Marijuana in Vermont and the Increased Economic Burden of Schizophrenia

By Dean Whitlock and Christine L. Miller, Ph.D.

Dean Whitlock is a freelance writer working in the fields of substance abuse prevention and community health. He is a member of Smart Approaches to Marijuana in Vermont.

Christine L. Miller, Ph.D. is a Pharmacologist with a focus on neuroscience, specifically the genetics, biochemistry, and biomarkers of psychoses and other major mental disorders. Since 1992, she has published over thirty peer-reviewed research studies on topics in her focus areas, and she is a reviewer for over a dozen scientific journals, including Schizophrenia Bulletin, Bipolar Disorders, Biological Psychiatry, and the Journal of Neuroscience.

Introduction

The RAND Report on the possible legalization of Marijuana in Vermont, which was presented to the Vermont legislature in January, was supposed to be a Cost-Benefit analysis that would enable a fully informed discussion of the pros and cons of legalizing recreational marijuana. Unfortunately, the report falls very short on the Cost side of the analysis. Nowhere is this more evident than in Chapter 3, where it minimizes the effects of marijuana use on mental health and provides no cost estimate for whatever effects there would be. In the analysis we provide below, you will see that the conservative estimate of the cost for just one social impact could consume half of the lower range of tax revenue estimated by the RAND Report, whereas the potential escalation in this one social cost would completely eclipse the high end of the report's estimate for tax revenue.

The RAND authors state that calculating social costs (that is, costs for mental health treatment, addiction treatment, other healthcare, social services, automobile injuries and deaths, lost hours and lives of work, the economic burden of lost years of education and so on) is too complicated for them to undertake (though they had no trouble calculating economic gains for a half-dozen regulation/taxation scenarios based on a complicated algorithm for calculating current and increased use rates in Vermont and its neighboring states). They also spend most of four pages in Chapter 3 in a textbook explanation of the uncertainties inherent in the types of studies normally performed when researching any psycho-active drug, thereby creating the impression that marijuana research is inherently flawed. They fail to mention that the current research on marijuana is comparable in design and strength of findings to the early research into the harms of tobacco. Then they base their statements about mental health outcomes – specifically schizophrenia – on a summary analysis cited in the report (Hall, 2014)[1] that in turn bases one of its main arguments on a misstated conclusion from a previous report (Hickman et al., 2009).[2] This one error puts their calculations about schizophrenia off by two orders of magnitude (see the section below: *The RAND Report Draws Misleading Conclusions*).

The RAND authors are correct that it is difficult to calculate the social costs of using psychoactive drugs, but it is possible; in fact, such calculations have been made for alcohol and tobacco use for years. The calculations are not perfect, in the same way that the RAND Report's calculations of the potential pot market are not perfect, requiring the specification of wide margins of error. In this paper, we make such a calculation for one of the most costly aspects of the mental health consequences of marijuana use: the very real risk that there will be a statistically significant increase in the incidence of schizophrenia in Vermont. And the cost increase we are able to calculate is substantial: from $4.9 million per year, based on the increase in consumption in one state where it was legalized, to $11.1 million per year, based on the increase in consumption predicted by the RAND Report. The costs per individual would beggar many of the families that have to bear them, and the surplus burden of cost will fall on the taxpayers of Vermont. These costs might not be covered by tax revenue from legal sales. The real world tax revenues accrued by Colorado from sales of recreational marijuana in the first year following legalization ($53 million) would amount to only $7.4 million in Vermont on a population basis.

The calculations have been summarized in tables that begin on page 12.

Marijuana Use is Strongly Associated with Mental Health Disorders

In its section on Cannabis Use Disorder (CUD), the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (the DSM-5, published by the American Psychiatric Association) lists several mental health disorders that are strongly associated with CUD. These include anxiety disorders, major depressive disorder (and suicide attempts), bipolar I disorder, antisocial disorder, obsessive-compulsive disorder, and paranoid personality disorders. Figure 1 shows the percentage of people diagnosed with CUD who are also diagnosed with one or more of the associated disorders.

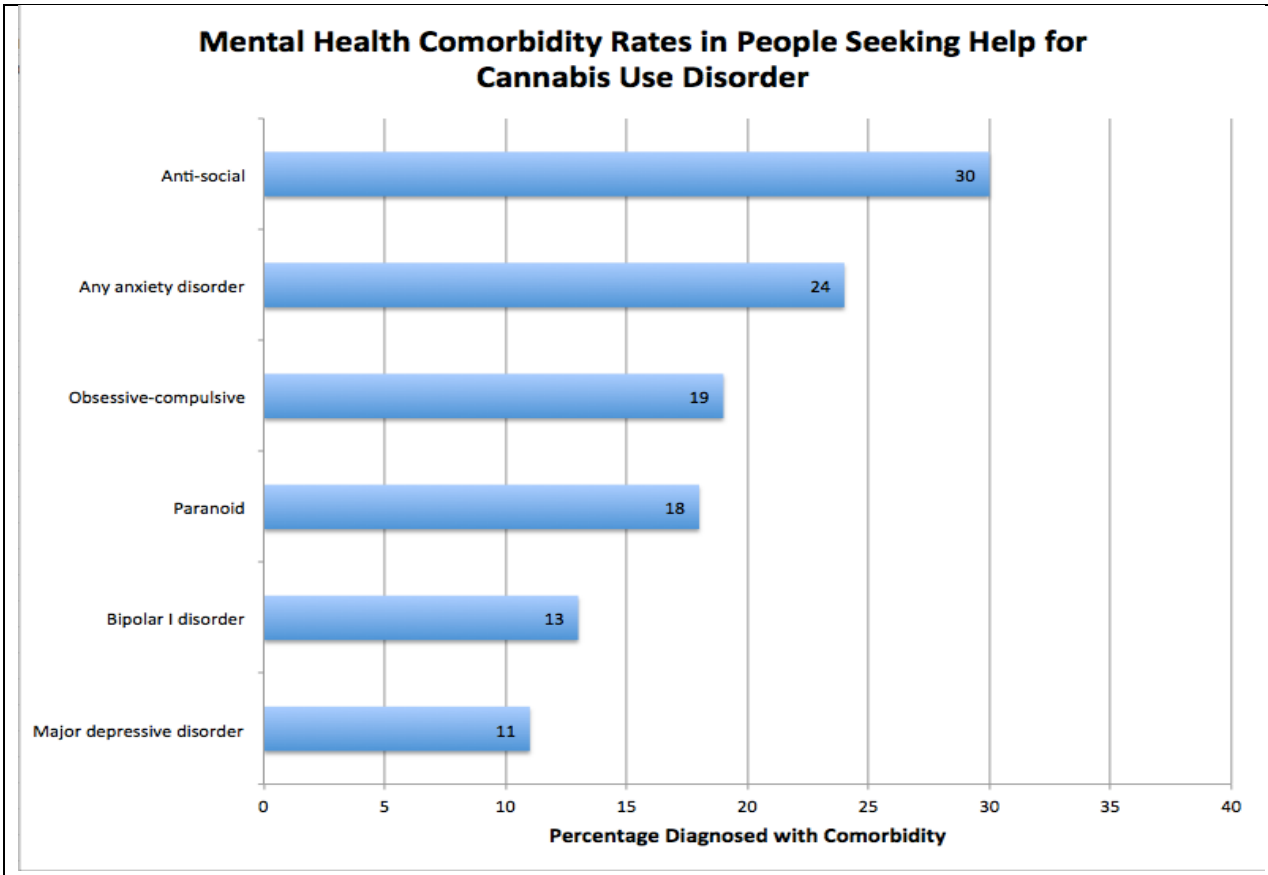

Figure 1 (data from DSM-5, 2013)

In addition, the DSM-5 states, "Approximately 33% of adolescents with cannabis use disorder have internalizing disorders (e.g., anxiety, depression, posttraumatic stress disorder), and 60% have externalizing disorders (e.g., conduct disorder, attention-deficit/hyperactivity disorder)."

The association with suicide (and, by extension, depression) is born out by data from Vermont's Youth Risk Behavior Survey (YRBS), administered every two years in Vermont's middle and high schools. The 2013 data in Figure 2 show a striking correspondence between suicide attempts and the rate of marijuana use, consistent with larger, more well-controlled studies on suicide discussed in the next section.

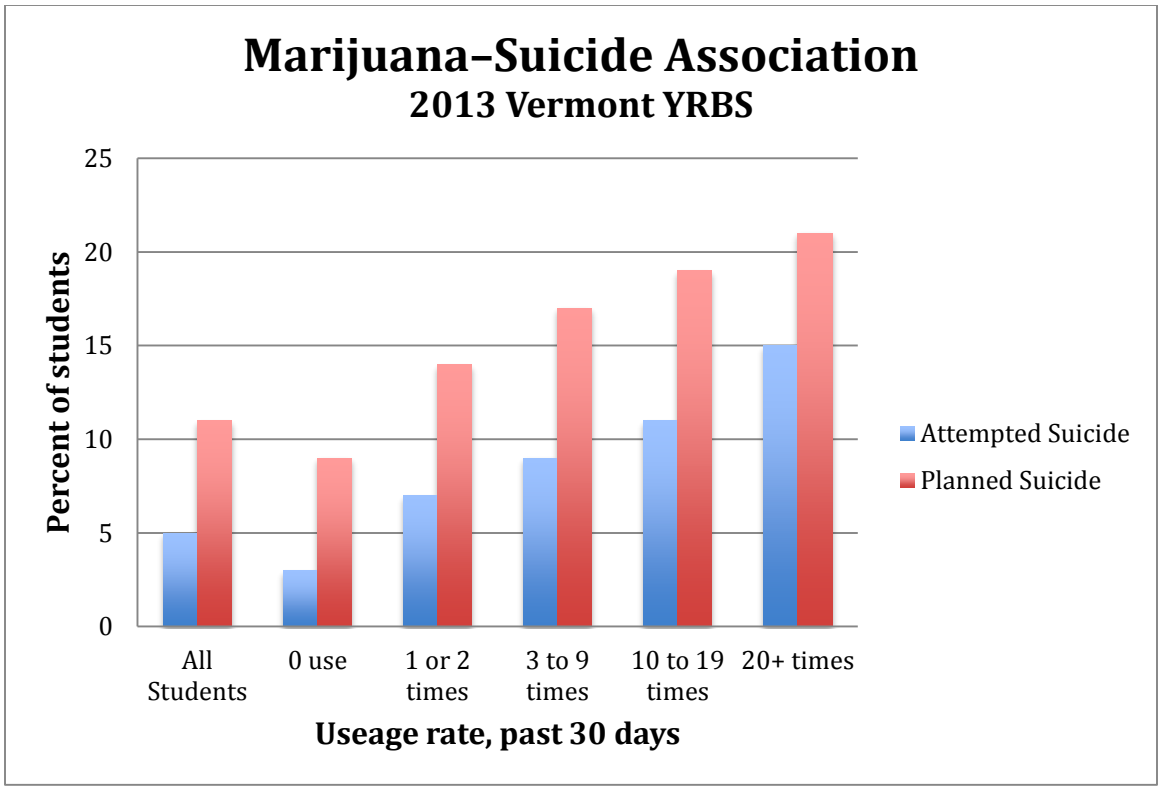

Figure 2 (data from Vermont High School YRBS, 2013)

These associations do not in themselves indicate that marijuana use causes mental health disorders, but that possibility should not be ignored.

Marijuana Use is a Causal Factor in Mental Health Disorders

There is an ongoing debate as to whether marijuana use causes mental health disorders or is caused by them. Those who argue that the mental health disorder came first claim that sufferers turn to marijuana for relief from their symptoms. Those who argue that marijuana use came first rely on observational and epidemiological studies to determine causation. As the RAND Report points out, observational studies seldom provide sufficient controls to confirm causation with complete certainty, and it would be completely unethical to run an experiment in which subjects were treated with high doses of marijuana over a period of time adequate to cause chronic mental health disorders.

That said (and as the RAND report also points out), there are well-accepted criteria for judging whether observational data are likely to be true. Furthermore, overwhelming evidence of just that quality, accumulated over the past decade, indicates that marijuana use is not only a major risk factor that can precipitate the onset of mental health disorders in those predisposed and worsen the course in those afflicted, it can also be a causal factor in these mental health disorders. Not all cases of these disorders are caused by marijuana use, because there are other causal factors; e.g., genetics and family history, childhood trauma, emotional stress. The causal factors are not exclusive, they are additive, each one increasing the risk that the disorder will occur and that it will be more severe. Some

disorders seem more susceptible to the effects of marijuana; hence the varying rates of association in Figure 1. In Figure 2, the most obvious confounder of the association with suicide presented in the graph, i.e. pre-existing depression, has been addressed in epidemiological studies and ruled out (Clarke et al., 2014)[3]. Other studies have additionally controlled for a host of other demographic factors that would potentially confound this association with suicide (Arendt et al., 2012; Kvitland et al., 2014)[4,5], and still found up to a 7-fold increase in risk.

Looking at the environmental factors associated with psychoses in general and schizophrenia in particular, we find that, while the causal relationship between marijuana use and schizophrenia may not be proven beyond a shadow of a doubt, it remains the most well replicated finding in schizophrenia research today. In an editorial published by the Dana Foundation, a leading psychiatric epidemiologist affiliated with Kings College in London, Dr. Robin Murray, convincingly puts forth evidence that marijuana is likely causal for schizophrenia[a]. Other prominent scientists appear to have reached the same conclusion. In a 2014 review of research world wide (citing 358 studies), Radhakrishnan et al.[6] state, "Emerging evidence supports a number of associations between cannabis and psychosis/psychotic disorders, including schizophrenia. These associations – based on case-studies, surveys, epidemiological studies, and experimental studies indicate that cannabinoids can produce acute, transient effects; acute, persistent effects; and delayed, persistent effects that recapitulate the psychopathology and psychophysiology seen in schizophrenia . . . At the present time, the evidence indicates that cannabis may be a component cause in the emergence of psychosis, and this warrants serious consideration from the point of view of public health policy."

The RAND Report acknowledges this conclusion, citing Radhakrishnan et al.[6] and several other review studies: ". . . in numerous longitudinal studies, the temporal pattern of the association is usually more consistent with the marijuana-use-leads-to-mental-illness model than with a self- medication (i.e., mental illness leads to marijuana use) account." (p.37) But then the authors attempt to deconstruct the evidence, pointing out the essential flaw in all observational and epidemiological studies noted above as though it were unique to marijuana research and negated the majority of the studies: ". . . despite considerable effort, researchers have been unable to rule out the possibility that the association between marijuana use and psychotic symptoms is due to some common risk factor."

While this is true, it is also without precedent that a factor known to induce symptoms of the disease in the clinic, often in subjects without a personal or family history of major mental illness or addiction (D'Souza et al., 2004; Morrison et al., 2011; Bhattacharyya et al., 2011; Freeman et al., 2014)[7-10], and which is associated with the disease in large epidemiological studies (reviewed by Moore et al., 2007; Giordano et al., 2014)[11,12] would not be viewed as a causative agent. If a suspected carcinogen were to exhibit such a pattern of study results, responsible public health programs would parallel those currently directed toward the smoking of tobacco, with the goal of removing it from the environment rather than increasing its presence.

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[a] Appraising the Risks of Reefer Madness, by Sir Robin Murray, M.D. *Cerebrum*, January 7, 2015. http://www.dana.org/Cerebrum/2015/Appraising_the_Risks_of_Reefer_Madness/

Obviously, to rule out the possibility of some predisposing risk factor underlying such associations is always very difficult, and honest scientists always include a statement to that effect in their conclusions no matter how definitive their data might be. To quote Dr. John Hughes of the University of Vermont, who has studied both tobacco and marijuana for over 30 years, ". . . this criticism is true of over 80% of data on health risks. For example, all, yes all, the data we have on whether smoking is harmful is from non-randomized trials." After listing the accepted criteria for judging whether observational data is likely to be true, Dr. Hughes adds, "I think most scientists would conclude that recreational use [of marijuana] is harmful."

The RAND Report Draws Misleading Conclusions

Continuing their deconstruction, the RAND authors state: "if cannabis use does have a causal impact on psychosis, it appears to be highly contingent on the timing and intensity of cannabis use and possibly on a genetic propensity or other existing personal and environmental risk factors." (p.37) This is true, but what they fail to make clear is that the genetic risk factors apply to a very large percentage of the general population. Given that the worldwide average prevalence of schizophrenia is commonly stated in textbooks to be 1% (though with significant variations in this number between regions and through time), a fairly conservative estimate would therefore be that 10% of the population have had a family member with psychosis in either 1st- or 2nd-degree relatives. Using the example of one woman in the United States as an index case of schizophrenia, that woman will have on average 2.01 children (https://www.cia.gov/library/publications/the-world-factbook/fields/2127.html) and 4.01 grandchildren, along with 1.0 siblings on average and 2.01 nephews or nieces (9% in total). The fertility of men (but not women) with schizophrenia is generally lower by approximately a factor of 0.44 (Haukka et al., 2003), which would decrease the probability of children and grandchildren proportionately (but not siblings and nieces or nephews), lowering the average at-risk pool to about 7% for index cases of either gender.

In addition, the prevalence of other disorders with a risk for psychosis, such as the 1% prevalence for bipolar 1 (Merikangas et al., 2011)[14] and the associated 1st- and 2nd-degree family members (again 9%), would add to the at-risk pool. Fertility of those with bipolar 1 disorder is not impaired. Some overlap in family member risk might occur between schizophrenia and bipolar 1 pedigrees, but surely not enough to lower the total prevalence of those with a positive family history of psychosis to below 10%. Thus, to dismiss the increased risk of psychosis as relating only to those with a genetic predisposition is to discount a very large segment of the population of Vermont, or anywhere else.

The report goes on to say that these contingencies might account for (quoting from Hall, 2006), ". . . first, why the risk of psychosis in cannabis users is only increased 2–3 times; second, why there have not been large increases in the incidence of psychoses in line with the rise in rates of cannabis use in young adults in recent decades; and third, why the age of onset of schizophreniform disorders might be earlier in cannabis users." (p. 194)

To answer the first question, we can only say that doubling or tripling the risk of psychosis is a significant increase. If we had a reasonable indication that eating GMO corn would

double or triple the risk of stomach cancer, we would not be debating a labeling law, we would be calling for a complete ban on GMO corn.

To answer the second question, we point to the Monitoring the Future studies, produced by the University of Michigan, which show that marijuana use *decreased* from 1976 until about 1990. This trend in the U.S. was paralleled (plus or minus a couple of years) in at least a few other countries around the world. The key fact is that no study covered the entire time period "before marijuana became popular" (1960s) until "after marijuana became popular" (mid to late 1970s). We have a problem here in the U.S. in that we lack a centralized data acquisition structure to support psychiatric epidemiology. In Europe, the national health systems provide more such structure, with the result that their epidemiological studies are more robust. Some studies there (Der, Gupta and Murray, 1990)[15] suggest that schizophrenia rates may have dropped in the U.K. during the same period when marijuana use rates were dropping in the U.S. and elsewhere, but unfortunately marijuana use data was not collected in the U.K. during that same time period.

The third question is surprising, because that is exactly what you would expect and do find in the research: the age of onset of schizophreniform disorders would be expected to be similarly affected as that in schizophrenia, i.e. lower in marijuana users, in particular because the age of onset in bipolar disorder, a related disorder with a more affective component, has also been shown to be lowered by marijuana use. The lowering in age of onset strongly points towards marijuana use being a causative factor. Many people start using in their teens, prior to the peak age of onset for these disorders. (The typical age of onset for schizophrenia occurs before age 30, though prodromal symptoms (precursors to full psychosis) often appear earlier.)

Finally, the RAND authors cite Hall (2014)[1] to say that ". . . any population effects of marijuana on the psychoses are likely to be small." (p.38) They quote from Hall's source for this statement (Hickman et al., 2009)[2] and conclude that, "This implies that thousands of users would have to be prevented from use for a year to prevent one case of schizophrenia."

The emphasis by the RAND report should have been on the point that there would be just one year of abstention required to prevent one case (and how many drug treatment programs would limit their goals to such a short time frame after all). Thus, if Hall (and the RAND authors) had looked more critically at the somewhat misleading presentation of Hickman's conclusions:

> if cannabis is related causally then the risk of schizophrenia in 1997–99 for men aged 20–24 was approximately 1 in 1500 for heavy cannabis users and 1 in 2400 for light users. For women aged 20–24 the risk of schizophrenia was 1 in 4000 for heavy cannabis users and 1 in 6600 for light cannabis users. (p. 1858)

they might have been inclined towards a different slant on the data. In point of fact, Hickman's statement has been reinterpreted by a few researchers, most effectively by James MacCabe of the Institute of Psychiatry, Kings College, London (MacCabe et al., 2010)[16] . MacCabe points out that the calculations are for preventing a case of schizophrenia in just one year, which means the ratio between those who must abstain from marijuana over a lifetime to those who will therefore be saved from schizophrenia in

their lifetime is orders of magnitude less than the RAND report would have you believe. MacCabe adds two other factors to his analysis. First, Hickman's calculation is based on marijuana use doubling the risk of developing psychosis in weekly users. Research conducted since then indicates that, for daily users, there is a greater increase in risk (DiForti et al., 2015)[17]. Second, the calculation is based on the weaker strains of marijuana available in the late 1990s, when the data Hickman used was collected. (From 1990 to 2012, potency has risen from 4% Δ^9-THC on average to 12% Δ^9THC or higher, at least a threefold increase.) For this type of marijuana product, DiFort et al. (2015)[17] have demonstrated that daily use increases the risk by more than fivefold. In such a scenario, prevention efforts would be even more worthwhile.

It is important to remember that even one new case per year adds a tremendous emotional and financial burden to the family in question, and that, almost always, the financial component will be shared by taxpayers. To this we add a final consideration: According to the National Survey on Drug Use and Health (NSDUH), Vermont has one of the highest per-capita rates of marijuana use in the country, and it also has one of the highest rates in the country of people seeking treatment for mental health disorders. In the first of its income scenarios, the RAND Report calculates that there could be a 54% increase in marijuana use in Vermont if it is legalized (p. 122, Table 7.1). It is now up to us to calculate what the resulting increase in mental health disorders in Vermont could cost if, as more and more research indicates, marijuana use is a causative factor in the onset of schizophrenia.

Mental Health Disorders are Costly, Psychosis and Schizophrenia Most of All

The likelihood of marijuana's causation for various mental disorders has not yet been definitively ranked, but we have chosen to focus on the economic burden of schizophrenia because it is the most severe of the disorders and the most expensive to deal with. Individuals with schizophrenia require ongoing treatment from the very first appearance of symptoms (usually before age 28). As the disease progresses, sufferers come to require constant guardianship, housing, and board for the rest of their lives. The incidence of violent outbursts, which have been shown to increase with concomitant substance use (Fazel et al., 2009)[18], adds to the burden. Mental health insurance, for those who have it, doesn't begin to cover the costs. Most families cannot cover the full costs either, and sufferers often outlive their parents in any case. In the short or long run, the state pays a very large portion of the burden.

Calculating the Cost to Vermont Now and After Legalization

These calculations, with their references and assumptions, have been summarized in the tables that start on page 12.

The economic burden of schizophrenia has been estimated in several studies. Wu et al estimated the annual total cost in the U.S. in 2002 as $62.7 billion (Wu et al., 2005)[19]. This number is supported by similar results from other studies (Mangalore and Knapp, 2007;

Sado et al., 2013)[20,21]. To get from this number to the current Vermont burden and from that to the cost after legalization takes several steps. First, calculate the current annual schizophrenia burden in Vermont (see Table A):

1. Multiply total U.S. schizophrenia costs by Vermont/U.S. population ratio for those aged 18 and over.
2. Adjust for inflation since 2002.

   The result is $200,035,719 per year.

Next, calculate how much of this Vermont cost can be attributed to marijuana use (the *population attributable fraction*, or PAF). Again, several studies have attempted to calculate this factor. We have evaluated estimates available for PAF from three studies (Arsenault et al., 2002; Henquet et al., 2005; DiForti et al., 2015)[22,23] as seen in Tables B1-3, and selected two that controlled for confounding variables. Employing the PAF from a longitudinal study conducted in Germany for the ESPD cohort (Henquet et al., 2005)[23] (see Table B):

3. Multiply the ESPD PAF (0.039) by the Vermont/ESPD ratio for weekly use (0.108/0.041).
4. Multiply the total current Vermont burden (step 2) by the PAF from step 3.

   The result is $20.6 million per year.

Next, calculate the additional PAF costs that would result from legalization. For this, we use the percent increase in marijuana use after legalization as estimated in the first income scenario in the RAND Report (p. 122, Table 7.1; see our Table C):

5. Multiply the current Vermont PAF costs in step 4 by 0.54.

   The resulting increased cost due to legalization is $11.1 million dollars per year.

Here it should be noted that the 54% increase in use projected by RAND might not be realized immediately after legalization or, alternatively, that an initial increase in users might be followed by a plateau or even a decline if sectors of the market were to decide that marijuana wasn't the product for them because of price or alternative preferences. The actual data now in from Colorado (NSDUH report, 2013-2014)[24] show that use by those 18 and over increased by 46% in the first two years after legalization as compared to the time period just prior to legalization, 2011-2012. The largest portion of the change came in the first year (2012-2013), when the use rate jumped 28%; thus, there has been some slowing of the growth in new users but, as yet, no decline. It is interesting to note that the RAND Report, in its second income scenario (p. 128, Table 7.3), actually deals with the situation where the price and source of the product affect the growth of new users. While the first income scenario assumes that the legal price in Vermont will be lower than the black-market price, resulting in a greater increase in consumption, scenario two assumes that the black-market price will be lower than the legal price. In that case, they assume only a 25% increase in consumption, all of it driven by non-price effects, an increase remarkably similar to the actual Colorado increase in the first year. (Below, we discuss other factors that could affect either consumption rates or incidence rates.)

Using the real-world scenario presented in Colorado, where the black-market was the only source of product in the first year after legalization (storefronts did not open until January

of 2014), we can estimate a lower boundary to the projected cost by assuming that the user numbers might plateau at 28% following legalization in the State of Vermont, should the black market price remain low enough to keep many users away from storefronts. We can them apply it to the PAF estimate derived in Table B-3 from the DiForti et al. (2015) study, as shown in Table C-2. The lower boundary of the projected cost for the additional economic burden of schizophrenia would then be approximately $4.9 million per year.

Thus we have an idea of the annual additional cost that legalization of marijuana will impose on the people of Vermont *for this single harm due to marijuana use.* (And note that these costs apply only to new cases of schizophrenia. They do not include additional costs that would result from poorer disease prognosis and worse outcomes in those individuals already diagnosed with schizophrenia who would begin to use marijuana once it was legal and more available.)

Possible Escalation in Economic Costs

The costs due to increased incidence of schizophrenia assume an average prevalence in the U.S. of 0.5% (Wu et al., 2005)[19] based on the study of Kessler et al. (2005)[25]. This estimated percentage incorporates a degree of uncertainty that relates to how the data is acquired: either through contacts with clinicians and subsequent diagnoses, which is more accurate diagnostically speaking but underestimates the actual community prevalence; or by surveys administered by health professionals in random contacts with members of the community (Kessler et al., 2005)[25], which likely results in a more accurate estimate of prevalence.

Apart from the fact that not all diagnoses of schizophrenia are reported at the state level (depending on the state), not all individuals with schizophrenia are formally diagnosed. The State of Vermont issued a report[26] on the numbers of individuals with schizophrenia treated in any form of community service in 2011, and found the number to be 0.3% of the population aged 18 and older. This percentage is obviously lower than the 0.5% figure used by Wu et al. (2005)[19], and likely underestimates the true prevalence. Many individuals with schizophrenia can be found in homeless surveys, where it is estimated they represent somewhat over 10% of the population (Foster et al., 2012)[27]. Others are housed in jail, because their behavior often leads to arrests. Here, too, the estimates of the percentage are uncertain, depending on whether the surveys are conducted in federal, state, or county prisons. Most frequently they are found in local or county prisons, where the estimates are that individuals with recent psychotic symptoms (within the past 12 months, as verified by a medical visit) represent from 13.7% to 17.5% of the inmates (James and Glaze, 2006)[28]. Not all those with psychotic symptoms will be chronic schizophrenics, but many who are not yet may be heading that way, given lifestyle factors such as drug abuse and post-traumatic stress. In addition, those with mental illness in the prison system tend to be part of a "revolving door" system (Baillargeon et al., 2009)[29], so that a survey of the point prevalence at one time during the year will underestimate the absolute number of different individuals with schizophrenia who will be housed during the full course of any given year.

Applying corrections for prevalence of schizophrenia based on Vermont's homeless population and the prison population likely brings the true prevalence to more than 0.5%,

which would increase the PAF cost estimates above. And then there are the uncertainties in the RAND Report's various calculations of the increase in consumption. For example, in their economic scenarios, they note that just the non-price effects on consumption could range from "…5 to 50 percent, with 35 percent being a best guess" (p. 119), but they use 25% in their calculations to be conservative. They also note (p. 121) that using a different demand curve model for price elasticity might result in a consumption increase that is 10% greater than the projection they use in their scenarios.

To conclude, the most clear cut approach to this issue is for policy-makers to consider what future Vermont ultimately wants to embrace. At the extreme, if everyone in Vermont were to become weekly users of marijuana (with occasional forays into daily use), which would mirror the pattern considered socially acceptable for adult alcohol use, the expected increase in the rate of schizophrenia in the group of new weekly users would be at least doubled (Moore et al., 2007)[11]. The associated increase in costs of schizophrenia for Vermont would roughly double as well (after subtracting the upper estimate of $20,603,679 for the current contribution of marijuana users from the total costs of $200,035,719) yielding a potential upside net cost of $179,432,040 per year. (Note that the net additional cost would be increased if the lower estimate for current PAF were to be applied instead). The federal government might absorb some of these excess costs, but surely not all.

A final note: In making the parallel with alcohol use above, it is important to point out the differences in impact on psychosis risk. Whereas marijuana use triggers temporary symptoms of psychosis in 12%-15% of all users (Thomas, 1996; Barkus et al., 2006; Smith et al., 2009)[31-33], alcohol does so in only about 0.5% (Perala et al., 2010)[34]. The conversion rate from all prodromal[b] psychoses to full psychosis is about 35% (Cannon et al., 2008)[35], and from there the conversion to chronic schizophrenia spectrum disorders is 46% for marijuana-induced psychosis but only 5% for alcohol-induced psychosis (Niemi-Pynttäri et al., 2013)[36]. Marijuana is therefore potentially much more dangerous than alcohol just in terms of its association with both psychosis and the potential conversion to schizophrenia.

Contact Information

Christine L. Miller, Ph.D.: cmiller@millerbio.com

Dean Whitlock: boatman@deanwhitlock.com

Smart Approaches to Marijuana in Vermont (SAM-VT): infosamvt@gmail.com

[b] Prodromal refers to symptoms that may, but not always, signal the onset of a disease.

Appendix – Calculation Tables

Table A: The current annual cost of schizophrenia to Vermont

Vermont population 2014, 18 yrs and older	U.S. population 2002, 18 yrs and older	Est. annual scz cost to U.S., 2002 dollars	VT scz cost based on %U.S. pop	VT scz cost compounded for inflation (2002-2015)
503,756	209,454,000	$62,700,000,000	$150,799,227	$200,035,719
Source: census on internet http://quickfacts.census.gov/qfd/states/50000.html	Source: US Current Population Survey Report 2002 Demographic Research Unit 915 L Street Sacramento, CA 95814 http://www.dof.ca.gov January 2004	Source: Wu et al., 2005[19]	=(503,756/209,454,000) x ($62,700,000,000)	Source: http://www.usinflationcalculator com/inflation/historical-inflation-rates/
		These costs include both direct and indirect impacts (treatment costs, living costs, in-home care and loss of economic productivity)		If compounded annually; the average yearly rate of inflation was 2.3%.

Table B-1: Current VT population attributable fraction cost (PAF)

Fraction of VT schizophrenia patients attributable to marijuana use, assuming marijuana is a component cause of this disease, based on Dunedin (NZ) cohort study (uncorrected for demographic confounders)

PAF Dunedin study, for schizophreniform psychosis*	PAF Dunedin, for scz spectrum*	Rate of almost weekly use Dunedin study	Rate of almost weekly use VT, 2012-2013	PAF estimate for VT	Annual cost estimated to VT caused by this PAF**
0.08	0.0503	0.094	0.166	0.0888*	$17,763,171
Source: Fergusson et al., 1997; Arseneault et al., 2004[12]	Source: Niemi-Pynttari et al., 2013; Arendt et al., 2008; Fusar-Poli et al., 2013	Source: Fergusson and Horwood, 2000[38]	Source: Vermont Youth Risk Behavior Survey 2013	=(0.166/0.094) x 0.0503	=$200,035,719 x 0.0888
See p. 115, center column; derived from long-term outcome data on entire cohort	Assumes 46% conversion to scz spectrum disorder from cannabis-induced psychosis cases[36] and 73% conversion from entire cohort of schizophreniform psychosis[37] =(0.08 x 0.46)/0.73	Age 15-21 yr; 6 year use rate; see Table 2 last two entries (4.7% + 4.7%); range of use from 0.96 times per week to more than 1.4 times per week	High school seniors; avg age 18; range of use from 0.75 times per week to more than 4.5 times per week.		The $200,035,719 was derived from last column in Table A

*****This estimate for current PAF for Vermont is likely low, because it relates to low potency strains of cannabis common in the last century.

Table B-2: Current VT population attributable fraction cost (PAF)

Fraction of VT schizophrenia patients attributable to marijuana use, assuming marijuana is a component cause of this disease, based on ESPD (DE) cohort study (corrected for major demographic and personal history confounders)

PAF ESPD study, for cannabis-induced psychosis	PAF ESPD for scz spectrum,	Rate of weekly to almost daily use ESPD study	Rate of weekly to almost daily use VT, 2012-2013	PAF estimate for VT	Annual cost estimated to VT caused by this PAF**
0.062	0.039	0.041	0.108	0.103*	$20,603,679
Source: Henquet et al., 2005	Source: Niemi-Pynttari et al., 2013; Arendt et al., 2008; Fusar-Poli et al., 2013	Source: Henquet et al., 2005	Source: Vermont Youth Risk Behavior Survey 2013	=(0.108/0.041) x 0.039	=$200,035,719 x 0.103
See p. 115, center column; derived from long-term outcome data on entire cohort	Assumes 46% conversion to scz spectrum disorder from cannabis-induced psychosis cases[36] and 73% conversion from entire cohort[37] =(0.062x0.46)/0.73	See Table 1 of Henquet et al. Use was greater than or equal to 3 times per week Ave. age of study participants was 18.3 yrs	High school seniors; avg age 18; range of use from 2.5 times per week to more than 4.5 times per week.		The $200,035,719 was derived from last column in Table A

*****This estimate for current PAF for Vermont is likely low, because it relates to low potency strains of cannabis common in the last century.

Table B-3: Current VT population attributable fraction cost (PAF)

Fraction of VT schizophrenia patients attributable to marijuana use, assuming marijuana is a component cause of this disease, based on South London (SLndn) cohort study (corrected for major demographic and personal history confounders)

PAF SLndn study, for cannabis-induced psychosis	PAF SLndn for scz spectrum*	Rate of weekly to daily use SLndn study	Rate of weekly to almost daily use VT, 2012-2013**	PAF estimate for VT	Annual cost estimated to VT caused by this PAF***
0.24	0.151	0.186	0.108	0.088	$17,603,143
Source: DIForti et al., 2015	Source: Niemi-Pynttari et al., 2013; Arendt et al., 2008; Fusar-Poli et al., 2013	Source: DiForti et al., 2015; control cohort	Source: Vermont Youth Risk Behavior Survey 2013	=(0.108/0.186) x 0.151	=$200,035,719 x 0.088
	Assumes 46%* conversion to scz spectrum disorder from cannabis-induced psychosis cases[36] and 73% conversion from entire cohort:[37] =(0.24 x 0.46)/0.73	Mean age of cohort 28,5 yrs Range of use from "weekends" (twice per week?) to daily	High school seniors; avg age 18; range of use from 2.5 times per week to more than 4.5 times per week.		The $200,035,719 was derived from last column in Table A

*****The % conversion from high potency cannabis has been determined only for low to moderate potency cannabis but the conversion for high potency cannabis may be different (quite possibly larger, which would result in a higher PAF cost than that presented in this table).

** It is unclear how the mismatch in ages of the VT and SLndn cohorts would affect the proportional comparison of the use rates; peak use in the U.S. occurs at age 21, with a gradual decline thereafter, but whether that same pattern applies to the SLndn cohort is unknown.

***Those interviewed for the control group in the SLndn study were screened out if they had experienced a prior diagnosis of psychosis, even if they were normal at the time of interview. If their prior psychosis was temporally related to cannabis use and they had discontinued their use because of these symptoms, the screening protocol may have selected for individuals in the control group who had proven to be resistant to the effects of cannabis, particularly because of the older mean age of the cohort. This trend would have served to decrease the estimated PAF. However, this study also concerned the use of high potency cannabis, which would have served to inflate the PAF as compared to the ESPD cohort.

Table C-1: Upper boundary of additional PAF cost projected: utilizing increased use projected by RAND and the ESPD PAF factor

Increased use projected by RAND	Added economic impact of scz based on use increase projected by RAND
0.54	$11,125,987*
Source: The RAND Report	= $20,603,679 x 0.54
p. 122, Table 7.1, (line 9-line 3) divided by line 3	Assumes that the increased use will impact current use groups equally (yearly, monthly, weekly, daily), resulting in a net consumption increase of 54% in each group due to a combination of increase in usage frequency (users migrate to a more frequent use group) and amount consumed in each use. Frequency and strength per use both correlate with risk for psychosis (*Di Forti et al., 2015*)[7].

* Using the PAF calculated for Vermont (Table B-2) based on ESPD study of Henquet et al. (2005)[23].

Table C-2: Lower boundary of additional PAF cost projected: utilizing increased use experienced by Colorado in 1st year following legalization, and SLndn PAF factor

Increased use projected by Colorado	Added economic impact of scz based on use increase projected by RAND
0.28	$4,928,880*
Source: NSDUH report	= $17,603,143 x 0.28
2012-2013 vs 2011-2012	Assumes that the increased use will impact current use groups equally (yearly, monthly, weekly, daily), resulting in a net consumption increase of 54% in each group due to a combination of increase in usage frequency (users migrate to a more frequent use group) and amount consumed in each use. Frequency and strength per use both correlate with risk for psychosis (*Di Forti et al., 2015*)[7].

*Using the PAF calculated for Vermont (Table B-3) based on SLndn study of DiForti et al. (2015)[17]

Table D: Expected tax revenue to Vermont based on Colorado revenues realized in the 1st year following legalization

Population in Colorado, 18 and over*	Population Vermont, 18 and over*	Colorado tax revenue from recreational marijuana, 1st year	Monthly use in Colorado 18 and over; year preceding legalization	Monthly use in Vermont, 18 and over; most current data	Projected 1st year tax revenue to Vermont, based on population and use
4,097,238	503,756	$53,000,000	0.104	0.118	$ 7,393,561
Source: census on the internet: http://quickfacts.census.gov/qfd/states/50000.html	Source: census on the internet: http://quickfacts.census.gov/qfd/states/50000.html	Sources: http://money.cnn.com/2015/02/12/news/economy/colorado-marijuana-tax-revenue/	Fraction of population last month use, 2011-12; Source: http://www.samhsa.gov/data/sites/default/files/NSDUHsaeSpecificStates2012/NSDUHsaeColorado2012.pdf	Fraction of population, last month use, 2012-13; Source: http://www.samhsa.gov/data/sites/default/files/NSDUHsaeSpecificStates2013/NSDUHsaeVermont2013.pdf	=(503,756/4,097,238) x $53,000,000 x (0.118/0.104)

*Data for those 21 and over not available; 18 and over is a good approximation for comparison purposes.

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