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A cannabis reader: global issues and local
experiences

Perspectives on cannabis controversies, treatment and
regulation in Europe

Editors

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8
VOLUME II

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Chapter 8

Assessing the population health impact of cannabis use

Keywords: cannabis – drug policy – economics – health – mental health – public health

Setting the context

There is a tendency in discussions of responses to cannabis use to rely on faulty logic. From the perspective of drugs professionals, these might manifest themselves in terms of a mild prejudice: ‘study finds that mass media prevention campaign had boomerang effect’ becomes ‘mass media preventions do not work’. Or perhaps ‘higher prevalence of schizophrenia among cannabis users’ becomes ‘there is a causal link between schizophrenia and cannabis use’.

In a stronger form, the media may encourage the inference of unrelated behaviours in relation to cannabis. Issues of cannabis potency, mental health and crime often share headlines. We may cite examples noted in the EMCDDA’s press corpus during production of this monograph: ‘Deranged cannabis smoker obsessed with Satanism stabbed country vicar to death’ (1); ‘Son twisted by “skunk” knifed father 23 times’ (2). Public and political debate on cannabis users can sometimes be drowned out by the noise generated by such salacious headlines.

This chapter — written by Wayne Hall, one of the world’s most published experts on cannabis use — advocates a sceptical eye with regard to claims made for the public health impact of cannabis. Developing the theme of public health impact studies discussed by Robin Room in the previous chapter, this chapter looks at the difficulties involved in assessing the global effect of cannabis use on the health of entire populations.

(1) *London Evening Standard*, 17 October 2007.

(2) *Daily Mail*, 23 July 2007.

On a practical level, the chapter provides a checklist to help researchers to question any assumptions or to avoid causal inferences⁽³⁾. From an epidemiological point of view, the data on the precise impacts of chronic cannabis use are weak, especially compared with what we know about alcohol and tobacco. Furthermore, assessing the impact of cannabis problems is difficult and beset with ethical problems, not least because of the illicit status of the drug and a tendency for it to be discussed in conjunction with, or compared with, other illicit drugs that carry higher toxicological risks.

The chapter also mentions an ‘inflationary–deflationary dialectic’, in which cannabis problems have been both demonised by moralists and belittled by pro-cannabis organisations. Decoupling cannabis from political discussions is necessary in order to quantify the harms of cannabis, and to place them against a neutral background where they are compared with other health issues. The chapter also suggests that the temptation to focus on adverse health effects needs to be balanced with potential positive effects of cannabis use. This argument is often applied to defend moderate alcohol use vis-à-vis the harms of binge drinking or alcoholism. While efforts to quantify the public health harms of illicit drug use are currently only in an embryonic stage, research into any ‘balancing’ public health benefits is extremely rare.

Further reading

- Hall, W., Pacula, R. (2003), *Cannabis use and dependence: public health and public policy*, Cambridge University Press, Cambridge.
- MacCoun, R., Reuter, P. (2001), *Drug war heresies: learning from other vices, times and places*, Cambridge University Press, Cambridge.
- Mackay, C. (1852), *Memoirs of extraordinary popular delusions and the madness of crowds*, Office of the National Illustrated Library, London.

See also the grey literature list in the Appendix to Volume 1 of this monograph.

⁽³⁾ See also the comments on meta-reviews by Bergmark, this monograph.

Assessing the population health impact of cannabis use

Wayne Hall

There are major technical challenges in assessing the impact that cannabis use has on the health of users and public health (Hall, 1999). These include difficulties in deciding whether cannabis use is a contributory cause of the adverse health and psychological effects attributed to its use and in quantifying the magnitude of these adverse health effects. These technical challenges are amplified by the difficulties in separating the political debate about the legal status of cannabis use from appraisals of its health effects.

Making causal inferences

Before a claim can be accepted that cannabis causes an adverse health outcome there must be evidence that there is an association between cannabis use and the health outcome; the association is not due to chance; cannabis use preceded this outcome; and we can make a case for the implausibility of alternative, non-causal explanations of the association (Tukey and Brillinger, 1984; Hall, 1987; Strom, 2000).

- Evidence of association: reasonable evidence of an association between cannabis use and a health outcome (e.g. schizophrenia) is provided by finding a relationship between cannabis use and the outcome in case-control, cross-sectional, cohort or experimental studies.
- Excluding chance: evidence that chance is an unlikely explanation of the relationship is provided by constructing a confidence interval around the sample value of a measure of association. We infer that an association exists if the confidence interval does not include the null value (i.e. the value consistent with no relationship). The width of the confidence interval provides an indication of the degree of uncertainty surrounding the inference, while its upper limit indicates how large an association may have gone undetected (Altman and Gardner, 2000).
- Ascertaining temporal order: if cannabis use is the cause of an effect, then there should be good evidence that cannabis use precedes it. The strongest evidence that cannabis use precedes certain health effects is provided by either a cohort study or an experiment. In the former the researcher observes that cannabis use precedes the health effect while in the latter the experimenter ensures by design that it does so.

- Deciding between alternative explanations: the hardest criterion to satisfy is that of excluding the possibility that the relationship between cannabis use and the health outcome is due to an unmeasured variable that causes both cannabis use and the adverse health outcome. In surveys of high-school-aged adolescents, for example, cannabis users typically perform more poorly at school than non-cannabis users (Hawkins et al., 1992). This may be because cannabis use is a cause of poor school performance but an equally plausible hypothesis is that learning difficulties cause both poor school performance and cannabis use (Lynskey and Hall, 2000).

Experimental evidence provides the 'gold standard' for ruling out these common causal explanations (Fisher, 1947; Cook and Campbell, 1979; Shadish et al., 2002). Randomly assigning adolescents to use cannabis or not, for example, would ensure that cannabis users and non-users were equivalent before using cannabis. Hence, any subsequent differences in educational performance could be attributed to cannabis use rather than to pre-existing differences in ability. When studying anything except acute and innocuous health effects, random assignment of individuals to use cannabis or not is impossible for ethical and practical reasons. It would be unethical, for example, to force some adolescents to use cannabis, and impracticable, even if ethical, to prevent those assigned not to use the drug from doing so.

Experimentation using laboratory animals is one way of getting around the impossibility of human experimentation. But suitable experimental animal models are not available for many of the putative adverse psychosocial effects of cannabis use such as psychosis, school performance and personal adjustment. In addition, there are problems in extrapolating results across species, different routes of administration (e.g. oral and parenteral in animals versus smoked in humans), and the very high doses that are typically used in animal studies.

When a suitable animal model does not exist, and randomisation of human subjects is impractical or unethical, statistical methods must be used to adjust for the effects of pre-existing differences in risk between cannabis users and non-users. If the relationship persists after statistical adjustment, the confidence is increased that the relationship is not attributable to the variables for which statistical adjustment has been made (MacLeod et al., 2004). This type of control has been used, for example, in longitudinal studies of adolescent cannabis use and psychosis (e.g. Caspi et al., 2005; Fergusson et al., 2005; Henquet et al., 2005).

Acute health effects

The acute health effects of any drug are easier to appraise than the chronic effects: the temporal order is clear; drug use and the effects occur closely together in time; and

if the effects are not dangerous, they can be reliably reproduced by giving the drug under controlled conditions. All this is true of the most common psychoactive effects of cannabis (e.g. euphoria, relaxation, sociability) and some of the more commonly reported adverse acute effects such as anxiety, panic and depression (Hall and Pacula, 2003).

It is more difficult to decide upon the causal contribution that cannabis use makes to relatively rare, acute adverse experiences such as flashbacks and psychotic symptoms. It is difficult to decide whether these are rare events that are coincidental with cannabis use, the effects of other drugs which are often taken together with cannabis, rare consequences of cannabis use that only occur at doses that are much higher than those used recreationally, cannabis effects that require unusual forms of personal vulnerability or the results of interactions between cannabis and other drugs.

Chronic health effects

Causal inferences about the long-term effects of chronic cannabis use become more difficult the longer the interval between use and the adverse effects. It takes time for adverse effects to develop and usually it takes even longer for a connection to be suspected between the two. This is largely because the longer the time interval between cannabis use and the health consequence, the more numerous the alternative explanations of the association that need to be excluded.

We often have to trade off rigour and relevance in evidence on the effects of chronic cannabis use. The most rigorous evidence is provided by laboratory investigations using experimental animals, but its relevance to human use is often uncertain. Epidemiological studies are manifestly more relevant in assessing human health effects, but they are usually less rigorous in assessing exposure to cannabis and in excluding alternative explanations of the associations. The consequence is increased uncertainty about the interpretation of epidemiological studies that affects interpretations of the causal significance of associations ('positive' studies) as well as studies that fail to find such relationships ('negative' studies).

A common interpretative problem with positive findings is that cannabis use is correlated with alcohol, tobacco and other illicit drug use that also adversely affect health. Generally, the heavier the cannabis use, the more likely that the person also uses these other psychoactive drugs (Newcomb and Bentler, 1989; Kandel and Yamaguchi, 1993). This can produce spurious associations between cannabis use and health outcomes, which makes it difficult to confidently attribute any adverse health effects to cannabis. This has been the case, for example, in interpreting the evidence on the role of cannabis use in motor vehicle accidents (Hall and Pacula, 2003; Mann et al., this monograph).

When studies fail to find adverse health effects of chronic cannabis use, for example immunological effects, it may be unclear whether this means that THC has few, if any, immunological effects in humans, or that our research has not had the sensitivity to detect its effects. The answer to this question depends upon the likely magnitude of any adverse effects, their relationship to dose, frequency and duration of use, and the ability of studies with small sample sizes to detect them (Hall and Einfeld, 1990).

An overall appraisal of causal hypotheses

Causal inferences are often made in the light of a research literature by judging the extent to which standard criteria such as those outlined by Hill (1977) are met. These criteria are not sufficient for establishing that an association is a token of a causal relationship since it is possible for the criteria to be met and yet to be mistaken in making a causal inference. In general, however, the more of the criteria that are met, the more likely it is that the association is a token of a causal relationship.

Strength of association: relationships that are stronger indicate that if cannabis is used there is a high likelihood that the health effect will also occur. Stronger relationships are generally more deserving of trust than weaker ones because the latter are more easily explained by measurement or sampling biases.

Consistency of relationship: relationships which are consistently observed by different investigators, studying different populations, using varied measures and research designs, are generally more credible than relationships which are not. This is because a relationship that persists despite differences in sampling and research methods is less likely to be explained by sampling, measurement or other biases.

Specificity is a desirable but not a necessary condition. It exists when cannabis use is strongly associated with the outcome, and the health outcome is rare in the absence of cannabis use. Specificity is desirable in that if it exists we can be more confident that there is a relatively simple and direct causal relationship but its absence does not exclude the possibility of a more complex causal relationship (e.g. in which the effect is conditional on the presence of other factors).

Biological gradient refers to the existence of a dose–response relationship between cannabis use and the health outcome: the more heavily cannabis has been used, the greater the likelihood of the health outcome. Satisfaction of this criterion is also desirable but not necessary since there may be other patterns of relationship between exposure and disease, for example a threshold effect, an ‘all or none’ effect or a curvilinear relationship.

Biological plausibility refers to the consistency of the relationship with other biological knowledge. If we can think of no conceivable mechanism whereby cannabis can produce such an effect, then we may have grounds for scepticism. But in the face of compelling evidence of association from well-controlled studies, implausibility may be a signal that existing theories are wrong or that we need to develop new theories that explain previously unknown phenomena.

Coherence means that the relationship coheres with, or makes sense of, other information about the natural history and biology of the disease. This, too, is desirable but not necessary: it is desirable that we have independent information that we can trust but its absence is not fatal, since the other information with which it is inconsistent may be in error.

Assessing the magnitude of risk

The standard epidemiological measures of risk magnitude are relative risk and population attributable risk. The relative risk is the increase in the odds of experiencing an adverse health outcome among those who use cannabis compared with those who do not. It may be quantified as a relationship between the frequency and duration of cannabis use and the risk of experiencing an adverse health outcome. The population attributable risk represents that proportion of cases with an adverse outcome that can be attributed to cannabis use, if it is causal.

The two measures of risk have different uses and implications. Relative risk is most relevant to individuals attempting to estimate the increase in their risk of experiencing an adverse outcome if they use a drug. Attributable risk is of most relevance to a societal appraisal of the harms of drug use. The importance of the two measures of risk magnitude depends upon the prevalence of drug use and the base rate of the adverse outcome. An exposure with a low relative risk may have a low personal significance but a large public health impact if a large proportion of the population is exposed (e.g. cigarette smoking and heart disease). Conversely, an exposure with a high relative risk may have little public health importance because very few people are exposed to it, but it may have major significance for those individuals who are exposed.

Another way of assessing the health risk posed by cannabis use is to compare its health risks with those of other widely used recreational drugs such as alcohol, tobacco, cocaine and heroin (Hall et al., 1999). Such comparisons minimise double standards in the appraisal of the health effects of cannabis use by using a common standard for comparison. The comparison, however, is more difficult than it seems at first, even in the case of the more widely used and best-studied drugs, alcohol and tobacco. Comparison is even more difficult in the case of less commonly used illicit drugs like cocaine, heroin, ecstasy and amphetamine.

First, we know much more about the risks of acute and chronic tobacco and alcohol use than we do about the risks of cannabis use. The legal drugs have been consumed by substantial proportions of the population over centuries and there have been more than 50 years of scientific studies of the health consequences of their use (see English et al., 1995). Cannabis, by contrast, has been much less widely used in Western society, for a shorter period, and primarily by healthy young adults who have usually discontinued their use in their mid- to late 20s (Hall and Pacula, 2003).

Second, the prevalence of regular use of cannabis is much lower than that of alcohol and tobacco. In principle, this problem could be addressed by estimating what the health effects of cannabis use would be if its prevalence approached that of alcohol and tobacco. Although conceptually simple, in the absence of good data on the quantitative risks of cannabis use a large number of contestable assumptions have to be made in order to make such estimates.

We cannot simply estimate what the health risks of cannabis use would be if it were as commonly used as alcohol and tobacco by multiplying its estimated risks on current patterns of use by the number of potential users in the population. This calculation assumes that the risks are the same regardless of who uses cannabis, or the legal regime under which it is used. These may be unreasonable assumptions because (i) the variability among the characteristics of cannabis users or the diversity of 'types' of people who use cannabis when its prevalence of use is low might increase under a regime of legal use and (ii) if cannabis use were legal it would be possible to reduce some of the respiratory risks of cannabis smoking by encouraging cannabis users to ingest or vaporise rather than to smoke the drug. It would also be easier if cannabis use was legal to give users advice on how to reduce other risks, for example by not driving a car for several hours after using the drug, and restricting the frequency of use to weekly or less often.

Are there any benefits of cannabis use?

The benefits of cannabis use are rarely discussed in cannabis policy debates. The exception is its possible use to treat symptoms of chronic illnesses that are unresponsive to current medical treatment (Hall and Pacula, 2003). The key role played by health effects in the policy debate has meant that there has been very little research on the benefits of recreational cannabis use. If, as economists argue, adults are the best judges of their own interests, then the fact that a substantial proportion of adults in developed societies use cannabis for recreational purposes is *prima facie* evidence that some cannabis users benefit from its use (Hall and Pacula, 2003). There is an absence of evidence for more specific benefits of cannabis use, although a number of such effects have been suggested.

One possible benefit is that moderate cannabis use may improve mental health, as recent evidence suggests may be true for moderate use of alcohol (Rodgers et al., 2000). In the case of cannabis, epidemiological studies to date have typically found that the heavier the cannabis use is, the poorer the user's mental health (see Hall and Pacula, 2003, Chapter 13) but more and much better controlled research is needed (MacLeod et al., 2004).

The evidence is also limited and mixed on a second possible benefit of cannabis use, namely, that of substituting for the use of arguably more harmful drugs like alcohol, cocaine and heroin. The epidemiology of alcohol and cannabis use suggest a complementary relationship in that heavy consumers of alcohol are more likely to be heavy cannabis users and vice versa, particularly among young people (see Hall and Pacula, 2003, Chapter 13). The evidence among adults is more mixed, with race, ethnicity and country of origin influencing the findings. The evidence on the relationship between cannabis and other illicit drugs is controversial (Hall and Pacula, 2003). Both questions deserve to be better investigated.

There is better evidence for the therapeutic uses of cannabis. There is reasonable evidence for the therapeutic use of THC as an antiemetic agent in the treatment of nausea and vomiting caused by cancer chemotherapy. More effective antiemetic agents are now available, so it remains to be seen how widely the cannabinoids will be used for this purpose. There is also reasonable evidence for the efficacy of THC in the treatment of AIDS-related wasting. There is evidence that cannabinoids may have analgesic and antispasmodic properties that warrant further research into their effectiveness (Hall and Degenhardt, 2003).

The social and political context of appraisal

Appraisals of the hazards of most drug use are affected by the societal approval or disapproval of the drug (Room, 1984). Those who approve of using the drug tend to engage in 'problem deflation' by minimising the adverse health and social effects of its use. Those who disapprove tend to engage in 'problem inflation' by uncritically accepting any evidence of harm.

An inflationary–deflationary dialectic has affected appraisals of the health effects of cannabis use. Politically conservative opponents of cannabis use, for example, justify its continued prohibition by citing personal and social harms of its use (e.g. Nahas and Latour, 1992). When the evidence is uncertain, they resolve the uncertainty by assuming that cannabis use is unsafe until proven safe. Complementary behaviour is shown by those proponents of decriminalisation who discount evidence of harm and resolve uncertainties about the ill-effects of cannabis use by demanding evidence that is difficult

to provide, arguing that until uncertainty is resolved individuals should be allowed to choose whether or not they use the drug.

Problem deflationists typically discount the adverse effects of their preferred drugs by denying that there is a causal connection between drug use and particular adverse health effects. A popular way of discounting evidence of adverse health effects of drug use is to set such a high standard of proof that we can never 'know' whether it causes the effect. The standard of proof reflects the degree of confidence we require in a causal connection between drug use and harm. In courts of law, the standard of proof demanded depends upon the seriousness of the offence and the consequences of a conviction. The standard is 'beyond reasonable doubt' in criminal cases that may lead to imprisonment if convicted while the 'balance of probabilities' is acceptable in civil cases where the penalties are fines. Sceptics often demand something close to 'beyond reasonable doubt'.

The standard legal method for resolving a dispute in the face of uncertainty is to create a default outcome by placing a burden of proof upon one or the other side in the case. The arguer who bears the burden of proof loses the case if they fail to discharge their burden. The accused in a murder trial, for example, is presumed to be innocent until proven guilty because it is the prosecution's burden to make a case for guilt beyond reasonable doubt; failure to do so means that the defendant has to be acquitted.

In the debate about the legal status of cannabis, the question of who bears the burden of proof is controversial (see Rescher, 1977, Chapter 12). If the burden of proof falls on those who claim that the drug is safe, uncertainty will be resolved by assuming that it is unsafe until proven otherwise; conversely, if the burden falls on those who claim that the drug is unsafe, then it will be assumed to be safe until proven otherwise. Proponents of continued prohibition of cannabis use appeal to established practice (Whately, 1963 [1846]), arguing that since the drug is illegal the burden of proof falls on those who want to legalise it to demonstrate its safety. Proponents of legalisation often argue that there was no evidence that cannabis was harmful when its use was criminalised. Some argue that, in any case, the burden of proof falls upon those who wish to use the criminal law to prevent adults from choosing to use a drug (e.g. Husak, 1992).

Improving assessments of the health effects of cannabis

The following proposals aim to improve assessments of the health risks of cannabis by ensuring that ignorance is disclosed, making it easier to identify what we need to know in order to reduce it, and making it less likely that empirical issues will be confused with moral ones and vice versa.

Avoid treating cannabis as a special case

According to some, cannabis is a ‘mind-expanding’, ‘consciousness-raising’ drug, which is especially benign in its effects on health. To its opponents, cannabis is a ‘deceptively dangerous’ drug in which the absence of acute toxic effects disguises its insidious adverse effects on users and society (Nahas and Latour, 1992). We should instead adopt the same approach to evaluating the health effects of cannabis use that are used in appraising the health effects of alcohol, tobacco and other illicit drugs.

Burden of proof should be responsive to evidence

Any inquiry into the health effects of cannabis should begin with the assumption derived from pharmacology and toxicology that it may harm the health of some users when used at some dose, frequency or duration of use, or some methods of administration (Fehr and Kalant, 1983). Given that cannabis is an intoxicant like alcohol, and a drug that is usually smoked like tobacco, there are additional reasons to expect that cannabis will share at least some of the acute and chronic health effects of these two drugs.

This expectation does not mean that we assume that cannabis use is unsafe until proven safe. Rather, it means that the burden of proof will be responsive to the state of the evidence and it may vary for different health effects. If there is a *prima facie* case for cannabis causing a specific harm, then evidence of safety should be required. A *prima facie* case could comprise either direct evidence that cannabis has ill effects in humans (e.g. from a case-control study), or a compelling argument for such an effect, for example the fact that the constituents of cannabis and tobacco smoke are similar, and that tobacco smoking causes respiratory cancers, makes it likely that heavy cannabis smoking is also a contributory cause of these cancers (Hall and MacPhee, 2002).

Use a reasonable standard of proof

If we require proof beyond reasonable doubt that there are adverse health effects of cannabis, then very few conclusions will be drawn about its health effects, and very little advice can be given on how to reduce these risks. Reasonable inferences and sensible, if fallible, health advice can be given if evidential criteria are used to draw conclusions about the probable adverse health effects of cannabis in the same way as we do about any other drug. This standard may be taken to be satisfied by the consensus of informed scientific opinion that sufficient evidence has been provided to infer a causal connection between cannabis use and a health outcome. A consensus is indicated by the views expressed in authoritative reviews in peer reviewed journals and consensus conferences of experts (e.g. Institute of Medicine, 1982; Fehr and Kalant, 1983; WHO Programme on Substance Abuse, 1997).

Apply standards consistently

There will continue to be disagreements about standards of proof, burden of proof and what kinds of evidence count, but whatever evidential standards are used should be applied even-handedly. The best protection against the use of double standards in their application is for those conducting appraisals of the health effects of cannabis to be as explicit as possible about the evidential standards that they have used, and as even-handed as possible in their application.

Separate the legal and health issues

We would improve our appraisal of the health effects of cannabis if we clearly separated it from the legal issue. The two issues are connected since the adverse health effects of cannabis use are one of the justifications offered for treating cannabis use as a criminal offence. Consequently, if there were no adverse health effects of cannabis use, a different justification would need to be found for its continued prohibition.

Even if there are adverse health effects of cannabis, the connection between the adverse health effects of cannabis and its legal status is not as simple as has been assumed. If adverse health effects were a sufficient warrant for the legal prohibition of cannabis use then logic would demand that alcohol and tobacco use should also be prohibited. Our failure to prohibit alcohol and tobacco use indicates that socially important values other than personal or public health are at stake. These include individual autonomy and personal liberty, and the economic and social costs of trying to prevent a substantial proportion of the adult population from doing something that they want to do. These values must be weighed against public health, and a balance produced as the outcome of a political process that is informed by a fair appraisal of the health risks of cannabis use (Hall and Pacula, 2003).

The failure to separate the health and legal issues means that the appraisers' views about the legal status of cannabis often prejudice their appraisals of its health effects. A clear distinction between the two issues is the best way of ensuring a fair and useful discussion of both.

Conclusions

Causal inferences about the adverse health effects of cannabis are complicated by a dearth of good studies of relationships between cannabis use and health outcomes; uncertainty in some cases about which came first, the cannabis use or the health effect; difficulties in excluding plausible alternative explanations of associations that have been observed in the absence of experimental studies; and, in the case of null

findings, uncertainty as to whether they provide reasonable evidence of the absence of effects, or only an absence of evidence. An estimation of the magnitude of the health risks of cannabis is handicapped by the absence of epidemiological studies that provide quantitative estimates of the risks in representative samples of users. Attempts to compare the public health significance of cannabis use with that of more widely used drugs like alcohol and tobacco are complicated by the greater comparative ignorance of the adverse health effects of cannabis use, and by the marked difference in their current prevalence of use. More attention needs to be given to evaluating evidence for and against benefits claimed for cannabis use.

A fair appraisal of the health effects of cannabis has been hampered by a deflationary–inflationary dialectic between opponents and proponents of cannabis use. Problem deflation has been assisted by demands for unreasonably high standards of proof, and the disagreement about who bears the burden of proof has prevented a resolution of uncertainty about these health effects.

Our appraisals of the health effects of cannabis would be improved if we: stopped treating cannabis use as a special case; distinguished clearly between health and legal issues; varied the burden of proof depending upon the state of the evidence about adverse health effects; used a reasonable standard of proof; and above all else, applied evidential standards consistently and even-handedly.

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