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Level of Cigarette Consumption and Duration of Smoking Abstinence during Failed Quit Attempts among Long-Term Daily Smokers: The Role of Race/Ethnicity and Cessation Aids

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Abstract

The goal of this study was to determine whether race/ethnicity and use of smoking cessation aids are associated with the duration of the last serious quit attempt and reductions in cigarette consumption among long-term daily smokers who tried, and failed, to quit smoking during the preceding year. Data came from the 2010–2011 Tobacco Use Supplement survey conducted in the US, and analyses included 6,672 reports of long-term daily smokers (i.e., smokers who smoked daily for one year or longer) who made at least one serious quit attempt in the past 12 months. About 39% of these smokers used at least one smoking cessation aid during their last quit attempt. Use of aids was significantly lower for non-Hispanic Black (NHB, 29%) and Hispanic (HISP, 29%) smokers than for non-Hispanic White (NHW, 42%) smokers, possibly due to differences in socioeconomic status and access to healthcare for smoking cessation. The effect of using any aids on mean cigarette reduction and duration of the last long quit attempt (i.e., one that lasted a day or more) was similar across race/ethnicity. Using any aids did not substantially influence mean cigarette reduction but was positively associated with duration of the quit attempt: the duration was 6 days longer (CI=3:10), on average, when aids were used than when smokers attempted to quit unassisted. Race/ethnicity was significantly associated with mean cigarette reduction ($p=0.023$); non-Hispanic American Indian and Alaska Native smokers had the highest mean reduction (of 3 cigarettes, CI=1:5) among the racial/ethnic groups considered. The duration of assisted attempts may be related to an increased likelihood of quitting successfully in the near future.

Keywords

health-risk behavior; national survey; replicate weights; self-report; substance use

COMPLIANCE WITH ETHICAL STANDARDS

Conflict of Interest: Author Julia N. Soulakova declares that she has no conflict of interest. Author Lisa J. Crockett declares that she has no conflict of interest.

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

1. INTRODUCTION

1.1. Study Rationale and Goals

The efficacy of pharmacological and behavioral aids for smoking cessation has been examined in many studies [1–3], e.g., a meta-analysis of 150 clinical trials addressing the efficacy of nicotine replacement therapy [3]. However, possible benefits of using aids during unsuccessful quit attempts have not been yet addressed. Given that smoking cessation is a process rather than a discrete time event [4], having an unsuccessful quit attempt (i.e., smoking abstinence followed by smoking relapse) should be perceived as a natural part of the smoking cessation process [5]. Making a quit attempt (even a failed one) could help the smoker transition from the “action” stage to the “maintenance” stage, the final stage in the transtheoretical model of behavioral addiction change [4]. The benefits of the (failed) quit attempt could differ depending on whether a smoker used or did not use a smoking cessation aid during the attempt and could also differ for diverse racial/ethnic groups. Because it is not possible to assess directly the benefits of assisted and unassisted quitting with respect to increased likelihood of transitioning to the maintenance stage, we focus instead on predicting two behaviors which are likely to improve chances of quitting successfully in the future: decreased nicotine dependence and prolonged smoking abstinence during assisted and unassisted quit attempts among long-term daily smokers (defined as smokers who had smoked daily for the past 12 months or longer). The assumption is that smokers who have substantially decreased their nicotine intake and achieved longer quit attempts in the past year will be more likely to quit smoking entirely in the near future. We considered how race/ethnicity and use of cessation aids predicted these two behaviors.

The specific goals of the study were to identify:

1. racial/ethnic differences in smoking cessation aids used and duration of use while trying to quit smoking;
2. differences in the average duration of the last quit attempt associated with smoking cessation aids used during the quit attempt;
3. differences in the average cigarette consumption reduction (over the past 12 month period) associated with race/ethnicity and using any aids during the last *long* quit attempt, while controlling for nicotine dependence and other important individual factors; and
4. differences in the average duration of the last *long* quit attempt associated with race/ethnicity and using any aids, while controlling for nicotine dependence other important individual factors.

We note that goals 1 and 2 refer to all long-term daily smokers who had at least one serious quit attempt in the past 12 months. Goals 3 and 4 refer to those long-term daily smokers who had at least one *long* serious quit attempt (i.e., who remained abstinent from smoking for a day or longer during their last quit attempt) in the past 12 months.

1.2. Background

About 43% of smokers have had at least one *long* serious quit attempt (i.e., remained abstinent from smoking for one day or longer) in the past 12 months [6]. Unassisted attempts (i.e., attempts without any pharmacological or behavioral aids) account for the majority of all quit attempts [8, 9, 10]: the rates of unassisted quitting range from 64% [11, 12] to 85% [2] depending on the definition of quitting used and the subpopulation examined (e.g., successful quitters or recent quitters). Attempts with pharmacological or behavioral aids account for less than 40% of quit attempts; for example, in 2009–2010 pharmacological aids were used in 31% of quit attempts and behavioral interventions were used in about 7% of quit attempts [12].

Relapse rates among attempters are very high: about 80% of quitters relapse within the first 3 months of quitting and about 60% of those who do not relapse within the first 3 months do relapse in the next 3 months [13]. The relapse rates are high among smokers who quit unassisted as well as those who quit using an aid. Specifically, among smokers who did not use any smoking cessation aids during their last quit attempt the majority of quitters relapsed within the first 8 days of the attempt and only 3–5% of the quitters remained abstinent 6 months after quitting [14]. Among smokers who used a nicotine patch (or a nicotine gum) only about 14% (17%) remained abstinent from smoking 12 months later [15].

Racial and ethnic disparities have been detected in the 2004–2013 trends in tobacco-related invasive cancer incidence and death rates [16]. Specifically, between the period from 2004–2008 and the period from 2009–2013, comparisons among four races (White, Black, American Indian/Alaska Native and Asian/Pacific Islander) and two ethnicities (Hispanic, non-Hispanic) indicated that Whites and non-Hispanics had the smallest (in absolute value) annual percentage decreases (APDs) in cancer incidence and Whites, Asian/Pacific Islanders and Hispanics had the smallest APDs in cancer death rates [16]. Furthermore, racial/ethnic disparities have been observed in smoking-related behaviors, including smoking prevalence and smoking prevalence trends [7, 18], quit attempts and intentions to quit smoking [19, 20], and using behavioral or pharmacological aids for smoking cessation, e.g., nicotine replacement therapy [3, 14, 21]. Specifically, among diverse racial/ethnic groups, non-Hispanic American Indians and Alaska Natives (AIAN) have the highest smoking prevalence (32%), followed by non-Hispanic White (NHW) and non-Hispanic Black (NHB; both rates are approximately 22%), followed by Hispanics (HISP, 16%) and non-Hispanic Asians (ASIAN, 13%) [6]. Also, among 18–30 year old smokers, HISP occasional smokers had lower odds of having quit attempts and NHB smokers had higher odds of intending to quit relative to the NHW smokers [18]. NHB and HISP also have lower rates of using a smoking cessation aid [3, 14, 22, 23].

In addition to race/ethnicity, quitting with a smoking cessation aid or unassisted may depend on several other individual factors. For example, use of aids was more prevalent among smokers who were more nicotine dependent [11, 12, 14], women [11, 13], older smokers (45+ years old) [12], smokers with higher socioeconomic status, e.g., wealthier smokers [11, 24], more educated smokers [11, 13], and smokers covered by private or military insurance [25], compared to their counterparts.

2. METHODS

2.1. Data

In this study we analyzed the 2010–2011 Tobacco Use Supplement (TUS) to the Current Population Survey [26] data for long-term daily smokers, i.e., respondents who indicated being daily smokers at the time of the survey and 12 months before. The survey is based on multi-stage sampling, where the overall sample is representative of the civilian, non-institutionalized US population [26]. The survey was designed to estimate the trends in the prevalence of cigarette smoking and other tobacco use, to monitor the progress and efficiency of programs targeting smoking cessation and tobacco control, and to provide data on many other research topics related to tobacco use in the US [26]. The initial sample consisted of 17,789 long-term daily smokers for whom we had complete information on the primary and key secondary measures discussed in sections 2.2 and 2.3. However, only 6,672 long-term daily smokers reported at least one quit attempt in the past 12 months and were included in the study.

The TUS questionnaire has a hierarchical structure, where respondents may be asked different survey questions depending on their responses to the previously asked questions. For example, first a current smoker is asked the question “During the past 12 months, have you stopped smoking for one day or longer because you were trying to quit smoking?” Respondents who answer “Yes” are asked to report additional information regarding that quit attempt. Respondents who answer “No” to the initial question are asked, “During the past 12 months, have you made a serious attempt to stop smoking because you were trying to quit — even if you stopped for less than a day?” Responses to these survey questions were used to identify smokers who made only short (i.e., lasting less than a day) quit attempts and those who made at least one long quit attempt in the past 12 months.

2.2. Primary Measures

Cigarette consumption reduction over the past 12-month period was defined using responses to the survey questions: “On the average, about how many cigarettes do you now smoke each day?” and “Around this time 12 months ago, on the average, about how many cigarettes did you smoke each day?” Cigarette consumption reduction was defined as the difference between the (average) number of cigarettes smoked per day 12 months ago and the number of cigarettes smoked per day at the time of the survey. Positive values on this measure correspond to decreased (average) consumption over the past 12 months while negative values of the reduction correspond to increased consumption over the past 12 months. Because the reported number of cigarettes smoked per day was truncated at 40 (i.e., if a smoker indicated smoking 45 cigarettes per day the number 40 was recorded), we measured reduction in cigarette consumption only for the 6,533 smokers who indicated smoking less than 40 cigarettes at both time points and 139 smokers who indicated smoking 40 or more cigarettes at only one time point; smokers who indicated smoking 40 or more cigarettes at both time points ($n = 126$) were coded as missing on this variable. We note that for the 139 (2.1%) smokers who indicated smoking 40 or more cigarettes per day at one time point only the consumption reduction measure may be an approximation because the exact mean number of cigarettes smoked per day may be different from the 40 cigarettes used in

the definition. However, given the small percentage of such possibly imprecise data, the overall measure is expected to be accurate.

Duration of the last (serious) quit attempt (in days) was defined for all smokers. If a respondent indicated having no long serious quit attempt in the past 12 months then zero was recorded for the duration of the last serious quit attempt.

2.3. Additional Measures

Smoking cessation aids used during the last quit attempt included pharmacological aids (a nicotine patch; a nicotine gum or nicotine lozenge; a nicotine nasal spray or nicotine inhaler; medications such as Chantix® or Varenicline; Zyban®, Bupropion, or Wellbutrin®; and another prescription medication) and behavioral aids (a telephone help line or quit line; one-on-one counseling; a stop smoking clinic class or support group; internet sites or a web-based program; and acupuncture or hypnosis). These measures were constructed using responses to survey questions similar to and including the following question “Thinking back to the last time you tried to quit smoking in the past 12 months, did you use any of the following products: A nicotine patch?”.

Using any aids (yes, no) differentiated between smokers who reported using at least one pharmacological or behavioral aid, i.e., assisted attempts, and those smokers who reported using neither pharmacological nor behavioral methods out of the surveyed ones, i.e., unassisted attempts. Smokers who reported any long or short quit attempt also reported the smoking cessation aids used during the quit attempt.

Two **nicotine dependence** measures included smoking within 30 minutes of awakening (yes, no) and night-smoking (yes, no), i.e., sometimes awakening during the night to have a cigarette.

History of smoking behaviors included four measures: (1) age of onset of daily smoking (younger than 18 years old, 18 years old or older); (2) heavy/non-heavy smoking status 12 months ago, where heavy smoking corresponded to smoking 20 or more cigarettes per day, on average, and non-heavy smoking corresponded to smoking less than 20 cigarettes per day, on average; (3) menthol smoking status 12 months ago (menthol, non-menthol, no usual type), i.e., type of cigarettes usually smoked; and (4) having multiple long quit attempts in the past 12 months (yes, no).

In addition to the measures discussed above we considered **sociodemographic characteristics** and **survey mode** (interview conducted in-person or by phone). These measures are listed in Table 1.

2.4. Analytic Approach

All data analysis was performed using survey package in SAS®9.4 [27]. The main weight and 160 replicate weights were used to correctly adjust for the multi-stage design of the survey and non-response, e.g., Rao-Scott chi-square tests with Balanced Repeated Replications with Fay correction of 0.5 for variance estimation were used for analyses of

contingency tables [28, 29]. We used the Bonferroni method when performing multiple comparisons and report adjusted p-values. The overall significance level was 5%.

To investigate the potential effect of race/ethnicity and assisted cessation on the average cigarette consumption reduction and the average duration of the last long quit attempt (goals 3 and 4), we built and fitted two multiple linear regression models. Initial models included all two-way interactions between using any aids and the other factors, including the interaction with race/ethnicity. The final model was identified via an analog of a backward elimination approach with a 5% significance level for elimination of the least significant interaction, one at a time. The main effects were retained in the final model regardless of their statistical insignificance.

3. RESULTS

3.1. Characteristics of Long-term Daily Smokers Who Attempted to Quit Smoking in the Past 12 Months

Among 6,672 daily smokers who indicated having at least one quit attempt in the past 12 months, 13.9% (957) had only short attempts, 29.6% (1,981) had exactly one long quit attempt and 56.5% (3,734) had multiple long quit attempts. The average duration of the last quit attempt (including short and long attempts) was 19.1 days (CI=17.6:20.6); 60.6% (3,873) of last quit attempts were unassisted; and the average reduction in cigarette consumption was 1.4 cigarettes (CI=1.2:1.6), i.e., on average, cigarette consumption decreased 1.4 cigarettes over the 12-month period. Among 5,715 daily smokers who had at least one long quit attempt in the past 12 months, the average duration of the last long quit attempt was 22.2 days (CI=20.5:23.9), 61.6% of the attempts were unassisted, on average, the cigarette consumption decreased 1.4 cigarettes (CI=1.2:1.6), and about 91.6% of smokers reduced, and 8.4% of smokers increased, the daily cigarette consumption over the past 12 months.

About 55.3% of smokers reported smoking within 30 minutes of awakening (based on 6,619 reports, i.e., 53 missing values), and 14.2% reported engaging in night-smoking (based on 6,636 reports, i.e., 36 missing values). Among daily smokers, 52.5% reported that they started smoking daily before they turned 18 years old, 67.2% indicated that they usually smoked non-menthol cigarettes 12 months ago, 31.5% usually smoked menthol cigarettes 12 months ago and 1.3% smoked “no usual type” 12 months ago; finally, 55.8% indicated being non-heavy smokers 12 months ago, i.e., smoked less than 20 cigarettes per day, on average.

Table 1 presents sample summary statistics for the sociodemographic and survey factors. As is illustrated, the majority of long-term daily smokers who had at least one quit attempt in the past 12 months were 25–44 years old, male, NHW, had some college or a Bachelor’s degree, resided in the southern US, and resided in a metropolitan area.

3.2. Goal 1: Racial/Ethnic Differences in Smoking Cessation Aids Used While Trying to Quit Smoking

Overall, about 39.4% of daily smokers used at least one smoking cessation aid during the last quit attempt (including both long and short attempts). About 30.8% of quit attempters

used only pharmacological aids, 2.7% used only behavioral aids and 5.9% used at least one pharmacological and at least one behavioral aid.

Table 2 presents the prevalence of each smoking cessation aid used during the last quit attempt for each racial/ethnic group. The rates of using any aid differed significantly across race/ethnicity: the rates were significantly lower for NHB (OR=0.56, 99% CI=0.43:0.74) and HISP (OR=0.58, 99% CI=0.40:0.83) than they were for NHW smokers. The rates of using pharmacological aids also significantly differed across race/ethnic groups: the rates were significantly lower for NHB (OR=0.53, 99% CI=0.40:0.72) and HISP (OR=0.59, 99% CI=0.41:0.86) smokers than they were for NHW smokers. No racial/ethnic group differences were detected in the use of behavioral aids.

Among pharmacological aids considered, there was an overall racial/ethnic difference in the rates of using a nicotine gum or lozenge and Chantix®/Varenicline. Specifically, the rate of using a nicotine gum or lozenge was significantly lower for NHB (OR=0.59, 99% CI=0.37:0.95) than it was for NHW smokers. The rate of using Chantix®/Varenicline was significantly lower for NHB (OR=0.41, 99% CI=0.26:0.63), ASIAN (OR=0.22, 99% CI=0.06:0.76) and HISP (OR=0.40, 99% CI=0.20:0.80) than it was for NHW smokers.

Among those who used nicotine products (patch, gum, lozenge, nasal spray or inhaler) while trying to quit smoking, the average duration overall (all nicotine products combined) was about 23 days (CI=20.0:25.4). The average duration of using a nicotine product also differed significantly across the racial/ethnic groups: AIAN and MULT smokers used the products for a shorter period, on average, than NHW smokers: the corresponding mean differences relative to NHW were -13.1 days (99% CI=-21.2:-4.9) for AIAN and -10.9 days (99% CI=-18.0:-3.9) for MULT smokers. There were no differences detected for NHB, ASIAN and HISP smokers relative to NHW smokers. We note that out of 1,840 smokers who indicated using any nicotine products, only about 97.3% specified the exact duration of using the products. Thus, the latter results are based on slightly smaller sample sizes, as is indicated in Table 2.

The total average duration of using a medication pill (Chantix®, Varenicline, Zyban®, Bupropion, Wellbutrin® or another medication pill) while trying to quit smoking was about 42 days (CI=37.5:45.9). No differences in duration were detected among NHW, NHB, MULT and HISP; other groups were not considered due to small group sample sizes. We also note that out of 1,170 smokers who indicated using at least one medication pill, only about 97.4% specified the exact duration, leading to a slightly smaller analytical sample (see Table 2).

3.3. Goal 2: Differences in the Average Duration of the Last Long Quit Attempt Associated with Race/Ethnicity and Assisted Cessation

Table 3 illustrates the results of analyses comparing daily smokers with a short versus long last quit attempt in the past 12 months in terms of specific smoking cessation aids used during the attempt. Short attempts (compared to long attempts) were associated with using any aid; any pharmacological aid; any behavioral aid (at 10% level); nicotine gum or lozenge; Chantix® or Varenicline; Zyban®, Bupropion or Wellbutrin®; and acupuncture or

hypnosis. There were no significant associations between duration and use of the other surveyed aids; the rates of using another prescription medication were not compared due to frequencies being close to zero.

3.4. Goal 3: Differences in the Average Cigarette Consumption Reduction Associated with Race/Ethnicity and Using Any Aids During the Last Long Quit Attempt

The multiple regression for the average cigarette consumption reduction ($F=30.4$, $df=28$, $p<0.001$; $n=5,646$) contained all sociodemographic and survey factors depicted in Table 1, two nicotine dependence measures, four measures of history of smoking behaviors, using any aids during the last long quit attempt and a significant interaction between using any aids and having multiple long quit attempts in the past 12 months ($p=0.016$). Among smokers who did not have prior long quit attempts (in the same year) the model-based mean reduction estimates were 1.4 ($SE=0.4$) for smokers who did not use any aids and 0.9 ($SE=0.4$) for smokers who did use the aids. Among smokers who had a prior long quit attempt (in the same year) the estimates were 1.5 ($SE=0.4$) for smokers who did not use any aids and 1.8 ($SE=0.4$) for smokers who did use aids.

However, neither of these differences was statistically significant. In addition, the mean reduction did not differ between assisted and unassisted attempts, overall.

The average reduction in smoking was significantly associated with race/ethnicity ($p=0.023$). Figure 1 depicts the model-based estimates: the highest mean reduction (of 2.7 cigarettes) was observed for AIAN daily smokers. However, after multiplicity adjustments there were no significant differences when diverse racial/ethnic groups were compared to NHW. Among other main effects not included in the interaction, the following were significant: age ($p=0.003$), gender ($p=0.009$), smoking or not within 30 minutes from awakening ($p<0.001$), and heavy/non-heavy smoking 12 months ago ($p<0.001$), as well as region ($p=0.006$) and survey mode ($p=0.025$). Figures 2 and 3 depict the model-based estimates for some of these factors. Specifically, the average cigarette reduction was positively associated with being younger, i.e., 18–24 year old smokers had significantly higher average reduction than did 65+ year old smokers (adjusted $p=0.015$), being a female, being a heavy smoker 12 months ago, and not smoking within 30 minutes after awakening. In addition, smokers who had a phone interview reported a higher reduction in cigarette use, on average, than smokers who had an in-person interview, but the mean difference was only 0.4 cigarettes. Among the four US regions, the highest average reduction (of 1.9 cigarettes) was estimated for the West US region, which was significantly higher than for the Northeast (adjusted $p=0.021$) and South (adjusted $p=0.003$) regions but the mean differences were less than one cigarette.

3.5. Goal 4: Differences in the Average Duration of the Last Long Quit Attempt Associated with Race/Ethnicity and Using Any Aids During the Attempt

The multiple regression for the average duration of the last long quit attempt ($F=47.1$, $df=25$, $p<0.001$, $n=5,715$) contained only the main effects, i.e., all sociodemographic and survey factors depicted in Table 1, four measures of history of smoking behaviors and using any aids during the last long quit attempt. The following effects were significant: using any aids

($p<0.001$), having multiple long quit attempts in the past 12 months ($p<0.001$), heavy/non-heavy smoking status 12 months ago ($p<0.001$), menthol smoking status 12 months ago ($p=0.048$), and metropolitan status ($p<0.001$). The average duration of the last quit attempt was 31.3 days ($SE=4.5$) for smokers who used aids during the attempt and 24.5 days ($SE=4.3$) for smokers who did not use any aids during the attempt; the mean difference in the duration (M) for assisted attempts relative to unassisted ones was 6.1 days ($CI=2.7:9.6$).

In addition, the average duration of the last long quit attempt was 36.1 days ($SE=4.6$) for smokers who did not have prior long quit attempts in the past 12 months and 19.6 days ($SE=4.3$) for smokers who had prior long quit attempts ($M=16.1$, $CI=12.6:19.6$); 30.9 days ($SE=4.5$) for smokers who were not heavy smokers 12 months ago and 24.9 days ($SE=4.3$) for smokers who were heavy smokers 12 months ago ($M=5.9$, $CI=3.0:8.9$); 30.5 days ($SE=4.3$) for smokers residing in metropolitan area and 25.3 days ($SE=4.5$) for smokers residing in non-metropolitan area ($M=5.2$, $CI=2.5:7.9$). The differences among diverse menthol smoking status groups were not significant after multiplicity adjustments.

4. DISCUSSION

4.1. Overall Patterns of Unassisted and Assisted Quit Attempts of Long-Term Daily Smokers

Among current long-term daily smokers, the majority did not attempt to quit within the past 12 months in the 2009–2010 period. Among those who had at least one quit attempt, about 60% tried to quit unassisted and about 40% tried to quit using a smoking cessation aid. Behavioral aids were drastically underused (9%) in comparison to pharmacological aids (37%). Among pharmacological aids, the most commonly used aids included a nicotine patch, Chantix® or Varenicline, and a nicotine gum or lozenge. These results for (unsuccessful) quit attempts of current smokers are consistent with those reported in the literature for successful quit attempts among former smokers [2, 8, 25], including a study that also used the 2010–2011 TUS data [12]. This could indicate that smokers who were long-term daily smokers and tried to quit in 2009–2010 and those who successfully quit smoking in 2009–2010 were similar in terms of the prevalence of unassisted attempts, prevalence of attempts with a pharmacological aid and prevalence of attempts with a behavioral aid. While direct comparisons between current and former smokers are needed to confirm that strategies for quitting are similar for successful and unsuccessful quitters, such a similarity would be consistent with the five-stage transtheoretical model and would highlight common strategies associated with transitioning between the various stages as well as a natural pattern of “going back” to the previous stage, i.e., smoking relapse for unsuccessful quitters trying to deal with an addictive behavior [5, 30].

Daily smokers who used nicotine products (during the last quit attempt in the past 12 months) used the products on average for 3.2 ($CI=2.9:3.6$) weeks (in total), and smokers who used medication pills used the medications on average for 6.0 ($CI=5.4:6.6$) weeks (in total). Both estimates are substantially lower than the minimum recommended duration; for example, the NicoDerm® CQ® patch should be used for 8 weeks for less nicotine-dependent smokers and 10 weeks for more nicotine-dependent smokers [32], Chantix® should be used for at least 12 weeks [33], and Zyban® should be used for at least 7 weeks

[34]. Therefore, it appears that smokers who tried to quit using an aid did not use the aid for a sufficient amount of time, on average, which could potentially explain why some assisted quit attempts are not successful.

4.2. Racial/Ethnic Differences in Smoking Cessation Aids Used, Cigarette Consumption Reduction and Duration of the Last Quit Attempt

The rates of using smoking cessation aids when attempting to quit were significantly lower for NHB and HISP (29% or less) than they were for NHW smokers (42%). Specifically, the rates of using a pharmacological aid were significantly lower for NHB and HISP (28% or less) than they were for NHW smokers (39%). These results agree with those reported previously for daily smokers using 2003 TUS data [35] and for successful quitters using 2010–2011 TUS data [12], where the odds of using a pharmacological aid (versus quitting unassisted) were shown to be significantly lower for NHB and HISP than they were for NHW former smokers. The rate of using a nicotine gum or lozenge was also significantly lower for NHB (8%) and the rate of using Chantix® or Varenicline was significantly lower for NHB, ASIAN and HISP (7% or less) than the corresponding rates (12% and 15%, respectively) for NHW smokers. These results agree with prior findings regarding the use of a nicotine replacement therapy [21, 23, 35] and a pharmacological aid [35]. Taken together, the present and prior results indicate a greater tendency to use pharmacological aids among NHW smokers compared to smokers from some other racial/ethnic groups, particularly NHB and HISP.

The racial/ethnic discrepancies in the rates discussed above could be due to differences in socioeconomic status (SES), which accounts for a large portion of the health discrepancies associated with race/ethnicity [37], and a related factor, access to healthcare [38]. For smokers with lower SES, currently marketed pharmacological treatments may be unaffordable; for example, in 2006 the estimated cost of a 30-day supply was about \$120 for a nicotine patch, \$107 for Chantix®, and \$70 for Bupropion, the least expensive option among prescription aids [39].

Race/ethnicity was also significantly associated (after adjusting for multiple covariates) with the mean cigarette consumption reduction over the past 12 months in smokers who had a long quit attempt in the past 12 months. However, the maximum difference in reduction relative to NHW daily smokers was only 2 cigarettes (it corresponded to AIAN daily smokers). A more substantial difference in consumption reduction (4 cigarettes) was estimated for smokers who were heavy smokers (12 months prior to the survey) relative to smokers who were non-heavy smokers. The study also explored the interaction between race/ethnicity and using any aids. The interaction was not significant in both models, indicating similar effects of using any aids on mean cigarette reduction and duration of last long attempt across all racial/ethnic groups considered.

4.3. Smoking Cessation Aids Used During the Last Quit Attempt, Cigarette Consumption Reduction and Duration of the Last Quit Attempt

Exploratory analyses indicated that short attempts were associated with higher rates of using any smoking cessation aid, any pharmacological aid, a nicotine gum or lozenge, a

medication pill for smoking cessation, and acupuncture or hypnosis, while long quit attempts were associated with lower rates of using these aids. There are several potential reasons for these differences, e.g., smokers who used smoking cessation aids could be less serious about quitting and may rely on aids as a “substitute” for their commitment and personal motivation to quit. Additionally, there are many possible confounding factors; for example, other research indicates that smoking cessation aids are primarily used by smokers who are more nicotine dependent. Therefore, the observation that short attempts are associated with higher rates of using some aids could be due to the different nicotine dependence levels rather than type of aids used [11, 14].

Additional results concerning using any aids during the last long quit attempt indicated that using aids is positively associated with the average duration of the quit attempt: assisted attempts were about 6 days longer (on average) than unassisted attempts. There was no overall effect of using aids on the mean cigarette reduction over the past 12 months. While there was a joint effect of using any aids and having (or not) prior long quit attempts in the past 12 months, the post-hoc comparisons were not statistically significant and the mean reductions did not exceed 2 cigarettes for all subgroups of smokers. Therefore, we conclude that using aids is associated with longer serious quit attempts, on average, but not with a substantial reduction in cigarette consumption over the past 12-month period.

The study also revealed other individual attributes of smokers (who had at least one long quit attempt in the past 12 months) that were associated with the average reduction in cigarette consumption and duration of the last long quit attempt. Being in a younger age group, female, AIAN, not smoking within 30 minutes from awakening, and being a heavy smoker 12 months ago were all positively associated with the mean cigarette consumption reduction. Not having a prior long quit attempt in the past 12 months, being a non-heavy smoker 12 months ago and residing in metropolitan area were positively associated with the mean duration of the last long quit attempt.

4.4. Study Limitations and Future Research Goals

This study used self-reports of daily smokers and therefore all information is subject to respondent’s accurate recall and truthful reporting [31,40–45]. There is a concern that cigarette consumption could be underreported while the duration of the last long quit attempt could be overreported. While reliability of these two measures has not been investigated, a related TUS reliability study documented adequate reliability of several self-reported smoking measures, e.g., the number of cigarettes smoked per day when a former smoker smoked daily [46].

This study did not address the efficacy of particular smoking cessation aids in supporting successful smoking cessation. For example, while the smokers were surveyed regarding use of acupuncture and hypnosis and these reports were included in the study, the efficacy of these methods has not yet been confirmed in the literature: in one study the 6-month outcomes of hypnotherapy for smoking cessation were similar to no treatment [47] and in another the 6-month outcomes of acupuncture were equivocal due to the lack of consistent bias-free results [48].

An additional possible study limitation is that the model-building methods were tailored to the study goals, i.e., only the two-way interactions between using any aids and the other factors was considered. Given that different initial models and model-building approaches may lead to essentially different regression models from the one used in the study, the proposed final models should not be viewed as the best models for describing the general relationships; for example, some two-way interactions not considered in this study might be significant.

The study also did not adjust for the time since the last quit attempt. Because smokers who attempted to quit recently and those who attempted to quit some time ago (in the past 12 months) could potentially differ in current cigarette consumption, time since the last quit attempt could be another important factor to consider. Future studies utilizing detailed information on the number of quit attempts in the past 12 months and their dates could help to better capture the short-term and long-term benefits of (failed) quit attempts.

Future research could also examine cigarette consumption reduction as a binary measure, differentiating between smokers who increased consumption and those who decreased or maintained their level of cigarette consumption over the past 12 months. Our preliminary analyses of this binary measure indicated that the prevalence of increased cigarette consumption differs among the racial/ethnic groups ($p=0.045$). The prevalence of increased consumption was 7.7% for NHW, 9.5% for NHB, 13.2% for HISP, 12.4% for AIAN, 11.0% for ASIAN, 17.1% for HPI, and 8.9% for MULT. However, in some of the racial/ethnic groups only a few smokers reported increased consumption, and the only significant difference in prevalence was between HISP and NHW smokers (unadjusted $p=0.004$). A future study carefully adjusting for other potentially important covariates could help identify subpopulations of daily smokers who increased their cigarette consumption to better inform policy makers and healthcare professionals about these at-risk subpopulations.

Our findings indicated that long-term daily smokers, overall, use similar smoking cessation strategies (including unassisted quitting) as those reported for successful quitters, raising a key question for the future studies: “What did current smokers do differently during their last serious quit attempt from those who successfully quit?” For example, there could be different persistence and motivation levels during the last quit attempt and/or differences in previous quitting behaviors such as the number and duration of previous quit attempts. Answering this question will help researchers identify behaviors and actions that help smokers remain in the “maintenance” stage, i.e., sustain their abstinence from smoking.

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Figure 1.
Model-based 95% Individual Confidence Intervals for the Mean Cigarette Reduction by Race/Ethnicity

Figure 2.
Model-based 95% Individual Confidence Intervals for the Mean Cigarette Reduction by Age and Gender

Figure 3.
Model-based 95% Individual Confidence Intervals for the Mean Cigarette Reduction

Table 1

Characteristics of Long-term Daily Smokers Who Had a Serious Quit Attempt in the Past 12 Months and Survey Mode; Data from the 2010–11 Tobacco Use Supplement, US

Characteristic	Total	
	Count	Percent*
Age		
18–24	638	14.8
25–44	2832	41.7
45–64	2666	37.0
65+	536	6.5
Gender		
Male	3090	51.1
Female	3582	48.9
Race/Ethnicity		
non-Hispanic White	5343	76.9
non-Hispanic Black	590	10.8
non-Hispanic American Indian or Alaska Native	98	0.9
non-Hispanic Asian	108	1.8
non-Hispanic Hawaiian or Pacific Islander	20	0.2
non-Hispanic Multiracial	163	2.1
Hispanic	350	7.2
Highest Level of Education		
Less than High school	1005	16.3
High school (or equivalent)	2773	40.7
Some college or a Bachelor's degree	2741	41.0
Graduate degree	153	2.0
Region		
Northeast	1356	17.4
Midwest	1951	27.9
South	2063	37.2
West	1302	17.5
Metropolitan Status		
Metropolitan	4829	79.6
Non-metropolitan	1843	20.4
Survey Mode		
Telephone	3855	55.6
In-person	2817	44.4
Sample Size (Population Count)	6,672 (8,629,232)	

Table 2

Prevalence (%) and Duration of Smoking Cessation Aids Used During the Last Quit Attempt; Percentages are computed for each race/ethnicity separately*; Data from the 2010– 11 Tobacco Use Supplement, US

Aids	NHW	NHB	AIAN	ASIAN	HPI	MULT	HISP	Total
Pharmacological Aids								
	39.1	25.5 <0.001	36.0 NS	29.8 NS	9.0	43.9 NS	27.5 0.001	36.7 <0.001
Nicotine Patch	19.9	15.1	21.2	12.8	2.8	17.9	17.7	19.0 NS**
Nicotine Gum or Lozenge	12.4	7.7 0.017	11.9 NS	15.7 NS	7.1	15.9 NS	11.2 NS	11.9 0.040
Nicotine Nasal Spray or Inhaler	1.5	1.2	0.4	0.0	0.9	0.0	0.3	1.3
Total duration of nicotine product use: mean (SE) and count	23.8 (1.7) n=1481	20.4 (3.6) n=114 NS	10.7 (2.5) n=29 <0.001	25.1 (6.1) n=24 NS	11.6 (12.4) n=3	12.9 (2.3) n=52 <0.001	17.2 (3.9) n=87 NS	22.7 (1.4) n=1790 <0.001
Chantix® or Varenicline	14.6	6.5 <0.001	8.8 NS	3.6 0.002	0.0	15.8 NS	6.4 0.002	12.9 <0.001
Zyban®, Bupropion, or Wellbutrin®	4.7	2.9	1.7	4.4	1.9	1.9	1.3	4.2
Another Prescription Medication	0.5	0.9	0.0	1.2	0.0	0.1	1.0	0.6
Total duration of medication pill use: mean (SE) and count	41.0 (2.3) n=1001	52.4 (11.6) n=58	14.5 (6.2) n=11	47.6 (16.6) n=9	14.0 (0.0) n=1	42.0 (22.5) n=32	40.2 (15.1) n=27	41.7 (2.1) n=1139 NS
Behavioral Aids								
Telephone Help Line or Quit Line	3.5	2.9	6.4	3.4	0.0	5.9	4.2	3.6
One-on-one Counseling	2.4	4.0	3.6	0.7	0.0	4.6	1.3	2.6
Stop Smoking Clinic Class or Support Group	2.3	2.5	0.6	0.0	1.9	2.1	2.0	2.2
Internet or Web-based Program	2.0	1.4	2.8	4.0	0.0	5.7	1.7	2.1
Acupuncture or Hypnosis	2.0	1.0	1.0	0.2	0.0	0.7	1.2	1.7
Any Aid	41.8	28.8 <0.001	36.0 NS	29.8 NS	9.0	51.8 NS	29.3 <0.001	39.4 <0.001

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* p-values correspond to the Rao-Scott Chi-Square tests: Total presents the p-value for testing the overall differences across the racial/ethnic groups, the other columns present the p-values for significant comparisons to NHW (these p-values are adjusted for multiplicity), groups with n = 20 were excluded from all comparisons; „NS“ stands for non-significant; bold font denotes performed comparisons; duration of smoking cessation aids (mean and standard deviation) is computed only for those smokers who indicated using the smoking cessation aids

Table 3

Prevalence (%) of Smoking Cessation Aids Used During Short and Long Quit Attempts; Data from the 2010–11 Tobacco Use Supplement, US

Aids	Short Attempt (i.e., of less than a day), n=957	Long Attempt (i.e., of a day or longer), n=5,715	Total	p-Value
Pharmacological Aids	41.1	35.9	36.7	0.017
Nicotine Patch	18.5	19.1	18.9	NS
Nicotine Gum or Lozenge	14.8	11.5	11.9	0.027
Nicotine Nasal Spray or Inhaler	1.7	1.3	1.3	NS
Chantix® or Varenicline	16.8	12.2	12.9	0.001
Zyban®, Bupropion, or Wellbutrin®	6.1	3.8	4.2	0.011
Another Prescription Medication	0.4	0.6	0.6	Not assessed
Behavioral Aids	10.4	8.3	8.6	0.053
Telephone Help Line or Quit Line	4.5	3.4	3.6	NS
One-on-one Counseling	2.0	2.6	2.6	NS
Stop Smoking Clinic Class or Support Group	2.3	2.2	2.2	NS
Internet or Web-based Program	2.1	2.1	2.1	NS
Acupuncture or Hypnosis	2.9	1.5	1.7	0.006
Any Aid	45.8	38.4	39.4	0.001