**Inequality and adolescent cannabis use: a qualitative comparative analysis of the link at national level**

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**Abstract**

Aim: this article explores the link between income inequality and adolescent cannabis use at the national level, in the context of other relevant social conditions, in developed countries.

Methods and data: fuzzy set qualitative comparative analysis is applied to two datasets that contain information on the national prevalence of past year cannabis use among 15 and 16 year olds, taken from the ESPAD and HBSC surveys, with supplementary data from the MtF and ASSAD surveys for the USA and Australia (n = 97 for the ESPAD and n = 72 for the HBSC dataset). The datasets also include data on national rates of income inequality (Gini coefficient), wealth (GDP per head), welfare support (average benefit replacement rates), urbanisation and labour market conditions (youth unemployment).

Findings: the combination of high inequality and high urbanisation forms part of configurations that are consistent with being usually sufficient to cause high adolescent cannabis use, alongside high GDP per head in the ESPAD dataset, and low welfare support in the HBSC dataset.

Conclusion: social conditions, and particularly the combination of income inequality and urbanisation, should be considered when studying the causation of high levels of adolescent cannabis use at the national level in developed countries.

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**Introduction**

This article introduces the use of qualitative comparative analysis (QCA) to the field of drug policy studies. It does so through an exploration of the link between income inequality and adolescent cannabis use in the contexts of other social conditions which may influence the prevalence of illicit drug use at the national level.

The use of illicit drugs by young people has historically been a driver of public concern and policy (Berridge, 2013; Kohn, 2001; Mills, 2013). There have been suggesting that social conditions may have more effect than drug policies on levels of use (Faupel, Horowitz, & Weaver, 2004; Stevens, 2011). But study of the influence of social conditions on drug use prevalence is rare. This article focuses on the potential influence of income inequality, alongside other theoretically relevant social conditions (in particular, socio-economic conditions) on adolescent drug use; specifically cannabis use by 15 and 16 years olds in economically developed countries that have similar cultural backgrounds. It is important to study influences on cannabis use at this age for at least two reasons. One is that cannabis use in adolescence is probably more damaging to both mental health and educational attainment than it is at older ages (Di Forti et al., 2015; Hall, 2015). The other is that it would be highly relevant to public policy debates if it were found that social conditions that can be changed by social policy influence the prevalence of this behaviour

QCA is presented as a method for the examination of a social phenomenon that is likely to have causes that are complex, multiple and contingent. The sample of countries in cross-national analysis tends to be small. QCA has been designed for the analysis of configurational causation in small samples of cases. This article does not present confirmatory analyses that aim to close debate. It does not aim to provide a complete, definitive explanation of the causes of cross-national variation in rates of adolescent cannabis use, but rather an exploratory analysis of the ways in which the influences of social conditions may combine. According to a search of the *Web of Science* - using the search terms (‘QCA’ OR ‘qualitative comparative analysis’) AND ‘drug’ - this is the first article to apply QCA to the analysis of illicit drug use[[1]](#endnote-1).

The article explains some theoretical reasons why inequality and other social conditions may affect adolescent drug use. It also explains the QCA approach. It then presents the data that were collected, the analyses applied, and results of this fuzzy set qualitative comparative analysis (fsQCA). The limitations and implications of these findings are discussed. The article concludes with a brief summary of its contribution to research on the social conditions that may influence adolescent cannabis use.

**The social conditions of adolescent cannabis use**

The association between social conditions and illicit drug use has been observed in a number of single-country qualitative and quantitative studies (e.g. ACMD, 1998; Bourgois, 1996; Faupel, Horowitz, & Weaver, 2004; Legleye, Janssen, Beck, Chau, & Khlat, 2011; Seddon, 2006; Shaw, Egan, & Gillespie, 2007; Singer, 2008). Cross-nationally, a linear, positive correlation between countries’ levels of income inequality and illicit drug use has been observed by Wilkinson and Pickett (2008). They propose a bio-psycho-social explanation for this relationship. They argue that social hierarchy produces stress amongst primates, including humans. This ‘status anxiety’ leads to the production of excessive levels of the stress hormone, cortisol, and to higher levels of anxiety and depression where inequality is greater. These then lead to higher rates of illicit drug use, as well as a wide range of other social problems, including violence, child mortality, mental illness and early deaths.

This proposed cause is not specific to adolescence and has been challenged by several authors on various grounds (see Rowlingson, 2011 for a review). But there are other ways in which such a link could be explained. These include the social development model of Catalano and Hawkins (1996) and the less deterministic (and less well established) concept of subterranean structuration (Stevens, 2011). The social development model resembles several other models of the determinants of public health (Rayner & Lang, 2012) in positing a variety of proximal and distal influences on adolescent behaviour. These include ‘position in the social structure’ alongside ‘individual constitutional factors’ and other ‘external conditions’ as the starting points for development through childhood. This will also be influenced by ‘prosocial’ and ‘antisocial’ opportunities and reinforcements to produce different patterns of delinquency and drug use in adolescence (Catalano & Hawkins, 1996, p. 159). In this model, countries which have higher rates of relative poverty will see more children influenced to develop along ‘antisocial’ lines, leading – in combination with other influences - to higher rates of illicit drug use.

The social development model shares with the bio-psycho-social model the assumption that drug use is likely to be highest among poor and socially marginalised groups. This is not supported by the available data, which suggests that cannabis use at the age of 16 may be higher in wealthier groups (Aston, 2015; Chowdry, Crawford, & Goodman, 2009; Humensky, 2010; ). This is a finding that can be explained by using the hybrid concept of subterranean structuration (Stevens, 2011). This combines the concepts of ‘subterranean values’ (Matza & Sykes, 1961) with a sociological approach to the interplay of structure and agency, known as ‘structuration’ (Giddens, 1984). It merges these two concepts in arguing that subterranean values of hedonism, excitement and instant gratification have become, as suggested by both Jock Young (2007; 1971) and Zygmunt Bauman (2007), cultural resources that young people use to create their repertoires of action. Young and Bauman have observed this especially in those more unequal countries where ‘turbo-capitalism’ has deepened social stratification, and where such stratification is performed through consumption. Young people at the higher end of unequal income distributions are enabled to express these values as they have more money to spend. Young people at the lower end may seek to counter the pains of social ‘relegation’ to which they are exposed (Wacquant, 2007). Illicit drug use can do this through its psychoactive effects (perhaps especially the calming and distancing effects that cannabis users often report [Müller & Schumann, 2011]). It can also provide a way to perform identities that reject demeaning forms of low paid work and low cost consumption, in favour of more romanticised, rebellious personae (Stevens, 2011; Sandberg & Pedersen, 2009). Such performances of outlaw identity through drug use may also be attractive to some wealthier young people who wish to avoid being seen as mere dependents on their parents (Mohamed & Fritsvold, 2010). So inequality may intensify the social conditions of illicit drug use at both ends of the income scale.

In different ways, these theories suggest that high levels of inequality are likely to increase a country’s prevalence of illicit drug use among young people. They also suggest that other social conditions may influence such behaviour if they affect bio-psycho-social stress, adolescent development and the attractions and availability of opportunities to use cannabis. So the conditions with which inequality is likely to combine in influencing adolescent cannabis use include welfare support, urbanisation, wealth and labour market conditions. Welfare policies may moderate the impact of inequality on young people by reducing the effects of both income and status inequalities. Urbanisation has been found to affect youth mental health and behaviour in previous studies (Weatherburn & Lind, 2001; Lederborg et al, 2011; Peen, Schoevers, Beekman, & Dekker, 2010). It may increase drug use by increasing stress and by creating more concentrated social networks through which drugs (and cultural norms related to drug use) may flow (Aldridge, Measham, & Williams, 2011). Young people in wealthier countries may have more disposable income with which to indulge any motivations to use drugs. A lack of labour market opportunities for young people may increase the relative attractions of seeking pleasure and status in drug use. These conditions are likely to combine in ways that are not yet theoretically predictable and have rarely been studied empirically. We therefore need an analytical approach that can help us in developing theoretical and empirical knowledge of the causes of national prevalence of illicit drug use and of how they combine with each other.

**Set relationships, necessity and sufficiency in QCA**

QCA has been developed by Charles Ragin and others (Marx, Cambré, & Rihoux, 2013; Ragin, 2000, 2008; Rihoux, Rezsöhazy, & Bol, 2011) and has most often been applied in the fields of political science, business and management, and historical sociology (see the bibliography at http://www.compasss.org/bibdata.htm). It is a new technique in this field, and so this article will explain its principles and application. It will try and avoid the use of technical language, although such details will be given in endnotes.

QCA does not rely on correlations between variables (as regression analysis does), but rather on set relationships between cases. Ragin (2000) argues that such set relations are implicit in all causal hypotheses. To hypothesise that a particular condition is a *sufficient* cause of a particular outcome is equivalent to proposing that cases that have the condition form a subset of cases that have the outcome. Cases which do not have the outcome but do have the purportedly sufficient condition would challenge the notion that the condition is sufficient to cause the outcome. Similarly, to hypothesise that a particular condition is a *necessary* cause of a particular outcome is equivalent to proposing that cases with the outcome form a subset of cases with the condition. Cases which have the outcome but do not have the purportedly necessary condition would challenge the notion that the condition is necessary to cause the outcome.

To describe whether a case is a member of a set of cases that have a condition or an outcome, the case can be given a membership score for the set. These can be in the form of crisp set scores of either one (the case is in the set that has that condition or outcome) or zero (the case is not in the set). They can also be in the form of fuzzy set scores, which range from one to zero, depending on the degree to which the case is considered to be a member of the set of cases that has the condition. Scores above 0.5 indicate that a case is more in than out of that set. Scores below 0.5 indicate that a case is more out of than in that set. And 0.5 represents the crossover point of maximum ambiguity as to whether a case is in in or out of the set. Fuzzy set scores are calibrated from raw data, as exemplified below.

Once set scores for individual conditions have been given to cases in the sample, it is then possible to calculate set scores for their membership in the negation of each set. The negation of a set for a condition is the set for the absence or opposite of that condition. It is calculated by subtracting the set score for the original condition from one. For example, the analyses below look separately at the outcome of *high* adolescent cannabis use and its negation; *low* adolescent cannabis use. If a case has a fuzzy set score of 0.8 for high adolescent cannabis use, it has a score of 0.2 (1 minus 0.8) for low adolescent cannabis use.

Fuzzy set scores also enable the calculation of the degree to which a configuration of conditions is present in each case. A case’s set score for a configuration of conditions can be calculated by taking the case’s lowest fuzzy set score for any condition that is included in an ‘AND’ configuration. The case’s set score for an ‘OR’ configuration is its highest set score for any condition that is included in that configuration. Take, for example, a case that has fuzzy set scores of 0.9 for the set of high income inequality and 0.3 for the set of high urbanisation. Its set score for the set of high income inequality AND high urbanisation would be 0.3. Its set score for high income inequality OR high urbanisation would be 0.9.

Set scores also enable the identification of relationships between sets; e.g. whether cases that are members of a set for a condition or configuration form a subset or a superset of cases with the outcome. If they form a superset, then cases’ set scores for the condition/configuration will consistently be greater than or equal to their scores for the outcome. This would be consistent with the condition being necessary to cause the outcome. If cases with the condition/configuration form a subset of cases with the outcome, then cases’ set scores for the outcome will consistently be greater than or equal to their scores for the condition/configuration. This would be consistent with the condition being sufficient to cause the outcome.

In neither scenario would this prove that the configuration is a real cause of the outcome. This requires the identification of causal mechanisms, in addition to repeated observations of consistent correlations or set relationships (Dupré & Cartwright, 1988). This is why, in the text below, some configurations are described as being ‘consistent with’ necessity or sufficiency, rather than being described as necessary or sufficient causes. In QCA, the strength of a set relationship between a configuration and an outcome is described as ‘consistency’ (equivalent to significance in regression analysis). The extent to which a configuration explains variation between cases in the outcome is described as ‘coverage’ (equivalent to R squared in regression analysis)

**Data**

As Ragin (2000) argues, the selection of cases for a comparative analysis is crucial. The sample should include theoretically relevant cases that are similar in important respects. This enables observed differences in the outcome of interest to be attributed, at least provisionally, to the influence of the potentially causal conditions that are being studied. The analyses presented here focus on economically developed democracies that share a similar, European cultural background. This includes 22 European countries alongside the USA, Canada and Australia.

*Data selection and sources*

The data for these analyses comes from publicly available surveys that cover adolescent cannabis use and potentially causal social conditions at the national level.

There are always judgements to be made in comparative research on the balance between having, on the one hand, the ideal indicators of the theoretical concepts of interest and, on the other, the data that are available for use, especially when relatively small sample sizes restrict the number of indicators that can be used. Some conditions were considered but were not included in the analysis. They included expenditure on social protection, rates of arrest and imprisonment for drug offences, and educational attainment (as measured by the Program for International Student Assessment [PISA]). However, they were considered less relevant to the theoretically expected link between social conditions (and specifically socio-economic conditions) and adolescent cannabis use. Some data also had problems of comparability. For example, the available data on arrest and imprisonment for drug offences use different definitions in different countries (Killias et al., 2010), while PISA’s comparisons of educational attainment are of questionable validity (Carnoy, 2015).

Comparable data on countries’ expenditure on social protection as a proportion of gross domestic product (GDP) are available from the Organisation for Economic Cooperation and Development (OECD). However, this condition did not contribute to the explanation of rates of adolescent cannabis use in preliminary analysis and so was excluded from the analyses reported here. Preliminary analysis was also carried out including a qualitatively calibrated condition for each country’s levels of decriminalisation of cannabis possession. As also found by Vuolo (2013), this condition added little to the explanation of national levels of adolescent cannabis use. It was also less relevant to the theoretical focus on social rather than policy conditions, and so was also excluded from the final analysis.

Two international research projects produce comparable information on adolescent cannabis use. The European School Survey Project on Alcohol and Other Drugs (ESPAD) is a cross-national collaboration of independent research teams. It administers a standardised, anonymous, pen-and-paper questionnaire in classrooms to at least 2,400 school students in each country who turn 16 in the year of the survey (the average age of respondents is 15.8) (Hibell, 2014). The project aims to create a cluster-randomised, representative sample of school students in each country. The questionnaire includes questions on whether the respondent has used cannabis in the past 12 months or past 30 days. Past 12 month cannabis use is the focus of the analyses in this article. More details, data and results from the ESPAD project are available from its website: [www.espad.org](http://www.espad.org).

The second source of data on adolescent cannabis use is the Survey of Health Behaviour in School-Aged Children (HBSC). This is also a collaboration between research teams which aims to create nationally representative prevalence estimates of adolescent substance use, among other health behaviours (HBSC Network, 2014). Like ESPAD, HBSC uses a pen-and-paper, anonymous, standardised questionnaire in classrooms with a cluster randomised sample of school students. The desired average age is slightly lower, at 15.5, than in the ESPAD survey. The usual sample size, at 1,500, is also slightly lower; the aim is to create national prevalence estimates with 95 per cent confidence intervals of plus or minus three per cent (Roberts et al., 2009). HBSC reports separate prevalences for the language communities of Belgium and the nations of the UK. For analysis here, the population weighted averages of these rates were used for these two countries. The HBSC questionnaire also asks about cannabis use in the past year. More information and results from the HBSC survey are available at [www.hbsc.org](http://www.hbsc.org).

With very similar methods, ESPAD and HBSC share similar limitations. These include the absence from the samples of students who were not at school on the day of the survey. They may be those who are most likely to be using illicit drugs. Other limitations include the range of different response rates across countries and the possibility of response bias when asking people to be honest in answering questions, even anonymously, on illicit drug use. These and other limitations are discussed in more detail in previous publications of the ESPAD and HBSC findings on drug use (e.g. Hibell et al., 2012; WHO, 2009), but it should be mentioned that the school-based survey method has been found to be robust (Bjarnason & Adalbjarnardottir, 2000) and that the resulting comparable prevalence estimates have been found to be reliable (Steppan, Kraus, Piontek, & Siciliano, 2013).

For comparative analysis, theoretically important countries that share similar contexts to that specified in case selection should be included. If they are not, there is a danger of excluding contradictory cases and their configurations of conditions from the analysis. Two important countries for this analysis are Australia and the USA. Neither is included in ESPAD, and Australia is not in HBSC. In order to include valuable information from these countries, data was extracted from surveys that use very similar methods. In the USA, this was the Monitoring the Future (MtF) survey (http://www.monitoringthefuture.org/). In Australia, it was the Australian Secondary Students Alcohol and Drugs (ASSAD) survey (White & Bariola, 2012). Both administer standardised, anonymised class room surveys to a random sample of adolescents in the same school grade as ESPAD and HBSC, using very similar methods and questions[[2]](#endnote-2).

Data on other theoretically relevant social conditions were gathered for each year for which ESPAD or HBSC data was collected. The Gini coefficient is a widely used - although imperfect (Salverde, 2011) - measure of national income inequality. It measures the dispersion of the distribution of incomes between individuals in the country. It ranges from zero (everyone receives the same income) to one (one person receives all the income). For this article, values of the Gini coefficient for disposable income for each country in each year were collected from the OECD’s online database of economic indicators (OECD, 2015a). For missing values, last observation carried forward (or nearest observation carried backward, in the case of years with no earlier value) was used.

The countries’ levels of welfare support may moderate the impact of income inequality (Esping-Anderson, 1990; Wilkinson, 2005). There is no direct measure of welfare support, but a useful indicator is provided by the value of a range of common welfare benefit types. Their value is measured by the extent to which they replace the ‘average production worker wage’ in each country in each year; i.e. the replacement rate. The Comparative Welfare Entitlement Database (CWED) contains data on unemployment, sickness and pension replacement rates - for both a typical individual and a typical family - over a number of years for a panel of developed countries (Scruggs, 2014). These data were collected from the CWED database (http://cwed2.org/). The average of these six replacement rates was calculated for use in this analysis as a measure of welfare support in each country in each year[[3]](#endnote-3).

National wealth (as measured by GDP per head) was chosen as a proxy indicator of the financial ability of young people to spend on consumption. Data on GDP per head (in 2005 US dollars, adjusted to 2005 purchasing power parity) was also downloaded from the OECD online databank (OECD, 2015b). Data on national rates of urbanisation (i.e. the proportion of a country’s population that lives in urban areas) for each year were collected from the World Bank’s online database (World Bank, 2015). The same database was used to collect data on rates of youth unemployment (percentage of total labour force aged 15-24).

*Data preparation and calibration*

Two datasets were created for analysis; one with the ESPAD cannabis use data, and one with the HBSC data (with additional data for Australia and the USA from the ASSAD and MtF surveys for the ESPAD dataset, and from ASSAD for the HBSC dataset). Data on cannabis use were available from the ESPAD surveys of 1995, 1999, 2003, 2007 and 2011. From HBSC, data were available for 2001/2, 2005/6 and 2009/10. The availability of data from more than one wave of each survey enables the inclusion of a larger number of observations in the dataset, with a separate row for each country for each year. This brought the sample sizes up to a numbers for which it was possible to use an adequate number of potentially causal conditions in QCA (Marx, 2010). Not all of the data on adolescent cannabis use or potential influences on it were available for all countries for all years of the two surveys. For analysis, only cases in rows of the datasets that had complete data for all these indicators (with imputation of some missing data for inequality as noted above) were included (n=97 for the ESPAD dataset and n=72 for the HBSC dataset). Each country in each year was treated as a separate case in the analyses presented below. The cases shown in table one were present in these datasets.

*Table 1 here*

The medians and ranges for these conditions in each dataset (combining all observations for countries and years together) are shown in table two. The values are slightly different for each dataset due to their inclusion of different years and countries. For example, the inclusion of Belgium in the HBSC dataset increased the maximum value for urbanisation.

*Table 2 here*

It would have been possible to calibrate these data into crisp sets for analysis, but this would have excluded much information on the degree of differences between the attributes displayed by the cases (Ragin 2000). So the data were calibrated into fuzzy set scores for use in fsQCA.

The approach to calibration was to view the distribution of the raw data (across all the countries and years available from 1995 to 2011) in order to see what degree of difference between countries could be considered as a difference in kind. This was done through a combination of substantive knowledge of cases (e.g. which cases would usually be thought of as having a qualitatively ‘high’ level of a particular condition) and examination of the distribution of observations (e.g. looking for ‘break points’ in the distribution where there were no or few actual cases observed). This enabled identification of countries that could certainly be said to have high or low levels of that condition; these were the countries that were consistently at either end of the distribution across the years of the surveys. A value just below the minimum value for these high level countries was chosen as the threshold for being fully in the set of countries that had high levels for that condition (i.e. cases above this threshold were given a fuzzy set score of one). A value just above the maximum value of the low level countries was used as the threshold for being fully out of that set (i.e. cases below this threshold were given a fuzzy set score of zero). The nearest break point to the median value that made substantive sense was used as the point of maximum ambiguity as to whether a case was in or out of the set of high values for that condition (i.e. a fuzzy set score of 0.5). For example, for GDP the fuzzy score of 0.5 was assigned to an empty value in the distribution below the minimum values for the UK, Germany and Australia, as these would usually be considered to be wealthy countries.

Table three displays the calibration thresholds chosen for conditions in the datasets. These were applied to both datasets. Note that the point of maximum ambiguity for high adolescent cannabis use in the HBSC dataset was slightly lower than that for the ESPAD dataset. This is because the median for the HBSC dataset was also lower, possibly due to the slightly younger average age of respondents.

*Table 3 here*

**Fuzzy set qualitative comparative analyses**

The calibration and analysis of data used the QCA package in R that was authored by Duşa and Thiem (2014). It proceeded according to the steps that they recommend (Thiem & Duşa, 2013). QCA does not assume causal symmetry; there may be different causes for high or low levels of a specified outcome (Ragin, 2000). So separate analyses were carried out for high and low levels of adolescent cannabis use.

*Testing for necessity*

The first step was to check for any conditions or configurations of conditions that were consistent with being necessary for the outcomes of high or low adolescent cannabis use. In neither the ESPAD nor HBSC datasets were there any non-contradictory necessary configurations for these outcomes, at the 0.965 threshold for consistency that is recommended by Thiem & Duşa (2013)[[4]](#endnote-4).

*Testing for sufficiency*

In order to identify those configurations of conditions that were consistent with sufficient for the outcomes of high and low adolescent cannabis use, fuzzy set truth tables were created. These are displayed in tables four and five. Each row of these tables shows a configuration of conditions that describes one or more case in the datasets. The columns for conditions in these tables indicate the presence of each condition in each configuration. One indicates the presence of a high level of that condition (as described by a fuzzy set score above 0.5). Zero indicates the presence of a low level of that condition (as described by a fuzzy set score below 0.5)[[5]](#endnote-5). These tables do not display ‘logical remainder’ configurations; i.e. the logically possible configurations that had no actual cases in the datasets.

The tables also give values for the degree to which each configuration is consistent with being sufficient for each outcome[[6]](#endnote-6). In analysis of such tables, there is a judgement to be made about the threshold for consistency. Configurations that have consistency values above this threshold represent cases that are considered to form a subset of cases with the outcome; i.e. to be consistent with a relationship of causal sufficiency between the configuration and the outcome. For ease of comparison between the two datasets, the 0.9 consistency threshold that is suggested by Thiem and Duşa (2013) was used. Configurations that exceed this threshold in the truth tables are indicated in bold for the outcome of high adolescent cannabis use, and in italics for the outcome of low adolescent cannabis use.

*Tables 4 and 5 here*

*Parsimonious solutions of the truth tables*

The next step in QCA is to carry out ‘Boolean minimisation’ in order to identify the most parsimonious way of describing the consistently sufficient configurations. This is called the ‘parsimonious solution’ of the truth table. The QCA R package does this by comparing the configurations that are above the consistency threshold in the truth table. It looks for conditions in these configurations that make no difference to this outcome (i.e. the condition and its negation are both present in otherwise identical sufficient configurations). It excluded such conditions from the minimised solution.

For example, the fourth and fifth row of the truth table for the HBSC dataset displays two very similar configurations. They are both considered consistent with being sufficient for high adolescent cannabis use. In QCA notation, upper case indicates the presence of a condition (i.e. a high level). Lower case indicates the negation of the condition (i.e. a low level). And \* represents AND. So these configurations can be written as:

w\*I\*GDP\*U\*YU

w\*I\*GDP\*U\*yu

As can be seen, these two configurations are identical apart from the difference in the condition for youth unemployment. It appears not to make a difference to the outcome if this condition is at high (YU) or low (yu) levels. So it can be excluded from the minimised solution of the truth table. This leaves the configuration w\*I\*GDP\*U. For the parsimonious solution of the truth table, this configuration was further minimised by considering logical remainder configurations[[7]](#endnote-7). The logical remainders include configurations that are identical to those written above, apart from the GDP condition (they are w\*I\*gdp\*U\*YU and w\*I\*gdp\*U\*yu). To create the parsimonious solution, these configurations can be treated as consistent for the outcome. So the GDP condition is excluded, leaving the configuration I\*U\*w in the parsimonious solution.

This configuration is one element of the minimised, parsimonious solutions that are displayed in tables six and seven[[8]](#endnote-8). Each element of the solutions is minimised from different consistent configurations in the truth tables. Both solution includes two miminised configurations, which are linked by OR (+ in QCA notation). The finding that the causation of high adolescent cannabis use may involve one configuration OR another is consistent with QCA’s assumption of equifinality; there may be multiple causal pathways to the same outcome.

*Tables 6 and 7 here*

These tables display the consistency and coverage[[9]](#endnote-9) of each solution, as well as the cases that have each element of the solution. It is common to find – and consistent with the theoretical assumptions of QCA – that configurations that are highly consistent do not cover all cases of the outcome; some causal pathways to the outcome may involve conditions that are not included in the analysis. In this analysis, the solutions cover just under half of the cases’ membership in the outcome. This suggests that conditions apart from the social conditions under study here could play a role in a fuller explanation of national levels of adolescent cannabis use.

The parsimonious solutions for the truth tables for both datasets suggest that there is not a sole condition that influences adolescent cannabis use on its own, as every element of each solution includes more than one condition.

For the ESPAD dataset, the potentially causal configuration with the highest coverage is the combination of high inequality AND high urbanisation AND high GDP. There is another highly consistent configuration, but this account only for cases from one country; Ireland. It would be safer to assume that this country is an idiosyncratic cases for which a more parochial explanation is required (Karstedt, 2001), than to assume that the configuration of conditions that it displays in the analysis is generally sufficient to cause high adolescent cannabis use.

For the HBSC dataset, there are also two configurations with high consistency for the outcome of high adolescent cannabis use. One is very similar to the solution for the ESPAD dataset that has the highest coverage. It also represents a very similar range of cases. It is the configuration of high inequality AND high urbanisation AND low welfare support. There is another element to the parsimonious solution that represents some central European cases; the configuration of low inequality AND low GDP AND low youth unemployment. The suggestion of a separate, central European pathway towards high adolescent cannabis use is intriguing. But our confidence in the reliability of this explanation may be reduced by the fact that at least one of the configurations that are minimised to produce this element of the solution (i.e. w\*i\*gdp\*u\*yu, displayed in the second row of the HBSC truth table) also has relatively high consistency (>0.8) for the outcome of low adolescent cannabis use.

The combination of high income inequality and high urbanisation is present in the configurations which have the highest coverage for both datasets. So the consistency and coverage of their combination (I\*U) was calculated. For the ESPAD dataset, this configuration had consistency of 0.893 and coverage of 0.448. For the HBSC dataset, it had consistency of 0.926 and coverage of 0.511. This configuration may be considered the most parsimonious way to describe the combined results of these two analyses. The configuration of high income inequality AND high urbanisation is consistent with usually[[10]](#endnote-10) being sufficient to cause high adolescent cannabis use.

*Table 8 here*

For each configuration, values were also calculated for their consistency with being sufficient for the outcome of low adolescent cannabis use. These are also displayed in tables four and five. In the ESPAD dataset, no configuration exceeded the 0.9 threshold for consistency. In the HBSC dataset, there was one configuration that exceeded this threshold. It is displayed in the bottom row of table five, which represents the case of Portugal in 2009. Inclusion of logical remainder configurations in the Boolean minimisation of this configuration produced the parsimonious solution displayed in table eight. Its coverage of the outcome of low adolescent cannabis use is quite low (<0.25). This analysis supports the assumption of QCA that causation may not be symmetrical; the causes of a low level of adolescent cannabis use may not merely be the mirror image of the causes of a high level. These analyses also suggest that these social conditions have relatively little, if any, part to play in explaining the outcome of low adolescent cannabis use.

Taken together, these analyses support the assumption of QCA that causation of social phenomena tends to be configurational. No social condition was found to be sufficient on its own to cause either high or low levels of adolescent cannabis use. The configuration with the highest coverage that was consistent with usually being sufficient to cause high adolescent cannabis use included both high income inequality and high urbanisation. So the theoretical proposal that social conditions may form part of the explanation is also supported for the outcome of high adolescent cannabis use.

*Analytical limitations and sensitivity*

Of course, these analyses have their limitations. There is, for example, the ever-present problem of operationalisation. We cannot be certain that the selected indicators are both valid and reliable measurements of the underlying constructs which are theorised to be causally connected. Measurement error is always a possibility, especially due to the many biases that can enter the measurement of adolescent drug use (Kilmer, Reuter, & Giommoni, 2015). But even relatively well-known macro-economic indicators, including GDP per head and income inequality, have their issues (Malinvaud, 1989).

Proponents of QCA (e.g. Ragin, 2000) argue that regression analyses are highly sensitive to the specification of the model. But this is also an issue for QCA (Krogslund, Choi, & Poertner, 2015). For example, its findings may be sensitive to the choices of the cut-off threshold for consistency. In order to test the sensitivity of the analyses, the truth tables for each dataset were generated again, but with the consistency threshold setat both 0.85 and 0.8. Boolean minimisation was then performed to produce a parsimonious solution for each new truth table. This produced some different configurations in the parsimonious solutions to those in tables six and seven for high adolescent cannabis use, but these solutions always including high inequality AND high urbanisation in the element of the solution with the highest coverage. The configuration presented in table eight for low adolescent cannabis use was less stable. It appeared in the parsimonious solution when the consistency threshold was set at 0.8, but not at 0.85. It was never the case that one condition was sufficiency on its own to cause high rates of adolescent cannabis use.

When pooling data from different survey waves into the same sample, there is a danger of ignoring how time may affect the results. Hino (2009) suggests that pooling cases in QCA is more appropriate when - as in this article - the variation of interest is between the cases, rather than across time. But in order to check the robustness of these analyses across time, the procedure recommended by García-Castro and Arino (2013) was followed. The consistency of the parsimonious solutions displayed in tables six, seven and eight were tested separately for each year of the survey (including the observations from Australia with their nearest ESPAD or HBSC survey year). This showed that these solutions for high adolescent cannabis use were highly consistent across time. This suggests that the cross-sectional findings reported here for high adolescent cannabis use are stable across the time period covered by the data and that these results are not dependent on including cases from the same countries across the survey years in the same, pooled sample[[11]](#endnote-11). There was some effect of time on the result for low adolescent cannabis use in the HBSC dataset. The consistency of this solution was above 0.9 for 2005 and 2009, but below 0.7 for 2001.

The cross-sectional nature of these analyses also limits the causal inferences that should be drawn from them. It does not establish causal precedence and does not exclude the possibility of reverse causation[[12]](#endnote-12). More research is needed in order to establish robust analysis of configurational causation of adolescent cannabis use over time, and this will require further methodological development of the QCA approach (Hino, 2009).

In interpreting the results of these analyses, the danger of committing the ecological fallacy should be borne in mind. These analyses have used national – not individual – level data to analyse differences between countries. For example, data on adolescent cannabis use represent the national aggregate level, not the level displayed by any particular individual. The results of these analyses should therefore not be applied to individuals.

**Discussion**

The results of these analyses highlight a cluster of countries that have relatively high levels of cannabis use. This includes Anglophone countries that share an imperial/colonial relationship and protestant religious heritage; Australia, the UK, Canada and the USA. It also includes France (in 2011) and Spain. They have different linguistic, imperial and religious histories. What they all share is that they have relatively high levels of income inequality and urbanisation. There are other countries in the sample that have relatively high rates of income inequality (like Greece and Portugal) or relatively high rates of urbanisation (like Sweden and Finland), but have relatively low rates of adolescent cannabis use. So it appears that neither income inequality nor urbanisation is sufficient on its own to cause high adolescent cannabis use. Rather, these conditions may operate in tandem, and in contexts that are also influenced by other social conditions.

It may be, for example, that the production of bio-psycho-social stress by inequality that is highlighted by Wilkinson and Pickett (2008) is exacerbated by the stresses of urban living, especially in countries with low levels of welfare support. Urbanisation may also provide more of opportunities for anti-social activity and reinforcement. The social development model (Catalano & Hawkins, 1996) would expect this to exacerbate any tendency towards deviancy that is initiated by a relatively low position in the social hierarchy. The subterranean structuration (Stevens, 2011) approach would also highlight the increased strain and stress of the combination of inequality and urbanisation that might increase cannabis use at the low end of the income distribution. It would also point to the increased income and opportunities for transmission of subcultural drug use norms that might increase cannabis use among richer young people in wealthy countries that are both highly unequal and highly urbanised.

It is interesting that youth unemployment did not play a major role in the explanation of levels of adolescent cannabis use. When it did appear in solutions for high and low levels of this outcome, it was in the opposite direction to that which was theoretically expected. Low youth unemployment appeared in configurations that were consistent with sufficiency for high adolescent cannabis use. High youth unemployment appeared in the only configuration that was considered consistent for sufficiency for low adolescent cannabis use. This might suggest that high rates of adolescent cannabis use are more likely to be observed in countries which are more successful in including young people in the labour market.

The analysis also highlights some countries - including Ireland, the Czech Republic and Slovenia - for further analysis of why they have relatively high rates of adolescent cannabis use, despite not having the combination of high inequality and high urbanisation. Other countries that have had high rates of adolescent cannabis use but which are not covered by the solutions found in these analyses include Belgium, Denmark, Italy, the Netherlands and the Slovak Republic. There may be other causal pathways to this outcome in these countries.

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It is important to place these findings in the context of previous research on the influences on rates of adolescent cannabis use. A previous analysis of HBSC data, using Poisson regression methods, found that rates of frequent lifetime (40 or more occasions of) adolescent cannabis use were higher in more wealthy countries and among more wealthy individuals (Ter Bogt et al., 2014). The fact that wealth was important in this previous analysis supports the theoretical linkages between cannabis use and socio-economic conditions, as do other previous analyses of the HBSC data (Ter Bogt, Schmid, Nic Gabhainn, Fotiou, & Vollebergh, 2006). In Schmid’s (2001) analysis of the Swiss HBSC data, urbanisation was found to interact with perception of peers’ cannabis use. The predictive effect of peer perceptions in increasing cannabis use was higher in more urbanised cantons. This again suggests a combinatorial effect between urbanisation and another condition in influencing cannabis use. It would be useful to discover whether income inequality also influences the effect of such combinations through further cross-national research using similar data.

The fsQCA analyses above suggest that high urbanisation may form part of the explanation of high adolescent cannabis use at the national level, alongside high income inequality. A link between urbanisation and illicit drug use was also suggested by Peter Cohen (2006), who used it to explain why Sweden has relatively low prevalence of illicit drug use. But among countries included in the datasets for this article, Sweden has relatively high urbanisation (having fuzzy set scores around 0.88 for this condition, depending on the year). Yet Sweden has had very low relative rates of adolescent cannabis use (with fuzzy set scores of zero in every survey year except one). This contradicts Cohen’s suggestion that urbanisation is an independent cause of high illicit drug use. Rather, it may operate in combination with high income inequality as a contingent, sufficient cause of high adolescent cannabis use.

**Conclusion**

This article has used QCA – more specifically fsQCA - to explore the link between income inequality and adolescent cannabis use in the context of other social conditions at the national level in developed countries. It has found that the combination of high inequality and high urbanisation is consistent with usually being sufficient to cause high adolescent cannabis use. This explanation covers the occurrence of this outcome in countries including Australia, Canada, France, Spain, the UK and the USA. However, a substantial proportion of cases that had high adolescent cannabis use did not have this configuration. This suggests that, in line with the theoretical roots of QCA, the causation of high rates of adolescent cannabis use is multiple and complex. The social conditions included in these analyses may give us a partial explanation of why countries differ in their rates of adolescent cannabis use. More research is needed to provide a fuller explanation.

The analyses presented here demonstrate the value of QCA methods in suggesting how we might develop an understanding of the complex causation of drug use and drug policy outcomes. If nothing else, it suggests that future analysts of cross national differences in such outcomes may wish to include the combination of inequality and urbanisation as an attribute of interest. This article closes with an invitation to other researchers to take forward the exploration of how income inequality and other social conditions may influence national rates of illicit drug use and related problems, and to consider QCA as a tool for use in this collective task.

These tables do not display ‘logical remainder’ configurations; i.e. the logically possible configurations that had no actual cases in the datasets.

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**Tables**

















**Endnotes**

1. When upper case is used for AND or OR, this indicates that they are being used as Boolean logical operators. [↑](#endnote-ref-1)
2. The ASSAD survey does not report drug use by the school year in which the respondent is, as ESPAD, HBSC and MtF do, but separately by age. Therefore, the mean of 15 and 16 year olds was used for the ESPAD dataset, while the value for 15 year olds was used in the HBSC dataset (as this survey has a younger average age). Also, there is a slight mismatch in some of the survey years, as shown in table one. Data on other conditions was also taken from these years for Australia. [↑](#endnote-ref-2)
3. The CWED also contains an index of welfare generosity which is based on more information than the replacement rates. However, this is available for a smaller number of countries. In those countries that have it, it is highly correlated (Pearson’s r > 0.8) with the calculated average welfare replacement rate. [↑](#endnote-ref-3)
4. In both datasets, there were configurations that were consistent with being necessary for high adolescent cannabis use. But they were contradictory in that they were also consistent with being necessary for the negation of that outcome. So they cannot be considered as necessary causes of either outcome. Such paradoxical evidence on necessity can occur where a large proportion of fuzzy set scores for the potentially causal configuration are above 0.5 or higher, as this makes it more likely that the scores for this configuration will be higher than the scores for both the outcome condition and its negation. So Thiem and Duşa (2013) provide routines for the identification and exclusion of contradictory necessary configurations. [↑](#endnote-ref-4)
5. Technically, zero represents the presence of the negation of the calibrated set for that condition. Due to the calibrations thresholds chosen for this analysis, this can be taken to indicate a low level of each condition. [↑](#endnote-ref-5)
6. This consistency value is calculated by dividing the sum of cases’ scores for that configuration that are consistent with sufficiency (i.e. the total of those parts of their fuzzy set score for the configuration that are equal to or less than their score for the outcome) by the total of their scores for that configuration (Thiem & Duşa, 2013; Ragin, 2008). [↑](#endnote-ref-6)
7. In order to produce a more parsimonious solution, configurations that have no actual cases can be dealt with as if they may affect the outcome in either direction. These logical remainder configurations are treated ‘as instances of the outcome if doing so results in a logically simpler solution’ (Ragin, 2008, p.156). The low welfare support condition - w - cannot be excluded from this element of the parsimonious solution because the configuration of W\*I\*GDP\*U\*YU is present in the sample (in the sixth row of the HBSC truth table; the configuration of Spain in 2001) and is not considered as an instance of the outcome. This leaves open the possibility that w forms part of the causal configuration. [↑](#endnote-ref-7)
8. It is also possible to produce an ‘intermediate’ solution in QCA by using information on which direction it is expected that each condition will influence an outcome to prevent the assumption that it may affect the outcome in the opposite direction from being used in the process of minimisation. As the theoretical and empirical link between the conditions and the outcome in these analyses are not firmly established, it was considered that there were no such ‘easy counter-factuals’ in the analyses, and so no intermediate solutions were generated for these truth tables. [↑](#endnote-ref-8)
9. Coverage gives an indication of the empirical relevance of each consistent configuration. It represents the proportion of the total of all the cases’ scores for the fuzzy set of the outcome that is covered by the consistent part of cases’ scores for the configuration (Thiem & Duşa, 2013; Ragin 2008). [↑](#endnote-ref-9)
10. It is described as consistent with ‘usually’ being sufficient as its value for consistency is less than perfect (i.e. <1). [↑](#endnote-ref-10)
11. García-Castro and Arino (2013) also recommend the calculation of the Euclidian distances between two vectors – one for the consistencies calculate between cases for each time period and one for consistency within each cases across time periods - and the vector of the pooled consistency value. For the analyses of high adolescent cannabis use, this distance was well below the suggested threshold for identifying significant effects of time. As would be expected from the nature of the sample, which was created in order to examine variation across countries, there was a non-random pattern of different consistencies within countries across years. [↑](#endnote-ref-11)
12. fsQCA analysis was performed to test whether adolescent cannabis use formed part of configurations that were consistent with being necessary or sufficient for high income inequality. This found no configurations of social conditions with high or low adolescent cannabis use that were consistent with being necessity or sufficient to cause high income inequality at the consistent thresholds suggested by Thiem & Duşa (2013). [↑](#endnote-ref-12)