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ORIGINAL RESEARCH REPORT

Support for Marijuana (Cannabis) Legalization: Untangling Age, Period, and Cohort Effects

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In three large, nationally representative surveys of U.S. 12th graders, college students, and adults (N = 9 million) conducted 1968–2015, Americans became significantly more supportive of legal marijuana (cannabis) starting in the mid-1980's. Hierarchical models using age-period-cohort analysis on the adult (General Social Survey) sample showed that the increased support for legalization is primarily a time period effect rather than generational or age effect; thus, Americans of all ages became more supportive of legal marijuana. Among 12th graders, support for marijuana legalization was closely linked to perceptions of marijuana safety.

Keywords: Cannabis; marijuana; cohort; time; health

Marijuana (scientifically known as cannabis) is considered a Schedule I drug under the Controlled Substances Act of the United States. This classification means that marijuana has no medical benefit and use can lead to abuse. Other Schedule I drugs include lysergic acid diethylamide (LSD) and peyote. Schedule II drugs, purported to have less risk, include methamphetamine and oxycodone. Despite the strong position against marijuana by the federal government, several U.S. states and the District of Columbia have made marijuana legal for medical and/or recreational use. Several other states are in the process of considering similar forms of legalization or decriminalization. Some polls (e.g., Pew Center, 2015) have suggested that Americans have recently become more supportive of legalized marijuana. However, many of these polls cover only recent years or do not have detailed enough coverage in earlier years to detect curvilinear patterns. In addition, the underlying structure of this change remains unclear in at least two ways. First, is increasing support for marijuana legalization due to age, time period, or cohort/generational effects? Second, what role does perceived risk profile of marijuana have to do with support for legalizing marijuana?

Age, Period and Cohort Effects

Support for marijuana legalization can be seen as the outcome of three different effects. *Age effects* refer to changes across lifespan development. So, for example, if young people support legalization, but their support wanes as they grow older, this would be an age effect. This pattern would be consistent with some observations on drug use, which is often more elevated during adolescence and young adulthood, and then declines with age (Chen and Kandel, 1995).

Period effects, sometimes called *cultural effects*, refer to changes across time period. So, with marijuana legalization, it could be that greater tolerance is part of a broader cultural change, such as that found in decreasing trust in government (Twenge et al., 2014) and increasing tolerance for others (Twenge et al., 2015). Indeed, cultural changes in tolerance were correlated with support for marijuana legalization when matched by year (Twenge, et al., 2015). Evidence for a broad cultural change in marijuana legalization would suggest a period effect.

Cohort effects, sometimes called *generational effects*, refer to changes that are associated with birth cohort, or year of birth. If individuals from more recent birth cohorts support marijuana legalization to a greater extent than those from past cohorts, it could be evidence of cohort effects. If this is the case, the increasing acceptance of marijuana would likely be due to *generational replacement*, or the replacing of the current population with members of the next generation.

And, of course, all three of these effects could be occurring at the same time. The challenge is to statistically tease these effects apart. With cross-sectional data such as one-time polls, differences in support by members of different age groups can be caused by either age effects or cohort effects. With over-time data from people of the same age, changes can be due to period or cohort effects.

Fortunately, it is possible to separate the effects of age, period, and cohort using over-time data on multi-age samples (such as the General Social Survey, GSS) and the use of hierarchical linear modeling (HLM) procedures structured for this type of work (called APC analyses; e.g., Yang, 2008). We include such analyses in the present research.

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Perceived Risk of Marijuana

Given that the initial decision to place cannabis as a Schedule I drug was based on its lack of medical benefits and risk of abuse, it is plausible that changes in acceptance of will co-occur with or be driven by a decreased perception of risk. This possibility fits with many of the current political observations and research data. Acceptance of marijuana for medical use has been the first stage of legalization in many states. In 1996, California was the first state to legalize medical marijuana, and at present even socially conservative states like Georgia are legalizing possession of cannabis oil for treating specific ailments.

Studies show a link between use and perceived risk. Marijuana use dropped between the 1970's and the 1980's when high school students increasingly saw marijuana as dangerous (Bachman, Johnston, O'Malley, & Humphrey, 1988). The "just say no" campaign associated with Nancy Reagan is an example of a cultural practice highlighting the dangers of marijuana. Similar increases in the perceived danger of other drugs also occurred, suggesting a broad, cultural change during this time period (O'Malley, Bachman, & Johnston, 1988). More recent data show a similar pattern with alcohol use (Keyes, Schulenberg, O'Malley, Johnston, Bachman, Li, & Hasin, 2012), with use dropping as perceived risk increases. Likewise, support for drug legalization in the GSS has arguably showed cohort effects with the strongest support from Baby Boomers (Nielsen, 2010), although these data analyses were not done with nested models so it is challenging to know if they will hold up to more sophisticated techniques. Alternative methods, such as analyses of Twitter streams, have seen support for marijuana increasing in recent years (Thompson, Rivara, & Whitehill, 2015).

The Present Research

Our goal in the present research is to understand changing support for marijuana legalization. To do this we draw from three surveys conducted over time: the GSS, Monitoring the Future (MtF) and the American Freshman survey (AF). To our knowledge, the GSS is the largest single data set including a question on marijuana legalization with a multi-age sample over time. We will use HLM models to separate age, period and cohort effects for the GSS survey responses on marijuana legalization.

We will also examine two other data sets, MtF and AF, to confirm these patterns in larger samples of specific age groups. In addition, AF began asking about marijuana legalization 5 years earlier (in 1968) than the GSS (1973). These time-lag datasets hold age constant, so any changes must be due to either period or cohort effects.

In addition, MtF – unlike the other two surveys – includes items on the perceived risk or marijuana use. To examine the role that beliefs about the risks and benefits of marijuana play in changing support for marijuana legalization, we examine these attitudes as they relate to support for marijuana legalization.

We predict that we will find increasing support for marijuana legalization which, given analyses of other attitudes in the GSS data, will be largely driven by time period effects. We predict increasing support will be linked to a decreased perceived risk of marijuana use.

Method

Samples

General Social Survey. The GSS contains a nationally representative sample of Americans over 18. It was collected in most years between 1972 and 2014 ($N = 56{,}859$; for the questions in the current survey, N ranges from 29,631 to 35,048). The GSS data and codebooks can be found online (Smith et al. 2013). As suggested by the GSS administrators, analyses were weight by the variable WTSSALL, making the sample nationally representative of individuals rather than households and the Black oversamples collected in 1982 and 1987 were excluded.

Monitoring the Future. This survey samples representative high schools in the United States (see http://www.monitoringthefuture.org). Participation rates of schools are between 66% and 80%, and for students are between 79% and 83% (Johnston, Bachman, O'Malley, and Schulenberg, 2013). About 15,000 students in each grade are surveyed each year in the spring, with some questions, including those on attitudes toward marijuana legalization and perceived risk, only given to subsamples. Data are available 1976–2015, $N = 92{,}973$.

American Freshman. This survey is based on a nationally representative sample of first-year students at four-year colleges or universities. It has been conducted since 1966 (Pryor, Hurtado, Saenz, Santos, and Korn, 2007), with 2015 the most recent data available when we performed our analyses. We used the aggregated data with individual-level standard deviations (e.g., Twenge, Campbell and Gentile, 2012), thus ensuring that the effect size is based on variation among individuals and thus comparable to the other datasets. For the item used here, $N = 9{,}046{,}894$.

Items

We used relevant items regarding attitudes toward marijuana legalization in the GSS, MtF and AF.

General Social Survey. We used one item ($N = 33{,}909$): "Do you think the use of marijuana should be made legal or not?" Response choices of "should" and "should not."

Monitoring the Future. MtF includes two questions on marijuana legalization. First: "In particular, there has been a great deal of public debate about whether marijuana use should be legal. Which of the following policies would you favor?" In 2012, the words "Not counting 'medical marijuana' (with a doctor's prescription)" were added before "which of the following . . ." Response choices "using marijuana should be entirely legal," (coded 3), "it should be a minor violation – like a parking ticket – but not a crime," (coded 2) "It should be a crime" (coded 1), and "don't know." We excluded "don't know" responses.

To create a dichotomous variable comparable to the other two surveys, we also coded "entirely legal" as "yes" and "a minor violation" and "a crime" as "no." Second: "If it were legal for people to USE marijuana, should it also be legal to SELL marijuana?" In 2012, "Aside from 'medical marijuana," was added to the beginning of the question. Response choices: "No" (coded 1), "Yes, but only to adults" (coded 2), and "Yes, to anyone" (coded 3) and "don't know." We excluded "don't know" responses. To create a

dichotomous variable, we coded both "yes, but only to adults" and "yes, to anyone" as "yes" and "no" as "no."

To assess the perceived risk of marijuana use we used the following: "The next questions ask for your opinions on the effects of using certain drugs and other substances. How much do you think people risk harming themselves (physically or in other ways), if they... smoke marijuana regularly?" Response choices: "No risk," "slight risk," "moderate risk," "great risk." We excluded "can't say, drug unfamiliar" responses.

American Freshman Survey. To assess attitudes, we used a single item: "Marijuana should be legalized" with response choices: "disagree strongly," "disagree somewhat," "agree somewhat," "agree strongly." The percentage who chose either "agree somewhat" or "agree strongly" are given in the annual data reports.

Data Analysis Plan

General Social Survey. To separate the influence of time period (i.e., survey year), generational cohort, and age on change in attitudes toward the legalization of marijuana, we analyzed data for the item "Should marijuana be made legal?" using a logistic variant of the age-period-cohort model discussed by Yang and Land (2006). More specifically, responses to this dichotomous item (1 = should legalize; 0 = should not legalize) were analyzed by using a weighted hierarchical cross-classified logistic regression model to estimate the probability of choosing the "Should Legalize" option, *P*(*Legalize*). The first level (L1) of this model[1] takes account of variability in responses due to the standardized age of the respondent:

$$\text{L1: In}\left[\frac{p(Legalize)}{1-p(Legalize)}\right]=\beta_{0jk}+\beta_{1jk}\left(Age_{ijk}\right)+\beta_{2jk}\left(Age_{ijk}^{2}\right)$$

where π_{0jk} is the intercept of the model, and represents the log odds of choosing the legalization option for respondents at the average age level (i.e., 44.5 years, *SD* = 11.2) at each birth cohort, *j*, and time period, *k*. The odds ratio of π_{0jk}, exp (β_{0jk}), can be converted to the probability of endorsing the legalization options by: $\frac{\exp(\beta_{0jk})}{1+\exp(\beta_{0jk})}$, which reflects the probability of a respondent with the average age (i.e., 44.5 years) choosing the option favoring legalization of marijuana, *P*(*Legalize*). The slope, β_{1jk}, is the increase in the odds of choosing the "should legalize" option given a one standard deviation increase in age, and β_{2jk} reflects a quadratic term to account for possible curvilinear relations between age and the odds of choosing the "should legalize" option. The second level (L2) of the model can be stated:

$$\begin{aligned}\text{L2: } \beta_{0jk} &= \theta_0 + b_{00j} + c_{00k}\\ \beta_{1jk} &= \theta_1 + b_{10j} + c_{10k}\\ \beta_{2jk} &= \theta_2 + b_{20j} + c_{20k}\end{aligned}$$

This model accounts for variability in the intercept and slope parameters between birth cohorts and time periods. Here θ_0 is the overall log odds of selecting the legalization option, and b_{00j} and c_{00k} are the effects away from the overall log odds for each birth cohort, *j* (operationalized here as the year of birth) and each time period, *k*. Additionally, this model included the weight WTSSALL, which is included in the GSS database; this weight corrects for the number of adults in the household. We also deleted oversampled African American respondents in the years 1982 and 1987 from analysis to ensure the data were nationally representative.

Notably, this model is the same as the age-period-cohort model proposed by Yang and Land (2006) and applied in several recent investigations (e.g., Twenge, Carter, & Campbell, 2014; Twenge, Campbell, & Carter, 2015), with the exception that the current model accounts for the fact that dichotomous outcome variables follow a Bernoulli distribution, rather than a continuous normal distribution. The model parameters were estimated using full-information maximum likelihood. All models were estimated and statics reported were computed using the HLM7.0 software program (Raudenbush, Bryk, & Congdon, 2013).

Monitoring the Future and American Freshman. These data are from similar age participants (i.e., 12th graders and college freshman) sampled over a period of decades. Thus analyses focus on the changes in support over time (i.e., cross-temporal data). Age is held constant, so any changes are due to time period or birth year cohort differences. The key results are correlations between year and value. In addition, we reported the data in 5 year blocks in.

Results

Our results focus on each data set separately. We begin with the GSS which involves more complex analyses, and then present the data from MtF and AF.

General Social Survey. Inspection of the L1 portion of the logistic HLM showed a general decrease in the probability of endorsing legalization as age increased, π_1 = –.40, $t(33{,}539)$ = –11.79, $p < .001$. At the mean survey year (1994), those at the mean age of 44.50 years had a 25% chance of endorsing the legalization option across all birth years and time periods; those at age 20 showed a 37.3% chance of endorsing the item, whereas those at age 80 had a 12.6% chance of endorsing the legalization option (see **Figure 1**).

Inspection of the L2 model showed that the largest influence on the probability of endorsing legalization was the time period respondents were surveyed, $\chi^2(24)$ = 1,618, $p < .001$, with a large variance component of .323 (or *SD* = .568). The graph shows a general trend such that the probability of choosing the legalization option has increased greatly, particularly in the last 20 years. Between 1973 and 1978 there was a relatively small increase in the probability of endorsing legalization, rising from 16.3% in 1973 to 26.1% in 1978. However, this was immediately followed by a general decrease, with the probability of endorsement reaching its lowest in 1987 at 13.9%. The increase appears to begin between 1991 and 1993, at which point a steady increase is observed. The trend begins to increase sharply around 2006; in fact, between 2006 and 2014, the

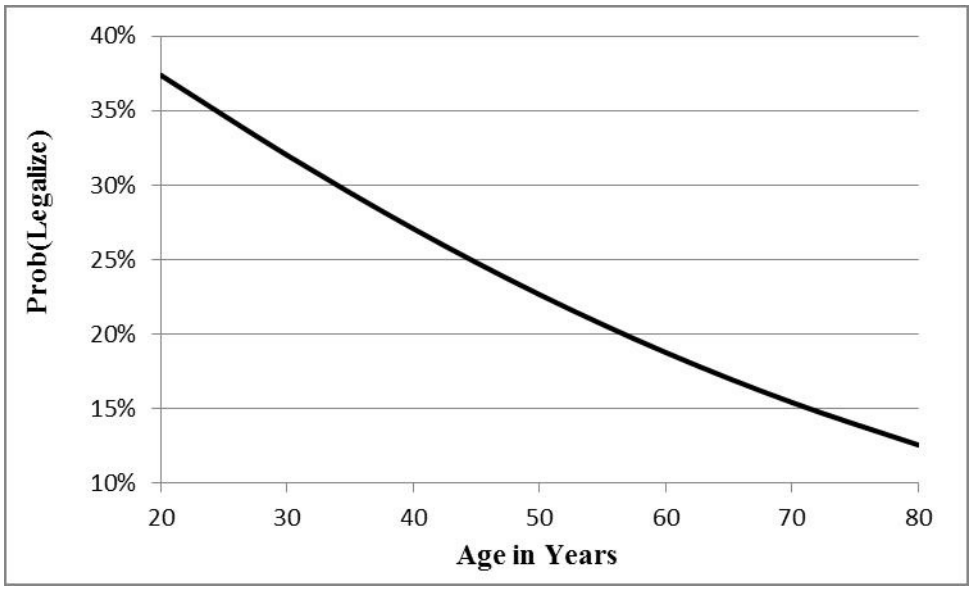

Figure 1: Percent supporting the legalization of marijuana at each age, controlling for time period and cohort effects, General Social Survey.

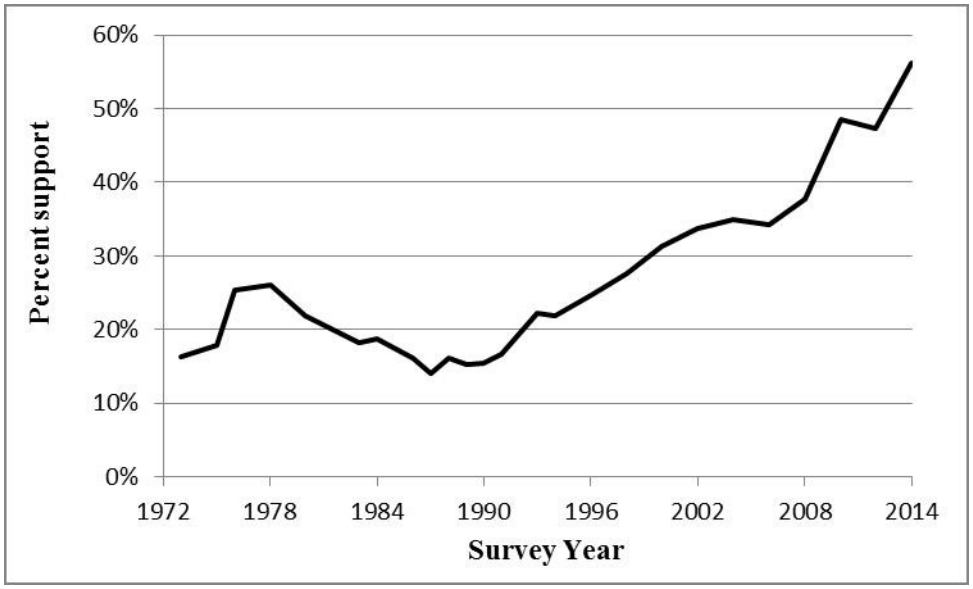

Figure 2: Percent supporting the legalization of marijuana at each survey year, controlling for age and cohort, General Social Survey, 1972–2014.

probability of endorsing the legalization option jumped from 34.3% to an all-time high of 56.3%. Notably, 2014 is the only year in which respondents had a greater than 50% chance of choosing the legalization option, but was close in 2010 and 2012, at 48.5% and 47.3%, respectively (see **Figure 2**).

Birth year showed a significant influence on the probability of endorsing legalization, $\chi^2(107) = 329.07$, $p < .001$, but a small variance component of .028 (or $SD = .167$). As seen in **Figure 3**, those born between 1947 and 1957 had the highest probability of endorsing legalization across ages and time periods, ranging from 31.2% in 1953, the all-time high, and 28.7% in 1957. Those born in the 1920s, 1930s, and early 1940s were the least likely to endorse legalization, with the lowest in the birth year of 1941 at 20.8%. Although there was a small spike in the early 1910s and mid-1970s, most other birth years tended around the average of 25%.

A significant but small influence of time period on the age trajectory (i.e., the slope parameter, π_1) was found, $c^2(24) = 230.34$, $p < .001$, with a variance component of .019 (or $SD = .137$). **Figure 4** shows the age trajectory in the years 1973, 1984, 1994, 2004, and 2014. As can be seen, the strength of relation between age and the probability of endorsing the legalization option has become slightly weaker over time. This graph also underscores the effects of time period. For example, in 2014, 67.2% of 20 year olds, 58.4% of 40 year olds, and 48.9% of 60 year olds endorsed legalization. In contrast, in 1973 these numbers were 33.9%, 18.8%, and 9.5%, respectively. Notably,

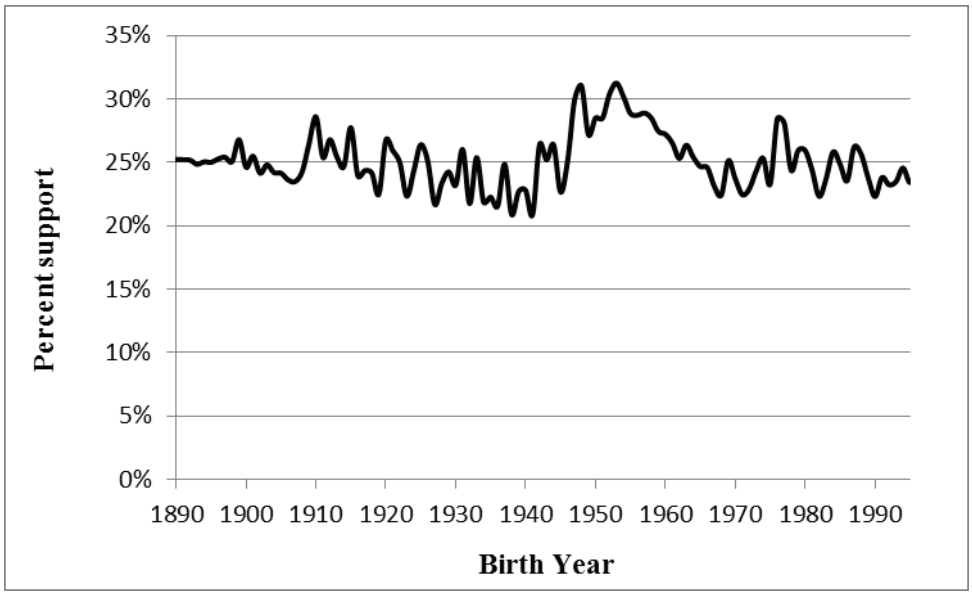

Figure 3: Percent supporting the legalization of marijuana at each birth year with $n > 10$ (1890–1995), controlling for age and time period, General Social Survey.

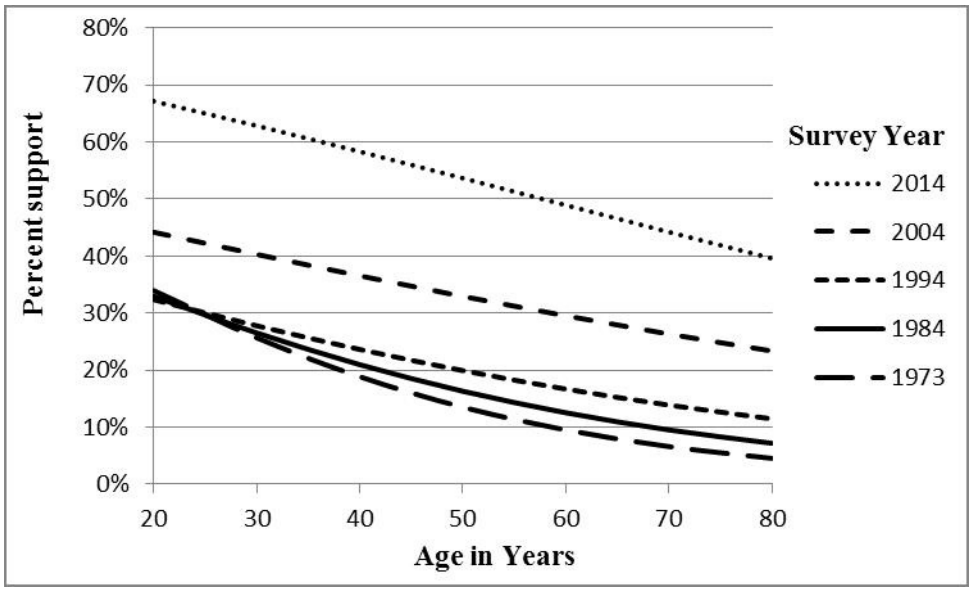

Figure 4: Age trajectories for support of legal marijuana by survey year, General Social Survey.

in 2014, this represents an expected 25.7% decrease in the probability of endorsing legalization between ages 20 and 60, compared to an expected 72% decrease in 1973, suggesting the age gap in attitudes toward legalizing marijuana is steadily thinning. Finally, birth year showed no considerable influence on the age trajectory, $c^2(107) = 144.44$, $p = .009$, with a variance component of .002 (or $SD = .044$). All influences on the quadratic effect were very small and non-significant.

Monitoring the Future. High school seniors are also increasingly likely to support the legalization of marijuana, also with a curvilinear pattern similar to that in the GSS data. Support reached a low in the 1980s and early 1990s and increased from then to 2014 (see **Table 1**). In terms of model fit, a simple correlation between year and support for legal marijuana use (at the individual level) was r (91,128) = .08, $p < .001$, indicating increased support over time. Likewise, a regression equation including year and year squared showed a stronger curvilinear effect, Beta = .17, $p < .001$ than linear, Beta = .05, $p < .001$. For legal marijuana sales, the correlation with year was $r(92,617) = -.02$, $p < .001$, indicating less support. A regression equation including year and year squared showed a stronger curvilinear effect, Beta = .06, $p < .001$ than linear, Beta = –.03, $p < .001$. Another question is the relationship between perceived risk and use. We found that 12th graders' perceived risk of marijuana use rises and falls in a very similar curvilinear pattern, with $r = -.96$ between

	n	68–69	70–74	75–79	80–84	85–89	90–94	95–99	00–04	05–09	10–15	*d (1st to last)*	*d (lowest 1980s–90s to highest 2010s)*
12th graders													
Legal to use (1–3)	92.973	–	–	2.13 (.79)	1.87 (.80)	1.66 (.77)	1.72 (.83)	1.97 (.86)	2.01 (.83)	2.02 (.81)	2.24 (.79)	.14	.74
Legal to use (Y)	92,973	–	–	39% (.49)	26% (.44)	19% (.39)	25% (.43)	35% (.48)	35% (.48)	34% (.47)	47% (.50)	.16	.67
Legal to sell (1–3)	94,543	–	–	1.88 (.62)	1.80 (.63)	1.71 (.66)	1.69 (.67)	1.79 (.66)	1.81 (.67)	1.77 (.65)	1.80 (.62)	–.13	.17
Legal to sell (Y)	94,543	–	–	74% (.44)	68% (.47)	59% (.49)	58% (.49)	65% (.48)	66% (.47)	64% (.48)	69% (.47)	–.11	.21
Perceived risk of regular use	106,794	–	–	2.88 (1.06)	3.42 (.83)	3.65 (.69)	3.62 (.75)	3.36 (.92)	3.30 (.95)	3.25 (.98)	2.89 (1.12)	.01	–.85
College students													
% support legalization	9,046,894	23% (.42)	45% (.50)	47% (.50)	29% (.45)	19% (.40)	26% (.43)	33% (.47)	37% (.48)	40% (.48)	52% (.50)	.64	.77
Adults (GSS)													
Legal to use (y/n)	33,909	–	20% (.40)	27% (.44)	23% (.42)	17% (.38)	21% (.41)	28% (.45)	34% (.47)	36% (.48)	51% (.50)	.65	.77

Table 1: Attitudes toward marijuana legalization and risk of use among U.S. 12th graders, college students, and adults, 1968–2015.

Notes:

[1] Dashes = question was not asked in those years, or $n < 100$.

[2] Standard deviations in parentheses.

[3] d = difference between means (first year vs. last year; highest to lowest) expressed in standard deviations.

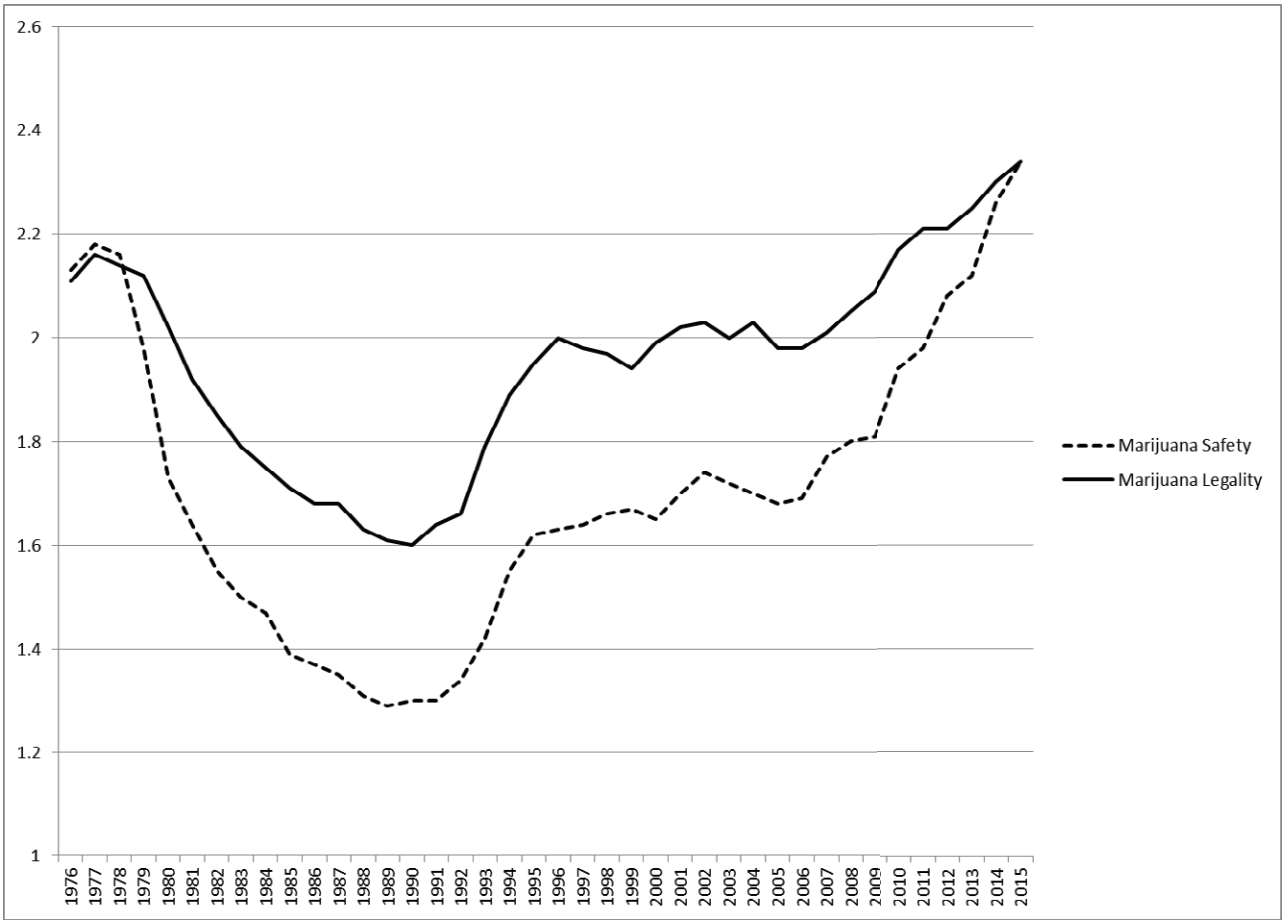

Figure 5: Opinion on legalizing marijuana (1–3 scale) and perceived safety of regular marijuana use (1–4 scale), 12th graders, Monitoring the Future, 1976–2015.

the yearly means of the two variables (see **Figure 5**; note this figure has "risk" reverse-scored as "safety" so that the trends are scored in the same direction). (The relationship between these two variables cannot be tested at the individual level as they are asked of different respondents).

American Freshman Survey. Entering college students show a similar pattern. However, the AF data start earlier (1968) than the other samples. Thus, they show a more complex pattern with support for legalization rising from the late 1960's into the 1970's, dropping during the 1980's, and then rising into the present (see **Table 1** and **Figure 6**). In terms of model fit, a bivariate, ecological correlation between year and support for legalization (at the group level), weighted by sample size per year, is r (44) = .15, *ns*. In a regression equation including year and year squared showed a stronger curvilinear effect, Beta = .66, $p < .001$ than linear, Beta = .45, $p < .001$.

Discussion

The goal of this paper was to better understand changing attitudes towards marijuana legalization in three large representative surveys. Across all three surveys, Americans became less supportive of legal marijuana between the 1970s and the 1980s, with support steadily rising from the 1980s to the 2010s. In the AF data, which begin in 1968, support for legalization increased from the mid-1960's to the 1970's, suggesting that legalization came into favor in the 1970s, waned during the 1980s, and has now returned at even higher levels.

According to the HLM analyses of the GSS data, these changes in support of legal marijuana are primary due to period effects. That is, the change appears to be broadly supported, not just carried forward by a single generational cohort.

We were able to examine the link between support for marijuana legalization and perceived risk in the 12th grade dataset. Perceptions of risk and support for legalization move in tandem, with high perceived risk linked to low support for legalization and low perceived risk linked to high support of legalization.

Limitations

Although the evidence for increasing support for legalization is very clear over the last 25–30 years, there are several important limitations to this research. First, the data from the GSS, although likely the best available, are limited. For example, the models suggesting period effects do not include the future beliefs of today's young adults or the young adult beliefs of people born in the 1930's or 1940's. There is no way around these gaps in the data. Thus, the age trajectories used in the models must necessarily depend on the existing data for those generations and age groups. Second, the evidence for relatively low levels of support for marijuana in the 1960's are from a

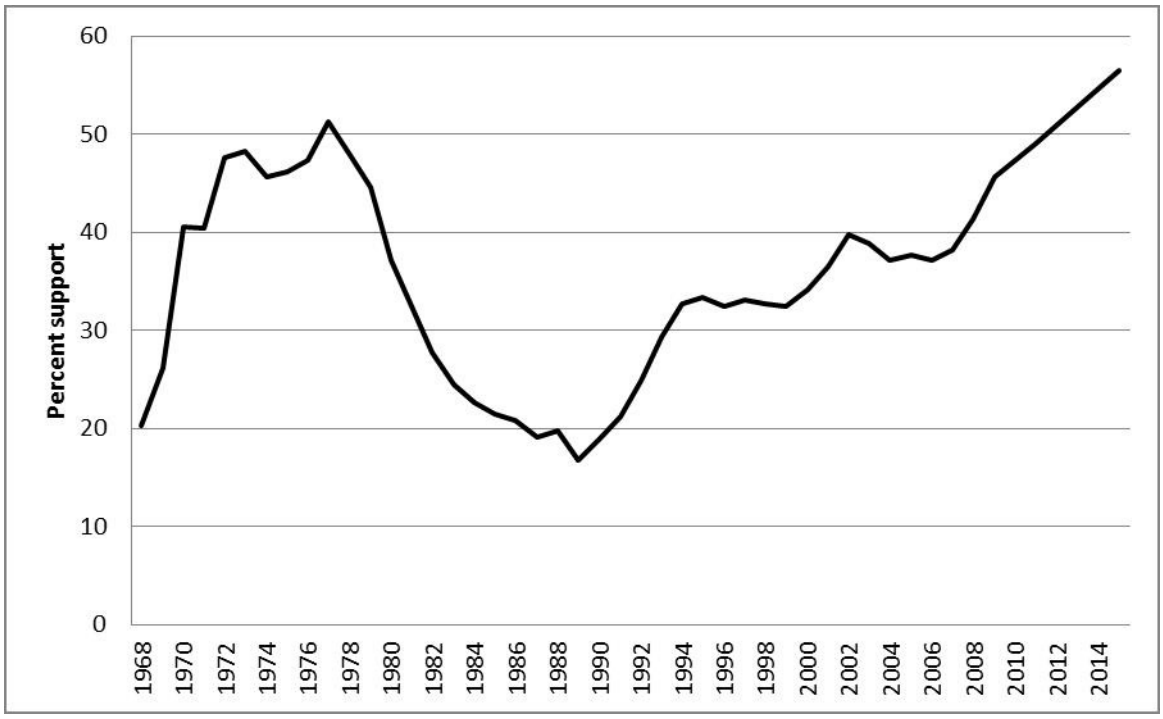

Figure 6: Percent of entering college students supporting legalizing marijuana, American Freshman survey, 1968–2015.

single, albeit large, sample of entering college students. More data on these earlier decades would have been useful in drawing conclusions. Third, the link between support for marijuana legalization and perceived risk is correlational. We do not know if there is a causal link in either direction or if a third variable is causing changes in both.

Future Support for Legalization

From the current data, it appears that support for marijuana legalization is increasing. If this process continues, support for legalization might be a clear majority opinion in a decade. However, given the curvilinear historical findings, it is possible that a reversal in support could again occur. Our best guess from these data, however, is that it would be accompanied by a shift in beliefs about the dangers of marijuana versus the benefits. It is hard to see that a profound reversal in these beliefs about risks given the exaggerated level of risk vs. reward in the DEA's Schedule I where cannabis is placed on an equal plane of risk with heroin. However, some risks of cannabis use have been identified, especially with high levels of use among young people. Most notable is the link between cannabis use and psychosis (Radhakrishnan, Wilkinson, & D'Souza, 2014) which has had some effect on the scheduling of cannabis in Britain (Hamilton, Lloyd, Hewitt, & Godfrey, 2014). Greater awareness of these risks could eventually lead to a reversal in the trend toward supporting legal marijuana.

Conclusions

Data from three large datasets show increasing support for marijuana legalization starting in the late-1980's/early-1990's. The trend appears to primarily reflect a period effect, or be broadly cultural. Support for legalization is linked to decreasing perceptions of the dangers of marijuana. It is unclear from these data how the support will change in the future, but if the current trends hold, support for marijuana legalization will become increasingly widespread.

Competing Interests

The authors have no competing interests to declare.

Note

[1] This model is simply the logistic form of a quadratic regression equation, and can be written as:

$$P(Legalize \mid \beta_{ijk}) = \frac{1}{1+\exp\left(\beta_{0jk} + \beta_{1jk}\left(Age_{ijk}\right) + \beta_{2jk}\left(Age_{ijk}^{2}\right)\right)}$$

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