Caffeine Use in Children and Adolescents: Impact on Sleep and Alertness

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NIH Workshop: The Use and Biology of Energy Drinks: Current Knowledge and Critical Gaps
Objectives

- Describe “drivers” of caffeine/energy drink use in children
  - How caffeine is perceived
  - Sources of information about caffeine
- Summarize caffeine and performance effects in children
- Summarize caffeine and sleep effects
  - Association with other sleep health behaviors
- Identify knowledge gaps, future research directions

No disclosures
Expectancies in Caffeine Use

- Perceived “energy boost”; cost concerns 11-18yo (Aus)\(^1\)
- Increased use in depressed adolescents suggest expectancy to regulate mood, alleviate depression, reduce anxiety\(^2\)
- Reversal of effects of sleep disturbance

\(^1\) O’Dea 2003; \(^2\) Whalen 2008
Caffeine Expectancies

Self-report caffeine use HS students (n=196)

- 68/86% 48/24hr use (6.1% ED)
- Gender: ED consumption M>F; appetite suppression F>M
- Expectancies for withdrawal/dependence, sleep disturbance, energy but overall expected impact low
- Mixed use (coffee/soda) vs low caff/high soda clusters
  - Earlier TOD consumption, ↑ consumption ED
  - Higher expectancies for energy/performance/mood enhancement; appetite suppression
  - Reasons: “Getting through the day”; fun/experimentation
  - Increased daytime sleepiness

Ludden & Wolfson 2010
Caffeine Expectancies

- **Energy drink consumption in female secondary students (SA)**
  - 52% users; popularity attributed to advertising by 35.0%
  - Reasons for use:
    - "Vitality" (25.6%); “to be alert” (20.8%)
    - Current energy drink use correlated with consumption by a family member or close friend
    - Active ingredients not known by 69.6%

- **Protective effect awareness of effects 6th-8th graders** (n=913) (It): 60.4% vs 6.4% low vs high consumers endorse ED “bad for your health”

1 Aluqmany et al 2011; 2 Gallimberti 2013
Caffeine Expectancies

- Qualitative study of 16-21yo vs 22-35yo regarding factors driving purchase intent ED
  - Highest levels consumption
  - Ads: emphasis packaging/image; little awareness age-specific marketing
  - Brand loyalty, familiarity
  - Association use with social function; image>efficacy
  - Energy seeking (kick/hit)=highest caffeine content
  - Less concern safety (assumed) despite awareness potential health effects
  - Concern sugar content
  - Taste (> physiologic impact, social function)

Bunting 2013
ABA: Voluntary restriction of marketing/sales to <12yo
“Drinks” (8-32oz) single-serving nonresealable vs “shots” (2-2.5oz)
Portion size; 2/3 standard size can encourages rapid, multiple consumption
Consumer confusion with “sports drinks” for rehydration
Advertise “performance enhancement”
Youth-targeted advertising> adults: MTV, Comedy Central, Adult Swim; social media, sponsorship extreme sports
- Children<12yo saw 62 energy beverage ads=“children drinks” (2010)
Targeting younger groups
- Advocare “Spark” (marketed for adults/teens): 120mg caffeine
- “KickStart Spark” (marketed for 4 year olds and up): 60mg caffeine/8oz
<table>
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<th>Product</th>
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<td>Jolt</td>
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*Label lists side effects, age limit, “not substitute for sleep”

*FDA limits caffeine content sodas to 71 mg/12 oz*
Explore the world of Red Bull

- Motorsports
- Bike
- Surfing
- Skateboarding
- Snowboarding
Energy Drinks: Performance Effects

- Reported improved work and exercise endurance, mental performance, alertness
- 3 studies young adults, Red Bull vs H₂O, placebo¹:
  - Decrease reaction time, increase subjective alertness and aerobic endurance, improvement memory, concentration, anaerobic endurance; inconsistent increase HR
- Study placebo vs caffeine/taurine combination in college students²: no effect memory; ↓ HR, ↑ BP

¹Alford et al, 2001  ²Bichler et al, 2006
Caffeine: Performance Effects

- Does caffeine improve cognitive performance?
  - Lab studies in adults show improvement attention, psychomotor skills (ie, reaction time)
  - Mixed effects short/long-term memory, complex cognitive functions

- Does caffeine improve or just restore performance after impairment secondary to sleepiness?
  - High rate basal sleepiness in “normal” study participants
  - Rebound sleepiness following acute discontinuation
  - Withdrawal associated with caffeine dependence
Caffeine: Performance Effects

- Role of improved sleep off caffeine?
- Homeostatic sleep drive and circadian-mediated time of day effects (midday>evening)?
- Effect on real world daytime function is “not fully known”
Caffeine: Performance Effects

- Literature of DB PC studies in adults:
  - Caffeine improves performance on simple and complex attention tasks, and affects the alerting, and executive control networks
  - Inconclusive evidence on dose-related performance effects of caffeine, or influence of habitual caffeine consumption on performance effects
  - Caffeine's effects cannot be attributed to withdrawal reversal
  - BUT, these effects have not been studied in children

  Einother 2013
Caffeine: Performance Effects

- Healthy children: mixed results; improved vigilance/reaction time, attention, manual dexterity; little evidence for cognitive effects
  - Effects dependent dose and previous exposure
  - Evidence of withdrawal-related deterioration in performance
    - Lower response time; persists for 1 week

¹ Bernstein et al, 1998
Caffeine: Performance Effects

- DB placebo-controlled study 35 9-11 yo caffeine consumers vs low/non-consumers\(^1\)
  - Post overnight abstinence, consumers had poorer performance cognitive task
  - Accuracy improved more in consumers following caffeine compared to placebo
  - Supports withdrawal reversal hypothesis of caffeine effects

\(^1\text{Heatherly et al, 2006}\)
Caffeine: Effects on Sleep

- Sleep: dose-related reduction TST, increased SOL, reduction SWS; intake 300mg → 2hr decrease SD, 2x increase NW\(^1\)
  - Effect SOL, TST 150 mg caffeine > 10 mg methylphenidate
  - Insomnia common reason for cessation/reduction
  - Sleep disturbance → sleepiness → increased use
  - Withdrawal → sleepiness/fatigue (78% studies)

\(^1\)James, 1998
Caffeine: Effects on Sleep

- 2004 NSF poll: > 1 serving/day: 33% older/28% younger school-age, 18% preschoolers; associated with less sleep
- 2006 NSF Poll: Those adolescents consuming 2+/d more likely to have:
  - Sleep problems: later bedtime, increased SOL, difficulty staying asleep, shorter SD, WD/WE discrepancy
  - Daytime sleepiness: napping, falling asleep in school/ doing homework, feeling cranky, irritable; report depression, get lower grades
- Daytime sleepiness may be mediator of negative impact of caffeine on academic achievement

James et al 2010
Caffeine: Effects on Sleep

- Randomized discontinuation caffeine in 12-24 mth old Guatemalan daily coffee drinkers increased sleep 30 min/night\(^1\)
- Dose-dependent insomnia reported in ADHD children treated with caffeine
- Parent-reported increased difficulty sleeping with caffeine in low consumers\(^2\)

\(^{1}\text{Engle et al, 1999}; {2}\text{Rapoport et al, 1984}\)
Caffeine: Effects on Sleep

- NICHD survey (1998): high caffeine intake 6-10th graders associated 2x difficulty sleeping, am fatigue

- Survey of 7-9th graders (2 week sleep diary and caffeine use):
  - Intake range 0-800mg/d; mean intake range 0-380mg/d
  - 20% averaged >100mg/d; increased on weekends, in boys
  - Higher caffeine intake associated with ↓ sleep duration, increased WASO

1Orbeta et al 2006, 2Pollack et al, 2003
Caffeine: Effects on Sleep

- Survey of 7-9th graders (2 week sleep diary and caffeine use):  
  - Intake range 0-800mg/d; mean intake 53mg/d; 20% averaged >100mg/d; increased on weekends, in boys  
  - Higher caffeine intake associated with decreased sleep duration, increased WASO

- 1998 NICHD US survey > 15,000, grades 6-10  
  - >1/2 moderate to high intake  
  - High consumers almost 2x difficulty sleeping, am fatigue

\(^1\)Pollack et al, 2003, \(^2\)Orbeta et al, 2006
Caffeine: Effects on Sleep

- High school students reporting consuming the most caffeine also had the highest levels of multitasking with media-related electronic products\(^1\)

- Caffeine consumption is also linked to nicotine use in adolescents\(^2\)
  - May further disrupt sleep and perpetuate the cycle of sleep fragmentation – daytime sleepiness- stimulant use\(^3\)

\(^1\)Calamaro 2009, \(^2\)Martin 2008; \(^3\)Jaehne 2009
Future Research Directions

- Consumption rates across groups, across products
- Knowledge gaps among consumers
- Reasons for use, expectancies
- Social context of consumption types, amounts, timing
- Impact of performance in children/adolescents, including attention, school/athletic
- Impact on sleep and alertness
- Genetic factors
  - Higher concordance rates monozygotic twins caffeine consumption, tolerance, etc
  - Polymorphisms A2A receptor gene/adenosine deaminase linked individual differences
Thanks for your attention!
Energy Drinks: Regulation

- FDA does not regulate or label caffeine content in energy drinks\(^1\)
  - 1980: FDA proposes elimination caffeine soft drinks
  - 1981: Manufacturers claim caffeine “flavor enhancer”
  - 1990 NLEA requires strict beverage labeling\(^2\)
  - 1994 Dietary Supplement Health and Education Act; some energy drinks classified as “dietary supplements”
  - FDCA does not require disclosure caffeine content

\(^1\) Reissig et al, 2009 \(^2\) Pomerantz 2013
Caffeine/ED Regulation

- Health CA maximum recommended caffeine intake:
  - Children 4-6y 45 mg/day*
  - Children 7-9y 62.5 mg/day*
  - Children 10-12y 85 mg/day*

- CA (2011-13): max caffeine per single-serve container 180mg, all non-resealable containers one serving, requires caffeine content on label and include warnings for use by children and certain sensitive adults; ED reclassified as “food”

- Healthy Kids Association (Aus)
  - “Until a safe consumption level of caffeine for children is determined, beverages with added caffeine as an ingredient are not recommended for school aged children”

- Warning labels/restrictions: Iceland, Sweden, Norway, Denmark, France, Turkey, Italy, EU, S Korea, India

* 2.5 mg/kg body wt/day based on average body wt
Caffeine/ED: Regulations

- IOM (2007) recommends prohibiting sale of caffeinated products in school
- Stimulant containing energy drinks have no place in the diets of children or adolescents AAP (2011)
  - “Sleep disturbances...are considered variable and individualized effects”
- AMA (2013): Recommends no marketing to <18yo
- 74-78% US parents agreed energy drinks should not be marketed/sold to children/teens and 85% supported regulations requiring caffeine content disclosure and warning labels¹

¹Yale Rudd Center Report 2012