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Is adolescence a time of heightened risk taking? An overview of types of risk-taking behaviors across age groups

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ABSTRACT

Adolescence often is thought to be the age period of heightened risk taking (e.g., substance use, reckless driving, sexual risks, delinquency) by both researchers and the general public. In the present article we challenge this assumption by examining the prevalence of a wide variety of real-world risk-taking behaviors across different age groups. Focusing on North American data, we first explore types of risk-taking behaviors across different age groups, both within and across different domains of risk taking. Second, we consider historical trends in risk taking, given that prevalence and types of risk-taking behaviors can change over time. Overall, our review highlights that *emerging adulthood* (i.e., 19–29 years of age) is the age period when risk taking is most prevalent across multiple domains. Risk taking in many domains, however, is common across the entire adult lifespan, sometimes with the appearance of minimal differences among emerging adults and adults. Moreover, while the majority of risk-taking behaviors have declined over time, this pattern is not consistent for all behaviors and all age groups. Thus, our understanding of whether adolescence is a heightened period of risk taking requires answering the questions: "For what type of risk taking" and "How does that type of risk-taking behavior change or not change across age and historical time periods?"

Introduction

Adolescence often is thought to be an age period of heightened risk taking (e.g., substance use, reckless driving, delinquency) by both researchers and the general public (e.g., Dahl, 2004, Spear, 2010). In this review we adopt the lay-person definition of risk taking, which is any behavior that risks adverse consequences. A wide variety of theories have been proposed to account for this "heightened" risk taking. We highlight a few of these theories here; for example, low self-control (Byrnes, 1998; Gottfredson & Hirschi, 1990; Romer, Duckworth, Sznitman, & Park, 2010; Romer et al., 2011), impulsive choices (i.e., preferring immediate rewards such as gaining the approval of peers; Gardner & Steinberg, 2005), and rational choices (i.e., sensitivity to both risks and benefits; Reyna & Farley, 2006). Heightened risk taking also is thought to be the result of a tolerance for ambiguity (Tymula et al., 2012) which can lead to age-appropriate exploratory behavior (e.g., sensation-seeking; Ellis et al., 2012; Romer, Reyna, & Satterthwaite, 2017, Wilson & Daly, 1985; Zuckerman, 2007). Across many cultures, adolescents also experience increased opportunities for risk-taking due to gaining independence (Arnett, 1992; Silva, Shulman, Chein, & Steinberg, 2016). Further, neurodevelopmental imbalance models of adolescent brain development suggest that asynchrony in the maturation of neural circuitry within and between different brain networks leads to heightened activation of the limbic-striatal networks during early to mid-adolescence, and thus increased novelty, emotional

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processing, and sensation-seeking in comparison to other age groups (e.g., Casey, 2015; Steinberg, 2008 although see Pfeifer & Allen, 2012; Romer et al., 2017 for criticisms of these models).

There often is an assumption that adolescents engage in more risk taking than all other age groups; that is, that risk taking peaks in adolescence. Moreover, general phrases such as 'heightened adolescent risk taking' can suggest that adolescent risk-taking tendencies are consistent across different types of behaviors (e.g., binge drinking, delinquency; Bromiley & Curley, 1992). In the present article we challenge these assumptions by examining data on the prevalence of a wide variety of real-world risk-taking behaviors across different age groups. For the purposes of this paper, we refer to adolescence as the age period between 11 and 18, and emerging adulthood as the age period between 19 and 29. Given the different contexts and responsibilities of high school students in comparison to individuals in their 20s, it is important to examine the prevalence of risk taking separately for these two age groups.

We believe that our review paints a fairly clear picture: When considering *multiple domains* of risk-taking in North America, adolescence on average is *not* the period of the lifespan during which most risk-taking behaviors are heightened in comparison to other age groups, particularly for the current generation of adolescents. Rather, it seems that *emerging adulthood* (i.e., 19–29 years of age) is the age period when risk-taking is most prevalent across multiple domains. Further, risk taking in many domains is common across the entire adult lifespan (both currently and historically), sometimes with the appearance of minimal differences between emerging adults and older adults.

In this review, we first describe the findings that lead to these conclusions. We highlight data from a popular risk-taking scale (the Domain-Specific Risk Taking Scale) to explore how risk taking may differ across different domains and age groups. Throughout the review and across different domains, we also present national U.S. data (or Canadian if U.S. data were not available) on specific types of risk behaviors within a domain (e.g., seatbelt use within the health and safety domain) to further illustrate patterns of risk taking. Second, we consider historical trends over the past 20–70 years (depending on the availability of the data) in some types of risk taking, by age group. Historical trends are critical to investigate given that prevalence and types of risk-taking behaviors can change over time. We conclude this review with some potential theoretical reasons for why emerging adults, compared to other age groups, may have higher prevalence of risk taking across multiple domains. Indeed, several factors may be useful to consider, including individual (e.g., self-control)-, situational (e.g., hot versus cold context)-, and social/cultural-level (e.g., timing of careers and parenthood, opportunities) characteristics, and, importantly, their interaction (e.g., Figner & Weber, 2011). Indeed, affective context can impact an individual's self-control (e.g., Figner, Mackinlay, Wilkening, & Weber, 2009; Prencipe et al., 2011), while social/cultural factors (e.g., age-based norms, structural constraints, opportunities) can play a role in the way in which individual and situation-level characteristics play out across the lifespan (e.g., Duell et al., 2016). Consideration of these different factors can help identify who takes risks, when, and why.

Types of risk taking across age groups

Real-world risk taking encompasses a wide range of behaviors, including substance use, gambling, criminal activity, etc. Often these behaviors are studied in separate lines of work (e.g., extensive research has investigated problematic substance use, for example, but not in conjunction with other risk-taking behaviors such as driving without a seatbelt), making it difficult to understand how risk-taking patterns may vary based on type of behavior. Further, even less research exists that has considered variation among age groups, including adults, in prevalence rates for different types of real-world risk-taking. One scale that directly compares the prevalence of types of risk taking is Weber, Blais, and Betz (2002) Domain-Specific Risk-Taking Scale (DOSPERT). The DOSPERT assesses risk taking in six domains: ethical choices (e.g., passing off somebody else's work as your own, revealing a friend's secret to someone else, having an affair with a married man/woman), financial investing and gambling (e.g., investing 10% of your annual income in a moderate growth mutual fund, betting a day's income at a high-stake poker game), and behaviors relating to recreation (e.g., going down a ski run that is beyond your ability, going whitewater rafting at high water in the spring), social interaction (e.g., disagreeing with an authority figure on a major issue, speaking your mind about an unpopular issue in a meeting at work), and health/safety (e.g., drinking heavily at a social function, driving a car without a seatbelt, sunbathing without sunscreen). Weber et al. (2002) reported Cronbach's alpha scores of 0.69–0.90 within the DOSPERT domains and item-total correlations ranging from 0.35 to 0.57.

The DOSPERT was designed to target *adult* risk taking across different domains, given that it asks about behaviors that are not age appropriate for adolescents (e.g., affairs, financial investments, etc.). The DOSPERT asks individuals to indicate the likelihood that they would engage in different types of risk-taking behaviors if they were to find themself in that situation; thus, it measures likelihood rather than actual engagement. Likelihood of engaging in risk-taking behavior, however, is highly correlated with subsequent behavior. For example, Weber et al. (2002) found that the likelihood of engagement in domain-specific risk activities correlated significantly with the frequency of past risk behaviors in the same domains (mean $r = 0.49$, with particularly high correlations for the Ethics, $r = 0.74$, Recreational, $r = 0.64$, and Health/Safety subscales, $r = 0.71$). Telzer, Fuligni, Lieberman, and Galvan (2013) also found a significant correlation ($r = 0.54$) between the likelihood of engaging in risk behavior next year and actual risk behavior the following year in a study of 15- to 17-year-old adolescents. Moreover, a study by Hanoch, Johnson, and Wilke (2006) demonstrated that actual risk takers in one domain (e.g., skydivers) had high scores on the relevant DOSPERT subscale (e.g., recreational) but average scores on the other domains. An updated 30-item version scale was created by Blais and Weber (2006). The authors found comparable reliability estimates and scale intercorrelations with the original measure reported in Weber et al. (2002).

Studies using the DOSPERT to date have included community samples of adults and/or samples of university students, which afforded us the opportunity to explore age group differences on the DOSPERT between university students and adults. Our inclusion criteria for studies were a North American sample, samples that did not combine university students with older adults in the analyses, and the use of the 30-item revised scale of the DOSPERT. We found four relevant university student studies and seven relevant

community adult studies – see Appendix for list of studies. Unfortunately, we did not find any studies that directly compared university students to community adults in the same study. To examine age group differences, we compared the means of risk-taking likelihood across the six domains between the four samples of university students (M_{age} = 20.14) and seven community samples of adults (M_{age} = 36.82) – See Fig. 1.

Overall, university students generally had consistently higher means than the adults across the recreational, social, and health domains (*ps* < 0.001), particularly in the recreational domain. In no cases did adults have a higher mean than the university students in the recreational domain. This finding is not surprising as extensive research indicates that as individuals get older, the reporting of novelty- and sensation-seeking behaviors tends to decline (e.g., going down a ski hill beyond their ability; e.g., Steinberg et al., 2008). In contrast, the ethical and financial domains were the most comparable for university students and adults.

An adolescent version of the 30-item DOSPERT was created by Figner, Garrote, Kotabe, and Weber (2010). It is the same as the adult revised version with the exception that items that are inappropriate for adolescents are changed (e.g., having an affair with a married man/woman is changed to "dating someone else's girlfriend/boyfriend"; betting a day's income at a high-stake poker game is changed to "betting all your pocket money on an online gambling game"; speaking your mind about an unpopular issue in a meeting at work is changed to "speaking out against a popular opinion at school"; drinking heavily at a social function is changed to "drinking at a party", etc.). Unfortunately, only one North American study has used the adolescent version of the revised 30-item DOSPERT (Goldenberg, Telzer, Lieberman, Fuligni, & Galván, 2017), Thus, there are not enough data to examine any age-related differences between adolescents and the other two age groups (i.e., university students and community adults), but age group comparisons would be interesting to consider in future research.

Although the DOSPERT demonstrates one way to investigate risk taking across different domains, within a domain there also may be variation in which age groups are engaging in *specific* types of behaviors. For example, the "Health and Safety" domain captures a variety of different behaviors such as engaging in unprotected sex, seatbelt use, and injury proneness (e.g., not wearing a helmet). Publicly available health risk data allows us to look at the prevalence of specific health risk activities across age groups. For example, U. S. national data on sexually transmitted infections (STIs; an outcome associated with unprotected sex) indicates that it is emerging adults aged 20–24 who have the highest rates of HIV diagnoses, chlamydia, and gonorrhea - see Figs. 2 and 3, although for chlamydia and gonorrhea, adolescents aged 15–19 are not that far behind. Risk for STIs is associated with high-risk sexual behavior and less utilization of health services, but it also is important to note that biologically, female adolescents and young women are more susceptible to STIs than older women because of increased cervical ectopy (i.e., cells that line the inside of the cervix grow on the outside; Cates, 1990; Shannon & Klausmer, 2018).

Not wearing a seatbelt is another risk behavior within the Health and Safety domain of the DOSPERT. Of concern, among passenger vehicle accident *deaths* in the United States in 2018, the age groups that had the highest percentage of unrestrained deaths were the adults aged 21–24 and 25–34 (58% and 60%, respectively) - see Fig. 4. It is interesting to note that the 16–20-year-old group was nearly the same as the 35–44-year-olds (53% and 54%, respectively). While data from the Youth Risk Behavior Survey has revealed that high school students have inadequate seatbelt use, with over 40% of high school students reporting that they did not always wear a seatbelt in the past 30 days (Yellman et al., 2020), the data in Fig. 4 suggests that poor seatbelt use clearly is not an adolescent-specific risk behavior.

Relatedly (although not measured in the DOSPERT), distracted driving due to cellphone use has become a growing health and safety concern. National U.S. data indicate that over 25% of drivers aged 21–24 reported reading text messages and/or emails at least sometimes while driving (see Fig. 5). Additionally, over 10% of adolescents (16–20 years old), emerging adults (21–24 years old), and adults (25–44 years old) reported sending text messages and/or emails at least sometimes while driving. Of course, many 16–20 year olds may not yet drive, but the data indicate that emerging adults and adults also are at-risk in this domain of risk taking, perhaps to an even greater extent than adolescents.

The health and safety domain of the DOSPERT also asks participant about their helmet use, which indicates risk for unintentional injuries. Often studies will report that unintentional injuries increase from childhood to adolescence (e.g., Casey & Caudle, 2013; Dahl, 2004; Geier, Terwilliger, Teslovich, Velanova, & Luna, 2010). Indeed, in the US, 6.66% of youth aged 10–14 years were treated for

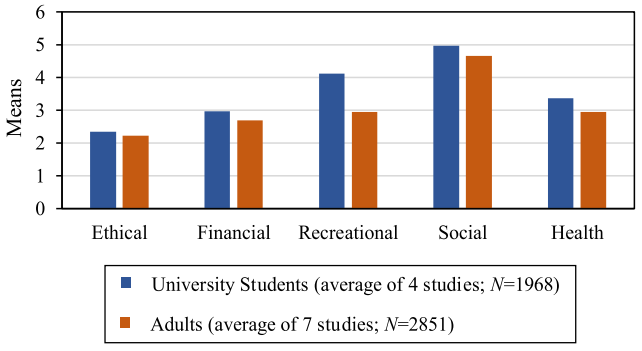

Fig. 1. Means for risk taking across age group and domains using DOSPERT-30, with a 7-point scale. Participant age ranges for each study are listed in the Appendix.

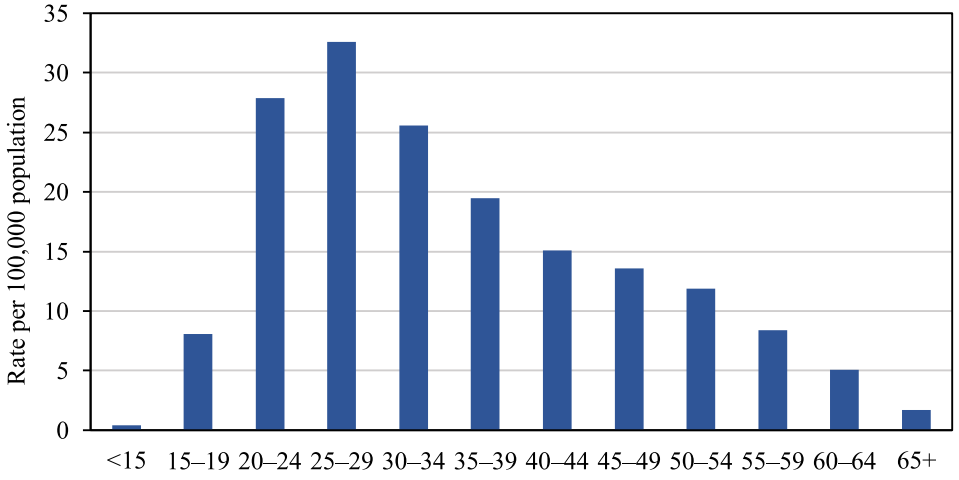

Fig. 2. Rates of diagnoses of HIV infection at age at diagnosis in the United States in 2018. Data retrieved from Centers for Disease Control and Prevention (2020c). HIV Surveillance Report, 2018 (Updated); vol. 31. http://www.cdc.gov/hiv/library/reports/hiv-surveillance.html.

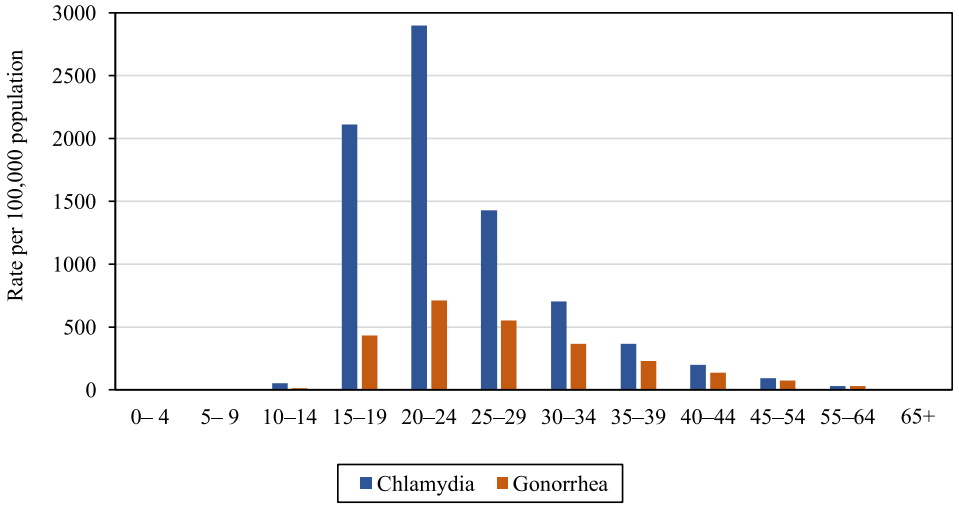

Fig. 3. Diagnosis rates per 100,000 population by age groups for chlamydia and gonorrhea in 2017 in the United States. Data retrieved from "Sexually transmitted disease surveillance" by Centers of Disease Control and Prevention (2018). cdc.gov/std/stats17/tables/10.htm for chlamydia and from "Sexually transmitted disease surveillance" by Centers of Disease Control and Prevention (2017). cdc.gov/std/stats17/tables/21.htm for gonorrhea. While rates are lower for Canada, the age group pattern is the same.

unintentional injuries in hospital emergency departments in 2018, in contrast to 8.25% of youth aged 15–19 – see Fig. 6. Although these data show an increase from childhood to adolescence, in the context of other age groups, adolescents are not unique in their unintentional injuries –in fact, emerging adults have slightly higher rates. Not surprisingly, older adults have the highest rates of unintentional injuries (primarily due to falls).

The DOSPERT scale of financial risk-taking encompasses questions on both gambling and risky investing. Gambling, in particular, can lead to a range of serious consequences for youth (e.g., addiction, financial problems, social consequences, etc.; Langham et al., 2015). Technology has permitted increased opportunities for underage gambling with the creation of online opportunities (Calado, Alexandre, & Griffiths, 2017; Griffiths & Parke, 2010). Several national studies in the U.S. and Canada have found that the prevalence of past year gambling among adolescents is over 40% (Calado et al., 2017; Huang & Boyer, 2007; Welte, Barnes, Tidwell, & Hoffman, 2008). In one large national sample from the UK in 2019, the prevalence of online gambling across age groups was compiled, from adolescents to older adults – see Fig. 7. Over 15% of youth aged 16 to 24 engaged in online gambling in the past month; however, the highest gambling prevalence (28%) was found among adults aged 45–54 years old population.

Two other domains of risk taking that are less extensively covered within the DOSPERT are substance use and criminal activity. Below, we highlight some current national data on these two domains across age groups.

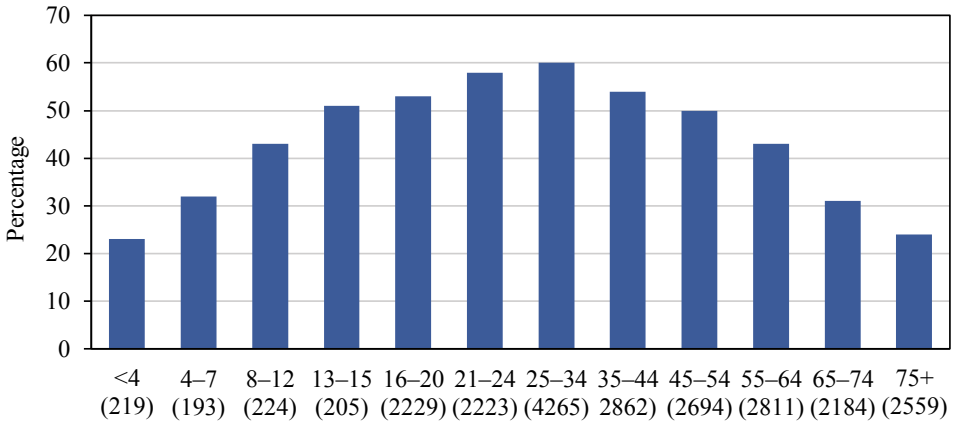

Fig. 4. Age distribution for percentage of passenger vehicle occupants killed that were unrestrained in the United States 2018. Data retrieved from "Passenger vehicles: 2018 data (Traffic Safety Facts. Report No. DOT HS 812 962)" by National Center for Statistics and Analysis (2020). National Highway Traffic Safety Administration. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812962.

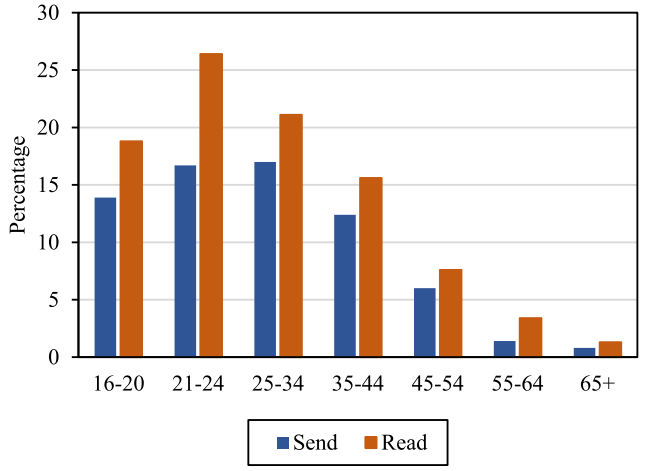

Fig. 5. Age distribution for percentage of at least sometimes sending and reading text messages and e-mails while driving in the United States 2015. Data retrieved from "National survey on distracted driving attitudes and behaviors – 2015 (Report No. DOT HS 812 461)" by Schroeder, Wilbur, and Peña (2018). Washington, DC: National Highway Traffic Safety Administration.

Substance use

Binge drinking. According to the Centers for Disease Control and Prevention, excessive drinking (i.e., binge drinking or heavy weekly drinking) is a costly and dangerous pattern of alcohol use, resulting in more than 95,000 deaths annually in the United States (Centers for Disease Control and Prevention, 2019; Sacks, Gonzales, Bouchery, Tomedi, & Brewer, 2015; Stahre, Roeber, Kanny, Brewer, & Zhang, 2014). Binge drinking is generally defined as consuming more than five drinks on a single occasion. The highest prevalence of binge drinking occurs in emerging adults (23–24 years; see Fig. 8; Johnston et al., 2019, 2017; Schulenberg, Johnston, O'Malley, Bachman, Miech, & Patrick, 2020), while adolescents represent a relatively low proportion of binge drinkers. Of course, in the U.S. legal drinking age is 21 so it may not be a surprise that emerging adults engage in binge drinking more than adolescents; however, data from Monitoring the Future (a nationally representative sample in the US) indicates that adolescents (grades 8, 10, and 12) had the *lowest* prevalence of binge drinking in 2018, compared to *all other older age groups*, including 60-year-olds (Johnston et al., 2019; Schulenberg et al., 2020).

Cannabis use. The same pattern of age group findings that we observed for binge drinking is found with the prevalance of smoking cannabis. Adolescents have the *lowest* prevalence of smoking cannabis in 2019, compared to *all other older age groups*, with the exception of adults aged 45 years and older – see Fig. 9.

Vaping and smoking. Vaping (i.e., use of electronic cigarettes) has become one of the most common tobacco-use methods among youth (Gentzke et al., 2019). Of concern, Marynak et al. (2017) found that over 98% of vapes sold in the United States contain nicotine; thus, the Centers for Disease Control and Prevention (CDC, 2020a) has warned that vaping is unsafe. According to the Canadian

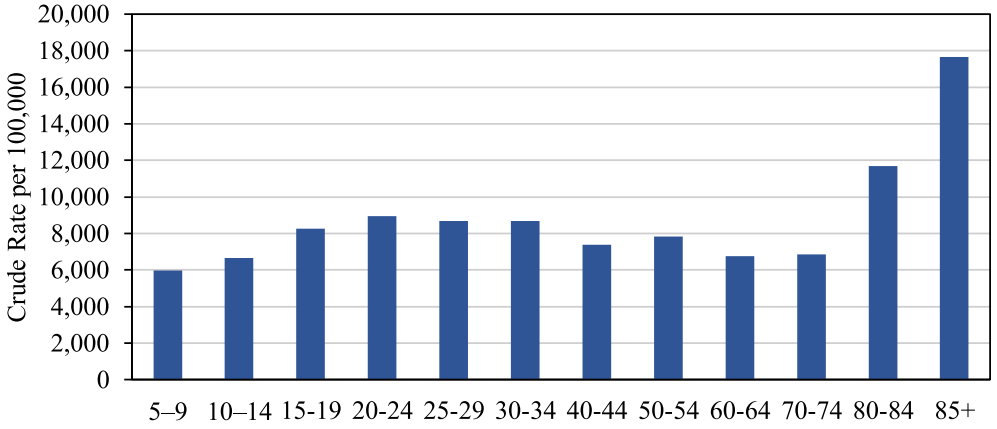

Fig. 6. Age distribution for rate of hospitalizations due to unintentional injuries per 100,000 population in the United States 2018. Data retrieved from "Web-based Injury Statistics Query and Reporting System Nonfatal Injury Reports 2000–2018" by the Centers for Disease Control and Prevention (2020b). https://webappa.cdc.gov/sasweb/ncipc/nfirates.html.

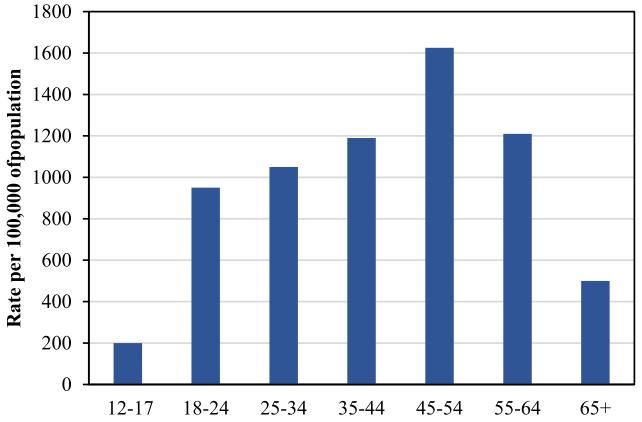

Fig. 7. Age distribution for prevalence of gambling in the past four weeks in Great Britain 2019. Data retrieved from "Gambling participation in 2019: Behavior, awareness and attitudes Annual report" by Gambling Commission in Great Britain (2020). https://www.gamblingcommission.gov.uk/PDF/survey-data/Gambling-participation-in-2019-behavior-awareness-and-attitudes.pdf

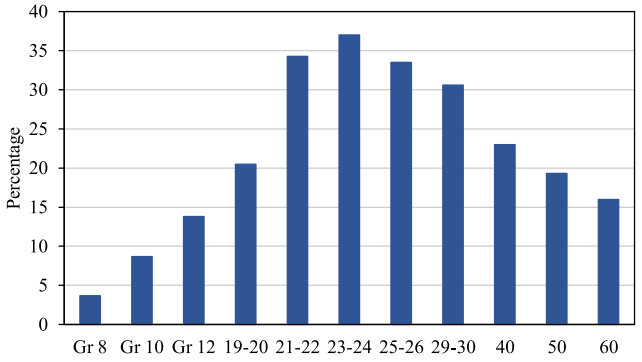

Fig. 8. Age distribution for 2-week prevalence of binge drinking five or more drinks in a row in the United States in 2018. Data retrieved from "Monitoring the Future Survey (1995–2019)" by National Institute on Drug Abuse (2019). https://www.drugabuse.gov/drug-topics/trends-statistics/monitoring-future

Tobacco and Nicotine Survey (2019), youth 15–24 have the highest prevalence of *daily* vaping (~5%) compared to older age groups (<2.4%; Statistics Canada, 2019). Youth aged 15–19 and 20–24 also have the highest prevalence of vaping in the past 30 days, compared to adults over the age of 25 (see Fig. 10). Comparatively, adults over the age of 20 have a higher prevalence of smoking

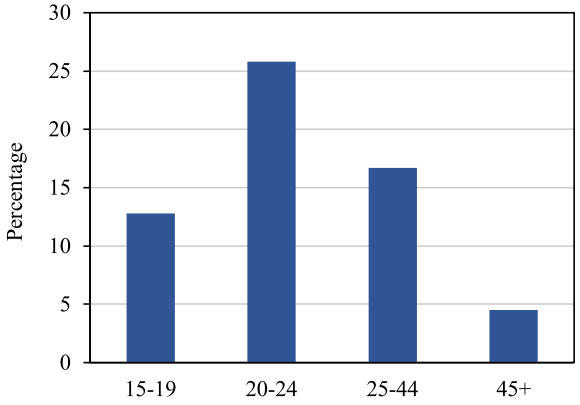

Fig. 9. Age distribution for prevalence of smoking cannabis in the past 30 days in Canada 2019. Data retrieved from "Canadian Tobacco and Nicotine Survey (CTNS): 2019 detailed tables" by Statistics Canada (2019) (2019). https://www.canada.ca/en/health-canada/services/canadian-tobacco-nicotine-survey/2019-summary/2019-detailed-tables.html

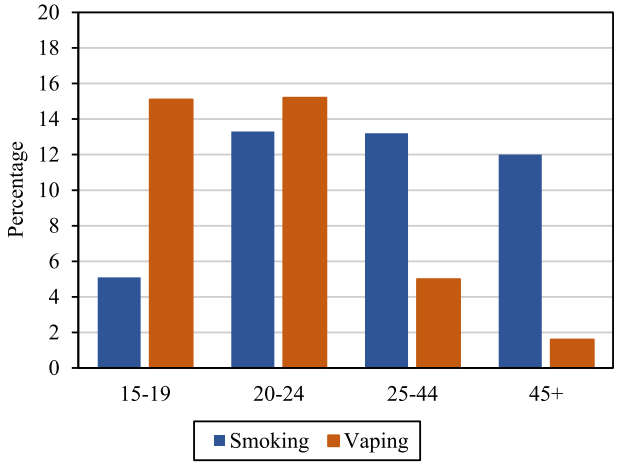

Fig. 10. Age distribution for prevalence of smoking cigarettes and vaping in the past 30 days in Canada 2019. Data retrieved from "Canadian Tobacco and Nicotine Survey (CTNS): 2019 detailed tables" by Statistics Canada (2019) (2019). https://www.canada.ca/en/health-canada/services/canadian-tobacco-nicotine-survey/2019-summary/2019-detailed-tables.html

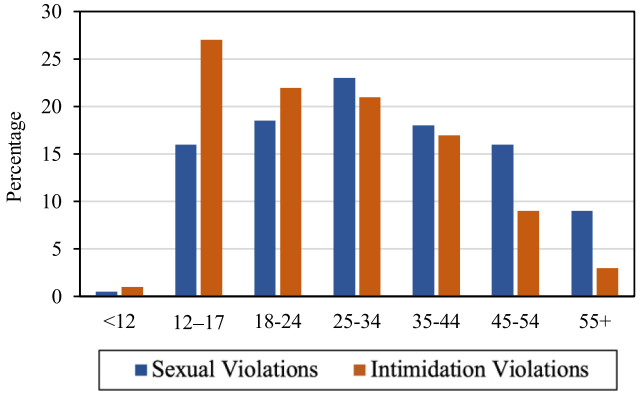

Fig. 11. Age distributions for persons accused of cyber-related sexual and intimidation violations in Canada 2012. Data retrieved from "Police-reported cybercrime in Canada, 2012" by Mazowita and Vézina (2014). Juristat: Canadian Center for Justice Statistics, 1.

cigarettes in the past 30 days than adolescents between the ages of 15 and 19. Therefore, although adolescents are less likely to smoke cigarettes compared to older age groups, they are more likely to vape than adults. The emerging adults, however, remain the group that stands out for their high engagement in both of these forms of risk-taking.

Criminal activity

Criminal activity – both minor (e.g., vandalism) and major (e.g., homicide) – is another domain that is less extensively covered in the DOSPERT, but that is critically important to examine when considering differences in risk-taking between adults and adolescents. Notably, age is one of the most robust predictors of delinquency and criminal activity (Hirschi & Gottfredson, 1983; Steffensmeier, Allan, Harer, & Streifel, 1989). A steep increase in criminal activity tends to occur in adolescence, peaking around age 18 or in the 20s, depending on the type of activity, and then declining throughout adulthood. For example, in 2012 adolescents aged 12–17 were more likely to be accused of cyber-related intimidation violations (i.e., threat of violence against a person) than all other age groups - see Fig. 11. This finding is consistent with a great deal of research indicating elevated levels of cyber-aggression among adolescents (e.g., Cappadocia, Craig, & Pepler, 2013; Modecki, Minchin, Harbaugh, Guerra, & Runions, 2014; Sugarman & Willoughby, 2013).

Adolescents aged 18 years had the highest rates of arrests for property crime, which includes burglary, larceny-theft, motor vehicle theft and arson (see Fig. 12). For violent crimes (e.g., homicide, robbery, aggravated assault), the age peak for arrests was 21–29 years of age (with 18- to 20-year-olds close behind), while for simple assault the peak was 25–29. Overall, therefore, these arrests clearly show steep increases in adolescence, but the *peak* is found only in adolescence for cyber-related intimidation violations and property crime. The peak arrests for violent crime and simple assaults, however, are in emerging adulthood. Even for aggressive-behaviors that are thought to be more typical of youth (e.g., hitting or kicking someone, teasing or swearing at someone), university students (i.e., emerging adults) report higher frequency of these behaviors than children and high school students (Willoughby, 2020) – see Fig. 13.

While crime is often lamented as a problem of youth, adults engage in some types of criminal activity more than adolescents. For example, adults are more likely than adolescents to be accused of sexual violations against a person (see Fig. 11). Adults also are much more likely than adolescents to engage in fraudulent activities. One recent study (Association of Certified Fraud Examiners, 2020) found that the age distribution of adults engaging in occupational fraud was bell-shaped, with 53% of the perpetrators between the ages of 31 and 45 – see Fig. 14.

Further considerations

A key point to keep in mind is that how we define the adolescent age period makes a difference. If we do not define adolescence as we did in this paper (i.e., 11–18 years), but instead define adolescence as 11–25 years (e.g., Sawyer, Azzopardi, Wickremarathne, & Patton, 2018; Steinberg, 2014), then *adolescence* can be thought of as a time of heightened risk taking. We argue, however, that it is important to distinguish between the high school years and the 20s given their different contexts and expectations. The 20s currently tend to be a transitional period of identity exploration (i.e., exploring careers, self-reflection, developing intimate relationships), instability (e.g., frequent residential moves; instability in love and work), and feeling "in-between" (i.e., neither adolescent nor adult, as lasting commitments in love and work often now are delayed until the late 20s) (Arnett, 2000), which in earlier times might have occurred in the high school years. Furthermore, if we combined 11–18 year olds with emerging adults in their 20s, pertinent information (e.g., risk factors, prevalence, etc.) would be lost. Indeed, evidence from this review highlights that these age groups are not uniform in their risk-taking behaviors.

There also may be historical trends over time that can complicate our understanding of which age groups are most likely to engage in different types of risk taking. Indeed, past data on prevalence rates may no longer be reflective of the current generation; thus,

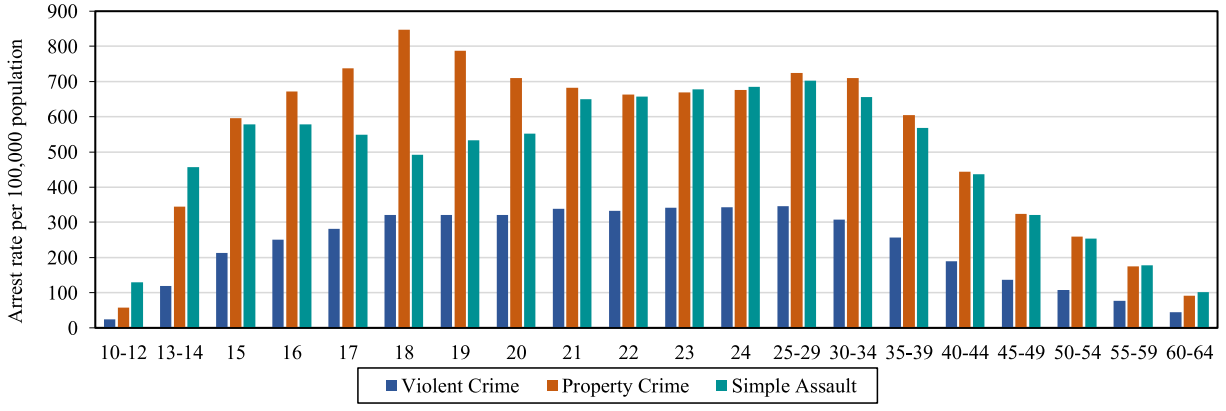

Fig. 12. Age distribution for rate of arrest trends for violent crime, property crime, and simple assault per 100,000 population in the United States 2019. Data retrieved from "U.S. Department of Justice, Statistical Briefing Book" from U.S. Office of Juvenile Justice and Delinquency Prevention (2020). https://www.ojjdp.gov/ojstatbb/.

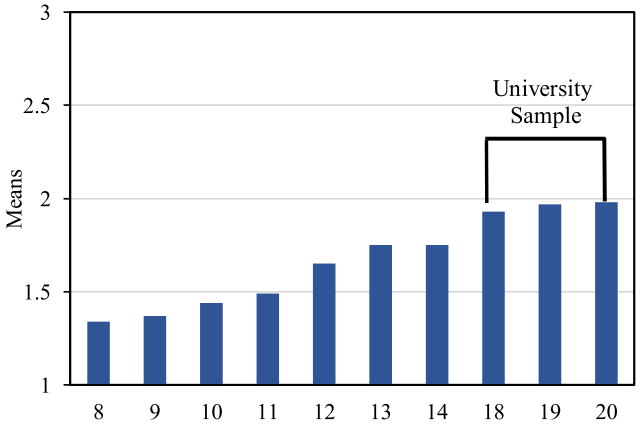

Fig. 13. Age distribution for mean levels of direct aggression in a community sample of 1284 youth in Canada (ages 8 to 14 years) and a sample of 1132 university students (ages 18 to 20 years) in the same region as the youth, on a 5-point scale from 1 = never to 5 = every day. Willoughby (2020) unpublished raw data.

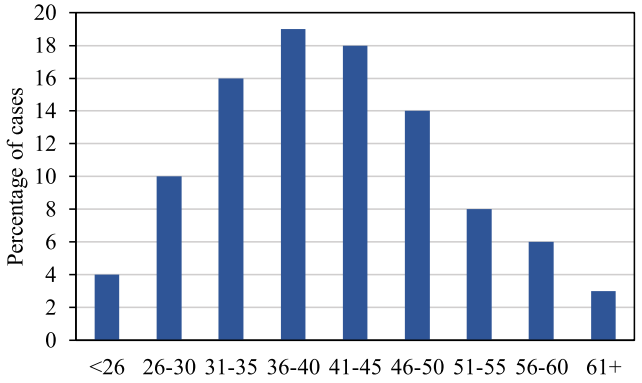

Fig. 14. Age distribution for prevalence of occupational fraud in the United States 2019. Data retrieved from "Report to the Nations: 2020 global study of occupational fraud and abuse" by the Association of Certified Fraud Examiners (2020). https://acfepublic.s3-us-west-2.amazonaws.com/2020-Report-to-the-Nations.pdf.

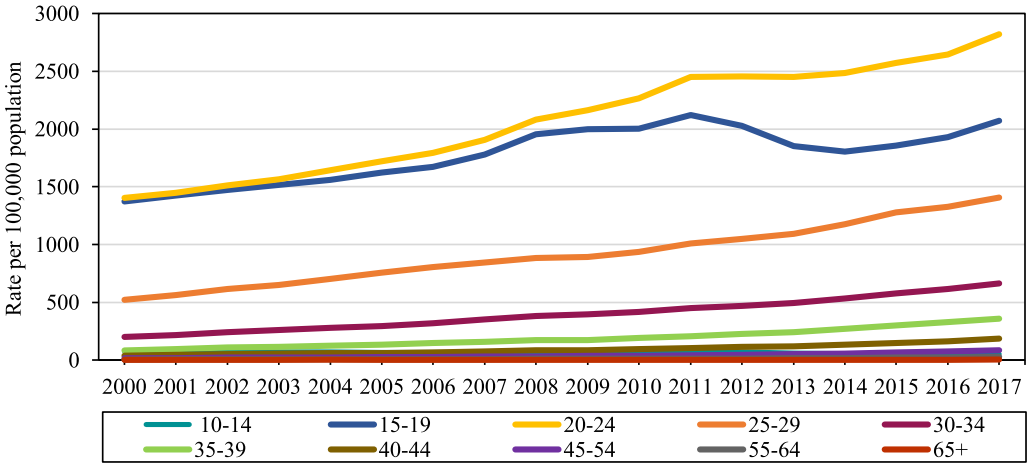

Fig. 15. Chlamydia diagnosis rate per 100,000 population by age groups in United States from 2000 to 2017. Reporting of chlamydia cases was not required in the U.S. until 2000. Data retrieved from "Sexually transmitted disease surveillance" by Centers for Disease Control and Prevention. (2000–2017). https://www.cdc.gov/std/stats17/default.htm.

reliance on this earlier data and on conclusions made in the past may inaccurately classify the current prevalence of risk-taking behaviors among different age groups. We explore this idea in the next section.

Historical trends over time

Types of risk-taking behaviors can change rapidly across history. For example, cross-sectional results from the Monitoring the Future study indicates that the prevalence of vaping in the past 30 days among adolescents increased rapidly from near zero in 2011 to 20% for 12th graders, 16% for 10th graders, and 6% for 8th graders in 2018 (Miech, Patrick, O'Malley, Johnston, & Bachman, 2020). Due to current technological advances, common risk behaviors today that were not present earlier also include cyber-related intimidation violations and texting while driving, although the broader issue of distracted driving is not new.

Historical *cross-sectional* data indicate that the prevalence of many types of risk-taking behaviors have changed significantly over time – and in different patterns for adolescents as compared to other age groups. For example, chlamydia has increased across almost all age groups over the last 20 years – see Fig. 15. Adolescents aged 15–18, however, were unique in experiencing a significant *decline* in rate of infection from 2011 to 2014. In contrast, gonorrhea remained stable across most age groups from 1997 to 2011 but then has started to increase since 2014 - see Fig. 16. Adolescents and emerging adults aged 15–24 years, however, both generally experienced declines in rate of infection from 1997 to 2014, particularly adolescents; in fact, so much so that emerging adults aged 25–29 years surpassed adolescents in rates of infection starting in 2014. These trend-level changes (both increases and declines) likely have multiple causes, such as expanded use of more sensitive diagnostic tests (during 2000–2011) and screening coverage, more complete reporting, as well as actual changes in incidence of infection likely because of poverty, drug use, stigma, decreased condom use, and recent budget cuts to local programs in the U.S. that support screening and follow-up care (Centers for Disease Control and Preventions, 2018, 2019b). Even more dramatic are the extensive fluctuations in rate of gonorrhea infection when one looks at the period from 1941 to 2017 - see Fig. 17. The sexual revolution of the 1960s likely was a reason for the increase in gonorrhea during that time, while the AIDS epidemic likely contributed to the decline in gonorrhea starting in 1981, which resulted in more condom use and less sexual activity (Peterman, O'Connor, Bradley, Torrone, & Bernstein, 2016). For example, from 1988 to 2011–2015, sexual activity declined sharply among U.S. adolescents aged 15–19 - the percentage of never-married adolescents who reported ever having sexual intercourse declined from 51.1% in 1988 to 42.4% in 2011–2015 for females, and from 60% to 44% for males (Abma & Martinez, 2017). Moreover, there was a decline in the proportion of adolescents relative to adults starting in 1980, which also may have contributed to the decline – see further discussion of this factor in the later section on declines in criminal activity.

In fact, the prevalence of the majority of risk-taking behaviors has declined over time. For example, binge drinking has declined from 1995 to 2019 among high school students (Goings et al., 2019; Johnston et al., 2019), while trends among 23- and 24-year-olds and older adults have remained stable or increased (see Fig. 18; Schulenberg et al., 2020). Indeed, several nationally representative studies have found that the largest trend-level increase in binge drinking is among adults over the age of 35 (Grant et al., 2017; Grucza et al., 2018). Researchers examining the decline in adolescent alcohol use suggest that the change may be associated with decreases in the frequency of adolescent face-to-face contact with peers in the evenings since 1980 (thus reducing opportunities for alcohol use), perhaps as a result of increased parental monitoring (see De Looze et al., 2017, 2019; Twenge, 2017). The decline in alcohol use also is associated with declines in smoking, unprotected sex, and delinquency (Borodovsky, Krueger, Agrawal, & Grucza, 2019).

Youth crime also has dramatically declined since the late 1980s/1990s. See Figs. 19–22 which show large declines for property crimes, simple assaults, and violent crime from the late 1980s/early 1990s to 2019, particularly among adolescents. In fact, homicide has declined worldwide since the Middle Ages but there have been large fluctuations over time (e.g., homicide rates declined in the U. S. between 1933 and 1964, increased again in the 60s and 70s, and then again declined starting in 1991 and continuing today; Eckberg, 1995). The current homicide decline which started in 1991 is a pattern that is being experienced in many countries (although there are steeper declines in the Western world), with the exception of Latin America (Rennó Santos et al., 2021).

There are no universally accepted explanations for the recent declines in crime. Several hypotheses have been proposed, particularly for the U.S., from greater policing and incarceration, economic factors, enhanced security devices, to lower alcohol and crack use, among others (e.g., Bunge, Johnson, & Baldé, 2005; Latzer, 2016), and likely a complex interaction among some or all of them (Blumstein & Wallman, 2006). While these explanations might account for some of the decline over time in specific countries such as the U.S. (and likely explain why some countries have higher homicide rates than others), they cannot explain the worldwide decline in homicide rates as countries differ widely in their approach to social justice, in their economic stability, vulnerability to the crack epidemic, etc. (Rennó Santos et al., 2021). For example, both Canada and U.S., although differing widely in the number of homicides, have similar rate declines since 1991 (see Fig. 23) yet differ in social justice approach, vulnerability to crack epidemic, exposure to Vietnam War, etc.

A prominent explanation that may better account for the current worldwide decline in homicide rates is the greying of the world population (e.g., Latzer, 2016; Rennó Santos, Testa, Porter, & Lynch, 2019). There has been a large increase in adults aged 25 and over in Canada and the U.S. due to the aging of the Baby Boom generation born after the Second World War, life expectancy improvements, the decline in fertility rates, etc. (Cutler & Meara, 2004). Fig. 23 highlights the change between 1960 and 2019 in the prevalence of different age groups in the U.S. population. The result of this change over time is that the adolescent population has increasingly become a smaller proportion of the U.S. population. As populations become older it is thought that societies become more peaceful and law-abiding (Brooks, Brooks, Greenhill, & Haas, 2019). Some criminologists argue that the decline in homicide rates is because of the increasingly smaller proportion of adolescents in comparison to the rest of the population, given that youth have the highest rates of criminal activity (e.g., Rennó Santos et al., 2019). In fact, Fig. 24 showing the fluctuation in homicide over time, and Fig. 18 showing the fluctuations in gonorrhea over time, demonstrate how the fluctuations in some behaviors in the U.S. follow the proportion of 15- to

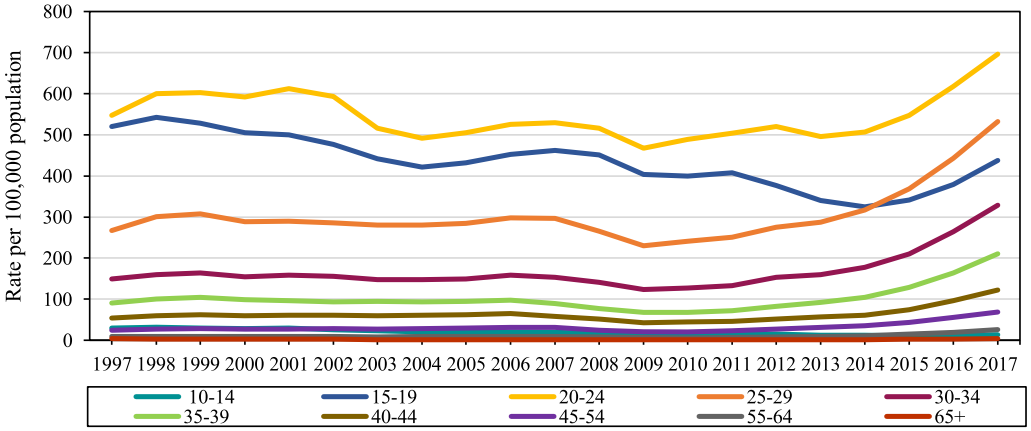

Fig. 16. Gonorrhea diagnosis rate per 100,000 population by age groups in United States from 1997 to 2017. Data retrieved from "Sexually transmitted disease surveillance" by Centers for Disease Control and Prevention. (1997–2017). https://www.cdc.gov/std/stats17/default.htm.

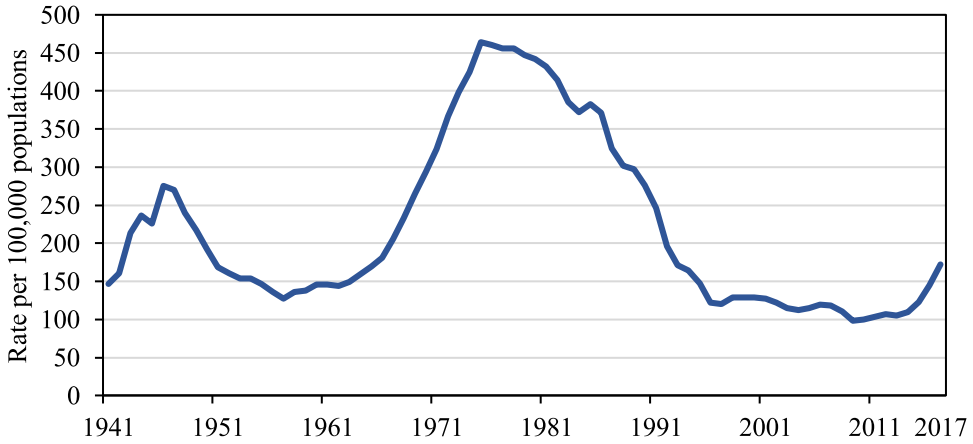

Fig. 17. Rate of gonorrhea per 100,000 population from 1941 to 2017. Data retrieved from "Sexually transmitted disease surveillance" by Centers for Disease Control and Prevention. (1941–2017). https://www.cdc.gov/std/stats17/default.htm.

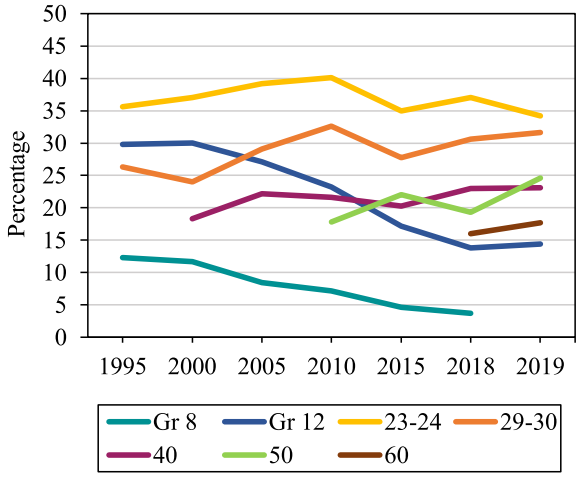

Fig. 18. Prevalence of Binge Drinking Trends by Age Group in the United States from 1995 to 2019. Data retrieved from "Monitoring the Future Survey (1995–2019)" by National Institute on Drug Abuse. https://www.drugabuse.gov/drug-topics/trends-statistics/monitoring-future.

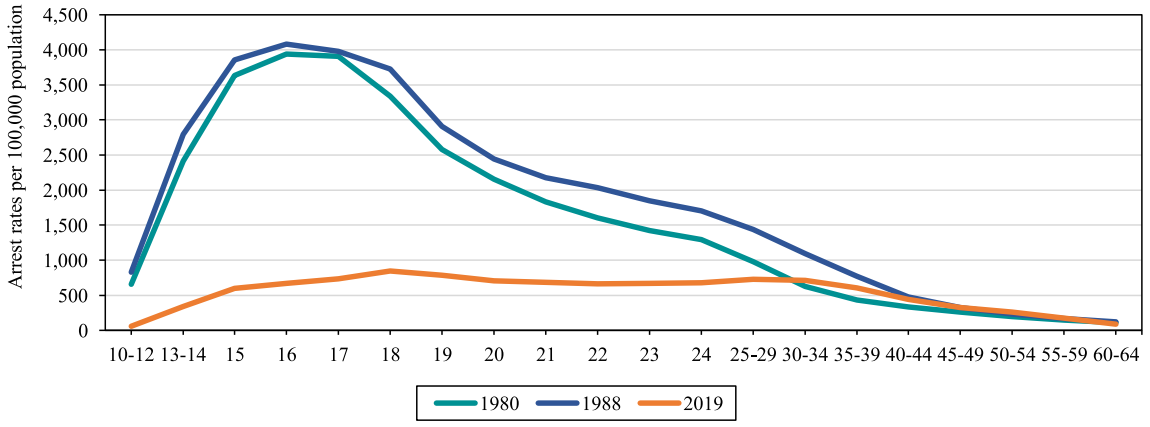

Fig. 19. Arrest rates per 100,000 population for property crime (burglary, larceny-theft, motor vehicle theft and arson). Data retrieved from "U.S. Department of Justice, Statistical Briefing Book" from U.S. Office of Juvenile Justice and Delinquency Prevention (2020). https://www.ojjdp.gov/ojstatbb/.

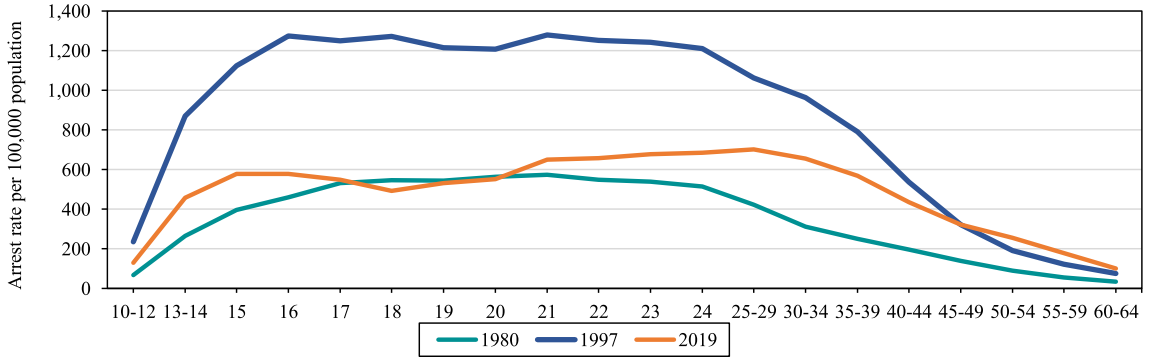

Fig. 20. Arrest rates per 100,000 population for simple assaults (e.g., attempting to do a serious bodily harm to someone – a misdemeanor. Data retrieved from "U.S. Department of Justice, Statistical Briefing Book" from U.S. Office of Juvenile Justice and Delinquency Prevention (2020). https://www.ojjdp.gov/ojstatbb/.

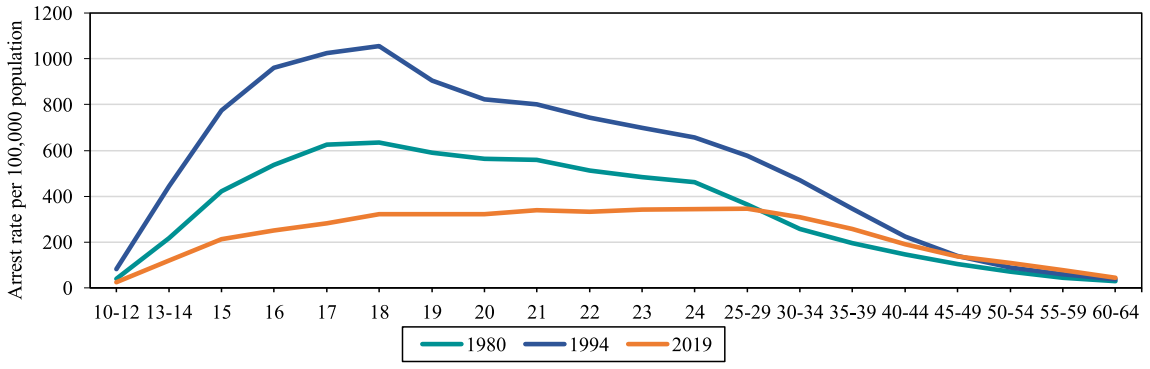

Fig. 21. Arrest rates per 100,000 population for violent crimes (e.g., homicide, robbery, aggravated assault). Data retrieved from "U.S. Department of Justice, Statistical Briefing Book" from U.S. Office of Juvenile Justice and Delinquency Prevention (2020). https://www.ojjdp.gov/ojstatbb/.

29-year-olds in the population. And given the current low birth rates, the youth population will likely continue to be small for some time, unless immigration levels increase significantly. Further, with the declining fertility rate, family sizes are smaller now than in 1960. According to Romer (2019), fewer children in the home means that parents have more time to spend with each child, likely resulting in lower youth problem behavior. Youth also would have less exposure to delinquent peers and siblings who model antisocial behavior.

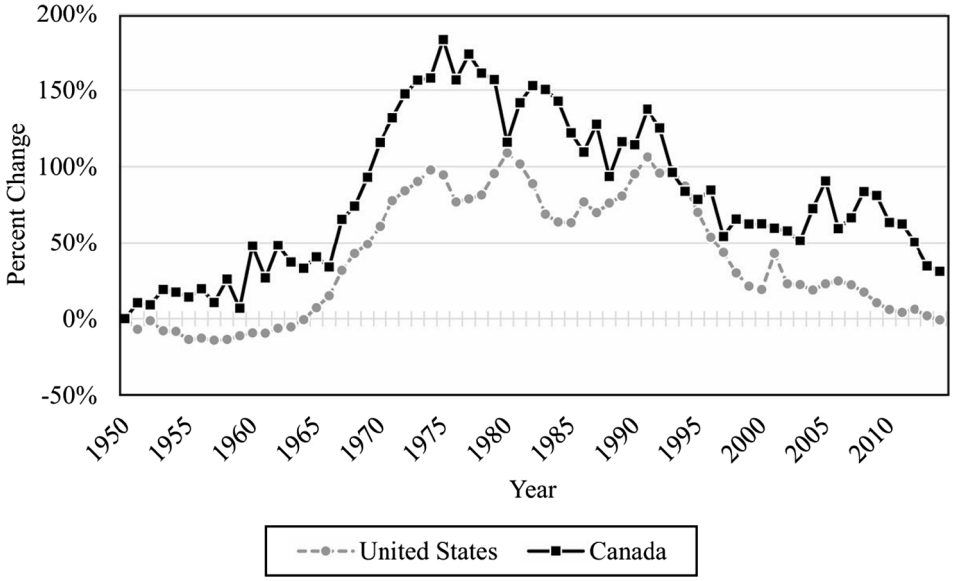

Fig. 22. Percent change in the homicide rate in the United States and Canada from 1950 to 2015. Data retrieved from Age, Period and Cohort Differences Between the Homicide Trends of Canada and the United States by Rennó Santos, Lu, and Fairchild (2021). The British Journal of Criminology.

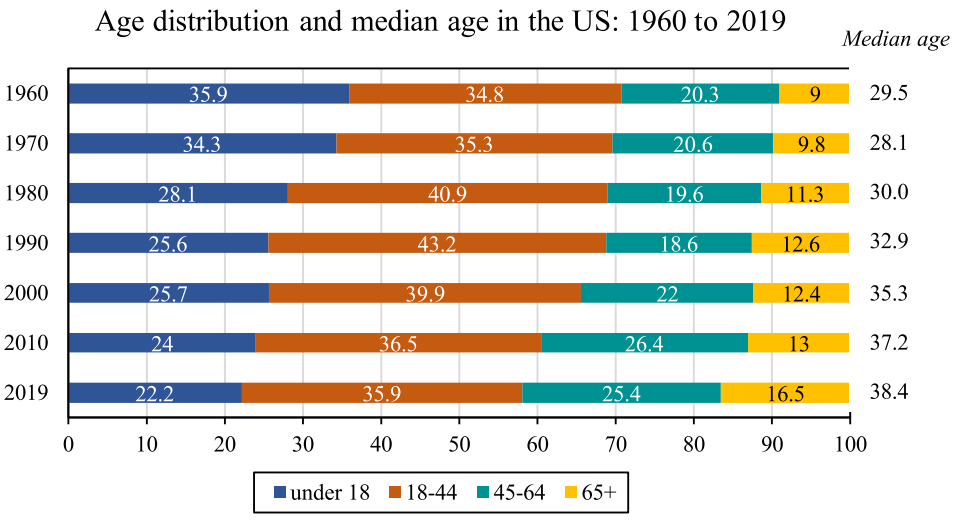

Fig. 23. Sources: U.S. Census Bureau. Numbers in graph are in percent.

One take-home message from all of these trend-level changes over time is that the current prevailing view that adolescence is a period of "heightened" risk taking likely is a carryover from an earlier time when that was sometimes true - for example from 1970 to 1990 when many forms of crime, STD rates, etc. peaked in adolescence or did not differ from emerging adulthood. Although even then there were differences depending on the type of risk behavior. For example, current rates of simple assault are similar to the 1980s, but both are much lower than the 1990s. In addition, these fluctuations over time drive home the point that prevalence rates of risk taking across type of behavior, age, and historical time period are not static, and should be assessed by researchers in order to gain a better theoretical and practical understanding of adolescent risk taking.

In fact, as Sweeten, Piquero, and Steinberg (2013) argue, age is just a proxy for a developmental process. Sweeten et al.'s longitudinal study of high-risk youth indicated that much of the age-related change in crime activity in their sample was associated with concurrent changes in exposure to antisocial peers and peer pressure. Indeed, having a smaller proportion of adolescents in comparison the rest of the population would result in exposure to fewer antisocial youth. Of course, there are multiple societal (e.g., declining fertility rate, increasing life expectancy, pandemic), sociological (e.g., social bonds, opportunity), and psychological factors (self-control, sensation-seeking) that covary with age and risk-taking activity (Greenberg, 2008). Attention to which time-varying factors

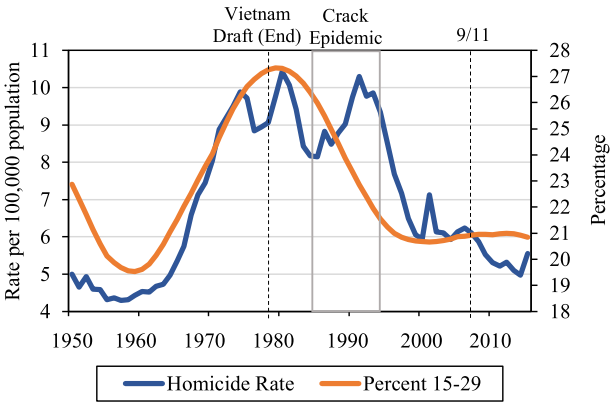

Fig. 24. Rate of homicide per 100,000 population and percent conducted by individuals between the ages of 15–29 in the United States from 1950 to 2015. Data retrieved from "Age, period and cohort differences between the homicide trends of Canada and the United States" by Rennó Santos, Lu, and Fairchild (2021). The British Journal of Criminology.

account for the age effect is important. One cannot intervene to reduce crime activity among youth if age is thought to be the primary "cause" of criminal activity as age cannot be changed.

Decisions about whether or not to engage in risk-taking is driven by individual-, situation-, and social/cultural-level characteristics, and, importantly, their interaction (e.g., Ciranka & van den Bos, 2021; Figner & Weber, 2011). Formal integrative theoretical models that consider multiple levels of influences (including individual, situation, and social/cultural), therefore, will be critically important in order to better understand why, when, and for whom, risk-taking is heightened at various stages of the lifespan, and in different domains. For instance, the Developmental Neuro-Ecological Risk-taking Model (DNERM; Defoe, Dubas, & Romer, 2019; Defoe, this issue) may be particularly useful. The DNERM focuses on the interaction between ecological factors (i.e., opportunity to engage in risk-taking) and individual factors (i.e., self-control) in the prediction of risk-taking behavior. This model specifically is focused on understanding adolescent risk-taking (encompassing ages 11–24) in the domains of substance use and antisocial behavior, but it could be developed to include predictions about which individuals, under which conditions, and at which stages of the lifespan, may be more or less likely to engage in various domains of risk taking.

In terms of individual-level characteristics, factors such as propensity towards sensation-seeking, emotion regulation, self-control, and the perception of greater risks versus rewards of any given risk behavior impact the likelihood of risk taking (e.g., Byrnes, 1998; Zuckerman, 2007). Situation-level factors such as whether a specific risk-taking decision is driven by deliberative (i.e., "cold") or affective (i.e., hot) psychological processes also play a role (e.g., Figner et al., 2009; Prencipe et al., 2011). Social/cultural factors (e.g., age-based norms, structural constraints, opportunities) have a strong impact on the way in which individual and situation-level characteristics play out across the lifespan (e.g., Duell et al., 2016). A consideration of the interaction between individual-, situational-, and social/cultural factors may help explain not only why some risk-taking behaviors are more prevalent at certain ages than others, but also why emerging adulthood is when many risk-taking behaviors are most prevalent in Western societies.

For example, some of the key cultural/social-level characteristics of the stage of emerging adulthood can help explain why emerging adults are more likely than other age groups to engage in many types of risk-taking behaviors (Arnett, 2004). Most importantly, in North America, social control (i.e., adult roles and relationships that discourage risk behavior - such as permanent jobs, marriage, and parenthood) is low during emerging adulthood. Emerging adults also don't experience high parental monitoring – a factor that is still very relevant in the lives of adolescents (and has been increasing in recent decades, see Twenge, 2017). Low social control would also influence the perception of risks versus rewards – tipping the scale in favour of perceived rewards. There is little risk involved in a drunken night out when one is old enough to not have to worry about being punished by parents, but young enough that there is no concern about getting up the next morning for a job or to get a child ready for school. Thus, the interaction between individual (e.g., low self-control) and cultural/social level factors may explain why emerging adults are particularly prone to engage in risk-taking – particularly in situations where these decisions are made at the affective ("hot") level.

However, for other types of situations (e.g., deliberative risk-taking that requires large amounts of financial resources, such as tax fraud or investing in a highly volatile stock), it may be the wealthy 50-year-old financier who is most "vulnerable". In yet other domains, such as social risks, adolescents may be particularly sensitive to peer exclusion, and thus engage in behaviors that minimize the risk of rejection from peers (e.g., Blakemore, 2018). Murray et al. (this issue) also emphasize that different domains of real-world risk-taking behaviors have different peak ages for involvement.

Using this interactional framework also has the advantage of not portraying all individuals in the same stage of life as having the same risk propensity within a domain. Indeed, some emerging adults may be at very low risk for delinquency – for example, those who choose to pursue adult roles such as marriage and parenthood, or those with very low impulsivity/sensation seeking. Similarly, a 45-year-old who is very impulsive and has not taken on many adult roles, may be a concern in terms of risk for engaging in criminal behavior.

Conclusions

It is clear that adolescence (ages 11–18) is *not* an age period of overall "heightened" risk taking. When examining risk taking across multiple domains and across different age groups, it was only cyber-related intimidation violations, aggression, and property crime that peaked in adolescence (and it was only late adolescence for property crime – i.e., 18 years). Yet despite the historical trend-level decreases among youth in many risk behaviors, our perceptions of adolescence as a time of 'heightened risk taking' has remained quite stable. It will be important to adjust our narrative to better reflect the current generation of youth. Using data from Monitoring the Future, Twenge and Park (2019) suggested that, in many ways, 17-year-olds in the current generation are more like thirteen year-olds were thirty years ago. For example, they reported that high school seniors in 2010–2016 reported "going out without parents" about as many times per week as eighth graders did in 1990–1994. Among the current generation, then, activities done outside of the company of parents (i.e., which would include most types of risk-taking), may begin ramping up only as adolescents graduate from high school, whereas in generations past these activities would have increased more rapidly near the start of high school. Thus, it is perhaps not surprising that "heightened risk taking" in a more global sense (i.e., high levels of engagement across multiple domains) would shift from high school to college/university. It may be more informative to discuss adolescence as the *onset* of many risk-taking behaviors or refer to specific types of behaviors in which adolescents actually do have the highest levels of risk taking, with reference to current data. Further, given that the differences in prevalence rates of risk taking across age groups (i.e., adolescents, emerging adults, adults) sometimes appear to be quite small, when considering what is unique about adolescent risk-taking it will be important to compare adolescent and emerging adult risk taking to risk taking that occurs in adulthood.

Nevertheless, although evidence supports moving away from the notion that adolescence is a *heightened* period of risk taking, risk taking among adolescents is still an important topic. As noted above, adolescence clearly is the age period when individuals *begin* to engage in many risk-taking behaviors. Also, to say that adolescents are not the ones engaging in the *most* risk-taking should not avert attention from the real and serious consequences that can result from maladaptive risk-taking. For example, over 15% of grade 12s reported that they engaged in binge drinking in the past 2 weeks (Fig. 8). Over 14% of adolescents read or sent text messages while driving in the past 30 days (Fig. 5) and 40% of adolescents who died in traffic car accidents were not wearing seatbelts (Fig. 4). A deeper understanding of adolescent risk taking is critical to help decrease some of the potentially devastating consequences that can result from these risks.

Although our review covered a wide range of risk-taking behaviors, both currently and historically, there are a number of limitations worth noting. First, our focus is on North American data. We expect that age trends in risk-taking behaviors would be similar in Europe given the similarities in the stage of emerging adulthood (as a period of instability, identity, self-focus, etc.) in European countries. On the other hand, trends in our data may not hold in cultures where emerging adulthood is less common. Extensions of this work to other cultures is necessary to gain a better understanding of cross-cultural differences and similarities (see also Defoe, this issue, and Murray et al., this issue).

We also focused exclusively on real-world (as opposed to lab-based) risk taking. The data clearly demonstrate that emerging adults engage in risk-taking behavior more frequently, on average, than adolescents in almost every domain. With real-world data, however, it is not possible to separate age from opportunity to engage in risk-taking; that is, we do not know whether emerging adults engage in more risk-taking behavior due to age-related developmental factors, or simply because they have more opportunities to engage in these risks. While studies on lab-based risk-taking behavior can be limited in terms of ecological validity (e.g., are decisions made in the lab to engage in "risky driving" in a video game comparable to decisions to engage in risky driving in the real world?), such research may provide a window into what age-based differences in risk-taking behavior would be if opportunity to engage in risk-taking behavior is equalized across age groups. A *meta*-analysis of age-group differences in lab-based risk-taking (Defoe, Dubas, Figner, & van Aken, 2015) found that adolescents took more risks than adults (with a medium effect size). Researchers interpreted these findings to imply that, if opportunity to engage in risk-taking behavior was held constant across adolescents and adults, adolescents would engage in more risk-taking. Although the Defoe et al. *meta*-analysis cannot be used to infer differences between adolescents and emerging adults (as participants included in the "adults" group ranged from 20 to 65, with a mean age of 25), it raises an important question of the role of developmental stage/age versus opportunity in the observed real-world differences in risk-taking behavior between adolescents and emerging adults. We suspect it would be difficult to separate these factors – and they may be strongly correlated. However, it would be interesting for researchers to identify, as just one example, groups of emerging adults and adolescents with low versus high opportunities for various domains of risk-taking behavior, and then compare their engagement in risk-taking behavior. Alternatively, researchers could conduct a series of regression analyses where risk-taking behavior in various domains is regressed on age group (adolescents and emerging adults), some measure of opportunity to engage in that domain of risk-taking, and the interaction between these two factors. Observing the unique and interactive variance explained in risk-taking behavior by age and opportunity may be helpful in addressing the question of the interaction between age and opportunity for decisions around risk-taking behavior.

Our attention on maladaptive risk taking is important, but it also is critical to examine adaptive risk-taking behaviors (see Duell & Steinberg's paper in this issue for a review of positive risk taking; also Ciranka & van den Bos, 2021; Ellis et al., 2012). We also did not investigate sex differences among each risk behavior. Given the wide range of behaviors we covered, it was not feasible to include separate graphs for males and females for each type of risk behavior. We also primarily report prevalence ratings; however, there are other factors that are important to consider when investigating types of risk taking, such as the frequency of engagement in each risk behavior.

Our focus in this review on the prevalence of types of risk taking and how they might vary across *age and historical time period* adds a critical dimension to the examination of adolescent risk taking. While many researchers are interested in individual differences in risk taking, we believe an overlooked factor is consideration of how types of behaviors and historical trends in society can impact our

conclusions of which age groups are most susceptible to risk taking. In other words, our understanding of whether adolescence is a heightened period of risk taking requires answering the questions: "For what type of risk taking" and "How does that type of risk-taking behavior change or not change across age and historical time periods?"

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.

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