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Do Societal Wealth, Family Affluence, and Gender account for Trends in Adolescent Cannabis Use? A 30 Country Cross-National Study

Tom F.M. ter Bogt[1], **Margreet de Looze**[1], **Michal Molcho**[2], **Emmanuelle Godeau**[3], **Anne Hublet**[4], **Anna Kokkevi**[5], **Emmanuel Kuntsche**[6], **Saoirse Nic Gabhainn**[2], **Iva Pejnovic Franelic**[7], **Bruce Simons-Morton**[8], **Sharon Sznitman**[9], **Alessio Vieno**[10], **Wilma Vollebergh**[1], and **William Pickett**[11]

[1]Interdisciplinary Social Sciences, Utrecht University, Utrecht, The Netherlands [2]Health Promotion, National University of Ireland, Galway, Ireland [3]UMR 1027, Inserm, Université de Toulouse, Toulouse, France ; Service médical du rectorat de Toulouse, Toulouse, France [4]Department of Public Health, Gent University, Gent, Belgium [5]University Mental Health Research Institute, Athens, Greece [6]Sucht Schweiz Research Institute, Lausanne, Switzerland; Behavioural Science Institute; Radboud University, Nijmegen, the Netherlands [7]Croatian National Institute of Public Health, Zagreb, Croatia [8]Prevention Research Branch, Division of Epidemiology, Statistics and Prevention Research, Eunice Kennedy Shriver National Institute of Child Health and Human Development, Bethesda, United States [9]School of Public Health, University of Haifa, Haifa, Israel [10]Dipartimento di Psicologia dello Sviluppo e della Socializzazione, Universita degli Studi di Padova, Padova, Italia [11]Department of Public Health Sciences, Queen's University, Kingston, Canada; Department of Emergency Medicine, Queen's University, Kingston, Canada

Abstract

Aims—To examine cross-national changes in frequent adolescent cannabis use (40+ times consumed over lifetime at age 15) over time and relate these trends to societal wealth, family affluence, and gender.

Design—Data from three cycles (2002, 2006, 2010) of the Health Behaviour in School-aged Children (HBSC) Study were used for cross-sectional and trend analyses of adolescent cannabis use.

Setting—Representative surveys in thirty European and North American countries.

Participants—160,606 15-year-old students.

Measurements—Respondents' life-time cannabis use, demographics, family affluence (FAS), and frequency of peer contacts were measured individually. Indicators of wealth (Gross Domestic Product per capita, GDP) and perceived availability of cannabis were obtained from national public data bases.

Findings—The frequency of lifetime cannabis use decreased over time among adolescents in Europe and North America, particularly in Western European countries and the United States of America (Relative Risk (RR) = 0.86: Confidence Interval (CI) 0.79 – 0.93). This trend was not

Corresponding Author: Tom ter Bogt, Interdisciplinary Social Sciences, P.O. box 80140, 3508TC Utrecht, The Netherlands, t.f.m.terbogt@uu.nl.

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observed consistently in rapidly developing countries in Eastern, Central, and Southern Europe. Over time (2002–2010) cannabis use became: (1) less characteristic of high GDP countries in contrast to lower GDP countries (RR = 0.74: CI 0.57–0.95); (2) less characteristic of youth from high FAS families in contrast to youth from low FAS families (RR = 0.83: CI 0.72–0.96); and (3) characterized by an increasing gender gap, i.e. consumption was higher among males (RR 1.26: CI 1.04–1.53). Perceived availability of cannabis and peer contacts remained strong predictors of frequent cannabis use.

Conclusions—Among 30 European and North American countries, cannabis use appears to have "trickled down" over time, with developing countries taking on the former (heavier) use pattern of richer countries, and less affluent youth taking on the former (heavier) use pattern of more affluent youth. Cannabis use continues to be more common among adolescent males than females.

Keywords

cannabis use; adolescence; societal wealth; family affluence; gender

Introduction

Cannabis use has been conceptualized as typical of affluent youth in wealthy societies (1), and generally young males have always been more prone to use the drug than females (2, 3). However, gender patterns of consumption and the relationship between societal and family affluence and cannabis use may be changing.

The Health Behavior in School-Aged Children (HBSC) study, with data collection most recently in 2002, 2006, and 2010, provides a unique opportunity to study trends in cannabis use in a large number (n=30) of European and North-American countries. We investigated the consistency over time of gender, societal wealth, and family affluence (FAS) as social determinants of cannabis use.

The gender gap in cannabis use

Determinants of cannabis use have been theorized to involve complex interactions between biological, genetic, personality, attitudinal, family, peer, and community variables (4). Existing empirical research on adolescent cannabis use suggests that gender, as an expression of a set of biogenetic and social factors, is a key predictor. Across geographical areas and time, adolescent males report higher prevalence of cannabis use compared to females and a greater tendency to abuse and develop dependence on cannabis (5). However, trends in use by gender are of particular interest as the gender composition of cannabis users may have changed.

During the last five decades, teenage female smoking and drinking have increased (6, 7). Two cultural trends worked in the same direction. First, the growing societal wealth in western countries promoted a unique youth cultural domain, involving special products, styles, and recreational activities such as dancing and partying. These fostered the consumption of smoking, drinking, and other (il)licit substances. Parker, Aldrige and Measam (8) have noted that consumption of alcohol, tobacco, and illicit drugs among youth in affluent countries such as the UK is so prevalent that it has become "normalized". Second, the emancipation of women enabled new opportunities for work and leisure, allowing women to explore public spaces such as pubs, bars, and clubs (9). Recent research shows that drinking prevalence is higher among adolescent males, but the gap between boys and girls is declining (10). In some European countries, females now smoke more than males (11), and female cannabis use has generally followed similar trends to that reported

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for males (12). While gender is a crucial factor in substance use, trends in the potential closing of the gender gap that have occurred with regard to smoking and drinking have never been studied with regard to cannabis use in a cross-national context.

Wealth and cannabis use

The effect on adolescent cannabis use of characteristics of the wider social context is also understudied, though economic factors such as affordability and availability are established determinants of tobacco and drug use (13). In a recent cross-national study Ter Bogt at al. showed that societal wealth is related to higher rates of cannabis use (1). The authors speculated that, historically, cannabis use might spread from richer to poorer countries. Furthermore, the aforementioned study of Parker et al. (8) found evidence that cannabis use has become less characteristic of youth with a risky heath profile, but is ever more typical of well adjusted, relatively healthy young people who include drug use as a recreational activity in their leisure time. It can be hypothesized that cannabis normalization has not only appeared in the UK, but that across Europe cannabis in addition to tobacco and alcohol, is now perceived by young people as a substance that is part of the range of drugs typical for night-life. Speculatively, young people from poorer countries may have adapted their behavior to cannabis use patterns of their peers in wealthier countries. (*Trickling-down Effect 1; between countries*). Across Europe, over the last two decades, a (relative) increase in cannabis use indeed emerged in the Central and Eastern European regions where market-orientated economies developed rapidly. The 2007 ESPAD study indicated significant increases in cannabis use (1995–2007) in Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Lithuania, Poland, Slovak Republic, Slovenia (but not in Latvia, Romania, Ukraine), hinting at the importance of increased social wealth as a potential determinant (12).

Furthermore, Ter Bogt et al. (1) also speculated that within countries, wealth and availability foster the emergence of a drug-using community of young people that plays a crucial role in the socialization of younger, potential cannabis users. Hence, leisure opportunities for a rising middle class may foster drug use and cultural acceptance of use, which is adopted later among youth from a lower socio-economic status or family affluence status (FAS), once they have the money and opportunity to buy drugs (*Trickling-down Effect 2; within countries, between classes*) (1). In some countries, this tendency may have leveled off, as the “trickling-down” has occurred at such a rate that cannabis use is now more characteristic of lower than higher SES youth (13). Again, trends in cannabis use and their reliance on societal wealth or family affluence have never been studied in a broad cross-national context.

The present study

Broad social trends hint at a changing gender composition of cannabis use, with greater parity in use between males and females. Furthermore, societal and family wealth may influence cannabis use among adolescents, with “trickling-down” effects from more affluent to poorer nations and groups. Our study therefore sought to:

1. describe cannabis use trends over the reporting periods of 2002, 2006, and 2010 in 30 European and North-American countries;
2. examine how gender, societal wealth, and family affluence relate to cannabis use;
3. test whether the gender gap in cannabis use is closing;
4. evaluate possible trickle down effects from higher to less affluent countries and from higher FAS youth to less affluent youth respectively.

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As noted above, in countries and social contexts where cannabis is readily available, adolescent cannabis use is higher (1, 14). Furthermore, the social context of adolescents is an important, if not the most important factor, in cannabis initiation and use (14). Therefore, we modeled perceived availability and peer contacts as covariates.

Methods

Study Population and Procedures

Health Behavior in School-Aged Children Study (HBSC), school-based anonymous surveys were conducted in 2002, 2006, and 2010 according to the HBSC research protocols. Samples were representative geographically, with variations in sampling criteria permitted to fit country-level circumstances. Some countries over-sampled sub-populations (e.g., by geography, ethnicity) and therefore survey weights were applied. Statistical criteria specified that samples submitted for international comparisons were sufficient to provide confidence intervals of ±3% for prevalence with sample design effects of no more than 1.2 times greater than would be obtained from a simple random sample.

Each participating country obtained approval to conduct the survey from the ethics review board or equivalent regulatory body associated with their respective institutions/countries. Participation was voluntary and informed consent was sought from school administrators, parents, and children according to local human subject requirements. At the student-participant level, response rates among countries varied by survey cycle and country, for example, in 2010 response rates at the individual level ranged from 44% to 92%. (15, 16). All protocols can be retrieved at: http://www.hbsc.org/methods/index.html (17) Illicit drug use questions in HBSC were administered to 15 year olds only.

Cannabis Use

The HBSC cannabis use items have been used since 1994 in all participating countries. In 2002, 2006 and 20010 students reported the frequency with which they had used cannabis in their lifetime on a scale from 1 to 7, with 1 = never, and 7 = 40 or more times. Students in the last category were characterized as frequent lifetime users and compared with those who reported never or less frequent lifetime use. This study regards 15-year old students for whom cannabis use is a new type of behavior. For example, the 2010 HBSC data show that the prevalence of life time use (17% of the sample) is close to that of last year use (13%), indicating that most of the cannabis consuming students have started using cannabis only recently. Therefore young people who have used the drug 40 times or more can be qualified as relatively heavy users.

Time

Trends in frequent lifetime cannabis use were expressed in terms of changes in prevalence per four-year survey cycle.

Individual-level predictors

Gender (males *vs*. females) and *family affluence* (FAS; the validated HBSC measure of family Socio Economic Status (SES))(16) were included as individual predictors. FAS regards the material conditions of participant's household (car, own bedroom, holiday frequency, number of computers). Responses were summed on a 0 to 9 point scale, with scores between 0 and 3 indicating low affluence, 4 to 5 indicating medium affluence, and 6 to 9 indicating high affluence.

Two measures described involvement with peers: (a) *frequency of peer contacts in the evenings*, assessed by question *How many evenings per week do you usually spend out with*

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your friends? (0 to 7 evenings per week); and (b) *frequency of peer contact through electronic communication*, assessed by question, *How often do you talk to your friends(s) on the phone or send them text messages or have contact through the internet?* (1 = rarely or never to, 5 = every day).

Country-level predictors

As indicators of societal wealth, estimates of *gross domestic product (GDP) per capita* (2011) were available by survey cycle and country from the World Bank. This measure represents the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products, divided by the midyear population (18).

Generalized *perceived availability of cannabis* was taken from the European School Survey Project on Alcohol and Other Drugs (ESPAD). Estimates were obtained for each country using the ESPAD survey cycle that immediately preceded each HBSC survey cycle. For each country and timeframe, the percentage of ESPAD students indicating that cannabis availability was “easy” or “fairly easy” to obtain was estimated using mean responses of participants.

Statistical Analysis

Data analyses were conducted with SAS 9.3 (SAS Institute, Cary, NC, 2012). Descriptive analyses were conducted to characterize the international sample by survey cycle and basic demographics. Prevalence values of *frequent lifetime cannabis use* were then estimated by survey cycle, country, and gender.

Trends Analysis—We evaluated trends in frequent lifetime cannabis use within each country using a Poisson regression analysis that modeled frequent use (*yes* vs. *no*) as the dependent variable and gender and time (year of survey cycle) as the independent variables. Models accounted for the clustered nature of the sampling scheme, with students nested within schools in 26 out of 30 countries. In four countries (Germany, Greenland, Slovakia, and Switzerland) that had incomplete school identifiers in the early cycles, clustering by school in these countries was conducted by down-weighting their respective samples using a conservative design effect of 1.2 (15). Coefficients and standard errors from the adjusted models were used to generate estimates of relative risk (RR) and associated 95% confidence intervals for each 4-year survey cycle.

Main Effects Analysis—We first examined bivariate correlations between predictors of cannabis use at the country level and reported rates of frequent lifetime use by cycle using a series of exploratory correlation analyses. Next, taking all countries together, Poisson regression analyses were conducted to predict frequent lifetime cannabis use. These analyses focused on the main effects of the various predictors measured at both individual (gender, FAS, peer contacts) and country levels (GDP per capita, perceived availability of cannabis). Countries were included as random effects in these models, and random intercepts indicating baseline levels of cannabis use were also assumed by country. (Note: in exploratory analyses models that considered fixed and random slopes for included countries were consistent, hence models with fixed slopes, but random intercepts, were ultimately presented). Due to the missing school identifiers in the aforementioned countries, we down-weighted all observations by a design effect of 1.2 in order to account for clustering at the school sampling unit level. A hierarchical series of models was developed as follows: *Model 1*: adjusted model for key individual-level predictors; *Model 2*: adjusted model for country-level predictors; *Model 3*: individual plus country-level predictors considered simultaneously; *Model 4*: individual plus country-level predictors considered with time

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(survey cycle). Model findings were presented in the form of adjusted relative risks and their associated 95% confidence intervals. Canada and the US were excluded from these analyses, as no comparable ESPAD data on perceived availability of cannabis were available.

Interactions with Survey Cycle—In *Model 5*, we tested for the presence of interactions by time (survey cycle) with several key predictors. Two-way interactions terms (survey cycle * each predictor) were introduced individually and then together into each model. Final model results were again presented in terms of relative risks and their associated confidence intervals adjusted for the clustered nature of the data collection.

Statistical Power—Because of the large sample sizes, the overall analysis had strong power and could detect main effects in the form of relative risks of 1.02 or larger (or conversely 0.98 or lower; alpha=0.05, 2 sided, design effect of 1.2). However, power to detect such effects varied substantially at the country level depending upon the prevalence of cannabis use and available sample sizes. For example, Greenland (496 boys, 556 girls) and the United Kingdom (7218 boys, 7389 girls) had the smallest and largest numbers of young people, respectively, that participated in the three cycles of the survey. When one compares the highest versus lowest proportions of young people reporting frequent lifetime cannabis use by survey cycle, after accounting for the clustered sample design, the power to detect differences in the observed prevalence between the highest and lowest cycles were quite modest in Greenland (42% in boys, 77% in girls) and very high (virtually 100% in both boys and girls) in the United Kingdom. Hence, modest sample sizes and an associated lack of statistical power in a few countries (See Table 1) may account for an absence of trends in those same countries.

Results

The sample

A sample of 15-year-old adolescents (weighted n=160,606) from 30 countries who participated in the 2002, 2006, and 2010 cycles of the HBSC survey and provided full responses to the lifetime cannabis use items (Table 1). There was sufficient variability in individual and country-level predictors to permit meaningful sub-analyses by gender and time, and to build various regression models.

Trends in Cannabis Use

The prevalence of *frequent lifetime use* of cannabis varied widely by country, gender, and survey cycle (Tables 2a and 2b). The 10 countries with the greatest increases (2002–2010) in terms of GPD per capita were Russia, Ukraine, Slovakia, Latvia, Lithuania, Croatia, Estonia, Czech Republic, and FYR Macedonia; Slovenia ranked 13 and Hungary 14 out of 30 (data not shown). Frequent cannabis consumption stabilized or rose in all of these countries. In high GPD Western/Southern European and North American countries, frequent cannabis use generally declined, particularly among male adolescents (Belgium, Canada, Denmark, France, Germany, Ireland, Spain, Switzerland, UK, US) and less often among female adolescents (France, Ireland, Italy, Netherlands, Portugal, UK). Boys universally reported higher prevalence levels compared to girls, with notable differences in the reported prevalence levels across time. Increases were observed for boys in Austria, FYR Macedonia, Latvia, Lithuania, and for girls in Russia.

Shown in Table 3 are the median overall percentages of *frequent* users across the 30 participating countries for the three time points. Prevalence levels were higher among boys compared to girls at all time points. Overall, the results show a significant decrease in frequent cannabis use among both and girls between 2002 and 2010.

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Main effects analysis

Table 4 shows the results of our Poisson regression modeling for the individual-level and country-level as well as temporal predictors of frequent lifetime cannabis use. A bivariate correlation analysis confirmed the potential importance of all of demographic and social factors that had been hypothesized to influence cannabis use *a priori*. Individual-level risk factors (*Model 1*) for *frequent use* included male gender, lower family affluence, and increased frequency of peer contact in the form of evenings out with friends or electronic media communications. The country level risk factor analysis (*Model 2*) showed that perceived availability is a consistent predictor of cannabis use compared to GDP per capita. When entered simultaneously into the model, perceived availability turned out to be a clear risk factor for frequent cannabis use (RR=1.40), while GDP per capita was a negative predictor (RR=0.70). This implies that in high GDP countries where availability is generally high, fewer young people report *frequent use* of cannabis than would be expected based on GDP alone, and vice versa.

When the individual predictors were modeled together with the country-level factors, the findings observed in Models 1 and 2 were generally replicated (*Model 3*), while some estimates were slightly attenuated. The time variable (survey cycle) was then added to the multivariate model. A decline in *frequent use* was evident with time. Observed relations with the individual-level predictors remained the same as before, and perceived availability remained associated with *frequent use*, but the relationships with GDP became weak and statistically non-significant (*Model 4*).

Interactions with Time

In *Model 5*, we present interactions with time (survey cycle) to test whether the associations of individual-level and country-level factors with cannabis use were similar across survey cycles. The survey cycle year 2002 was used as a referent group in these analyses. There was no significant interaction between survey cycle and frequent electronic communications with friends; hence, this term was dropped from the model. The remaining interaction terms were retained either because a statistically significant interaction was identified or because they were particularly relevant in terms of our *a priori* theories.

Interactions of survey cycle (2010 vs. 2002 only), with gender FAS, and GDP per capita were statistically significant while interactions between frequency of peer contact (evenings out with friends) or perceived availability of cannabis and survey cycle were non-significant. The models identified stronger associations between gender and cannabis use in the later cycles, suggesting that the effects of male gender were more pronounced over time. This strong overall pattern was not consistent across all countries, with some countries demonstrating a narrowing gap (e.g., Belgium, Canada, Czech Republic, Denmark, Estonia, Germany, Poland, Russia, Spain) and others a widening gap (e.g., Austria, Finland, France, Hungary, Ireland, Italy, Netherlands, Portugal, Ukraine, UK) in terms of changes in the relative male/female difference in cannabis use in 2010 compared with 2002 (data not shown). For GDP per capita and FAS, the models identified weaker associations between higher levels of societal wealth or family affluence and cannabis use in 2010 compared to 2002 (Table 4), indicating waning effects of GDP and FAS over time.

Discussion

This study, first, explored cannabis use trends among 15-year-old boys and girls in 30 European and North-American countries between 2002 and 2010. Overall, a significant decline occurred. Particularly in affluent countries in Western and Southern Europe and North America (Belgium, Canada, Denmark, France, Germany, Ireland, Italy, Netherlands,

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Portugal, Spain, UK, US), a decrease in frequent cannabis consumption was observed among boys and/or girls. On the other hand, stabilization or even increases in cannabis use were found particularly in the emerging market countries that have recently experienced a rapid increase in their GDP. In three of the twelve former communist countries in Eastern, Central, and Southern Europe, cannabis use increased among boys (FYR Macedonia, Latvia, Lithuania) and in one, it increased among girls (Russia). In the remaining nine countries, cannabis use stabilized over time.

Second, we tested whether societal and individual factors predicted differences in cannabis us. Country level factors of GDP per capita and perceived availability both related positively to cannabis use, indicating that in richer countries, in countries where cannabis is readily available (which increases as social wealth increases), use is higher. A significant relation was also found for individual factors such as gender, family affluence, and peer contacts, implying that males, adolescents from less affluent families, and adolescents with frequent peer contacts use more cannabis.

Third, we examined gender in relation to in cannabis use. We had expected to find a closing gender gap, but our results did not corroborate this assumption. Though male and female consumption patterns started to show more similarity in some countries (e.g., Belgium, Canada, Czech Republic, Denmark, Estonia, Germany, Poland, Russia, Spain) in others the gap widened (e.g., Austria, Finland, France, Hungary, Ireland, Italy, Netherlands, Portugal, Ukraine, UK) and across the whole sample cannabis became ever more characteristic of males. An overall decline was found for both genders, but this decline was steeper for girls compared to boys.

A potential explanation for this rather surprising overall finding may be found in a substance use “normalization thesis” proposed by Parker, Aldrige and Measham in the late 1990’s (8). These authors use the term “substance use normalization” to describe widespread alcohol and other substance use among well-adjusted and successful, goal oriented, non-risk taking young persons. The normalization thesis suggests that high substance use prevalence rates are associated with a shift in the recruitment of substance users from risky, deviant segments to non-risky, well adjusted segments of the youth population. Conversely, then, decreasing substance use rates may have an effect in the opposite direction. With declining rates of cannabis use, cannabis may become a more non-mainstream drug of choice. “De-normalization” of cannabis use would not only reinstall an older situation in which boys are more prone to cannabis use than girls, but also, because a higher proportion of this male user group is characterized by problem behavior, the decreasing cannabis using scene may become unattractive for girls. As risk taking increases social status among boys (19), it may be easier for boys to remain part of a cannabis using scene than for girls. Further research should explore whether the de-normalization of cannabis use has affected girls more than it did boys.

Finally, we examined whether potential trickle down effects may have occurred. The results indicated that GDP per capita became less important as a predictor of frequent cannabis use between 2002 and 2010. Family affluence demonstrated the same trend.

In line with our expectations, the study findings did support our assumptions on the role of wealth in cannabis use and our hypothesis of a between countries “*Trickling-down*” *Effect 1*. Cannabis consumption became relatively more common in less wealthy but strongly-developing countries across Europe. Adolescents from less affluent countries seem to have adopted consumption patterns consistent with their peers in richer countries. Interestingly, the apparent effects of GDP level off in the high GDP Western European countries, where cannabis use is declining, sometimes dramatically. Our results also provide evidence for a

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relationship between family affluence and cannabis use, and support the presumed "*Trickling-down*" *Effect 2*. In the 1990's family affluence was a positive predictor of frequent cannabis use, but now cannabis use has emerged as a more common behavior among adolescents from less affluent families, a trend that has strengthened in the first decade of the new century.

Thus, both high GDP and high FAS were less strongly related to frequent cannabis use in 2010 compared to 2002, and an analogous situation with observed changes in smoking prevalence has become visible. Historically, tobacco use was more prevalent in countries with higher societal wealth and among individuals with higher SES. More recently, however, poorer countries and individuals with lower SES levels have followed the pattern laid out by more affluent countries and groups. Nowadays, tobacco use tends to be more prevalent in poorer countries and among poorer individuals in Europe and North America (20–22). As the route of administration is most often similar for tobacco and cannabis, i.e., cannabis is usually smoked with tobacco, the decline in tobacco use in richer countries and among higher SES youth may be closely related to the observed decline in adolescent cannabis use.

Both for tobacco and cannabis, the recent decrease in especially richer countries and among higher SES groups may be explained by the recently increased attention for, and knowledge of, the harmful effects of substance use for young people and the subsequent implementation of prevention measures aimed at reducing substance use (e.g., European Commission, 2009 (23)). According to Mackenbach and McKee (24), wealthy countries are more likely to implement such measures because "people in more advanced industrialized societies have been shown to shift their priorities from basic economic and physical security towards subjective well-being, self-expression and quality of life" (p. 196). This implies that they "look more to the future and invest in measures that will enhance future health" (p. 196). Thus, while wealth in earlier decades fostered adolescent substance use due to increased opportunities for use (i.e., because of increased availability and the existence of a flourishing youth culture), nowadays, national health policies in wealthy countries may have contributed to the observed decrease of adolescent cannabis use.

Limitations

This study has some limitations. First, this study assumed "trickling-down" processes from richer to poorer countries and from more affluent to less affluent families. Although our results did not bring forward evidence that contradicted these potential trends, we did not measure "trickling-down" effects directly. Our study design did not involve the measurement of modeling, imitation, or transmission of cannabis use behaviors from one country to another or from affluent to less affluent youth. Future studies should incorporate such measures as a more direct test of such "trickling-down" theories. Second, in this study, we did not investigate several possible determinants of frequent cannabis use, including personality factors, such as sensation seeking and disinhibition or genetic and biological markers. Although we included an important set of social and individual factors in our models and showed that they contributed to cannabis use independently, a more elaborate model of cannabis use should also include additional biological, genetic, and personality factors, as well as their interactions. Third, we only had at our disposal lifetime measures of cannabis use and we could therefore not discriminate between current frequent users and youth that may have experimented with the drug at a lower frequency across a longer period of time. However, our study population involved relatively young, 15-year old students. The 2010 HBSC data show that for the grand majority life time use (17% of the sample) is close to use during the past year (13%), indicating that most of them have started using cannabis only recently (16). Fourth, it cannot be ruled out that the results could in fact be partially

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attributable to different response rates between countries. These were not recorded centrally for earlier years of the survey for all countries, and it is therefore not fully possible to account for these analytically due to missing response rate data. Analyses of the most complete (2010) data suggest that, if anything, higher survey response rates were associated with lower use of cannabis, although these results were not statistically significant (r=−.36; n=29; p=0.06 for boys; r=−.28; n=29; p=0.14 for girls).

Conclusion

The overall decrease in frequent cannabis use observed in our full study sample is reassuring. Frequent cannabis use, particularly at an early age, is a risk factor for cannabis dependence and misuse, and it may function as a gateway to use of other illicit substances. Substantial decreases in cannabis use that now occur in concert with decreasing tobacco and alcohol use (16) may translate into lower levels of substance abuse and hence improved health among adolescents and young adults. However, we did not find a decline in the gender gap, with males reporting higher cannabis use prevalence than girls overall and in most countries. Furthermore, a “trickling-down” from high GDP to low GDP countries and from adolescents from more and less affluent families may involve new risks. Health and wellbeing of adolescents from less affluent circumstances are less positive compared to their peers from richer countries and families (25). The stabilization or even increase in cannabis use, for example, in Eastern, Central, and Southern Europe has the potential to impair the health of young people already at higher risk to be unhealthy. Last, but not least, male adolescents have always been at higher risk for excessive use and dependence, and now that frequent cannabis use is concentrated in this group, relatively more users may face health problems. Future studies should therefore closely monitor tendencies for “trickling-down” and “de-normalization” effects in frequent cannabis use as fundamental indicators of substance use and health in adolescent populations.

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Table 1

Available sample sizes by country (n=30), gender and HBSC survey cycle.

Country	Sample (n) by Survey Cycle and Gender						
	Boys			Girls			Total
	2002	2006	2010	2002	2006	2010	
Austria	643	693	885	634	801	935	4591
Belgium	1658	1562	1349	1753	1468	1218	9008
Canada	528	1095	2612	679	1194	2829	8937
Croatia	619	773	1197	816	857	1227	5489
Czech Republic	806	842	747	854	823	775	4587
Denmark	656	762	577	713	790	649	4147
Estonia	619	801	661	648	786	737	4252
Finland	867	790	1008	874	895	1102	5536
FYR Macedonia	672	952	814	727	944	722	4831
France	1301	1139	913	1313	1083	993	6742
Germany	842	1271	736	899	1281	904	5933
Greece	643	650	842	681	766	806	4388
Greenland	100	207	189	138	210	208	1052
Hungary	498	550	798	812	637	936	4231
Ireland	345	914	962	574	771	733	4299
Israel	697	758	0	850	1239	0	3544
Italy	541	678	764	679	657	782	4101
Latvia	481	628	666	631	702	709	3817
Lithuania	981	940	945	923	921	847	5557
Netherlands	637	672	783	636	691	749	4168
Poland	1022	1092	685	1105	1195	725	5824
Portugal	378	613	680	422	770	873	3736
Russia	1138	1238	919	1436	1516	928	7175
Slovakia	0	591	961	0	661	953	3166
Slovenia	543	780	914	509	781	901	4428
Spain	821	1519	962	935	1546	1041	6824

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Country	**Sample (n) by Survey Cycle and Gender**						
	Boys			**Girls**			**Total**
	2002	**2006**	**2010**	**2002**	**2006**	**2010**	
Switzerland	770	733	1138	731	767	1108	5247
Ukraine	730	835	881	871	994	1016	5327
United Kingdom	2083	2492	2643	2204	2507	2678	14607
USA	754	649	968	871	635	924	4801
All countries							
Median	664	785	883	772	812	903	4816
Total	22373	27219	28199	24918	28888	29008	160606

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Table 2

a. Prevalence rates of frequent (>40 times) use of cannabis in lifetime and temporal trend, by country: 15 year old males

Country	Rate per 100 Males			Temporal Trend (change per 4 year cycle)					
	2002	2006	2010	B[a]	(SE)	RR[b]	95% CI		P
							LL	UL	
Austria	1.8	1.7	4.2	0.518	0.200	1.68	1.13	2.48	0.01
Belgium	8.6	4.8	4.9	−0.331	0.100	0.72	0.59	0.87	0.0009
Canada	17.7	9.4	9.8	−0.250	0.073	0.78	0.67	0.90	0.0007
Croatia	2.8	3.5	2.4	−0.087	0.166	0.92	0.66	1.27	0.60
Czech Republic	5.6	4.8	4.2	−0.135	0.118	0.87	0.69	1.10	0.26
Denmark	4.0	2.0	2.2	−0.387	0.200	0.68	0.46	1.01	0.05
Estonia	1.9	3.2	2.3	0.097	0.184	1.10	0.77	1.58	0.60
Finland	1.4	1.9	1.4	0.000	0.190	1.00	0.69	1.45	1.00
FYR Macedonia	0.2	0.2	1.3	1.349	0.514	3.85	1.41	10.6	0.009
France	8.6	7.2	6.2	−0.171	0.083	0.84	0.72	0.99	0.04
Germany [c]	6.6	3.3	1.2	−0.799	0.164	0.45	0.33	0.62	<0.0001
Greece	2.1	0.6	2.3	0.024	0.217	1.02	0.67	1.57	0.91
Greenland [c]	6.4	3.4	2.1	−0.559	0.384	0.57	0.27	1.21	0.15
Hungary	2.8	1.8	2.4	−0.067	0.206	0.94	0.62	1.40	0.74
Ireland	8.4	8.2	4.2	−0.375	0.130	0.69	0.53	0.89	0.004
Israel	1.8	1.6	----	−0.149	0.434	0.86	0.37	2.02	0.73
Italy	4.8	2.7	3.0	−0.241	0.168	0.79	0.57	1.09	0.15
Latvia	1.1	3.0	3.4	0.449	0.209	1.57	1.04	2.36	0.03
Lithuania	0.8	1.8	2.0	0.463	0.211	1.59	1.05	2.40	0.03
Netherlands	7.0	6.2	4.9	−0.190	0.120	0.83	0.65	1.05	0.11
Poland	3.8	3.0	3.1	−0.095	0.150	0.91	0.68	1.22	0.53
Portugal	4.6	2.5	3.0	−0.210	0.178	0.81	0.57	1.15	0.24
Russia	1.4	2.8	1.6	0.084	0.169	1.09	0.78	1.51	0.62
Slovakia [c]	----	1.9	2.2	0.139	0.419	1.15	0.51	2.61	0.74
Slovenia	7.8	3.8	5.6	−0.187	0.140	0.83	0.63	1.09	0.18

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a. Prevalence rates of frequent (>40 times) use of cannabis in lifetime and temporal trend, by country: 15 year old males

Country	Rate per 100 Males			Temporal Trend (change per 4 year cycle)					
	2002	2006	2010	B[a]	(SE)	RR[b]	95% CI		P
							LL	UL	
Spain	12.0	8.8	5.7	−0.325	0.127	0.72	0.56	0.93	0.01
Switzerland [c]	16.2	7.3	6.7	−0.466	0.086	0.63	0.53	0.74	<0.0001
Ukraine	2.1	2.0	1.9	−0.041	0.195	0.96	0.65	1.41	0.83
United Kingdom	10.9	7.4	5.4	−0.356	0.055	0.70	0.63	0.78	<0.0001
USA	14.5	8.1	10.3	−0.216	0.082	0.81	0.69	0.95	0.009
All countries	4.7	3.1	3.0	−0.223	0.021	0.80	**0.77**	**0.83**	**<0.0001**

b. Prevalence rates of frequent (>40 times) use of cannabis in lifetime and temporal trend, by country: 15 year old females

Country	Rate per 100 Females			Temporal trend (per 4 year cycle)					
	2002	2006	2010	B[a]	(SE)	RR[b]	95% CI		P
							LL	UL	
Austria	1.6	1.3	0.7	−0.352	0.291	0.70	0.40	1.24	0.23
Belgium	3.1	2.2	2.0	−0.262	0.147	0.77	0.58	1.03	0.07
Canada	8.1	6.5	7.2	−0.063	0.086	0.94	0.79	1.11	0.46
Croatia	1.1	1.9	0.9	−0.017	0.221	0.98	0.64	1.52	0.94
Czech Republic	2.8	2.8	2.5	−0.064	0.153	0.94	0.69	1.27	0.68
Denmark	0.6	1.3	0.8	0.106	0.303	1.11	0.61	2.01	0.72
Estonia	0.2	0.8	0.7	0.477	0.385	1.61	0.76	3.43	0.22
Finland	0.7	0.4	0.3	−0.462	0.357	0.63	0.31	1.27	0.2
FYR Macedonia [c]	0.0	0.1	0.1						
France	4.3	2.7	2.2	−0.359	0.127	0.70	0.54	0.90	0.005
Germany [d]	1.8	2.1	0.7	−0.573	0.303	0.56	0.31	1.02	0.06
Greece	0.0	0.4	0.3	0.521	0.623	1.68	0.50	5.71	0.4
Greenland [d]	4.6	2.4	0.0	−1.775	1.070	0.17	0.02	1.38	0.1
Hungary	0.5	0.3	0.2	−0.387	0.445	0.68	0.28	1.62	0.38

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b. Prevalence rates of frequent (>40 times) use of cannabis in lifetime and temporal trend, by country: 15 year old females

Country	Rate per 100 Females			Temporal trend (per 4 year cycle)					
	2002	2006	2010	B[a]	(SE)	RR[b]	95% CI		P
							LL	UL	
Ireland	3.6	3.7	1.4	−0.426	0.208	0.65	0.43	0.98	0.04
Israel	0.4	0.4	----	0.212	0.900	1.24	0.21	7.21	0.81
Italy	3.8	1.1	1.2	−0.582	0.231	0.56	0.36	0.88	0.01
Latvia	0.0	0.3	0.3	0.815	0.729	2.26	0.54	9.43	0.26
Lithuania	0.0	0.3	0.2	0.698	0.608	2.01	0.61	6.62	0.25
Netherlands	4.1	3.4	1.5	−0.511	0.177	0.60	0.42	0.85	0.004
Poland	0.5	0.6	0.8	0.200	0.309	1.22	0.67	2.24	0.52
Portugal	2.7	1.5	0.8	−0.615	0.245	0.54	0.33	0.87	0.01
Russia	0.2	0.5	0.8	0.716	0.345	2.05	1.04	4.02	0.04
Slovakia [c]	----	0.5	0.2						
Slovenia	4.9	1.7	3.5	−0.143	0.170	0.87	0.62	1.21	0.4
Spain	5.9	5.5	3.5	−0.211	0.138	0.81	0.62	1.06	0.13
Switzerland [d]	7.9	4.4	3.1	−0.351	0.276	0.70	0.41	1.21	0.2
Ukraine	0.5	0.3	0.1	−0.631	0.492	0.53	0.20	1.40	0.2
United Kingdom	6.3	3.9	2.1	−0.530	0.077	0.59	0.51	0.68	<0.0001
USA	7.3	7.3	5.2	−0.157	0.109	0.85	0.69	1.06	0.15
All countries	**1.8**	**1.4**	**0.8**	**−0.261**	**0.030**	**0.77**	**0.73**	**0.82**	**<0.0001**

[a] modeled relative change in adjusted beta for lifetime cannabis use, per 4 year cycle

[b] modeled relative change in age/gender adjusted relative risks of frequent lifetime cannabis use, per 4 year cycle

[c] estimated using traditional sample down-weighting methods

[a] modeled change in adjusted beta for frequent lifetime frequent cannabis use, per 4 year cycle

[b] age/gender adjusted relative risks of frequent lifetime cannabis use, per 4 year cycle

[c] model did not converge

[d] estimated using traditional sample down-weighting methods

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Table 3

Summary of temporal trends in frequent (>40 times) lifetime cannabis use among 15-year olds, by gender and HBSC survey cycle

	Overall median prevalence per 100 participants for the 30 countries, by Gender and Survey Cycle			Number of countries reporting significant linear trend between 2002 and 2010 ($p<0.05$)		
	2002	**2006**	**2010**	**Increase**	**No change**	**Decrease**
Frequent (>40 times) use						
Boys	4.7	3.1	3.0	4	16	10
Girls[a]	1.8	1.4	0.8	1	21	6

[a] model did not converge in two countries, N countries = 28

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Table 4

Results of multiple Poisson regression analysis examining individual-level, country-level and time variables as possible determinants of frequent lifetime use of cannabis, 2002 to 2010 HBSC.

Indicator	Model 1: Individual Level (n=145,946)		Model 2: Country Level (n=124,294)		Model 3: Individual + Country (n=116,835)		Model 4: Individual + Country + Time (n=116,835)		Model 5: Interactions with time (n=116,835)*	
	RR	**(95% CI)**	**RR**	**(95% CI)**	**RR**	**(95% CI)**	**RR**	**(95% CI)**	**RR**	**(95% CI)**
Individual Level Variables										
Male Gender	1.90	(1.78 to 2.03)			1.99	(1.84 to 2.15)	1.99	(1.84 to 2.15)	1.85	(1.62 to 2.11)
Family Affluence Scale Per unit increase (3 levels)									0.94	(0.86 to 1.04)
Medium vs. High	1.16	(1.08 to 1.24)			1.13	(1.04 to 1.23)	1.12	(1.03 to 1.22)		
Low vs. High	1.46	(1.30 to 1.63)			1.39	(1.22 to 1.59)	1.36	(1.20 to 1.56)		
Frequency of peer contact – days	1.41	(1.39 to 1.43)			1.41	(1.39 to 1.43)	1.40	(1.38 to 1.43)	1.37	(1.34 to 1.41)
Frequency of electronic contact	1.06	(1.04 to 1.09)			1.07	(1.04 to 1.10)	1.08	(1.04 to 1.11)	1.08	(1.04 to 1.11)
Country Level Variables										
GDP per capita – per 1.0 SD			0.74	(0.67 to 0.81)	0.76	(0.69 to 0.84)	1.00	(0.85 to 1.17)	1.67	(1.18 to 2.37)
Perceived availability - per 1.0 SD			1.40	(1.24 to 1.57)	1.27	(1.11 to 1.45)	1.22	(1.06 to 1.39)	1.05	(0.83 to 1.32)
Time										
Per 4 year cycle (2002 referent)							0.86	(0.79 to 0.93)		
2006 vs. 2002									0.83	(0.48 to 1.42)
2010 vs. 2002									1.37	(0.75 to 2.49)
Interactions with Time (2002 referent)										
Male gender * Cycle										
2006 vs. 2002									1.01	(0.84 to 1.21)
2010 vs. 2002									1.26	(1.04 to 1.53)
Increased FAS (3 levels) *Cycle										
2006 vs. 2002									0.91	(0.79 to 1.04)
2010 vs. 2002									0.83	(0.72 to 0.96)
Frequency of peer contact*Cycle										
2006 vs. 2002									1.03	(0.99 to 1.07)
2010 vs. 2002									1.03	(0.99 to 1.07)

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Indicator	Model 1: Individual Level (n=145,946)		Model 2: Country Level (n=124,294)		Model 3: Individual + Country (n=116,835)		Model 4: Individual + Country + Time (n=116,835)		Model 5: Interactions with time (n=116,835)*	
	RR	**(95% CI)**	**RR**	**(95% CI)**	**RR**	**(95% CI)**	**RR**	**(95% CI)**	**RR**	**(95% CI)**
GDP per 1.0 SD * Cycle										
2006 vs. 2002									0.82	(0.65 to 1.02)
2010 vs. 2002									0.74	(0.57 to 0.95)
Perceived availability per 1.0 SD *Cycle										
2006 vs. 2002									1.05	(0.91 to 1.22)
2010 vs. 2002									1.10	(0.94 to 1.27)

Notes: No data were available on perceived availability for Canada and the US, these countries were excluded from analysis. A multi-level analysis, with students nested within schools that in turn were nested within countries resulted in remarkably similar results. With respect to the variance partitioning, the individual, between-country and between-school variances in the frequent cannabis outcome across all countries were: for boys, 93.8% individual, 3.1% country, 3.1% school; for girls, 95.8% individual, 0.0% country, 4.2% school. We reverted to a more traditional analysis that down-weighted samples by a design effect, so that we could include more countries in the analysis.