



E-cigarette and marijuana use and the attainment of obesity prevention guidelines among U.S. adolescents

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ABSTRACT

The study objectives were to examine the associations of exclusive and dual use of e-cigarettes and marijuana and the attainment of the “Let’s Go! 5–2–1–0” obesity prevention guidelines and perceptions of weight status among U.S. adolescents. Data from the 2017 Youth Risk Behavior Survey, a school-based nationally representative cross-sectional study, were analyzed (N = 12,578). Participants were categorized based on their past 30-day e-cigarette and marijuana use as: non-users, exclusive e-cigarette users, exclusive marijuana users, and dual users. Adjusted logistic regression models were conducted. Of adolescents, 5.2% were exclusive e-cigarette users, 10.3% were exclusive marijuana users, and 7.4% were dual users. Compared to non-users, exclusive e-cigarette users were more likely (aOR = 1.55, 95%CI = 1.16–2.07) to meet the physical activity recommendation. Compared to dual-users, exclusive e-cigarette users were more likely (aOR = 1.47, 95%CI = 1.10–1.97) to meet the screen time recommendation. Compared to non-users, exclusive marijuana users were at increased odds to meet the fruit/vegetable recommendation (aOR = 1.33, 95%CI = 1.03–1.71), but were at decreased odds to meet the sugar-sweetened beverages recommendation (aOR = 0.81, 95%CI = 0.65–0.99). Compared to exclusive e-cigarette users, exclusive marijuana users were less likely to meet the screen time (aOR = 0.71, 95%CI = 0.54–0.93) and physical activity recommendations (aOR = 0.60, 95%CI = 0.43–0.84). Compared with dual users, exclusive marijuana users were more likely (aOR = 1.38, 95%CI = 1.01–1.88) to perceive themselves as slightly/very overweight. Compared to non-users, dual users were less likely to meet the sugar-sweetened beverages recommendation (aOR = 0.63, 95%CI = 0.46–0.87). Adolescent current marijuana users and dual users were less likely to meet obesity prevention guidelines. Prevention efforts are needed to reduce e-cigarette and marijuana use and increase adherence to these guidelines.

1. Introduction

While rates of adolescent combustible tobacco product (i.e., cigarette) use have continued to decline in recent years (Johnston et al., 2020), rates of noncombustible tobacco product (i.e., electronic cigarette (e-cigarette)) use have risen in U.S. high school youth (Gentzke et al., 2019; U.S. Department of, 2016). In 2019, e-cigarettes were the most commonly used tobacco product by high school students with 27.5% reporting past 30-day (current) use behavior (Wang et al., 2019). Rates of adolescent lifetime and current use of marijuana are also increasing among youth in the U.S. (Johnston et al., 2020; Terry-McElrath et al., 2020), with reported annual use rates of 36% in 12th

grade students and 29% in 10th grade students in 2019 (Johnston et al., 2020). Adolescents who use marijuana are at increased risk to initiate use of e-cigarettes and to be dual users of e-cigarettes and marijuana (Weinberger et al., 2020).

Tobacco product use is a leading preventable cause of morbidity and mortality. There are known adverse health effects associated with e-cigarette use including nicotine addiction, respiratory symptoms, asthma exacerbations, and e-cigarette or vaping product use associated lung injury (EVALI) (Walley et al., 2019; Overbeek et al., 2020). There is also concern that similar to individuals who smoke combustible tobacco products, individuals who use e-cigarettes may be at increased risk for cardiovascular disease (Conklin et al., 2019). Further, individuals who

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use marijuana are at increased risk for respiratory illnesses such as asthma (Winhusen et al., 2019) and also at increased risk for cardiovascular disease (Winhusen et al., 2019).

Obesity is also another leading preventable cause of morbidity and mortality. Rates of obesity in adolescents are 20.6% (Hales et al., 2018). Obesity in adolescents is also associated with adverse health consequences, some of which overlap with tobacco product- and marijuana-related morbidity, including type 2 diabetes, hypertension, cardiovascular disease, and metabolic syndrome (O'Connor et al., 2017; Daniels and Hassink, 2015). Previous research indicates that adolescent males who are obese are at increased odds of using e-cigarettes compared to peers who are not obese (Delk et al., 2018), and that female adolescents who use substances including marijuana are at increased odds to be overweight or obese (Hammami et al., 2019).

Even though the association of substance use and obesity is complex, (Lanza et al., 2017; Gearhardt et al., 2018) they share common risk factors (reward dysfunction and impulsivity) (Gearhardt et al., 2018). Particularly, use of e-cigarettes or marijuana is individually linked to increased appetite, (Farokhnia et al., 2020) reduced physical activity, and increased screen time, (Iannotti et al., 2009) all of which contribute to excess weight. In addition, research evidence suggests dual use of e-cigarettes and marijuana exacerbates the likelihood for risk behaviors compared to single or non-users (Jacobs et al., 2021). Given the rising rates of e-cigarette and marijuana dual use in adolescents and the potential associations with obesity, it is important to identify behaviors that may contribute to obesity in adolescents who use e-cigarettes and/or marijuana. These behaviors include unhealthy diet and inadequate exercise patterns during childhood and adolescence which may continue throughout adulthood if not modified early (Brown et al., 2019).

To evaluate this, we examined data from adolescents who participated in the 2017 Youth Risk Behavior Survey. To assess risk factors of obesity, we examined the associations of exclusive and dual use of e-cigarettes and marijuana and the attainment of the “Let’s Go! 5–2–1–0” obesity prevention guidelines from the Maine Youth Collaborative (Rogers et al., 2013). The ‘5–2–1–0’ recommendations have been used to screen and evaluate healthy behaviors in children in various settings and in research (Haughton et al., 2016; Khalsa et al., 2017; Narcisse et al., 2019; Le-Jenkins et al., 2020). These daily guidelines recommend that youth eat at least five servings of fruits and vegetables (‘5’), view two hours or less of screen time (‘2’), participate in at least one hour of physical activity (‘1’), and consume zero sugar-sweetened beverages (‘0’). We also assessed the associations between current e-cigarette and marijuana use and perceptions of weight status among adolescents. We hypothesized that compared to non-users of e-cigarettes and marijuana, exclusive e-cigarette users, exclusive marijuana users, and dual users of e-cigarettes and marijuana would be at reduced odds of meeting the ‘5–2–1–0’ recommendations and of perceiving themselves as slightly/very overweight. Specific to current users only, we also hypothesized that dual users would be at decreased odds to meet these recommendations and perceive themselves as slightly/very overweight than exclusive users of either e-cigarettes or marijuana.

2. Methods

2.1. Study design, participants, and procedures

Data for this study were derived from the 2017 Youth Risk Behavior Survey (YRBS), conducted by the Centers for Disease Control and Prevention (CDC), which employs a three-stage cluster design to obtain a nationally representative cross-sectional sample of U.S. adolescents in 9th through 12th grade. The YRBS monitors different categories of health-related behaviors among youth, including: alcohol and other drug use, diet, physical activity, electronic screen time, and weight perceptions. The data are representative of students in public or private schools in the U.S. The sampling frame for the 2017 national YRBS consisted of all regular public (including charter schools), Catholic, and

other non-public schools in the 50 U.S. states and the District of Columbia. One hundred and ninety-two schools were sampled and 144 participated in the survey, a 75% school response rate. Students completed the self-administered survey during one class period under the supervision of trained personnel. A detailed description of the methodology used for YRBS is published elsewhere (Brener et al., 2013).

A total of 14,956 students were eligible to participate and 14,765 adolescents completed the 2017 YRBS with usable data (81% response rate). Of the participants, 12,578 had complete e-cigarette and marijuana use data and constituted the final sample included in this study. A university IRB deemed the present study as “not human subjects” research since the 2017 YRBS data are de-identified and publicly downloadable at: www.cdc.gov/healthyyouth/data/yrbs/data.htm.

2.2. Measures

2.2.1. ‘5–2–1–0’ Behaviors

2.2.1.1. ‘5’ – Fruit and vegetable intake. Six questions assessed past 7-day fruit (including 100% fruit juice) and vegetable intake, and asked about participants’ intake of fruit, fruit juice, green salad, potatoes (excluding fries, fried potatoes, or potato chips), carrots, and other vegetables in the past seven days. Response options ranged from “did not eat...” to “4 or more times per day”. To determine the daily intake of fruits and vegetables, each participant’s responses to all six questions were averaged and then divided by seven. These averaged values were then dichotomized to determine whether participants met the ‘5’ recommendation and consumed ≥ 5 servings/day of fruits and vegetables or did not meet the recommendation and consumed < 5 servings/day of fruits and vegetables.

2.2.1.2. ‘2’ – Screen time. Two questions assessed daily screen time of: watching TV and playing video/computer games, or use of a computer for something other than school work. Responses to both questions were summed to estimate total number of hours spent on screen time. These summed values were then dichotomized to determine whether participants met the ‘2’ recommendation and had < 2 h/day of non-school related screen time or did not meet the recommendation and had ≥ 2 h/day of non-school related screen time.

2.2.1.3. ‘1’ – Physical activity. One question assessed past 7-day physical activity and asked whether participants were physically active for at least 60 min/day in the past week. To determine daily physical activity, participants had to report they were physically active on all seven days. These responses were then dichotomized to determine whether participants met the ‘1’ recommendation and were physically active for ≥ 1 h/day or did not meet the recommendation and were not physically active for < 1 h/day.

2.2.1.4. ‘0’ – sugar-sweetened beverage intake. One question assessed past 7-day sugar-sweetened beverage intake, and asked about participants’ intake of a can, bottle, or glass of soda or pop (not counting diet soda or diet pop) in the past seven days. Participants met the ‘0’ recommendation if they consumed 0 sugar-sweetened beverages/day and did not meet the recommendation if they consumed ≥ 1 sugar-sweetened beverage/day.

2.3. Perception of weight status

One question assessed weight perceptions, and asked participants to describe their weight. We used the YRBS-provided variable that dichotomized responses into: very/slightly underweight and about the right weight, and slightly/very overweight.

2.3.1. Current e-cigarette use and marijuana use

Two questions assessed current (past 30-day) e-cigarette and marijuana use and asked on how many days participants used e-cigarettes and how many times participants used marijuana during the past 30 days. Response options ranged from 0 days to all 30 days. These two items were combined to create one variable with four categories: non-users: did not use e-cigarettes or marijuana; exclusive e-cigarette users: used e-cigarettes, but did not use marijuana; exclusive marijuana users: used marijuana, but not e-cigarettes; and dual users: used e-cigarettes and marijuana.

2.3.2. Demographics

Demographic variables assessed include sex (male, female), race/ethnicity (Non-Hispanic White, Non-Hispanic Black, Hispanic/Latino, and Other) and grade level (9th, 10th, 11th, and 12th grade).

2.4. Statistical analyses

Data were weighted to consider the survey design including school and student nonresponse and oversampling of Non-Hispanic Black and Hispanic students. First, demographic characteristics of the study sample were described. Next, bivariate analyses with chi-square tests were performed to assess differences in participant demographics based on their current e-cigarette and marijuana use. Then, separate adjusted logistic regression analyses were conducted to assess the magnitude of the associations of e-cigarette and marijuana use with meeting the '5-2-1-0' recommendations and perceptions of weight status among all adolescents. For follow-up analyses, we excluded non-users and performed adjusted logistic regression analyses to assess current use group differences based on meeting the '5-2-1-0' recommendations and perceptions of weight status. All logistic regression analyses adjusted for sex, race/ethnicity, grade, combustible cigarette smoking, cigar smoking, and smokeless tobacco use. Results were considered significant when alpha value was < 0.05 . Adjusted odds ratios (aORs) were calculated using the complex samples logistic regression procedure (CSLOGISTIC) in IBM SPSS Statistics 26 which accounts for the complex YRBS survey design including assigned stratum and primary sampling unit.

3. Results

As shown in Table 1, 52% of participants were female, 43.7% were non-Hispanic White, 23.9% were Hispanic/Latino, 18.9% were non-Hispanic Black, and 11.9% were another race. There was a slightly higher percentage of adolescents in the 9th grade (27.1%), followed by the 10th (25.3%), 11th (24.4%) and 12th (23.0%) grades.

3.1. Demographics based on current use of e-cigarettes and marijuana

Overall, 5.1% of participants were exclusive e-cigarette users, 10.3% were exclusive marijuana users, and 7.3% were dual users of e-cigarettes and marijuana. All demographic variables differed based on current use groups (all $p < 0.001$) (see Table 1). As shown in Table 1, males and students in higher grade levels (10th-12th) had higher percentages of being exclusive e-cigarette users, exclusive marijuana users, and dual users. Non-Hispanic white adolescents had higher percentages of being exclusive e-cigarette users (7.5%) and dual users (9.6%), whereas they had the lowest percentage of being exclusive marijuana users (7.1%). Non-Hispanic black and Hispanic/Latino adolescents had the highest percentages of being exclusive marijuana users (16.8% and 12.7% respectively).

3.2. Demographics based on meeting the '5-2-1-0' recommendations

Overall, 0.9% of adolescents met all four '5-2-1-0' recommendations. Thirty-six percent did not meet any of the '5-2-1-0' recommendations, while 37.1%, 20.4%, and 5.6% met one, two, and three

recommendations, respectively. As shown in Table 2, specifically, 12.8% met the '5' recommendation of consuming ≥ 5 servings/day of fruits and vegetables, 34.2% met the '2' recommendation of < 2 h/day of non-school related screen time, 26.1% met the '1' recommendation of ≥ 1 h/day of physical activity, and 27.8% met the '0' recommendation of consuming 0 sugar-sweetened beverages/day.

Demographic characteristics are shown by participants overall, and by meeting the '5-2-1-0' recommendations in Table 2. There were significant differences in demographic characteristics and meeting the 5-2-1-0 recommendations. Males had higher prevalence of meeting the '5' fruit and vegetable intake, '1' physical activity, and '0' sugar-sweetened beverages daily recommendations compared with females (all $p < 0.001$). Race/ethnicity differed based on the '5' fruit and vegetable intake, '2' physical activity, and '0' sugar-sweetened beverages recommendations. A higher percentage of non-Hispanic Black adolescents met the '5' recommendation ($p < 0.001$) but had the lowest percentage of meeting the '2' ($p = 0.008$) and '0' ($p = 0.016$) recommendations. Grade level significantly differed based on the '5' fruit and vegetable intake, '2' screen time, and '1' physical activity recommendations. There was an inverse relationship between grade level and these recommendations. Specifically, 9th grade students had the highest percentages, while 12th grade students had the lowest percentages of meeting these three recommendations.

3.3. Demographics based on perception of weight status

Nearly one-third (31.1%) of participants perceived themselves as having a slightly/very overweight status. There were significant differences in demographic characteristics and perception of weight status. Females had a higher perception of being slightly/very overweight than males ($p < 0.001$). A higher percentage of Hispanic/Latino adolescents and 9th grade students perceived themselves as having a slightly/very overweight status ($p < 0.001$ and $p = 0.04$, respectively).

3.4. E-Cigarette and marijuana use based on meeting the '5-2-1-0' recommendations

Compared to non-users, exclusive e-cigarette users were 1.55 times more likely (95% confidence interval [CI] = 1.16–2.07) to meet the '1' recommendation of ≥ 1 h/day of physical activity (Table 3). Exclusive marijuana users were at increased odds to meet the '5' recommendation of consuming ≥ 5 servings/day of fruits and vegetables (aOR = 1.33, 95%CI = 1.03–1.71), but were at decreased odds to meet the '0' recommendation of consuming 0 sugar-sweetened beverages/day (aOR = 0.81, 95%CI = 0.65–0.99). Compared to non-users, dual users were also less likely to meet the '0' sugar-sweetened beverages recommendation (aOR = 0.63, 95%CI = 0.46–0.87).

Compared to dual users, exclusive e-cigarette users were 1.47 times more likely (95%CI = 1.10–1.97) to meet the '2' recommendation of < 2 h/day of non-school related screen time (Table 4). Compared to exclusive e-cigarette users, exclusive marijuana users were at reduced odds to meet the '2' recommendation of < 2 h/day of non-school related screen time (aOR = 0.71, 95%CI = 0.54–0.93) and '1' recommendation ≥ 1 h/day of physical activity (aOR = 0.60, 95%CI = 0.43–0.84).

3.5. Current use of e-cigarettes and marijuana based on perception of weight status

There were no differences based on current e-cigarette and marijuana use and perception of weight status among adolescents (see Table 3).

Compared with dual users, exclusive marijuana users were 1.38 times more likely (95%CI = 1.01–1.88) to perceive themselves as having a slightly/very overweight status (see Table 4).

4. Discussion

The present study found about 10% of adolescents reported exclusive marijuana use, 5% reported exclusive e-cigarette use, and 7.4% reported dual use. Overall, about 1% of the sample met all the ‘5–2–1–0’ daily health guidelines. This finding is consistent with other research highlighting poor nutrition and a lack of exercise in American youth in general (Haughton et al., 2016). Our findings indicated that when compared with non-users, exclusive users of e-cigarette were more likely to meet the ‘1’ physical activity recommendation outlined by the ‘5–2–1–0’ guidelines. When compared with dual users, as posited, exclusive users of e-cigarette were more likely to meet the ‘2’ screen time recommendation. Dunbar and colleagues (Dunbar et al., 2017) found that youth using e-cigarettes engaged in “healthier behaviors” compared to adolescents using combustible cigarettes. Thus, one potential explanation for our findings is that health-promoting and health-risk behaviors co-occur, and particularly, e-cigarette users may perceive e-cigarettes as “healthy” compared to other drug use (e.g., marijuana use). Thus, educational efforts should focus on the health risks of vaping, and the risks associated with ingredients contained in e-cigarettes such as nicotine addiction that can harm the developing brain during adolescence U.S. DHHS, (U.S. Department of, 2016).

Findings were mixed for the exclusive marijuana and dual user groups and the odds of meeting the ‘5–2–1–0’ recommendations when compared to non-users. Interestingly, exclusive marijuana users and dual users of e-cigarettes and marijuana were both more likely to meet the ‘5’ fruit and vegetable intake recommendation but less likely to meet the ‘0’ sugar-sweetened beverage recommendation. One potential reason for exclusive marijuana users and dual users having an increased likelihood to meet the ‘5’ recommendation could be that studies have linked marijuana use to increased appetite for high calorie/energy and palatable foods (Weltens et al., 2019) such as sweet beverages like fruit juices; and 100% fruit juice was included in the fruit and vegetable intake response options. However, most 100% fruit juices have a high sugar content which would not “count” towards the ‘5’ category but would “count” towards not meeting the ‘0’ category. Thus, this issue needs further research.

About one-third of adolescents in the present study perceived themselves as overweight, which is higher than the national prevalence of about one-fifth of adolescents being overweight (Hales et al., 2018). While there were no differences between non-users and current use groups, there were differences detected in the sub-analysis delimited to current use groups. Compared to dual users, adolescents who were exclusive marijuana users were more likely to perceive themselves as overweight. It is important to note that exclusive marijuana users were also at reduced odds to meet the ‘2’ screen time and ‘1’ physical activity recommendations compared to exclusive e-cigarette users. Thus, the increased likelihood of current marijuana users perceiving themselves as overweight may be related to low levels of physical activity as well as increased screen time and higher consumption of sugar-sweetened beverages. Taken together, these results suggest that marijuana consumption could influence appetite (Weltens et al., 2019)—for healthy and unhealthy diet— and sedentary behaviors. Previous studies have reported that marijuana use influences food intake, appetite, and metabolism with both chronic and acute use leading to increased food consumption and visceral adiposity (Farokhnia et al., 2020; Muniyappa et al., 2013). Further, marijuana use has also been linked to reduced physical activity and increased screen time for non-educational purposes (Iannotti et al., 2009). This finding highlights the clustering of marijuana use with other unhealthy behaviors, therefore increasing the need for more awareness and education for youths, health care providers, and policy makers. In terms of education, adolescent current marijuana users may benefit from education about improved health behaviors, and the association between marijuana use and cardiovascular health.

Several issues may have limited the generalizability of study findings. This study was cross-sectional and assessed perceptions at one

timepoint using a survey with general questions that do not assess contextual factors such as socioeconomic status. Longitudinal research with the addition of qualitative data (e.g., food diary), and specific questions about health behaviors and socioeconomic indicators might provide more information about eating patterns and reasons why adolescents had low intake of fruits and vegetables, for instance. The YRBS is a school-based survey, and thus does not represent adolescents who are not enrolled in a school—a group that has a disproportionately higher number of adolescents who are at increased risk for substance use (Brener et al., 2013). Our study purpose was to understand the association of e-cigarette and marijuana use with adherence to the ‘5–2–1–0’ guidelines among adolescents, thus, information about fruit and vegetable consumption and screen time were combined into a summary variable by the YRBS. Thus, for example, we were unable to examine whether a particular type of screen (e.g., use of television vs. video or computer games) was associated with meeting the obesity prevention guidelines due to the use of secondary data. Also, given that fruit juice was included in fruits and vegetables count, the data may not correctly reflect the sugar-sweetened beverage recommendation since not all youth are able to correctly identify if there is added sugar in their juices. Additionally, participants reported on their subjective judgment about their weight (i.e., very underweight, slightly underweight, about the right weight, slightly overweight, and very overweight) and based on the distribution of responses, the variable was collapsed into “very/slightly underweight and about the right weight” and “slightly and very overweight”. This categorization limited the study’s capacity for obtaining nuanced results on the collapsed subgroups.

5. Conclusion and recommendation

In sum, our findings show the majority of adolescents are not meeting the obesity prevention guidelines (Haughton et al., 2016) and adolescent current marijuana users and dual users were less likely to meet obesity prevention guidelines. In order to assess risks for adolescent e-cigarette and marijuana use with healthy habits by adhering to the ‘5–2–1–0’ obesity prevention guidelines among adolescents, pediatricians and public health professionals should consider implementing screening tools with questions about use and adherence or non-adherence to healthy habits during encounters (e.g., at their primary care visit, in the schools). Interventions have often been directed toward younger school-age youth; (Legault et al., 2016) thus, more research is needed to adapt interventions for adolescents and determine if these interventions are successful in influencing positive health behaviors. Furthermore, education and training programs need to enhance knowledge of the health effects of e-cigarette products (Hildick-Smith et al., 2015) and instruction on how to coach adolescents about healthy behaviors. (Zachary and Sisley, 2020) Adding education to high school health curricula about the risks of e-cigarette and marijuana use and the need for healthy eating and physical activity to enhance cardiovascular health is important for adolescents who do or do not engage in health-risking behaviors such as e-cigarette and marijuana use. (Milicic et al., 2019) In future studies, examining family factors, such as food availability at home and health behaviors of family members may shed light on ways that family health behaviors are related to adolescent health behaviors. Studies assessing the impact of interventions to teach adolescents about ‘5–2–1–0’ obesity prevention behaviors and how they impact health and motivate change in adolescent health are needed, as are studies investigating identification of e-cigarette and marijuana users and reducing their use of these drugs. Future research should seek to determine whether reducing use of e-cigarettes and marijuana results in increases in healthy eating and physical activity and reductions in screen time and consumption of sugar-sweetened beverages over time.

CRedit authorship contribution statement

Wura Jacobs: Conceptualization, Methodology, Formal analysis,

Writing - original draft, Writing - review & editing. **Laura Nabors:** Writing - original draft. **Melinda E. Mahabee-Gittens:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing. **Ashley L. Merianos:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- Brener, N.D., Kann, L., Shanklin, S., et al., 2013. Methodology of the youth risk behavior surveillance system—2013. *Morbidity Mortal. Weekly Rep. Recommendations Rep.* 62 (1), 1–20.
- Brown, T., Moore, T.H.M., Hooper, L., et al. 2019. Interventions for preventing obesity in children. *Cochrane Database Syst. Rev.* (7).
- Conklin, Daniel J., Schick, Suzaynn, Blaha, Michael J., Carll, Alex, DeFilippis, Andrew, Ganz, Peter, Hall, Michael E., Hamburg, Naomi, O'Toole, Tim, Reynolds, Lindsay, Srivastava, Sanjay, Bhatnagar, Aruni, 2019. Cardiovascular injury induced by tobacco products: Assessment of risk factors and biomarkers of harm. *A Tobacco Centers of Regulatory Science compilation. Am. J. Physiol. Heart Circul. Physiol.* 316 (4), H801–H827.
- Daniels, S.R., Hassink, S.G., 2015. The role of the pediatrician in primary prevention of obesity. *Pediatrics* 136 (1), e275–e292.
- Delk, Joanne, Creamer, MeLisa R., Perry, Cheryl L., Harrell, Melissa B., 2018. Weight status and cigarette and electronic cigarette use in adolescents. *Am. J. Prev. Med.* 54 (1), e31–e35.
- Dunbar, M.S., Tucker, J.S., Ewing, B.A., et al. 2017. Frequency of E-cigarette use, health status, and risk and protective health behaviors in adolescents. *J. Addiction Med.* 11 (1):55.
- Farokhnia, Mehdi, McDiarmid, Gray R., Newmeyer, Matthew N., Munjal, Vikas, Abulseoud, Osama A., Huestis, Marilyn A., Leggio, Lorenzo, 2020. Effects of oral, smoked, and vaporized cannabis on endocrine pathways related to appetite and metabolism: a randomized, double-blind, placebo-controlled, human laboratory study. *Transl. Psychiatry* 10 (1). <https://doi.org/10.1038/s41398-020-0756-3>.
- Gearhardt, Ashley N., Waller, Rebecca, Jester, Jennifer M., Hyde, Luke W., Zucker, Robert A., 2018. Body mass index across adolescence and substance use problems in early adulthood. *Psychol. Addict. Behav.* 32 (3), 309–319.
- Gentzke, A.S., Creamer, MeLisa, Cullen, K.A., Ambrose, B.K., Willis, G., Jamal, A., King, B.A., 2019. Vital signs: Tobacco product use among middle and high school students—United States, 2011–2018. *Morbidity Mortal. Weekly Rep.* 68 (6), 157–164.
- Hales, C.M., Fryar, C.D., Carroll, M.D., Freedman, D.S., Ogden, C.L., 2018. Trends in obesity and severe obesity prevalence in US youth and adults by sex and age, 2007–2008 to 2015–2016. *JAMA* 319 (16), 1723–1725.
- Hammami, Nour, Chaurasia, Ashok, Bigelow, Philip, Leatherdale, Scott T., 2019. A gender-stratified, multilevel latent class assessment of chronic disease risk behaviours' association with Body Mass Index among youth in the COMPASS study. *Prev. Med.* 126, 105758. <https://doi.org/10.1016/j.ypmed.2019.105758>.
- Haughton, C.F., Wang, M., Lemon, S.C., 2016. Racial/ethnic disparities in meeting 5-2-1-0 recommendations among adolescents in the United States. *J. Pediatrics* 175, 188–194.
- Hildick-Smith, Gordon J., Pesko, Michael F., Shearer, Lee, Hughes, Jenna M., Chang, Jane, Loughlin, Gerald M., Ipp, Lisa S., 2015. A practitioner's guide to electronic cigarettes in the adolescent population. *J. Adolesc. Health* 57 (6), 574–579.
- Iannotti, Ronald J., Kogan, Michael D., Janssen, Ian, Boyce, William F., 2009. Patterns of adolescent physical activity, screen-based media use, and positive and negative health indicators in the U.S. and Canada. *J. Adolesc. Health* 44 (5), 493–499.
- Jacobs, Wura, Idoko, Ehikowoicho, Montgomery, LaTrice, Smith, Matthew Lee, Merianos, Ashley L., 2021. Concurrent E-cigarette and marijuana use and health-risk behaviors among US high school students. *Prev. Med.* 145, 106429. <https://doi.org/10.1016/j.ypmed.2021.106429>.
- Johnston, L.D., Miech, R.A., O'Malley, P.M., Bachman, J.G., Schulenberg, J.E., Patrick, M.E., 2020. Monitoring the Future national survey results on drug use 1975–2019: Overview, key findings on adolescent drug use. University of Michigan, Ann Arbor, Michigan.
- Khalsa, Amrik Singh, Kharofa, Roohi, Ollberding, Nicholas J., Bishop, Laurie, Copeland, Kristen A., 2017. Attainment of '5-2-1-0' obesity recommendations in preschool-aged children. *Prevent. Med. Rep.* 8, 79–87.
- Lanza, H. Isabella, Pittman, Patricia, Batshoun, Jennifer, 2017. Obesity and cigarette smoking: Extending the link to e-cigarette/vaping use. *Am. J. Health Behav.* 41 (3), 338–347.
- Legault, L., LeBlanc, C., Epi, E.C.M.M., 2016. Using '5, 2, 1, 0' to promote healthy active living among school-age children attending a paediatric resident clinic: A prospective study/Utiliser le «5, 2, 1, 0» pour promouvoir une vie saine et active chez les enfants d'âge scolaire qui fréquentent une clinique de résidents en pédiatrie: une étude prospective. *Paediatrics Child Health* 21 (5), E43.
- Le-Jenkins, Uyen, Cartagena, Diana, Renaud, Michelle, Guston, Tina, 2020. Effectiveness of a primary care-based pediatric weight management program. *J. Doctoral Nursing Practice* 13 (1), 9–16.
- Milicic, S., Piérard, E., DeCicca, P., Leatherdale, S.T., 2019. Examining the association between physical activity, sedentary behavior and sport participation with e-cigarette use and smoking status in a large sample of Canadian youth. *Nicotine Tob. Res.* 21 (3), 285–292.
- Muniyappa, R., Sable, S., Ouwerkerk, R. et al. 2013. Metabolic effects of chronic cannabis smoking. *Diabetes Care.* 36(8):2415–2422.
- Narcisse, Marie-Rachelle, Long, Christopher R., Felix, Holly C., Howie, Erin K, Purvis, Rachel S., McElfish, Pearl A., 2019. Adherence to sleep guidelines reduces risk of overweight/obesity in addition to 8-5-2-1-0 guidelines among a large sample of adolescents in the United States. *Sleep Health* 5 (5), 444–451.
- O'Connor, E.A., Evans, C.V., Burda, B.U., Walsh, E.S., Eder, M., Lozano, P., 2017. Screening for obesity and intervention for weight management in children and adolescents: evidence report and systematic review for the US Preventive Services Task Force. *JAMA* 317 (23), 2427–2444.
- Overbeek, Daniel L., Kass, Alexandra P., Chiel, Laura E., Boyer, Edward W., Casey, Alicia M.H., 2020. A review of toxic effects of electronic cigarettes/vaping in adolescents and young adults. *Crit. Rev. Toxicol.* 50 (6), 531–538.
- Rogers, V.W., Hart, P.H., Motyka, E., Rines, E.N., Vine, J., Deatrck, D.A. 2013. Impact of let's go! 5-2-1-0: a community-based, multisetting childhood obesity prevention program. *J. Pediatric Psychol.* 38(9):1010–1020.
- Terry-McElrath, Y.M., O'Malley, P.M., Johnston, L.D. 2020. The growing transition from lifetime marijuana use to frequent use among 12th grade students: US National data from 1976 to 2019. *Drug Alcohol Dependence.* 108064.
- U.S. Department of Health and Human Services. 2016. E-Cigarette Use Among Youth and Young Adults. A Report of the Surgeon General. In: Department of Health and Human Services CfDcaP, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, ed. Atlanta, GA2016.
- Walley, Susan C., Wilson, Karen M., Winickoff, Jonathan P., Groner, Judith, 2019. A public health crisis: electronic cigarettes, vape, and JUUL. *Pediatrics* 143 (6), e20182741. <https://doi.org/10.1542/peds.2018-2741>.
- Wang, T.W., Gentzke, A.S., Creamer, M.R., et al., 2019. Tobacco product use and associated factors among middle and high school students—United States, 2019. *MMWR Surveill. Summaries* 68 (12), 1.
- Weinberger, A.H., Zhu, J., Lee, J., Xu, S. 2020. Goodwin RD. Cannabis use and the onset of cigarette and e-cigarette use: A prospective, longitudinal study among youth in the United States. *Nicotine Tobacco Res.*
- Weltens, N., Depoortere, I., Tack, J., Van Oudenhove, L. 2019. Effect of acute Δ^9 -tetrahydrocannabinol administration on subjective and metabolic hormone responses to food stimuli and food intake in healthy humans: a randomized, placebo-controlled study. *Am. J. Clin. Nutrition.* 109(4):1051–1063.
- Winhusen, Theresa, Theobald, Jeff, Kaelber, David C., Lewis, Daniel, 2019. Regular cannabis use, with and without tobacco co-use, is associated with respiratory disease. *Drug Alcohol Depend.* 204, 107557. <https://doi.org/10.1016/j.drugalcdep.2019.107557>.
- Zachary, Montgomery, Sislely, Stephanie, 2020. The pediatric obesity encounter: Literature and resources to help with 4 common issues. *Curr. Nutrition Rep.* 9 (2), 94–100.