Adolescent caffeine use: associations with other substance use and depression in an Australian rural population

Georgina Black1, Rachel M Roberts2, Rhys Scott1, Emily Hunt2
1Psychological Services, Families SA Statewide Services, Department for Education and Child Development, SA, 2School of Psychology, University of Adelaide, SA

Abstract

Introduction and aims: Research suggests that caffeine use is increasing in the adolescent population and that it may have adverse effects for their health and well-being; however, there is little evidence to support these findings in Australian, non-metropolitan samples. This study aims to describe frequency of caffeine use in an Australian rural adolescent sample, and its relationship to depression and other substance use.

Design and methods: Participants were 531 high school students from rural South Australia, who completed the 6-Item Kutcher Adolescent Depression Scale (KADS-6) and measures of frequency of caffeinated beverage consumption and other substance use.

Results: Caffeine use was frequent for the sample, and was shown to increase across adolescence. Associations were found with use of alcohol, tobacco and illicit substances. A significant relationship was found between frequency of caffeine use and depression, and specifically with experiences of low mood, anxiety and low energy. Hierarchical regression analyses revealed low energy to be the strongest predictor of caffeine use, when controlling for age.

Discussion and conclusions: This study supported findings that Australian rural adolescents frequently use caffeine and that caffeine use may be associated with adverse mental health outcomes including depression, and alcohol and substance use.

Introduction

Caffeine is the only legal psychoactive drug available to Australian adolescents. Despite known associations with risk taking behaviour, other substance use, and mood alterations, there has been limited research regarding caffeine use in Australian or rural adolescent populations. Caffeine use may be linked to adverse physiological [1-4], behavioural [5, 6] and psychological [3, 7-12] outcomes for adolescents, with US studies finding caffeine to be associated with the use of other substances [5, 13, 14] and depression in adolescents [12, 15]. Caffeine use in US children and adolescents is rising dramatically [16] and young people may be consuming more caffeine than adults on a mg/kg basis [11]. There has also been an increase in caffeinated products that are specifically marketed to adolescents, in particular soft drinks and energy drinks [16-18]. Australian researchers have found an increasing annual trend in rates of caffeine toxicity from energy drink consumption as measured by calls to a poisons information centre [19]. The increase in popularity of energy drinks may explain increases in caffeine use with age for American samples, with younger children reporting lower levels of caffeinated beverage consumption than teenagers [16, 18]. Research also indicates that there may be gender differences in rates of use, with boys consuming more caffeinated beverages than girls [20].

High caffeine use has been related to both sleep disruption and daytime sleepiness for adolescents [1, 12]. Adequate sleep is considered essential for mental health, with sleep deprivation leading to deterioration in cognition, memory and mood [21]. Temple (2009) suggests that caffeine could play a role in disrupting optimal growth and development through associations with sleep disruption and nutritional problems [3]. Caffeine has positive effects, such as enhanced well-being, concentration and energy levels, and negative effects such as anxiety, tension and jitteriness [8]. In some cases, the negative effects of caffeine may indicate a form of substance dependence, in line with DSM criteria [3, 10]. Research indicates that adolescents experience tolerance to caffeine, withdrawal symptoms (e.g. fatigue, drowsiness) and cravings, indicating physical dependence [7, 9, 11]. The behavioural effects that have
been investigated in correlational studies include impulsivity, sensation-seeking and risk-taking behaviours [5, 6].

It has been suggested that caffeine consumption could lead to preferences for and vulnerabilities to other substance use in adulthood [3]. In US adolescents, caffeine consumption has been found to be associated with cigarette use [5, 14]. Swanson et al. suggest that the connection may be due to the joint effect of a third variable, alcohol [22]. American teenagers have been shown to regularly pair energy drinks with alcohol, potentially increasing their overall intake of alcohol and the likelihood of adverse events and risk behaviours [23, 24]. Gunja and Brown found that in Australia, alcohol was the predominant substance being paired with energy drinks in cases of caffeine toxicity [19]. The relationships between caffeine and other substances may be explained by cross-sensitisation, the process by which one drug enhances the response to other drugs acting at the same neurobiological site [25]. Alternatively, the relationship between caffeine use and alcohol consumption may be explained by research which suggests caffeine use inhibits the ability to perceive sensory cues indicative of alcohol intoxication [26], and the popularity and availability of caffeinated beverages mixed with alcohol. The negative effects of caffeine use discussed above may be compounded by the adverse effects of other substances, such as alcohol and tobacco, multiplying the threat to adolescent health and well-being.

Luebbe and Bell suggest that caffeine use may be linked to negative affective experiences in adolescents, and in particular symptoms of depression [11]. They propose that symptoms of depression may be either causes or consequences of caffeine use: young people may experience anxiety and withdrawal as a result of caffeine use, or may use caffeine to relieve the apathy and lethargy related to depression [11]. Although relationships between caffeine use and depression are understudied, current research suggests that administration of caffeine could increase symptoms of depression and anxiety in healthy adult populations [6], and adolescents diagnosed with Major Depressive Disorder report higher levels of caffeine use [15]. Further, Whalen et al. found that for adolescents diagnosed with Major Depressive Disorder, higher reported caffeine use was related to higher self-reported depressive symptoms [12].

The majority of the research discussed above was conducted with metropolitan samples in the United States. There may be significant differences in caffeine use in Australia, due to the prohibition of caffeinated beverages in public school canteens, or differences in health literacy. In addition, research indicates that Australian adolescents living in rural areas engage in higher levels of substance use than their metropolitan counterparts [27]. Therefore, there may be a significant difference between caffeine use in the previously studied populations and Australian, rural adolescents. This study is a component of the Adolescent Mental Health, Behaviour and Life Experiences Survey, which explored multiple factors associated with adolescent mental health in an Australian rural population. The survey was conducted to inform subsequent detailed research regarding factors found to be related to adolescent health and well being. This study aims to describe frequency of caffeine use in this population. We expected to find associations between specific depressive symptoms (Low Mood, Anxiety, Low Energy) and frequency of caffeine use, and between overall depression scores and frequency of caffeine use. We also predicted associations between frequency of caffeine use and the consumption of alcohol and tobacco. In addition, we predicted differences in frequency of caffeine use and depression in relation to age and gender, with more frequent caffeine consumption in boys and older adolescents. Finally, the study aimed to determine which variables are most predictive of caffeine use for Australian rural adolescents. We predicted unique contributions to the prediction of frequency of caffeine use from age, gender, overall depression, depression symptoms, and tobacco and alcohol use.

**Method**

**Measures**

This study is a component of the Adolescent Mental Health, Behaviour and Life Experiences Survey. As part of the survey, participants completed the Kutcher Adolescent Depression Scale (KADS-6) [28], an
Australian modification of the Alcohol Use Disorders Identification Test (AUDIT) [29], and a series of questions addressing the frequency of use of substances including caffeine.

The KADS-6 is designed to assess symptoms consistent with DSM-IV diagnoses of Major Depressive Disorder. The scale consists of 6 items (see Table 3) in which respondents indicate the frequency of symptoms using a four point scale ranging from 0 (hardly ever), to 1 (much of the time), to 2 (most of the time) to 3 (all of the time).

The AusAUDIT is a 10-item measure of harmful consumption of alcohol with total scores from 0 to 40 with cut-offs for drinking above NH&MRC limits of 6 for females and 7 for males [29]. The questionnaire also included a series of items relating to the frequency of use of the following substances: caffeine, tobacco, marijuana, hallucinogens, amphetamines, cocaine, ecstasy, opiates, steroids, and non-medical use of prescription drugs. Participants recorded how often they generally used each substance on a 6-point scale: 1 (never), 2 (once), 3 (monthly or less), 4 (2 to 4 times a month), 5 (2 to 3 times a week), and 6 (4 or more times a week). Use of caffeine was defined as consumption of caffeinated beverages, incorporating coffee, soft drinks and energy drinks into a single questionnaire item.

**Procedure**

Ethics approval was obtained from the University of Adelaide and the South Australian Department for Education and Child Development Ethics Committees. Public schools in South Australia located outside of metropolitan Adelaide were sent information about the study, which forms part of the Adolescent Mental Health, Behaviour and Life Experiences Survey. Seventy-two schools were contacted and of those twenty-three schools participated. Schools were sent a list of contacts for mental health services to distribute to participating students.

**Participants**

Year 9 to 12 students from participating schools (n = 3008) were invited to complete the questionnaire. Participation rates were low and only 531 students participated (18%). Of those who participated, 55.7% were female, 98.5% were born in Australia, and 4.3% identified as Aboriginal or Torres Strait Islander. Ages ranged from 13 to 18 with a mean age of 15.08, SD = 1.21.

**Results**

**Caffeine use**

The sample recorded an average frequency of caffeine use between several times a week and several times a month (M = 4.6, SD = 1.4). As can be seen in Table 1, only a small number of participants reported having caffeinated drinks once or never. Caffeine use was frequent for a large portion of the population, with 59.6% of participants reporting that they drank caffeinated beverages 2 or more times per week. Mean frequency of caffeine consumption was the same for females and males (M = 4.9, SD = 0.1). A weak, positive correlation was found between age and frequency of caffeine use (rho = .10, p = .03), indicating that caffeine consumption may increase with age.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>32</td>
</tr>
<tr>
<td>Once</td>
<td>13</td>
</tr>
<tr>
<td>Monthly or less</td>
<td>68</td>
</tr>
<tr>
<td>2 to 4 times a month</td>
<td>94</td>
</tr>
<tr>
<td>2 to 3 times a week</td>
<td>138</td>
</tr>
<tr>
<td>4 or more times a week</td>
<td>168</td>
</tr>
</tbody>
</table>

Table 1  Caffeinated beverage consumption for a sample of 513 rural adolescents
Use of alcohol was low in this sample ($M = 0.8$, $SD = 0.9$), as was frequency of other drug use (Table 2). Caffeinated beverage consumption frequency was significantly and positively correlated with use of alcohol ($\rho = .33$, $p < .001$), tobacco ($\rho = .32$, $p < .001$) and marijuana ($\rho = .26$, $p < .001$). As expected, consumption of alcohol was also significantly correlated with use of tobacco ($\rho = .41$, $p < .001$) and marijuana ($\rho = .43$, $p < .001$). Weak, positive relationships were also found between frequency of caffeine use and the use of ecstasy ($\rho = .12$, $p = .01$), hallucinogens ($\rho = .10$, $p = .03$), amphetamines ($\rho = .11$, $p = .01$) and non-medical use of prescription drugs ($\rho = .09$, $p = .04$).

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Descriptive statistics for use of caffeine, tobacco, marijuana, hallucinogens, amphetamines, cocaine, ecstasy, opiates, steroids, and non-medical use of prescription drugs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ($SD$)</td>
</tr>
<tr>
<td>Caffeine</td>
<td>4.6 (1.4)</td>
</tr>
<tr>
<td>Tobacco</td>
<td>1.6 (1.2)</td>
</tr>
<tr>
<td>Marijuana</td>
<td>1.3 (0.8)</td>
</tr>
<tr>
<td>Hallucinogens</td>
<td>1.0 (0.1)</td>
</tr>
<tr>
<td>Amphetamines</td>
<td>1.0 (0.2)</td>
</tr>
<tr>
<td>Cocaine</td>
<td>1.0 (0)</td>
</tr>
<tr>
<td>Ecstasy</td>
<td>1.0 (0.3)</td>
</tr>
<tr>
<td>Opiates</td>
<td>1.0 (0.1)</td>
</tr>
<tr>
<td>Steroids</td>
<td>1.0 (0.2)</td>
</tr>
<tr>
<td>Non-medical use of prescription drugs</td>
<td>1.2 (0.6)</td>
</tr>
</tbody>
</table>

Depression

Many participants (18.2%) screened positive for depression on the KADS ($M = 3.1$, $SD = 3.3$). Incidence of depressed mood was even higher with 28.7% of participants responding that they experienced low mood, sadness or depression much of the time, 11.6% most of the time, and 1.1% all of the time. Incidence of anxiety was also high with 28.2% of participants responding that they experienced anxiety much of the time, 9.9% most of the time, and 1.7% all of the time. In addition, participants reported concerns about energy levels, with 31.5% experiencing low energy much of the time, 18.4% most of the time and 6.8% all of the time. Mean KADS scores for females ($M = 3.6$, $SD = 0.2$) were higher than mean KADS scores for males ($M = 2.3$, $SD = 0.2$). A Mann-Whitney $U$ test indicated that this difference was statistically significant (males $Md = 2.0$, $n = 229$) (females $Md = 2.0$, $n = 291$), $U = 26214.50$, $z = -4.23$, $p < .001$, $r = -.19$. The KADS total score had a positive correlation with age ($\rho = .11$, $p = .01$).

Caffeine use and depression

Mean frequency of caffeine consumption for those who screened positive for depression ($M = 4.9$, $SD = 0.1$) was higher than mean caffeine consumption for those who did not ($M = 4.5$, $SD = 0.1$). A Mann-Whitney $U$ test revealed a significant difference in levels of caffeine consumption for participants who screened positive for depression ($Md = 5.0$, $n = 89$) and those who did not ($Md = 5.0$, $n = 417$), $U = 15224.50$, $z = -2.75$, $p = .01$, $r = -.12$. A significant relationship was found, with KADS Total Score being weakly, positively associated with consumption of caffeinated beverages ($\rho = .16$, $p < .001$). Correlations were found between frequency of caffeine use and specific depression symptoms from the KADS (see Table 3).
Table 3  Spearman’s rho correlations for caffeine use, KADS total score and KADS items: low mood (1), worthlessness (2), low Energy (3), lack of pleasure (4), anxiety (5), suicide (6)

<table>
<thead>
<tr>
<th>Caffeine</th>
<th>KADS total</th>
<th>KADS items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.16**</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. Low mood, sadness, feeling blah or down, depressed, just can’t be bothered .12**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Feelings of worthlessness, hopelessness, letting people down, not being a good person .08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Feeling tired, feeling fatigued, low in energy, hard to get motivated, have to push to get things done, want to rest or lie down a lot .16**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Feeling that life is not very much fun, not feeling good when usually would feel good, not getting as much pleasure from fun things as usual .07</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Feeling worried, nervous, panicky, tense, keyed up, anxious .10*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Thoughts, plans, or actions about suicide or self-harm .13**</td>
</tr>
</tbody>
</table>

Note. * p < .05 and ** p < .01

Predictors of caffeine use
A multiple regression analysis was used to compare KADS Total scores, age and use of tobacco and alcohol as predictors of frequency of caffeine use. Preliminary analyses were conducted to ensure there was no substantial violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity. The model explained a significant proportion of variance in caffeine use, (Adjusted $R^2 = .11$, $F(4,427) = 14.32$, $p < .001$). This indicates that when they are combined these variables can account for 11% of the variance in frequency of caffeine use. Tobacco use contributed most to the model, ($\beta = .21$, $t = 3.83$, $p < .001$), followed by alcohol use ($\beta = .18$, $t = 3.20$, $p < .01$). Age and KADS Total scores did not make statistically significant unique contributions to the prediction of caffeine use.

A second regression analysis was conducted to assess the strength of specific depression symptoms as predictors of frequency of caffeine use. Hierarchical multiple regression was used to assess the ability of depression variables (Low Mood, Low Energy, Anxiety, Suicide) that were significantly correlated with caffeine use to predict caffeine use, after controlling for the influence of age. Age was controlled for due to its significant correlations with both frequency of caffeine use and depression. Preliminary analyses were also conducted to ensure no violation of the assumptions for this regression model. Age was entered at Step 1, explaining only 0.5% of variance in caffeine use. After entry of the depression variables at Step 2, the total variance explained by the model as a whole was 3.1%, $F(5,501) = 3.20$, $p < .01$. The depression variables explained an additional 2.6% of the variance in frequency of caffeine use, after controlling for age, $R^2$ change = .026, $F$ change(4,501) = 3.31, $p = .01$. In the final model, only Low Energy made a statistically significant unique contribution to the frequency of caffeine use ($\beta = .10$, $t = 2.02$, $p = .04$). All other depression variables recorded non-significant $\beta$ values.

Discussion
This study aimed to describe frequency of caffeine use in a sample of Australian rural adolescents, and guide further detailed research regarding the impact of caffeine use of the health and wellbeing of this population. A significant limitation of the current study is that the measure of caffeine use prevented respondents from reporting an upper limit to their consumption. Despite this, results indicated that caffeine use was frequent, with 26.9% of participants reporting that they drank caffeinated beverages 2 or 3 times a week and 32.7% 4 or more times a week. This study did not support higher frequency of caffeine use by adolescent males as compared to their female counterparts, however this result should be interpreted with caution given the limitation of the measure used. There was some evidence for a modest increase in frequency of caffeine consumption with age. Further research could seek to clarify the relationship between caffeine use, age and factors such as the marketing of energy drinks toward
teenagers [16, 18], increased autonomy, and increased academic pressure in the later years of schooling [17, 30], which may lead to higher caffeine use.

Tobacco and alcohol were the most frequently used substance following caffeine. Higher use of these substances may be explained by their greater social acceptance and broader availability to adolescents. The use of illicit substances was low for this population with most participants indicating that they had never tried the majority of other substances. This may be due to lower availability in rural areas or to differing social expectations for rural teenagers. However, the low level of reporting may also be due to social desirability, as the questionnaires relied on self-report data and were administered by teachers. Future research may benefit from recruiting adolescent participants through avenues other than schools, and exploring factors that may promote or inhibit substance use.

Frequency of caffeine use was found to be positively related to regular consumption of alcohol. This result supports further research regarding the nature of the relationship between caffeine use and alcohol consumption, such as the pairing of alcohol with caffeinated beverages. Frequency of caffeine use was also associated with tobacco use, indicating a need for further research, which may also seek to explore whether a pattern of use exists that incorporates caffeine, tobacco, and alcohol given the association between alcohol and tobacco use in this study. It is important to note that weak associations were found between the consumption of caffeinated beverages and marijuana, hallucinogens, amphetamines and non-medical use of prescription drugs, despite the low levels of reporting for these substances.

The results supported the prediction that depression would be associated with greater caffeine use, with frequency of caffeine consumption higher for those who screened positive for depression and related to higher scores on the KADS. In regards to specific symptoms of depression measured by the KADS, frequency of caffeine use was significantly related to low mood and anxiety, in support of previous evidence that links caffeine with negative affective experiences. However, it should be noted that the relationship between caffeine use and these symptoms may be entirely independent of depression and require further exploration. For example, these results indicate that more frequent caffeine use is related to feelings of low energy, contrary to previous research [8]. This could be explained by the link between high caffeine use and daytime sleepiness [1, 12]. Alternatively, future research could investigate sleep as a moderating factor between caffeine use and low energy related to depression.

Finally, the study aimed to investigate which variables are most predictive of caffeine use for Australian, rural adolescents. When considering other substance use, tobacco was the strongest predictor of caffeine use, followed by alcohol use. When assessing the strength of specific symptoms of depression as predictors of caffeine use, only low energy made a statistically significant unique contribution. This confirms the importance of adolescent energy levels in either motivating caffeine use or as a consequence of higher consumption. However, the cross-sectional nature of this research does not allow for analysis of causal pathways, and further research is needed to determine how energy levels are connected to caffeine use for this population.

This study provides evidence for high frequency of caffeine use and a relationship between frequency of caffeine use and symptoms of depression, as well as other substance use, in an Australian rural adolescent population. However, the representativeness of the current sample is uncertain given the low response rate and absence of information regarding characteristics of non-participants. Future work that undertakes a more detailed investigation of the positive and negative effects of caffeine use for adolescents could also reveal some of the motivating factors behind the high rates of caffeinated beverage consumption in this population. This research supports current concerns about adolescent caffeine use, and its consequences for the health and well-being of Australian adolescents.
Acknowledgments
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References


