



Adolescent substance use, sleep, and academic achievement: Evidence of harm due to caffeine

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A B S T R A C T

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Using academic achievement as the key outcome variable, 7377 Icelandic adolescents were surveyed for cigarette smoking, alcohol use, daytime sleepiness, caffeine use, and potential confounders. Structural equation modeling (SEM) was used to examine direct and indirect effects of measured and latent variables in two models: the first with caffeine excluded and the second with caffeine included. A substantial proportion of variance in academic achievement, which might otherwise have been attributed to the harmful effects of cigarette smoking and alcohol use, was found to be attributable to caffeine. Evidence was obtained that daytime sleepiness, which was found to be independently associated with usage of licit substances (nicotine and alcohol) and caffeine, may be an important mediator of the negative impact of those substances on academic achievement. Findings suggest the importance of including measurements of caffeine consumption in future studies of adolescent substance use.

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It is well-accepted that adolescent substance use can have substantial negative effects on short- and long-term development and adjustment (e.g., Blum & Nelson-Mmari, 2004; Patel, Flisher, Hetrick, & McGorry, 2007). One early sign of potential harm is compromised academic achievement, which may be both a consequence of (e.g., Ellickson, Tucker, & Klein, 2001) and contributor to (e.g., Bryant, Schulenberg, O'Malley, Bachman, & Johnston, 2003) increased substance use. As a consequence of substance use, poor academic achievement appears not only to be a frequent immediate negative effect in its own right but also a stable predictor of other negative outcomes including poorer physical and mental health during adolescence and in adulthood (e.g., Mirowsky & Ross, 2003; Sigfúsdóttir, Kristjánsson, & Allegrante, 2007). Of the range of licit and illicit substances used by adolescents, nicotine and alcohol have long been of particular concern (Bergen, Martin, Roeger, & Allison, 2005; Jeynes, 2002; Piko & Kovács, 2010).

Although interest in nicotine and alcohol is well justified, particularly considering their widespread use by adolescents, prevalence of use for both is greatly exceeded by the consumption of caffeine. Population surveys indicate that approximately 13% of American adolescents are likely to have smoked and 17% to have consumed alcohol in the *past month* (Substance Abuse and Mental Health Services Administration, 2002), whereas 75% of adolescents consume one or more caffeine beverages on a *typical day* (National Sleep Foundation, 2006). Although the ubiquity of caffeine possibly encourages beliefs that it is benign, its use cannot be assumed to be free of harm (e.g., James, 1997). When considering potential for harm, it is important to acknowledge that the range of available caffeine products has expanded greatly beyond the traditional beverages of coffee and tea. The main new additions include caffeine-containing “energy drinks” and a diversified variety of soft drinks to which

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caffeine is added. Product expansion has been accompanied by increased advertising designed to appeal to young consumers. It is not surprising, therefore, that there have been expressions of concern regarding the possible health implications of caffeine for young people and that such concerns have been accompanied by calls for increased research (e.g., Reissig, Strain, & Griffiths, 2009; Savoca et al., 2005; Temple, 2009).

Use of substances other than caffeine during adolescence has been associated with a wide array of behavioural and sociocultural outcomes and processes, with sleep emerging as a possible important mediator of behavioural sequelae (e.g., Mathers, Toumbourou, Catalano, Williams, & Patton, 2006; Pasch, Laska, Lytle, & Moe, 2010). Changed sleep patterns and architecture often occur in conjunction with active substance use. Additionally, substance use and changed sleep patterns, independently and combined, may negatively affect academic performance (e.g., Gromov & Gromov, 2009). Certainly, many adolescents receive less sleep than is thought desirable. For example, the United States National Sleep Foundation (2006) has estimated that as many as 80% of adolescents receive less than an optimal amount of sleep.

Sleep processes have particular salience in the context of regular caffeine use. At dietary doses, caffeine has the potential to increase latency to sleep (Landolt, 2008), and it has been reported that many adolescents actively employ caffeine to forestall sleep during nighttime leisure activities, including use of electronic devices such as videos and computer games (Calamaro, Mason, & Ratcliffe, 2009). In addition, sleepiness is a confirmed effect of caffeine withdrawal even after periods of abstinence as brief as several hours (e.g., Juliano & Griffiths, 2004). Because children and adolescents tend to have less regular patterns of caffeine consumption than adults (James, 1991), they may be at increased risk of experiencing withdrawal-induced daytime sleepiness (Heatherley, Hancock, & Rogers, 2006; Pollak & Bright, 2003).

To our knowledge, this is the first population study of adolescent substance use to also have examined caffeine use in relation to key outcomes, including daytime sleepiness and academic achievement. There are, however, previous reports of high prevalence of caffeine use among adolescents, and extensive evidence of adverse withdrawal effects in adult consumers (Juliano & Griffiths, 2004). Accordingly, the broad aim of the present study was to compare associations between nicotine, alcohol use, daytime sleepiness, and academic achievement with and without consideration of concurrent use of caffeine. We hypothesized that frequency of caffeine consumption in our sample of adolescents would substantially exceed use of nicotine and alcohol. In addition, we hypothesized that after controlling for potential confounders caffeine consumption would be (a) positively correlated with measures of daytime sleepiness and (b) inversely correlated with academic achievement.

Methods

Sample

The present study utilized population-wide cross-sectional data from the latest in the series *Youth in Iceland* surveys which monitor trends in a wide range of demographic and health-related variables (Sigfusdottir, Thorlindsson, Kristjansson, Roe, & Allegante, 2009). Conducted by the Icelandic Centre for Social Research and Analysis (ICSRA) in collaboration with the Icelandic Ministry of Education, Science, and Culture, the survey reported here took place during February 2009 among 9th and 10th graders in all secondary schools in the country. All aspects of data collection, including participant involvement based on passive parental consent, were in compliance with Iceland law on the protection of human subjects and approved by the Icelandic Data Protection Authority.

Under ICSRA oversight, teachers at each school supervised questionnaire completion onsite. All students who attended school on the day that the survey was scheduled completed the questionnaires within their regular classrooms. No identifying information was obtained. The response rate was 83.5% of the total national population in the relevant age groups, and yielded 7377 questionnaires (50.8% girls) available for analysis.

Measures

An estimated 90% of the approximately 320,000 inhabitants of Iceland are of Norse-Celtic decent, with 80% of the population belonging to the Lutheran State Church and no other religious institution having more than 3.0% of the population registered in its services (Statistics Iceland, 2009). Because of this homogeneity, exogenous variables such as race and religion, which are often used in research in other countries, were not included in the present analysis.

Academic achievement

Respondents were asked to report their average grades in the four core academic subjects of Icelandic, Mathematics, English, and Danish/Norwegian/Swedish (whichever one of these three languages was part of the individual respondent's syllabus), required of all students in the 9th and 10th grades in Iceland. The grade range in Iceland in these subjects is 0–10, with a score of less than 5 indicating a fail grade. Response options were 1 = "under 4", 2 = "about 4", 3 = "about 5", 4 = "about 6", 5 = "about 7", 6 = "about 8", 7 = "about 9", and 8 = "about 10".

Licit substance use

Respondents were asked to report how often in their lifetime they had smoked cigarettes or had a drink of alcohol of any kind. Response options were 1 = "never", 2 = "once or twice", 3 = "3–5 times", 4 = "6–9 times", 5 = "10–19 times", 6 = "20–39

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