ELSEVIER

Drug and Alcohol Dependence 69 (2003) 127–135

DRUG and ALCOHOL DEPENDENCE

www.elsevier.com/locate/drugalcdep

Substance abuse treatment need among older adults in 2020: the impact of the aging baby-boom cohort

Joseph Gfroerer [a,*], Michael Penne [b], Michael Pemberton [b], Ralph Folsom [b]

[a] *Office of Applied Studies, Substance Abuse and Mental Health Services Administration, Room 16-105, 5600 Fishers Lane, Rockville, MD 20857, USA*
[b] *Research Triangle Institute, 3040 Cornwallis Road, Research Triangle Park, NC 27709, USA*

Received 26 November 2001; received in revised form 13 June 2002; accepted 8 August 2002

Abstract

Background: There is concern that as the baby boom population ages in the US, there will be a substantial increase in the number of older adults needing treatment for substance abuse problems. To address this concern, projections of future treatment need for older adults (defined as age 50 and older) were made. *Methods:* Using data from the National Household Survey on Drug Abuse, regression models including predictors of treatment need in 2000 and 2001 were developed. Treatment need was defined as having a DSM-IV alcohol or illicit drug use disorder in the past year. Regression parameters from these models were applied to the projected 2020 population to obtain estimates of the number of older adults needing treatment in 2020. *Results:* The number of older adults in need of substance abuse treatment is estimated to increase from 1.7 million in 2000 and 2001 to 4.4 million in 2020. This is due to a 50 percent increase in the number of older adults and a 70 percent increase in the rate of treatment need among older adults. *Conclusions:* The aging baby boom cohort will place increasing demands on the substance abuse treatment system in the next two decades, requiring a shift in focus to address the special needs of an older population of substance abusers. There is also a need to develop improved tools for measuring substance use and abuse among older adults.

Keywords: Treatment; Epidemiology; Trends; Cohort; Age; Services

1. Introduction

Historically, alcohol and illicit drug abuse in the United States have been associated with young populations. Rates of problematic use have been shown by many studies to decline with increasing age, starting in the mid- to late 20s (SAMHSA, 2000a; DHHS, 2000). This is primarily due to reduced use of both alcohol and illicit drugs by people as they age. When people are in their 20s and 30s, the reduced use is related to significant shifts in responsibilities, such as a having a regular job, marriage and parenthood (Bachman et al., 1997; Gotham et al., 1997). The continued reductions in prevalence rates at later ages could be related to 'maturing out' (Winick, 1962) or to elevated mortality rates among substance abusers (Moos et al., 1994).

Birth cohorts that experience high rates of illicit drug use in youth have subsequently shown higher rates of use and associated problems as they age, relative to other cohorts (SAMHSA, 2000a). Illicit drug use in the US was rare in cohorts immediately preceding the baby-boom cohort, defined as those born from 1946 to 1964. The rate peaked in 1979, when the baby-boom cohort was ages 15–33. During that peak year, approximately 10% of the estimated 25 million current illicit drug users were age 35 or older. In 1995, when the baby-boom cohort was ages 31–49, the percentage of current illicit drug users who were over the age of 34 had increased to 27%. In 1995, 49% of the baby-boom cohort had ever used illicit drugs in their lifetime, compared to only 11% of adults aged 50 and older (SAMHSA, 1996). Rates of heavy alcohol use have also been shown to be higher among baby boomers than in earlier cohorts (DHHS, 2000). In addition to being more likely to be illicit drug and heavy alcohol users than previous cohorts, the baby-boom cohort is larger than earlier cohorts (Koenig

* Corresponding author. Tel.: +1-301-443-7977; fax: +1-301-443-9847
E-mail address: jgfroere@samhsa.gov (J. Gfroerer).

03765-8716/02/$ - see front matter
PII: S0376-8716(02)00307-1

et al., 1994). Taken together, these data suggest that the prevalence of problematic substance use among older adults may increase as the baby-boom cohort ages. In 1996, the oldest members of the baby-boom cohort reached age 50. In 1998, only 7% of admissions to publicly-funded substance abuse treatment programs involved patients age 50 or older (SAMHSA, 2000b). The higher rates of problematic substance abuse among the baby- boom cohort will likely lead to an increase in this number. This will require a shift in focus for treatment programs, which have dealt primarily with young populations, in order to address the special needs of an older population of substance abusers.

Information on the size and nature of this potential shift in treatment need is critical to treatment planners and policymakers. The purpose of this paper is to estimate the number of persons with a need for treatment for substance abuse problems in the United States in the year 2020. In 2020, the 50-and-older age group will include all of the surviving baby boomers as well as a post-baby-boom cohort (born 1965–70) that also experienced a high rate of illicit drug use during youth (SAMHSA, 1996).

A variety of methods has been used by researchers to project future disease burden in the United States and other countries. Projections of future prevalence of Alzheimer's disease in the US (Brookmeyer et al., 1998; Brookmeyer and Gray, 2000), diabetes in the Netherlands (Ruwaard et al., 1993), and mental disorders in Japan (Nakamura et al., 1997) have been made. Two early studies made projections of future prevalence of illicit drug use (Richards, 1981) and alcohol abuse and dependence (Williams et al., 1989). Most studies have made projections by first determining rates of incidence or prevalence of the health measure of interest within demographic subgroups, then applying these rates to population projections produced under various assumptions from census data. Adjustments for differential mortality related to the health measure under study have generally been incorporated, when available. Few studies have incorporated data on other (i.e. in addition to demographics) predictors of the outcomes of interest to improve the prevalence rate estimates. A study of future disability among the US elderly assessed the impact of changing levels of education in aging cohorts (Waidmann and Liu, 2000) based on current data showing the correlation between education and disability. Feenstra et al. (2001) included information on past smoking behavior in their model predicting the future prevalence of chronic obstructive pulmonary disease in the Netherlands. A study of future rates of melanoma in Canada discussed the importance of early sun exposure as a predictor, but the authors lamented that there were no data on the prevalence of sun exposure to use in their model (MacNeill et al., 1995).

In contrast with prior attempts to project future US substance abuse burden and most other studies projecting health-related measures, this study incorporates known predictors of substance abuse. Specifically, youths who initiate illicit drug and alcohol use in their early teenage years have been shown to be at greater risk of having substance abuse problems as adults than are youths who never use or who initiate use during their late teenage years (Anthony and Petronis, 1995; Grant and Dawson, 1997; Gfroerer and Epstein, 1999; SAMHSA, 2000a). The goal of this analysis is to take advantage of current data on the patterns of substance use initiation to estimate the prevalence of substance abuse problems in the future.

A previous study that employed a similar methodology estimated that the number of persons aged 50 and older who would need treatment for an illicit drug problem would increase from 147 000 in 1995 to 911 000 in 2020 (Gfroerer and Epstein, 1999). The current study employs some methodological improvements and focuses on a broader population of substance abusers, including those meeting DSM-IV criteria for dependence or abuse of either alcohol or illicit drugs.

2. Methods

The estimation of substance abuse treatment need among older adults in 2020 involved two steps. First, regression models were run predicting treatment need (defined as dependence on or abuse of either illicit drugs or alcohol) among the older adult population in 2000 and 2001. The purpose of these models was to determine parameter estimates that characterized the relationship between a set of independent variables and treatment need among older adults. Second, the parameters estimated from these models were applied to the projected 2020 older adult population, to generate estimates of treatment need in 2020. The 2020 population was constructed from the sample aged 30 and older in the 2000 National Household Survey on Drug Abuse (NHSDA) and aged 31 and older in the 2001 NHSDA so that the prevalences of predictor variables in 2020 could be determined directly. These two steps are described in more detail below, following descriptions of the data source and definitions used.

2.1. Data source

Data from the 2000 and 2001 NHSDA were used in this study (SAMHSA, 2001a). Regression models were based on the data for respondents age 50 and older ($n = 12\,933$), and the projected older adult population in 2020 was constructed by combining the 2000 NHSDA respondents age 30 and older with the 2001 NHSDA respondents age 31 and older ($n = 38\,596$). The NHSDA

is a nationally representative survey of the civilian, noninstitutional population age 12 and older in the US. The survey obtained data on substance use from 140 693 respondents interviewed anonymously in their homes during 2000 and 2001, using audio computer-assisted self interview procedures for all substance use questions. The household screening response rates (weighted) were 92.8% in 2000 and 91.9% in 2001. The interview response rates (weighted) were 74.1% for ages 30–49 in 2000 and 72.9% for ages 31–49 in 2001. For ages 50 and older, the response rates were 69.5% in 2000 and 69.9% in 2001 (SAMHSA, 2001b).

2.2. Measurement of treatment need

Treatment need is defined as being classified with substance dependence or abuse based on DSM-IV criteria (American Psychiatric Association, 1994). The NHSDA includes a series of questions designed to measure these criteria, using a past 12-month reference period (Epstein 2002).

Based on this definition, 271 of the 12 933 respondents age 50 and older were classified with substance dependence or abuse. This corresponds to an annual average estimate of 2.3% (weighted) of older adults, or an estimated 1.7 million dependent or abusing older adults. Of these, 10.2% were dependent on or abusing illicit drugs only, 85.8% were dependent or abusing alcohol only, and 4.0% were dependent or abusing both illicit drugs and alcohol. Among the estimated 244 000 older adults dependent on or abusing illicit drugs, the most common drugs of abuse were marijuana (42%), cocaine (36%), pain relievers (25%), stimulants (18%), and sedatives (17%).

An important limitation of the NHSDA data on dependence and abuse is that the classification of individual respondents does not constitute a clinical diagnosis for these disorders. The limited set of questions included in the survey, coupled with the fact that the survey is administered by professional survey interviewers, not psychiatrists or psychologists, introduces some inaccuracies in classification of individual respondents. However, the methodology is useful for epidemiologic analysis of aggregate data and has been applied to NHSDA data in a number of studies (Epstein, 2002).

2.3. Regression models

Since the regression model results were to be applied to a projected 2020 population constructed from 2000 and 2001 data, the modeling incorporated only variables that were present for the 30 and older sample and that could be assumed to remain unchanged for individuals as they age. These variables include age, gender, race/ethnicity, and substance use prior to age 31, including the age at first use. The 50 and older sample was split into two mutually exclusive groups based on their use of alcohol by the age of 30. Persons who had not used alcohol before age 31 were expected to have a very low probability of ever needing substance abuse treatment, so they were modeled separately from the rest of the population. This low-risk group accounted for 20.2% of the population of older adults in 2000 and 2001. The rates of treatment need were 0.4% in the low-risk group and 2.8% in the high-risk group (those who had used alcohol before age 31). Sample sizes were 2527 for the low-risk group and 10 406 for the high-risk group.

Logistic regression models were run on each of these two groups. The dependent variable in both models was whether the respondent had a need for treatment for a substance abuse problem within the past 12 months. Due to the small number of persons in need of treatment for the use of illicit drugs or alcohol in the low-risk group, the model for the low-risk group included only an intercept and the age of the respondent. For the high-risk group, independent variables included in the models were:

- Age (continuous)
- Gender (female, male)
- Race/ethnicity (white/other-not Hispanic, Hispanic, black-not Hispanic)
- Cigarette use (never smoked daily before age 31, smoked daily before age 31)
- Alcohol use (no use before 18, used before age 18 but not before 15, used before 15)
- Marijuana use (no use before age 31, used before 31 but not before 18, used before 18)

Only predictors that could be assumed to remain unchanged as people age beyond age 30 were considered for the models. Because initiation of cigarettes, alcohol, or marijuana rarely occurs after age 30 (Chen and Kandel, 1995), the variables representing use of these substances before age 31 approximate ‘ever use’. Nevertheless, the model did take into account initiation after age 30, since a few cases with initiation at age 31 or older would be included in the sample and classified as ‘no use before age 31’. Sample sizes for these regression models are shown in Table 1.

Logistic regressions were run using analysis weights and SUDAAN software to account for the complex sample design of the NHSDA in the calculation of parameter estimates and estimates of standard errors (Shah et al., 1996). An alpha level of 0.05 was used in determining statistical significance of regression parameters for the discussion of results.

In order to determine the adequacy of the fit of each model, the Hosmer–Lemeshow Lack-of-Fit statistic (Hosmer and Lemeshow, 1989) was utilized. SUDAAN does not produce this statistic, so it was obtained using SAS V8.2 (SAS Institute, 1999). Because SAS computes

Table 1
Sample sizes for low-risk and high-risk regression models and 2020 projection, by levels of variables in models

Domains of interest	Sample for regression models (age 50 or older in 2000/2001)		Sample for projections (age 30 or older in 2000 or age 31 or older in 2001)
	Sample size	Sample cases with treatment need	
Low-risk model[1]			
Total	2527	9	5277
High-risk model[1]			
Total	10 406	262	33 319
Gender			
Male	5225	198	16 201
Female	5181	64	17 118
Race/ethnicity			
Hispanic	461	22	2622
Black non-Hispanic	770	30	2984
White/other non-Hispanic	9175	210	27 713
Smoked daily before age 31			
Yes	5622	186	15 710
No	4784	76	17 609
Age at first alcohol use			
Before 15	1258	76	6617
15–17	3059	98	12 407
18–30	6089	88	14 295
Age at first marijuana use			
Before 18	174	17	7959
18–30	1421	96	6369
31+ or never	8811	149	18 991

[1] The low-risk sample was comprised of all respondents who either initiated after the age of 30 or never have used alcohol, and the high-risk sample was comprised of all respondents who had initiated alcohol use prior to the age of 31.

these statistics under a simple random sample assumption, it underestimates the variance and is therefore more likely to reject the null hypothesis of goodness-of-fit than a test that accounted for the sample design. Thus, if the test based on SAS failed to reject the null, then there is confidence that adjusting for the sample design would still produce the same conclusion. Additionally, following the methodology proposed by Nagelkerke (1991), we utilized a maximum re-scaled r-square, calculated from SUDAAN output, to determine the absolute percentage of variation explained by each model. Hence the r-square value has been corrected for both the sample design and weights.

2.4. Projection to 2020 population

A sample representing the total population age 50 and older in 2020 was constructed by combining the 2000 NHSDA sample of respondents age 30 and older with the 2001 NHSDA sample of respondents age 31 and older (Table 1). This was done by increasing each respondent's age at the time of the survey by either 20 (for 2000 respondents) or 19 years (for 2001 respondents), resulting in their age in 2020. The gender, race/ethnicity, and history of substance use of each respondent in 2000 and 2001 were assumed to be the same in 2020. Thus, all of the independent variables included in the regression models of the 50 and older population in 2000 and 2001 were also known for the 30 and older population that will be age 50 and older in 2020. Three adjustments were made to the analysis weights of these sample cases to make sure the sample appropriately represented the 2020 population. First, weights were divided by 2 so the 2 years of data would represent annual averages. Second, the age-gender-race distribution of the sample was forced through statistical adjustment to match population projections for the year 2020 developed by the Census Bureau (U.S. Census Bureau, 2000). This was done within single-year-of-age-by-race-by-gender groups up to age 69, 5-year–age-groups-by-race-by-gender groups for ages 70–94, and a final race-by-gender group for ages 95 and over. Finally, we adjusted the weights of the sample cases to account for an expected higher death rate among substance abusers than among non-substance abusers. Persons dependent on alcohol, but not illicit drugs, in 2000/2001 were assumed to have a 1.7 times higher risk of death after 20 years, and persons dependent on illicit drugs, but not alcohol, in 2000/2001 were assumed to have a 2.8 times higher risk of death (Neumark et al., 2000a,b).

Persons who were dependent on both alcohol and illicit drugs in 2000/2001 were assumed to have a $1.7 \times 2.8 = 4.8$ times higher risk of death. Thus, weights for respondents who were substance dependent in 2000/2001 were reduced, while weights for non-dependent cases were adjusted upward to result in a total (dependent plus non-dependent) sum of weights in each age–race–gender group that matched the Census projection for that age-race-gender group.

The parameters estimated from the two regression models were then applied to the constructed 2020 population. A predicted probability of needing treatment was assigned to each respondent, based on whether he or she had used alcohol by age 30 and the corresponding logistic regression model parameters. Weighted sums of the predicted probabilities were then tabulated, representing the estimated prevalence in 2020.

2.5. Estimation of standard errors and confidence intervals

Standard errors for 2000/2001 estimates were computed using SUDAAN software that accounts for the complex sample design of the NHSDA. Standard errors for the 2020 projections were calculated by applying a jackknife procedure in which the entire estimation process was repeated 38 times (19 superstrata by 2 replicates for each superstrata) with different random subsamples that each generated a different 2020 estimate. This methodology helps account for bias and variance associated with the modeling and prediction. Variances are calculated as:

$$Var(jk) = \sum_{h=1}^{19} \sum_{j=1}^{2} ((\Theta_{hj} - \Theta)^2)/2$$

where h = superstrata: defined as a state or aggregates of states; j = replicate number; Θ_{hj} = the estimate with the j-th replicate from the h-th superstrata removed and the weights of the remaining replicate doubled; Θ = the estimate from the full sample.

Because the estimated prevalence rates were small and necessarily between zero and one, asymmetric 95% confidence intervals were computed using a logit transformation. Standard errors and confidence intervals for the estimated numbers of persons were computed by multiplying the standard error and confidence intervals for corresponding rates by the population estimates.

3. Results

3.1. Regression models

The Hosmer–Lemeshow tests suggest that there was adequate fit in both the low-risk model ($P = 0.5928$) and the high-risk model ($P = 0.5462$). The maximum rescaled r-squares were $r^2 = 0.03$ for the low-risk model and $r^2 = 0.08$ for the high-risk model. These low r^2 values are typical of models with a dichotomous (0/1) outcome measure that has low prevalence, and also reflect the limited number of predictors available in the NHSDA that meet the requirement for this analysis that they be fixed for each person after age 30. Regardless of the low r^2 values, the adequacy of fit of the model still suggests that the model contains useful information regarding the population of interest.

In the low-risk model, age was not a significant predictor of treatment need (Table 2). Because of the low prevalence of treatment need and the small proportion of the population it represents, this model has a small impact on the overall estimates for 2020.

In the high-risk model, gender, cigarette use, age at first alcohol use, and age at first marijuana use were significant predictors of treatment need. Males were more likely than females to need treatment. Older adults who had smoked cigarettes daily before age 31 and older adults who had used alcohol before age 15 were more likely to need treatment. Use of marijuana before age 31 was associated with a greater risk of treatment need, and this risk increased with decreasing age at first use. Compared with persons with no marijuana use by age 30, older adults who had initiated marijuana use before age 18 were 3.6 times as likely to need treatment.

3.2. 2020 Projections

Applying these regression results to the projected population in 2020 resulted in an approximate tripling of the number of older adults needing treatment for a substance abuse problem, from 1.7 million (95% C.I.: 1.5 million to 2.0 million) in 2000/2001 to 4.4 million (95% C.I.: 3.1 million to 6.3 million) in 2020. As shown in Table 3, this is the result of a 50% increase in the population size (from 74.8 million to 112.5 million) combined with a 70% increase in the rate of treatment need (from 2.3 to 3.9%) in the older adult population. Increases are projected for all gender, race, and age groups. These models estimate that approximately half (48%) of the projected 2020 population of older adults needing treatment will be age 50–59, and two-thirds (64%) will be male.

4. Discussion

These data suggest that the number of adults aged 50 or older who need treatment for a substance abuse problem will increase from approximately 1.7 million in 2000 and 2001 to approximately 4.4 million in 2020. Although this analysis does not distinguish the specific kinds of problems that the estimated 5 million older-

Table 2
Logistic regression models for past year substance abuse treatment need among persons aged 50 or older

Covariates	β	S.E. of β	P-Value	Odds ratio (95% CI)
Low-risk model[1]				
Intercept	−1.86	2.89	0.520	–
Age (continuous)	−0.06	0.05	0.238	0.94 (0.86, 1.04)
High-risk model[1]				
Intercept	−4.09	0.64	< 0.001	–
Age (continuous)	−0.01	0.01	0.228	0.99 (0.97, 1.01)
Males vs. females	0.51	0.21	0.016	1.66 (1.10, 2.50)
Race/ethnicity				
Hispanic vs. white/other non-Hispanic	0.48	0.30	0.115	1.62 (0.89, 2.93)
Black non-Hispanic vs. white/other non-Hispanic	0.31	0.26	0.235	1.36 (0.82, 2.26)
Smoking history				
Smoked daily before age 31 vs. did not smoke daily before age 31	0.67	0.18	< 0.001	1.95 (1.38, 2.77)
Age at first alcohol use				
Before 15 vs. 18–30	0.77	0.23	< 0.001	2.16 (1.37, 3.39)
15–17 vs. 18–30	0.32	0.20	0.120	1.37 (0.92, 2.04)
Age at first marijuana use				
Before 18 vs. did not use before age 31	1.28	0.37	< 0.001	3.60 (1.74, 7.43)
18–30 vs. did not use before age 31	0.80	0.21	< 0.001	2.22 (1.48, 3.34)

[1] The low-risk sample was comprised of all respondents who either initiated after the age of 30 or never have used alcohol, and the high-risk sample was comprised of all respondents who had initiated alcohol use prior to the age of 31.

adult substance abusers in 2020 will have, it is apparent that the increasing rate of treatment need in this population is driven by an increase in problems associated with the use of illicit drugs and nonmedical use of prescription drugs. In 2000/2001, only 26% of persons age 50–69 were lifetime illicit drug users, defined as ever-used illicit drugs or used prescription drugs nonmedically. However, among the cohort projected to be age 50–69 in 2020 (age 30–49 in 2000 and age 31–50 in 2001), 56% were lifetime illicit drug users in 2000/2001, which the regression results indicate increases their risk for substance dependence or abuse. The increasing impact of illicit drug problems in the older-adult substance abuse treatment need population is also predicted in a prior study using a similar methodology, but applied only to illicit drug treatment need. In that study, the number of persons age 50 and older needing treatment for illicit drug use was projected to increase

Table 3
Estimated 2000/2001 and projected 2020 prevalence of substance abuse treatment need among persons age 50 and older

Domains of interest	2000/2001 estimates			2020 projections		
	Population (1000s)	Percentage of population needing treatment (S.E.)	No. persons (1000s) needing treatment (95% CI)	Population (1000s)	Percentage of population needing treatment (S.E.[1])	No. persons (1000s) needing treatment (95% CI)
Total	74 834	2.3 (0.2)	1722 (1469–2016)	112 476	3.9 (0.7)	4384 (3055–6258)
Gender						
Male	34 076	3.5 (0.3)	1190 (997–1418)	52 424	5.4 (0.9)	2817 (1996–3949)
Female	40 758	1.3 (0.2)	532 (391–723)	60 052	2.6 (0.5)	1567 (1021–2393)
Race/ethnicity						
Hispanic	5032	3.2 (0.8)	161 (99–260)	12 298	3.9 (0.9)	481 (293–780)
Black non-Hispanic	6905	2.5 (0.6)	174 (111–271)	12 147	3.9 (0.8)	471 (303–727)
White/other non-hispanic	62 896	2.2 (0.2)	1387 (1158–1659)	88 031	3.9 (0.8)	3432 (2260–5176)
Age group						
50–59	33 306	3.1 (0.3)	1034 (846–1261)	40 935	5.1 (1.2)	2092 (1264–3415)
60–69	20 038	2.0 (0.3)	394 (296–524)	37 927	4.2 (0.7)	1599 (1108–2293)
70–79	15 163	1.8 (0.5)	280 (173–451)	22 759	2.4 (0.4)	548 (384–779)
80–89	5669	0.3 (0.2)	14 (3–65)	8636	1.4 (0.3)	124 (77–200)
90+	657	0.0 (0.0)	0 (0–0)	2219	1.0 (0.3)	21 (11–40)

[1] Standard errors for projections are derived through jackknife replication methodology.

over 500% between 1995 and 2020 (Gfroerer and Epstein, 1999).

The accuracy of these projections is indicated by the standard errors and confidence intervals developed using jackknife replicates. However, there are three key assumptions underlying the projections that could affect their validity. The most important is the assumption that the probability of treatment need for older adults with the age, gender, race, and substance use characteristics specified in the models will be the same for older adults in 2020 as for older adults in 2000/2001. This is similar to the assumption made in many studies that have made projections of health-related measures by applying current prevalence rates within demographic groups to population projections. It is this assumption that motivated the inclusion of early substance use indicators into the models, because with the substantial shifts in substance use patterns beginning in the 1960s, models that considered only demographic characteristics would be inadequate for predicting future substance abuse prevalence. Recent research has suggested that patterns of progression from nonuse of substances to alcohol/tobacco use to marijuana use to the use of other drugs are different in different cohorts (Golub and Johnson, 2001). However, those results do not necessarily imply that our models of the probability of treatment need among older adults are invalid for other cohorts. Nevertheless, if persons born during the 1960s who initiated marijuana use in their early teens are less likely than persons born during the 1940s who initiated marijuana in their early teens to need treatment when they reach age 50, then the method used in this study will overestimate 2020 treatment need among older adults. This is an important issue that can be studied as future waves of the expanded NHSDA become available.

A second assumption is that the Census population projections are correct. While the Census provides alternative 'high' and 'low' projections based on expected migration trends, a midlevel estimate was used in this study. These population counts obviously are a major component of projected number of persons needing treatment in 2020, but their accuracy has very little impact on projected rates of treatment need in 2020.

The third key assumption underlying these estimates is the differential mortality rates applied to the projected sample. The adjustment for differential mortality is somewhat crude due to the paucity of data in the literature. While there are no directly applicable data that fit the framework of the estimation method used in this study, it is clear that substance abusers are at higher risk of mortality and this should be captured in any projections of future substance abuse. Therefore, the best data available were applied, which were based on a 14-year followup of cohorts of drug and alcohol dependent persons, rather than the 19- or 20-year periods covered by projections in this study (Neumark et al., 2000a,b). There was no basis for calculating a differential mortality over a 20-year period, so estimates as they were published were used, and the impact of this adjustment was assessed. Projections were rerun without the adjustment, i.e. assuming no difference in mortality between substance abusers and non-substance abusers. This showed that the adjustment made little difference. The adjustment reduced the estimated number of persons needing treatment in 2020 by about 66 000, or 1.5% of the total. Better data on the association between substance abuse and mortality is needed for improved projections of treatment need in future years.

It is worth mentioning a fourth assumption that is not an important factor in this study but could be in other studies using this method. Because this analysis focused only on older adults, it was reasonable to assume that changes in trends in the initiation of use of alcohol or drugs could be ignored, since initiation rarely occurs after age 30. The sample in this study captures measurement of initiation before age 30 within the 2020 population aged 50 and older. Studies using this method to project future substance abuse prevalence for the entire population, including those under age 50, would have to include assumptions about future levels of drug use initiation, as was done in an earlier study of illicit drug treatment need (Gfroerer and Epstein, 1999).

In terms of sampling and modeling error, the accuracy of the projection appears to be quite good. The relative standard error of the 2020 projection is only about 18%. Several predictors in the high-risk model were statistically significant, indicating that the model is an important component of the estimation. However, the low maximum re-scaled r^2 values demonstrate the difficulty in developing good models of rare characteristics with a limited set of predictors, and that more accurate projections could be obtained if better predictors were available. To build better models, more questions related to substance use history or other known predictors of future substance abuse could be added to future rounds of the NHSDA or to other large-scale surveys. For example, historical information on quantity and frequency of use, past history of treatment, and problems associated with use at earlier ages would likely improve the prediction. The impact of the adjustment for differential mortality on projections might also increase with the use of better predictors in the models. Analysis of larger samples, either by combining more years of data or by increasing the older adult sample of the NHSDA, would also help in developing better prediction models. In particular, a larger sample would allow separate regression models for age subgroups within the 50 and older population to account for potential age-related differences in the relationships between predictors and outcomes (e.g., late onset

substance abuse disorders). Even without larger samples, improved models of substance abuse treatment need among older adults will be possible using future survey data due to the increasing number of older adults classified with substance use disorders.

A final concern is the use of DSM-IV criteria to define treatment need among older adults. Because these criteria were developed and validated in samples of young and middle- aged people, the criteria may not be appropriate for elderly populations (Patterson and Jeste, 1999). Future research on substance abuse among older adults should look at alternative measures of substance abuse in the older adult population, and distinguish between different categories of substance abuse. For example, specific groups of interest might be persons in recovery, persons abusing prescription drugs, and persons abusing primarily illicit drugs. The approaches needed for effective prevention and treatment with older adults may need to be quite different for each of these groups. To assess these specific characteristics adequately using NHSDA data, it may be necessary to include new questions in the survey that address these topics and are designed specifically for administration to an elderly population. The current NHSDA questionnaire, for example, does not assess inadvertent misuse of prescription drugs, such as taking the wrong amounts or mix of prescribed drugs.

The projections given here demonstrate the magnitude of an emerging problem. However, further study is needed to address the specific nature of the problem more clearly. This might include developing projections for specific subgroups within the treatment need population, to determine the drugs of abuse, intensity of problems, and more detailed demographic characteristics of the population needing treatment. These analyses would probably require larger samples than are currently available, or may best be done with different methods than were used in this study. Another worthwhile area of inquiry would be to incorporate into models varying assumptions about interventions that might alter the progression to treatment need among substance-use initiators, and estimate the impact on treatment need in 2020. In terms of the actual impact on substance abuse treatment programs, it would be important for future studies to focus on a more narrowly defined treatment need population, such as the most severely impaired or those who are most likely to seek treatment. Currently, treatment need (as defined in this paper) far exceeds treatment utilization. Among the estimated 1.7 million older adults with substance abuse treatment need in 2000/2001, only 11.9% reported receiving any type of treatment for their substance abuse problem within the past year.

The methodology used in this study could be applied in other countries and to any population characteristic for which future prevalence is of interest. While it is desirable from a consistency standpoint to develop expected prevalence rates from the same data source as the one used for the projection (as was done in this paper), it is not necessary. Also, the use of a regression model to characterize the rate structure has advantages, but projections could be made by applying a set of prevalence rates from a cross-tabulation by all of the predictor variables, if sample sizes are large enough. The significant feature of the method used in this paper is the inclusion of predictors beyond demographics and the use of a sample survey that captures these predictors as a basis for the projected future population.

These conclusions are applicable to other countries facing large aging cohorts with elevated rates of illicit drug use. Much of the European Union, for example, experienced a baby boom in the 1960s, which is expected to lead to large increases in the number and proportion of the population aged 60 or older after 2020 (Lutz and Scherbov, 1999). When combined with the increasing rates of illicit drug use among younger populations in the 1960s and later (European Monitoring Centre for Drugs and Drug Addiction, 1996), this indicates that the increases in the number and proportion of older adults in need of substance abuse treatment described in this study are not limited to the United States.

In summary, these data support the notion that the aging of the baby-boom cohort in the US, with its relatively large size and high rate of substance use, will place increasing demands on the substance abuse treatment system in the next two decades. This will require a shift in focus among treatment planners to address the special needs of an older population of substance abusers. In addition, it is essential that improved tools for measuring substance use and abuse among older adults be developed. Better data are needed for predicting the future trends and also for measuring current problems as they continue to emerge.

Acknowledgements

Work by RTI researchers was supported by SAMHSA contract 283-99-0003. Data were collected by RTI under SAMHSA contract 283-98-9008.

References

American Psychiatric Association, 1994. Diagnostic and Statistical Manual of Mental Disorders, 4th edition. Washington, DC.

Anthony, J.C., Petronis, K.R., 1995. Early onset drug use and risk of later drug problems. Drug Alcohol Depend. 40, 9–15.

Bachman, J.G., Wadsworth, K.N., O'Malley, P.M., Johnston, L.D., Schulenberg, J.E., 1997. Smoking, Drinking, and Drug Use in Young Adulthood: The Impacts of New Freedoms and New Responsibilities. Lawrence Erlbaum Associates, Mahwah, NJ.

Brookmeyer, R., Gray, S., 2000. Methods for projecting the incidence and prevalence of chronic diseases in aging populations: application to Alzheimer's disease. Stat. Med. 19 (11-12), 1481–1493.

Brookmeyer, R., Gray, S., Kawas, C., 1998. Projections of Alzheimer's disease in the United States and the public health impact of delaying disease onset. Am. J. Public Health 88 (9), 1337–1342.

Chen, K., Kandel, D.B., 1995. The natural history of drug use from adolescence to the mid-thirties in a general population sample. Am. J. Public Health. 85, 41–47.

Epstein, J.F., 2002. Substance dependence, abuse and treatment: Findings from the 2000 National Household Survey on Drug Abuse. Analytic Series A-16. Office of Applied Studies, SAMHSA. DHHS Pub. No. (SMA) 02-3642.

European Monitoring Centre for Drugs and Drug Addiction, 1996. Annual Report on the State of the Drugs Problem in the European Union, 1995. European Communities.

Feenstra, T.L., van Genugten, M.L., Hoogenveen, R.T., Wouters, E.F., Rutten-van Molken, M.P., 2001. The impact of aging and smoking on the future burden of chronic obstructive pulmonary disease: a model analysis in the Netherlands. Am. J. Respir. Crit. Care Med. 164, 590–596.

Grant, B.F., Dawson, D.A., 1997. Age at onset of alcohol ase and its association with DSM-IV alcohol abuse and dependence: results from the National Longitudinal Alcohol Epidemiologic Survey. J. Subst. Abuse 9, 103–110.

Gfroerer, J.C., Epstein, J.F., 1999. Marijuana initiates and their impact on future drug abuse treatment need. Drug Alcohol Depend. 54, 229–237.

Golub, A., Johnson, B.D., 2001. Variation in youthful risks of progression from alcohol and tobacco to marijuana and to hard drugs across generations. Am. J. Public Health. 91 (2), 225–232.

Gotham, H.J., Sher, K.J., Wood, P.K., 1997. Predicting stability and change in frequency of intoxication from the college years to beyond: individual-difference and role transition variables. J. Abnorm. Psychol. 106 (4), 619–629.

Hosmer, D.W., Lemeshow, S., 1989. Applied Logistic Regression. Wiley, New York.

Koenig, H.G., George, L.K., Schneider, R., 1994. Mental health care for older adults in the year 2020: a dangerous and avoided topic. Gerontologist 34 (5), 674–679.

Lutz, W., Scherbov, S., 1999. First probabilistic population projections for the European Union. In: Lutz, W. (Ed.), Compendium of Family Studies in Austria. Austrian Institute for Family Studies, Vienna, pp. 123–139.

MacNeill, I.B., Elwood, J.M., Miller, D., Mao, Y., 1995. Trends in mortality from melanoma in Canada and prediction of future rates. Stat. Med. 14, 821–839.

Moos, R.H., Brennan, P.L., Mertens, J.R., 1994. Mortality rates and predictors of mortality among late- middle-aged and older substance abuse patients. Alcohol Clin. Exp. Res. 18, 187–195.

Nakamura, Y., Ojima, T., Oki, I., Tanihara, S., Yanagawa, H., 1997. Estimation of the future numbers of patients with mental disorders in Japan based on the results of National Patient Surveys. J. Epidemiol. 7 (4), 214–220.

Nagelkerke, N.J.D., 1991. Miscellanea: a note on the general definition of the coefficient of determination. Biometrika 78, 691–692.

Neumark, Y.D., Van Etten, M.L., Anthony, J.C., 2000. "Drug dependence" and death: survival analysis of the Baltimore ECA sample from 1981 to 1995. Subst. Use Misuse 35 (3), 313–327.

Neumark, Y.D., Van Etten, M.L., Anthony, J.C., 2000. "Alcohol dependence" and death: survival analysis of the Baltimore ECA sample from 1981 to 1995. Subst. Use Misuse 35 (4), 533–549.

Patterson, T.L., Jeste, D.V., 1999. The potential impact of the baby-boom generation on substance abuse among elderly persons. Psychiatr. Serv. 50 (9), 1184–1188.

Richards, L.G. (Ed.), 1981. Demographic trends and drug abuse, 1980-1995. National Institute on Drug Abuse Research Monograph 35. National Institute on Drug Abuse. DHHS Publication No. (ADM)81-1069.

Ruwaard, D., Hoogenveen, R.T., Verkleij, H., Kromhout, D., Casparie, A.F., van der Veen, E.A., 1993. Forecasting the number of diabetic patients in the Netherlands in 2005. Am. J. Public Health 83, 989–995.

SAS Institute Inc., 1999. SAS/STAT® User's Guide, Version 8. SAS Institute Inc., Cary, NC.

Shah, B. V., Barnwell, B.G., Bieler, G.S., 1996. SUDAAN User's Manual, Release 7.0. Research Triangle Institute, Research Triangle Park, NC.

Substance Abuse and Mental Health Services Administration, 1996. Preliminary Estimates from the 1995 National Household Survey on Drug Abuse. Advance Report Number 18. Office of Applied Studies, SAMHSA. DHHS Pub. No. (SMA) 96-3107.

Substance Abuse and Mental Health Services Administration, 2000. Summary of Findings from the 1999 National Household Survey on Drug Abuse. National Household Survey on Drug Abuse Series H-12. Office of Applied Studies, SAMHSA. DHHS Pub. No. (SMA) 00-3466.

Substance Abuse and Mental Health Services Administration, 2000. Treatment Episode Data Set, TEDS) 1993-98. Drug and Alcohol Services Information System Series: S-11. Office of Applied Studies. DHHS Pub. No (SMA) 00-3465.

Substance Abuse and Mental Health Services Administration, 2001. Summary of Findings from the 2000 National Household Survey on Drug Abuse. National Household Survey on Drug Abuse Series H-13. Office of Applied Studies, SAMHSA. DHHS Pub. No. (SMA) 01-3549.

Substance Abuse and Mental Health Services Administration, 2001. Development of Computer-Assisted Interviewing Procedures for the National Household Survey on Drug Abuse. Methodological Series M-3. Office of Applied Studies, SAMHSA. DHHS Pub. No. (SMA) 00- 3466.

U.S. Census Bureau, 2000. National Population Projections, II Detailed Files. (NP-D1-A) Annual Projections of the Resident Population by Age, Sex, Race, and Hispanic Origin: Lowest, Middle, Highest Series and Zero International Migration Series, 1999 to 2100. Online at http://www.census.gov/population/www/projections/natdet-D1A.html [May 30, 2002.]

U.S. Department of Health and Human Services, 2000. Special Report to the U.S. Congress on Alcohol and Health: Highlights from Current Research. June 2000 National Institutes of Health, National Institute on Alcohol Abuse and Alcoholism, Washington. NIH Publication No. 00-1583.

Waidmann, T., Liu, K., 2000. Disability trends among elderly persons and implications for the future. J. Gerontol. B Psychol. Sci. Soc. Sci. 55, S298–S307.

Williams, G.D., Grant, B.F., Harford, T.C., Noble, J., 1989. Population projections using DSM-III criteria: alcohol abuse and dependence, 1990-2000. NIAAA epidemiological bulletin No. 23. Alcohol Health Res. World 13 (4), 366–370.

Winick, C., 1962. Maturing out of narcotic addiction. Bull. Narc. 14, 1–7.