effect of income inequality on health may not be immediate and may, in fact, have a substantial lag time between exposure to inequality and eventual health outcome. We used the 2006 American Community Survey to examine the association of state-level income inequality and 2 types of physical disabilities. We used 6 different lag times, ranging between 0 and 25 years, on the total sample and on those who resided in their state of birth. Income inequality in 1986 had the strongest correlation with 2006 disability levels. Odds ratios were consistently 10% higher for those born in the same state compared withthe total population. (*Am J Public Health.* 2008;98:2187–2190. doi:10.2105/AJPH.2008.134940)

In the United States, studies using multilevel statistical techniques have found a relation between state-level income inequality and individual health outcomes, including self-reported health[1,2] and limitations in activities of daily living (ADLs).[3] This relation remained even when important individual-level variables such as income, education, age, and gender, were controlled for in the analysis.

The majority of studies on the income inequality–health relation have used current measures of both inequality and health. The 3 proposed mechanisms through which income inequality could affect individual health are as follows: systematic underinvestment in a wide range of health and social infrastructure,[4,5] unfavorable social comparison,[6,7] and lower levels of social cohesion and social capital.[8] Each of these potential mechanisms suggests the effect of income inequality on health would not be immediate and may, in fact, have a substantial lag time between exposure to inequality and eventual health outcome.

A few multilevel studies that have examined the "lag effect" of income inequality on individual health outcomes[9–11] have suggested that self-reported health was more strongly associated with income inequality from 15 years previous than from shorter or longer time lags. There is a clear need for additional use of multilevel modeling to explore individual health outcomes other than self-reported health and to consider outcomes at time periods other than the late 1990s[10,12] and different sources of data. Furthermore, all of these studies were limited by potential misclassification of exposure because they did not control for movements between states during the lag time period.[9] Finally, these studies were based on the Current Population Survey,[13] which does not include individuals in nursing homes and other institutions, who represent a significant portion of the seriously ill in this country.

To address these concerns, we used multilevel analysis techniques to examine the association of state-level income inequality and 2 types of disabilities measured in 2006 using 6 different lag times ranging between 0 and 25 years. Disability is an excellent predictor of medical and social service need, and it greatly influences quality of life and productivity.[14]

METHODS

Data

The 2006 American Community Survey (ACS) was a representative nationwide survey of more than 3 million people from households and group quarters, including nursing homes.[13] It had a response rate of 97.5%.[15] The sample of ACS respondents we used included 1 973 766 people 25 years or older, 1 021 095 of whom currently lived in their state of birth.

Measures

Individual-level variables. Two disability indicators were used[1]: limitations in activities of daily living (ADLs; i.e., having had a physical, mental, or emotional condition lasting 6 months or more that made it difficult to "dress, bathe, or get around inside the home")[2] and functional limitations (i.e., having had a condition that substantially limits 1 or more basic physical activities such as walking, climbing stairs, reaching, lifting, or carrying).

There are conceptual differences between these 2 disability measures. Functional limitations are less likely to be improved through environmental modifications than are ADL limitations and are therefore less vulnerable to variations in household income.[16] For example, acquiring an environmental modification such as an elevator in one's home may result in a change in ADL limitations (e.g., difficulty getting around inside the home) but would not substantially alter the response to the ability to climb stairs, which is 1 of the functional limitations.

Demographic variables included gender, age, education, race/ethnicity, and marital status. The poverty index expresses total family income as a percentage of the federal poverty threshold for a household of the same size and composition. These poverty thresholds are determined and published by the US government.[17] The poverty index was divided into 6 categories.

State level variables. State income inequality was measured using the Gini coefficient for each state.[10] This coefficient ranges from 0 to 1, with 0 indicating complete equality of income distribution (e.g., everyone has the same income) and 1 indicating complete inequality (e.g., 1 person has all the income in the region).[18] In