SMOKING AND TOBACCO IN OHIO PRISONS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the
Graduate School of The Ohio State University

By

Ross M. Kauffman, M.P.H., B.S.

* * * * *

The Ohio State University

2009

Dissertation Committee:
Professor Amy K. Ferketich, Adviser
Professor David M. Murray
Professor Mary Ellen Wewers
Professor Paul E. Bellair

Approved by

Adviser
Public Health
Graduate Program
© Copyright by
Ross M. Kauffman
2009
ABSTRACT

The rate of incarceration in the United States has grown steadily since the mid-1970s to a point where 1% of American adults are currently being held in jails and prisons. Prisoners are sicker than the general population with a high prevalence of many negative health behaviors. Tobacco use is one such behavior, with past surveys finding that up to 85% of prisoners smoke. The Smoking and Tobacco in Ohio Prisons (STOP) Project was undertaken to examine the impact of incarceration on smoking behaviors and lay the groundwork for further research into tobacco use in prisons. A total of 200 recently-arrived male inmates, drawn from two Ohio prisons, were surveyed about their tobacco use.

Several measures of tobacco use were evaluated as part of the study. Self-reports were found to be a valid measure of tobacco use in the sample, based on biomarker confirmation (sensitivity = 98.5%, specificity = 88.9%). Carbon monoxide breath tests were less valid (sensitivity = 85.4%, specificity = 91.7%), especially among occasional smokers; however, as a non-invasive, inexpensive way of measuring short-term smoking they may still offer a useful measure in some research contexts. Using an enzyme immunoassay to measure salivary cotinine offers a less-expensive alternative to the gold standard liquid chromatography tandem mass spectrometry, however the current study found that economic savings are moderated by false-positive results (sensitivity = 94.2%, specificity = 100.0%).
The prevalence of current tobacco use was high prior to (77.5%) and during incarceration (82.0%). While entry into the prison was found to be associated with increases in the number of smokers, average cigarette consumption declined from 15.7/day to 8.6/day ($p < 0.001$). Smokeless tobacco use, including dual use of cigarettes and smokeless tobacco, increased following incarceration, especially among those sentenced from Appalachian counties. The tobacco use survey also exposed a gap between prison policy and prisoners’ practice. A majority of smokers (51.2%) reported smoking indoors at least once since their arrival, and more than a third (34.1%) reported that they smoked inside on a daily basis. Despite widespread tobacco use among prisoners, a majority of users (70%) expressed a desire to quit smoking, indicating a high demand for effect cessation assistance.

Preliminary data were collected on participants’ adverse childhood experiences (ACEs) using an audio computer-assisted self-interview system. Response rates for these questions, which covered sensitive topics including sexual abuse and household dysfunction, were high (>97%). Past studies in the general population have linked ACEs to smoking behavior. Non-significant trends in the current study suggest the existence of a similar relationship in incarcerated populations, however the limited sample size does not allow for the clear demonstration of an association.
ACKNOWLEDGMENTS

Many people have contributed to the success of this project. I would like to thank the Behavioral Cooperative Oncology Group of the Mary Margaret Walther Program for their financial support during the planning of this project, and for the helpful feedback from BCOG members that helped shape this study in its early stages.

This study would not have been possible without the generous funding of the Centers for Disease Control and Prevention through grant 1R36DP001167-01.¹ No classroom lesson or secondary data analysis can ever compare with the experience of designing, conducting, and analyzing an original study, and I am honored to have been given the chance to do so.

The staff of the OSU Office of Responsible Research Practices deserve special recognition. Obtaining approval for prison research is notoriously challenging, yet thanks to the generous support of the ORRP staff the process was a painless one.

This project would never have been possible without the support of the Ohio Department of Rehabilitation and Correction. I am grateful for the help provided by the Bureau of Planning and Evaluation, with special thanks to Gayle Bickle and Lee Norton. The project was helped greatly by the staff and administrators of the two study sites. At each prison there was a correctional officer assigned to facilitate the

¹The contents of this dissertation are solely the responsibility of the author and do not necessarily represent the official views of the CDC.
study. These two men, Officer W. and Officer B., did much to make the project run smoothly and efficiently and have my sincere thanks.

There are many friends in the College of Public Health who have contributed to my learning and made my time in the program richer including Beth Pierson, Ellen Yard, Gebra Cuyun Grimm, Jennifer McGeehan, Linda Lord, and Yosef Khan.

I will always be indebted to Dr. Mira Katz, who offered me my first public health research opportunity in the Amish Project and who, in the years since, has been a constant source of encouragement and support.

For five years Dr. Amy Ferketich has served as an adviser, teacher, mentor, and friend. She has been present at every step in the dissertation process: from helping me narrow a general interest in prison health to the subject of prison tobacco use, to suggesting funding opportunities, to discussing methodological issues while writing dissertation chapters. I am at a loss to express the extent of my gratitude for all that Dr. Ferketich has done for me.

I would also like to thank my other committee members for their guidance: Dr. Paul Bellair who provided me with my first experience with prison research; Dr. David Murray whose always insightful comments and willingness to share from his broad experience have been valuable resources in refining this document; and Dr. Mary Ellen Wewers who has been a dedicated mentor and generously shared her time and expertise to deepen my understanding of tobacco research.

Finally, I would like to thank my family who have always supported me: my parents, brothers, and sister-in-laws who continue to inspire the best in me with their examples of lives well-lived, and my nephews and nieces for the joy they bring to my life.
VITA

October 1, 1981 .......................... Born - Bellefontaine, OH

2003 ........................................... B.S. Biology & Environmental Science, Eastern Mennonite University

2004-2005 ................................. University Fellow, The Ohio State University

2005-2006 ................................. Graduate Teaching Associate, Division of Epidemiology, School of Public Health, The Ohio State University

2005-2007 ................................. Graduate Research Associate, School of Public Health, The Ohio State University

2006-2007 ................................. Predoctoral Fellow, Mary Margaret Walther Program

2007 ......................................... M.P.H. Epidemiology College of Public Health The Ohio State University

PUBLICATIONS

Research Publications


**FIELDS OF STUDY**

Major Field: Public Health

Specialization: Epidemiology
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>ii</td>
</tr>
<tr>
<td>Dedication</td>
<td>iv</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td>v</td>
</tr>
<tr>
<td>Vita</td>
<td>vii</td>
</tr>
<tr>
<td>List of Tables</td>
<td>xii</td>
</tr>
<tr>
<td>List of Figures</td>
<td>xiii</td>
</tr>
</tbody>
</table>

Chapters:

1. The Incarceration Nation                                             | 1    |
   1.1 A Brief History of Incarceration                                 | 2    |
   1.2 Prison Demographics                                             | 5    |
   1.3 Prisoner Health                                                 | 7    |
   1.4 Tobacco and Tobacco Policy in U.S. Prisons                      | 8    |
   1.5 The STOP Project                                                | 15   |

2. Measuring Tobacco Use in a Prison Population                        | 18   |
   2.1 Background                                                       | 18   |
   2.2 Methods                                                          | 22   |
      2.2.1 Participants and Setting                                    | 22   |
      2.2.2 Measuring Tobacco Use                                       | 22   |
      2.2.3 Statistical Analysis                                        | 23   |
   2.3 Results                                                          | 25   |
      2.3.1 Sample Characteristics                                      | 25   |
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Sample demographic and tobacco use characteristics</td>
</tr>
<tr>
<td>3.1</td>
<td>Sample characteristics compared with incoming inmates</td>
</tr>
<tr>
<td>3.2</td>
<td>Participant tobacco use prior to and during incarceration</td>
</tr>
<tr>
<td>3.3</td>
<td>Pre-incarceration tobacco use by region of sentencing county</td>
</tr>
<tr>
<td>3.4</td>
<td>Frequency of self-reported indoor tobacco use by product type and facility</td>
</tr>
<tr>
<td>4.1</td>
<td>Operational definitions of adverse childhood experiences</td>
</tr>
<tr>
<td>4.2</td>
<td>Selected tobacco use characteristics and adverse childhood experiences in a sample of male inmates</td>
</tr>
<tr>
<td>4.3</td>
<td>Relationship between adverse childhood experiences and selected smoking behaviors in a sample of recently admitted male prisoners</td>
</tr>
<tr>
<td>4.4</td>
<td>Relationship between number of adverse childhood experience categories and selected smoking behaviors in a sample of prisoners</td>
</tr>
<tr>
<td>5.1</td>
<td>Performance of tobacco use measures in a sample of male prisoners</td>
</tr>
<tr>
<td>B.1</td>
<td>Design effects for selected tests</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Incarceration rates in selected nations and their worldwide rank</td>
<td>3</td>
</tr>
<tr>
<td>1.2 Incarceration rate in the United States, 1925-2005</td>
<td>5</td>
</tr>
<tr>
<td>1.3 Lifetime risk of incarceration by gender and race</td>
<td>6</td>
</tr>
<tr>
<td>1.4 Example of promotional materials for the “Play Ball with Newport” program</td>
<td>12</td>
</tr>
<tr>
<td>2.1 Receiver operating characteristics curve for carbon monoxide breath test</td>
<td>28</td>
</tr>
<tr>
<td>2.2 Exhaled carbon monoxide concentrations versus salivary cotinine concentrations measured by liquid chromatography tandem mass spectrometry</td>
<td>30</td>
</tr>
<tr>
<td>2.3 Receiver operating characteristics curve for a enzyme immunoassay cotinine test</td>
<td>31</td>
</tr>
<tr>
<td>2.4 Salivary cotinine concentrations measured by enzyme immunoassay versus liquid chromatography tandem mass spectrometry</td>
<td>32</td>
</tr>
<tr>
<td>3.1 Commissary price lists for tobacco products at STOP Project sites</td>
<td>46</td>
</tr>
<tr>
<td>3.2 Classification scheme for patterns of tobacco use</td>
<td>50</td>
</tr>
<tr>
<td>3.3 Overview of study participation</td>
<td>53</td>
</tr>
<tr>
<td>3.4 Patterns of tobacco use prior to arrest and during incarceration</td>
<td>65</td>
</tr>
<tr>
<td>3.5 Average per-capita consumption of cigarettes prior to and during incarceration</td>
<td>67</td>
</tr>
</tbody>
</table>
4.1 The adverse childhood experiences pyramid ............................. 77

4.2 Prevalence of adverse childhood experiences in incarcerated and general population ......................................................... 87

4.3 Prevalence of smoking behaviors by reported number of categories of adverse childhood experiences ..................................... 91
CHAPTER 1

THE INCARCERATION NATION

When prison is mentioned, what comes to mind? Most Americans have experienced incarceration only secondhand: through portrayals in the popular culture or a line in the speech of a politician promising safer communities in exchange for a vote. For them, prison is an abstract concept, rarely considered and easily dismissed. Yet for many others the impact of incarceration is much more direct. Each day more than 2.3 million people awake in American jails and prisons as wards of the state.\[1\]\[2\] Millions more must deal with the absence of a loved one, parent, sibling, friend, spouse, or child held behind bars.\[3\] More than half of those incarcerated leave behind a minor child when incarcerated.\[3\]

Even those who think little about the issues surrounding incarceration are affected by the practice of mass incarceration, as each must bear their part of the social and economic cost of imprisoning so many. The numbers are staggering. At the time of this writing, the United States imprisons a greater proportion of its residents than any nation in the world.\[4\] Fully 1% of all American adults are currently incarcerated in the nation’s jails and prisons.\[5\] The cost of housing and caring for this many prisoners is enormous. Currently annual expenditures on corrections are around $49 billion, with a 50% increase expected by 2011.\[5\] A major contributor to the cost
of incarceration is healthcare for prisoners. This document examines one important determinant of health among prisoners: tobacco use. In order to frame the issue, this chapter will provide some information on the history of incarceration in the United States and provide background on the makeup of current prison populations.

1.1 A Brief History of Incarceration

As noted above, the United States currently has the highest official rate of incarceration in the world.[4] As Figure 1.1 shows, the frequency with which the US imprisons its residents far surpasses even those nations ruled by what we would perceive as repressive regimes. No information is available from North Korea and numbers from China are likely highly understated. Even if these rates are in fact higher it does little to improve US standing on the subject.[4, 6] The current situation was not arrived at over night. To understand how it developed, one must examine the history of incarceration in the United States.

Early American correctional practices were developed partly in response to severe punishments meted out under the English penal system.[7] Under English law, even petty crimes could result in capital punishment or banishment.[7] In the Quaker colony of Pennsylvania reformers established workhouses, where incarceration served as an alternative to harsher punishments.[8] In these facilities prisoners could contemplate their crimes and repent from their sins, leading these facilities to be termed “penitentiaries.”[8] Life was difficult in many of the early prisons, with some facilities using enforced silence, corporal punishment, and solitary confinement to reform prisoners’ behavior.[7] By the mid 1800s a lack of success prompted prisons to shift their
Figure 1.1: Official incarceration rates in selected nations and their worldwide rank out of 217 nations. Source: International Center for Prison Studies, 2007.
focus from reform to control; leg irons and hard labor were used to keep prisoners in line during their incarceration. [7]

In the first half of the nineteenth century “flat” sentencing was used, whereby prisoners were given a fixed prison term dictated by the sentencing judge. [8] By mid-century, however, developments from foreign prison systems changed sentencing practice in many US prison systems. Australian prison warden Captain Alexander Maconochie and Irish prison director Sir Walter Crofton contributed to the development of the indeterminant model of sentencing. [8] Indeterminant sentencing added the carrot of reduced sentence length to the stick of punishment. The National Congress on Penitentiary and Reformatory Discipline was held in Cincinnati in 1870 involving representatives of prison systems from nearly every state in the nation. [8] The meeting included the adoption of the “Declaration of Principles” which established principles governing the practice of incarceration, including indeterminant sentencing. [9] During the 50 years following the conference, nearly every state codified indeterminant sentencing. [8]

For half a century, starting in the 1920s, the rate of incarceration remained relatively steady at around 110/100,000 residents. [10] This stability was despite dramatic political, economic, and social upheavals: the unprecedented wealth of the roaring 20s, the great depression of the 1930s, even the Second World War. The rate remained so steady that, in 1973, social scientists Blumstein and Cohen from the University of Chicago proposed a theory that the rate of incarceration was a constant. [11] Pointing to four decades of stable incarceration rates, they suggested that society would always adjust its standards such that the same proportion of the population was regarded as criminal. [11] Time, however, would quickly prove them wrong. Since the mid-1970s,
the number of Americans incarcerated has been climbing steadily, both in absolute and relative terms (see Figure 1.2).\cite{10, 12} Several factors are responsible for this increase, however the issue often identified as the primary driving force behind the increase is the decline of indeterminate sentencing.\cite{10}

### 1.2 Prison Demographics

When examining incarceration in the United States it is important to understand who is being impacted. Those held in American correctional institutions are not a representative subset of the general population. Differences in crime rates have resulted in a disproportionately male population, while variations in offending rates and sentencing disparities have led to an overrepresentation of racial and ethnic
The lifetime risk of imprisonment climbed steadily over the last quarter of the 20th century, rising from 1.9% for those born in 1974 to 6.6% for the cohort born in 2001. According to the most recent estimates available from the Bureau of Justice statistics, males in the U.S. have an 11.3% chance of being imprisoned during their lifetime, while 1.8% of females will be sent to prison at some point in their life (see Figure 1.3). Within both groups there is considerable racial variation. Those from Hispanic backgrounds are more than twice as likely to be imprisoned as their non-Hispanic white counterparts, while the rate of incarceration among non-Hispanic blacks is nearly twice that in the Hispanic population (see Figure 1.3). If current incarceration rates continue, almost 1 in 3 black males in the U.S. will be incarcerated during their life.
Prisoners tend to be less educated and financially worse off than those who are not incarcerated. More than 40% of prisoners have less than a high school education, compared to 18% of the general population. At the other extreme, around 13% of prisoners have at least some post-secondary education compared with 48% of those who are not institutionalized. Prisoners are likely to come from an impoverished background. In a survey of prisoners more than half reported earning less than $10,000 annually prior to their arrest, with nearly a third of all prisoners earning less than $5,000 each year.

1.3 Prisoner Health

Prisoners suffer from poorer health than those in the general population. Mental illness is widespread among those sentenced to prison. Prison populations have high rates of sexually transmitted diseases including HIV/AIDS, tuberculosis, and many chronic diseases. This poorer health may be explained in part by the high rates of negative health behaviors exhibited by those sentenced to prison including high-risk sexual behaviors, abuse of alcohol and other drugs, and smoking. As centers of concentrated disadvantage, jails and prisons may act as “epidemiological pumps.” In the close quarters of incarceration, pathogens are easily transmitted between individuals. Similarly prisoners are likely to be exposed to negative health behaviors which they may then adopt as a means of coping with the stresses of prison life. Once acquired, these diseases and negative health behaviors are then carried back to prisoners’ home communities, many of which are already disadvantaged.
The state has a legal and ethical obligation to protect prisoners’ wellbeing. The Supreme Court established a constitutional right for prisoners to receive a certain measure of healthcare. Specifically, “deliberate indifference to serious medical needs of prisoners” was found to be in violation of the Eighth Amendment’s prohibition on cruel and unusual punishment. The financial cost of prisoner health care is substantial; according to the most recent estimates provided by the Bureau of Justice Statistics, inmate medical care costs the state prison systems $3.3 billion annually. With an expanding and aging prison population, there is little hope for reduced costs for the taxpayer without targeted efforts to improve prisoner health. As preventive health efforts have the potential to reduce disease burdens and lower future healthcare spending, there is a need for such programs to be developed for the corrections system. Furthermore, as gathering points of high-risk individuals, prisons offer a prime setting for public health interventions benefiting not only prisoners, but also the communities to which the majority eventually return.

1.4 Tobacco and Tobacco Policy in U.S. Prisons

Smoking rates have traditionally been quite high among prison and jail inmates, with estimates in the range of 60-80%, compared with around 20% in the general population of the United States. These high smoking rates may be explained in part by tobacco’s lengthy history in the prison system. Tobacco was long a standard part of a prisoner’s rations in the United States. A report from the late 19th century documents how contractors could purchase prisoner labor at the cost of supplying prisoners with tobacco and as portrayed in popular media, tobacco has long served as a currency in prisons, where its durability, divisibility into units, and
inherent value have made it a natural medium for exchange. The inclusion of tobacco in prison rations is not merely a relic of the distant past. As recently as the mid 1980s, some 20 years after the Surgeon General’s first report on the negative health effects of smoking, around half the prison systems in the United States were still distributing free or reduced-price tobacco to their inmates.

The widespread use of tobacco by prisoners also impacts those who do not smoke. As one might expect, the high prevalence of smoking among the incarcerated translates into high concentrations of secondhand smoke in prisoner living quarters. A study of secondhand smoke in prisons found that levels in prisoner living quarters averaged 1.5 to 5 times greater than the average level in smokers’ homes, and in one area the concentrations of cigarette smoke in the air were found to be more than 12 times greater than those in a smoker’s home.

Though a majority of prisoners use tobacco products, there is evidence that many wish to quit tobacco use. In a sample of female prisoners 64% reported an interest in smoking cessation programs and 60.6% reported at least one previous quit attempt. To date there are no published reports of similar studies among male prisoners. Despite the high prevalence of tobacco use in incarcerated populations and the apparent demand for cessation assistance, little work has been done to develop effective cessation programs for prisoners. In fact, much of the basic epidemiological research needed to tailor interventions for the prison environment remains to be conducted. The first, and thus far only, study of a multi-component smoking cessation intervention for prisoners was published in 2006. Despite the stresses of prison life, more than a quarter of participants were tobacco free six months after the intervention. Prison systems in the United States, however, have sought another
means of controlling tobacco use in prisons. Rather than promoting voluntary quitting through comprehensive cessation programming, many correctional facilities in the United States have attempted to force changes in prisoner behavior by implementing policies restricting whether and how prisoners can use tobacco products. A recent survey of U.S. prison systems found that the growing number of prisons with total tobacco bans were less likely to offer their inmates cessation programming or quitting assistance in the form of nicotine replacement or medication than their counterparts with less restrictive tobacco policies. These are only the latest developments in what has been a rapidly changing regulatory landscape.

Over the past two decades there have been changes in the tobacco policies of American correctional institutions. Starting in the 1980s, economic pressures caused by ballooning prison populations and tightening in state budgets led many prisons to reconsider their tobacco policies. At that time many prisons still distributed free or reduced-rate tobacco to their prisoners and smoke-free living accommodations were rarely available for inmates. Through the 1990s, tobacco policies grew increasingly strict. The number of prison systems distributing free tobacco dropped from around half (53.0%) in 1986, to about a third (34.0%) in 1993 and a quarter (26.7%) in 1996.

By 2007 the practice of offering prisoners free or reduced-rate tobacco had ended completely. Even so, tobacco use in prisons has in no way disappeared. Prisons represent a lucrative market for tobacco companies, and during the 1980s and 1990s promotions were created to encourage prisoner tobacco use. An example of promotional materials for one such program is presented in Figure 1. Correctional departments could collect empty cigarette packets and redeem them for recreational
materials. For example, the empty packs from 96,000 cigarettes would provide prisoners with a dozen softballs.[44] The Tobacco Legacy Documents Library provides an opportunity to explore the scope of prison tobacco promotion, however as of this writing no formal examination of the topic has been published.

It was not just the tobacco corporations that benefited financially from the sale of tobacco in prisons; tobacco sales also represent a major source of income for correctional departments.[43] Facilities can earn thousands of dollars each day from tobacco sales, upwards of half a million dollars a year for a large prison commissary, and markups on tobacco products can be as high as 60% in some states.[43] Some states even produced their own tobacco products within the prison system before the liability for doing so became too great. As recently as 1997, the state of Illinois earned $47,000 a year from the sale of in-house brands of tobacco.[43] These immediate financial gains are, however, offset by a number of costs.

The cost of caring for the disability and disease caused by tobacco is one price correctional departments must pay. As previously mentioned, prisons have an obligation to provide for the healthcare of their charges as, according to the Supreme Court, “deliberate indifference to serious medical needs of prisoners constitutes the ‘unnecessary and wanton infliction of pain’ ... proscribed by the Eighth Amendment.”[27] Prisoners are, in fact, the only Americans constitutionally entitled to some measure of healthcare. The court set a relatively low minimum standard of care; however, the cost of even the most basic healthcare can still be enormous. In an age of shrinking revenues, state expenditures for corrections have increased at a rate of more than 6% annually, faster than spending increases for healthcare or education.[28] As of
Figure 1.4: Example of promotional materials for the “Play Ball with Newport” program, wherein prisoners turned in empty cigarette packets which their facility would redeem for exercise equipment. Source: Legacy Tobacco Documents Library, Bates # 94568375/8379.
2001, 12% of prison operating expenditures, $3.3 billion, was spent to cover health-care for prisoners.\textsuperscript{28} Given the well documented, negative health effects of smoking and other tobacco use, restricting tobacco use has been put forward as one means of controlling rising costs. Fear of litigation has also played a role in shaping tobacco policy, most notably following a declaration by the Supreme Court in the case Helling v. McKinney that involuntary exposure to secondhand smoke may constitute cruel and unusual punishment.\textsuperscript{45}

As stated above, most prison systems have sought to deal with the high prevalence of tobacco use by restricting where and how prisoners use tobacco. Early efforts primarily focused on the setting aside smoke-free living areas for those inmates who were not smokers. In the mid-1980s only a small fraction of prison systems, about 5%, offered smoke-free housing for non-smoking residents.\textsuperscript{37} By 1993 the number had climbed to 24%, increasing again to 85% by 1996.\textsuperscript{31,42} A survey conducted in 2007 found smoke-free living areas to be a near-universal offering of U.S. prison systems, with 96% of facilities offering such accommodations.\textsuperscript{41} Smoke-free housing reduces secondhand smoke exposure, but does little to alter the tobacco use behaviors of those who smoke. Consequently, a more recent strategy has been the utilization of indoor or total smoking bans to reduce the amount of tobacco consumed by inmates. Before 1993 no prison systems reported having total tobacco bans, and in 1996 less than 1 in 7 prisons had a total ban in place.\textsuperscript{31,42} By 2007 the majority of correctional departments, 60% of prison systems in the U.S., had implemented total bans while most of the remaining, 27% of the departments, had indoor smoking bans in place.\textsuperscript{41} The most commonly given reasons for implementing a tobacco policy, cited by nearly
70% of prison systems with a statewide policy, was protection of the health and safety of prison inmates and staff.\[41\]

The trend toward banning tobacco products in prisons could be perceived as purely beneficial for the public health of prisoners, however the full impact of these policy changes remains to be seen. Studies in both prison and inpatient psychiatric facilities have found that forced abstinence from tobacco products does not usually result in long-term cessation.\[46, 47, 48\] Information on the availability of tobacco cessation programming in prisons is unavailable prior to 2007, but a survey conducted that year found a negative association between total tobacco bans and the availability of cessation programs.\[41\] Few facilities with tobacco bans (39%) offered tobacco cessation programming when compared with facilities with only indoor smoking bans (86%).\[41\] While many prisons may be reducing tobacco consumption during a prisoner’s incarceration, little is being done to change tobacco use behaviors in the long term.

Another problem that has manifested itself in facilities with total tobacco bans is the rise of black market tobacco sales.\[36, 41\] Contraband finds its way into even the best run prisons. For the right price a person can get most anything, even in a prison: items can be smuggled in by newly arrived inmates, handed off during visitation, or guards may be coerced or bribed. There are accounts of contraband tobacco from “tobacco free” facilities as early as the mid-1800s.\[33\] In more recent years, there is strong evidence that even when cigarette sales are banned, tobacco will be available to those willing to pay the price. There are stories of cigarettes being sold for as much as $500 per carton.\[36\] With such strong economic forces in play, it is hardly surprising that tobacco quickly becomes a primary contraband item in facilities with
a ban, especially when guards, many of whom might be smokers themselves, may be willing to turn a blind eye or even take part in the trade of a commodity that is perfectly legal outside the facility.[36]

Though these problems are unlikely to decrease, it seems probable that prison tobacco restrictions will remain in place. Indoor tobacco bans are becoming increasingly common in public places and tobacco restrictions are more widely accepted by society at large. The social acceptability of tobacco smoking declines as the prevalence of smoking in the general population continues to drop.[32] Correctional departments have continued to announce the implementation of total tobacco bans in 2008.[49, 50, 51]

1.5 The STOP Project

Despite the high prevalence of smoking among prisoners and the rapidly changing regulatory landscape, little work has been done to date evaluating patterns of tobacco use among prisoners or examining the impact of tobacco restrictions on prisoner tobacco use. This document outlines work intended to address this gap in the literature. A study was undertaken to examine Smoking and Tobacco in Ohio Prisons, the STOP Project. The Ohio prison system is the 7th largest in the nation, and currently oversees more than 50,000 inmates in its prison facilities.[1] The Ohio Department of Rehabilitation and Correction (ODRC) had partial tobacco restrictions in place at the time the STOP Project was undertaken. Department of Corrections policy banned the smoking of cigarettes within all buildings on prison grounds and did not allow inmates or staff to smoke around building entrances.[52] A short time
after data collection for the project was completed, an announcement was made that Ohio prisons would be going tobacco free starting in March 2009.\cite{51}

To date, indoor tobacco bans have not been evaluated in the prison setting. The STOP Project was designed to examine how prisoner tobacco use changes following incarceration in a facility with an indoor tobacco ban by collecting detailed information about participant tobacco use prior to and during incarceration. The study also seeks to inform the current debate over appropriate tobacco policy for correctional settings by examining prisoners’ perspectives on tobacco in correctional settings and their opinions on prison tobacco policies. The project consisted of two complementary components: 1) the Tobacco Use Survey which used quantitative methods to measure tobacco use prior to and during incarceration, and 2) the Tobacco Policy Interview which used qualitative methods to explore the role of tobacco in prison, examine prisoners’ attitudes about prison tobacco restrictions, and evaluate the demand for cessation assistance in the prison setting.

This document describes key findings from the Tobacco Use Survey and explores the implications of these findings from a public health perspective. Chapter 2 examines measures of tobacco use, comparing self-reports and carbon monoxide breath testing with salivary cotinine testing. Biomarker confirmation of self-reported tobacco use is important to assure valid results in settings where there is a motivation to misreport. To date there has been only one study published comparing self-reported tobacco use to biomarker measures in prisoners.\cite{53} The sample consisted only of female prisoners in a facility where smoking was allowed in living areas and a carbon monoxide breath test was the only biomarker measured.\cite{53} Chapter 3 describes
patterns of tobacco use among low-security prisoners prior to and during their incarceration. General conclusions are drawn about the impact of an indoor tobacco ban on prisoners’ use of tobacco products during incarceration. Chapter 4 analyzes the relationship between adverse childhood experiences (ACEs) and tobacco use among prisoners. Previous studies have linked ACEs to deviance in adolescence and adulthood. Separately, ACEs have been linked to negative health behaviors and outcomes later in life in a sample representative of the general population. The current study explores the role ACEs may play in contributing to the high prevalence of smoking observed in prisons. The closing chapter summarizes the major findings of the study and examines future directions for prison tobacco research.
CHAPTER 2

MEASURING TOBACCO USE IN A PRISON POPULATION

2.1 Background

Following the release of the first Surgeon General’s Report on Smoking in 1964, the prevalence of smoking in the United States has decreased steadily from a peak of around 40% to its current level of around 20%.\textsuperscript{32, 54} However declines in smoking have not been equally realized in all segments of the population; among certain subgroups the prevalence of smoking remains quite high. One group for whom this is especially true is prisoners. Despite growing awareness of the harms of tobacco use and its decreased social acceptability, studies have consistently shown that some 60-80% of incarcerated individuals choose to smoke or use other forms of tobacco.\textsuperscript{31} Though the prevalence of tobacco use is very high among prisoners, their desire to quit is comparable to tobacco users in the general population with one study finding that more than 60% of incarcerated women who smoke were interested in quitting.\textsuperscript{39} The combination of a high prevalence of smoking and high desire to quit creates an ideal environment for intervention, however little work has been done to date to assist
prisoners in their efforts to quit. In fact much of the basic research necessary for the
design and evaluation of cessation programs has yet to be done in the prison setting.

Measuring tobacco consumption is central to understanding patterns of use in
populations and evaluating the efficacy of interventions. Several measures of tobacco
use have been widely utilized, the most common being self-reported tobacco use. Ask-
ing an individual about their tobacco use is the cheapest means of assessing tobacco
use and allows the researcher to gather a wide range of information including details
of past tobacco use and variations in current use. Self-reports have generally been
found to be accurate, however it may be prone to recall bias or intentional misre-
porting due to perceived social unacceptability of the behavior. Recall bias is a
potential concern in prison populations in which there is a higher prevalence of drug
and alcohol abuse and mental illness than in the general population. The only
published examination of prison tobacco use measures was limited to female prison-
ers and used self-reported tobacco use as the gold standard. This study showed
good agreement between women’s reported tobacco use and carbon monoxide breath
testing. While there has been limited evaluation of tobacco use among prisoners,
self-reporting of drug use by incarcerated individuals has been found to be reliable.
The prevalence of misreporting has been found to vary widely depending on the social
context within which a study is being conducted. Misreporting tends to be higher
among groups for whom smoking is perceived as being especially undesirable, as for
example among pregnant women. It remains unclear how social pressures may
impact reporting of smoking behaviors among prisoners. Tobacco is becoming in-
creasingly unacceptable in the general population, however given the high prevalence
of smoking among prisoners there may be no stigma attached to smoking or even pressure to over-report tobacco use.

Biomarkers for tobacco exposure provide a means of avoiding some of the problems associated with self-reporting by offering an objective measure, though this objectivity comes with several tradeoffs. The measurement of biomarkers is more costly than asking participants about their tobacco use and requires specialized equipment. Additionally biomarkers usually provide a measure of average or cumulative exposure over a period of time and cannot capture variations in exposure during that period.

Several markers have been used as proxy measures for tobacco use. Carbon monoxide (CO) is a colorless, odorless gas formed by the incomplete combustion of hydrocarbons, and is one of the components of tobacco smoke. During exposure to tobacco smoke, inhaled CO diffuses through the alveolar wall into the capillaries where it binds with hemoglobin to form a stable complex called carboxyhemoglobin.[58] Hemoglobin has a high affinity for CO, about 210 times that of oxygen, leading to rapid uptake and slow release of CO from the body.[58] Plasma concentrations of CO are strongly correlated with carboxyhemoglobin levels, allowing for measurement via testing of exhaled air.[59] CO has a half-life of 2-8 hours depending on an individual’s level of physical activity, allowing detection of smoking over a 6-24 hour period.[60] CO breath tests are brief, non-invasive, and provide immediate results. Following the initial purchase of a CO monitor (current models cost around $1000) testing exhaled CO levels is relatively inexpensive. The study of CO breath testing among female inmates, mentioned above, found good agreement between the breath test and self-reported smoking.[53]
The concentration of nicotine in a person’s body would seem a logical choice as a proxy for tobacco exposure, however nicotine’s short half-life of approximately 2 hours means it can only measure tobacco use over an 8-12 hour period.\footnote{60} In contrast, the nicotine metabolite cotinine with its longer half-life, around 16 hours for general population, provides a means of assessing tobacco use over a 3-4 day period.\footnote{60} Cotinine can be measured in several types of biological specimens, including serum, urine, or saliva.\footnote{60} There are several means of measuring cotinine concentrations with varying degrees of precision and cost. The most precise measures use chromatography to separate the cotinine from the sample then measure the concentration using mass spectrometry. This allows for a minimum detectable limit of around 1 ng/ml at a cost of approximately $25 per sample. Enzyme immunoassay tests are cheaper, costing about $15 per sample, but are less precise with a minimum detectable level of 10 ng/ml. Additionally, the immunoassay test is not specific to cotinine; some cross-reactivity with other nicotine metabolites may lead to a slight overestimation of cotinine in the sample.

The current study seeks to establish the performance of tobacco use measures among prisoners. Four measures were collected: 1) prisoner self-reports, 2) exhaled carbon monoxide, 3) salivary cotinine measured by enzyme immunoassay, and 4) salivary cotinine measured by liquid chromatography tandem mass spectrometry. The performance of the self-report, exhaled carbon monoxide, and enzyme immunoassay for cotinine were then evaluated using the liquid chromatography tandem mass spectrometry measured cotinine as the gold standard for comparisons. These data are intended to assist prison researchers in selecting appropriate measures of tobacco use for future studies and to guide their interpretation of those measures.
2.2 Methods

2.2.1 Participants and Setting

The study was conducted in two low-to-medium security Ohio prisons housing male inmates. A group of consecutively admitted prisoners were invited to take part in the study, starting with those prisoners entering the prison system 14 weeks prior to the start of interviews. Recruitment continued until 100 participants were obtained in each facility, giving a total of 200 participants for the study. To be eligible, participants had to be 18 years of age or older, speak sufficient English to complete the interview, and be residents of the general population of the facility at the time of the interview (not in solitary confinement, receiving medical care, or off compound for an outside court appearance). Individuals released from prison prior to their invitation to take part in the study were excluded.

2.2.2 Measuring Tobacco Use

Tobacco use was measured in four ways: self-reporting and three biomarker measures. Participants self-reported tobacco use by responding to a modified National Health and Nutrition Examination Survey tobacco use questionnaire. Two versions of the questions were asked. To assess tobacco use before incarceration, the questions were altered to begin ”Prior to your arrest...” while a second set of questions were asked about tobacco use since arriving at the facility in which they currently resided. Questions covered a broad range of tobacco products including cigarettes, cigars, pipes, snuff, chewing tobacco, and other tobacco products. Due to their relative brief period of incarceration in the prison, participants were asked to provide greater detail about their tobacco use during that time. For each tobacco product,
they were asked if they had used the product, even once, since arriving at the facility. In addition to asking about how much tobacco they used, participants were asked if they used tobacco indoors to assess their compliance with tobacco restrictions.

Three biomarkers of tobacco use were collected: a carbon monoxide (CO) breath test and two measures of salivary cotinine. The CO breath test was conducted using the Micro 4 Smokerlyzer® breath analyzer (Bedfont Scientific, USA, Williamsburg, VA). Saliva samples were collected using the Salivette® saliva collection device (Sarstedt Inc., Newton, NC). Two samples were collected from each individual to decrease the likelihood that there would be an insufficient volume of saliva for testing. Samples were sent to an external laboratory for analysis (J2 Laboratories, Phoenix, AZ). Laboratory staff were blind to the self-reported smoking status of the participants. Salivary cotinine concentration was measured using two methods, enzyme immunoassay (EIA) and liquid chromatography tandem mass spectrometry (LC/MS/MS).[61][62]

### 2.2.3 Statistical Analysis

Data analysis was done using Intercooled Stata 8.2 (StataCorp LP, College Station, TX). Since it is unclear what social pressures may influence reporting of tobacco use behaviors in this setting, assessment of salivary cotinine by LC/MS/MS was used as the gold standard. Based on the recommendation of Society for Research on Nicotine and Tobacco Subcommittee on Biochemical Verification, individuals with a salivary cotinine concentration \( \geq 15 \text{ ng/ml} \) were classified as tobacco users, while those with lower concentrations were assumed to be non-users.[60] Receiver operating characteristic (ROC) curves were constructed to examine the performance of continuous tests across various cut points. Maximization of the unweighted Youden index
(J) was used as the criterion to determine the optimum cut point for each test.[63] The Youden index is a means of examining the performance of a test with binary outcomes that places equal weighting on sensitivity and specificity. Specifically the Youden index is defined as:

\[ J = \frac{a}{a + b} - \frac{c}{c + d} \]

where \(a\) is the number of diseased individuals with a positive test (true positives), \(b\) is the number of diseased individuals with a negative test (false negatives), \(c\) is the number non-diseased individuals with a positive test (false positives), and \(d\) is the number of non-diseased with a negative test (true negatives). Stated another way, the index is the difference between the sensitivity of the test and the quantity one minus its specificity. Optimal cut points were used to assign a binary classification, tobacco user or non-user, from the continuous variables. The sensitivity and specificity were then determined for the binary outcomes and the positive and negative predictive values were calculated for each test at the prevalence of smoking observed in the sample.

Correlation coefficients were calculated for the CO and EIA measures relative to individuals’ LC/MS/MS values. Participants reporting smokeless tobacco use were excluded from the CO analysis because the breath test cannot detect smokeless tobacco consumption. Concentrations below the lower limit of the EIA test returned a value of “<10 ng/ml.” Given the small range of possible values, these were assigned the central value of 5 ng/ml for the correlation analysis. For some samples with a very high cotinine concentration, the EIA test could only specify the result as “>500 ng/ml.” These points were dropped when calculating the correlation coefficient.
A weighted kappa statistic was used to provide a second assessment of agreement between the EIA and LC/MS/MS measures which could include these dropped observations. Two methods were used to calculate the kappa statistic. For the first test results for both cotinine levels were categorized into eight fixed groups <15 ng/ml, 15-49 ng/ml, 50-99 ng/ml, 100-199 ng/ml, 200-299 ng/ml, 300-399 ng/ml, 400-499 ng/ml, and ≥ 500 ng/ml, allowing for a comparison of absolute agreement. For the second kappa calculation each measure was categorized into quintiles as a means of gauging relative agreement. A linear weighting scheme was used for both kappa calculations.

2.3 Results

2.3.1 Sample Characteristics

The interviewer reviewed a total of 322 prisoners to reach the target sample size 200. Of these, 40 (12.4%) failed to meet one or more of the eligibility criteria, leaving 282 eligible participants and yielding a response rate of 70.9%. The final sample of 200 individuals all provided self-reported tobacco use. Of these, 173 individuals (86.5%) provided samples for the CO, EIA, and LC/MS/MS tests. The remaining individuals were missing one or more values: 16 people (8.0%) declined to take part in either biomarker test, 8 (4.0%) completed the CO breath test but declined to provide a saliva sample for cotinine testing, and 3 (1.5%) completed the CO test and provided a saliva sample, however insufficient saliva was provided to conduct the LC/MS/MS test. A more detailed picture of participant movement through the study is presented in Chapter 3. Only the 173 individuals with complete data are included in the results presented here. Sample characteristics, including a comparison with those missing
one or more values, is given in Table 2.1. There were no statistically significant differences in demographic factors between the group of participants who agreed to provide all tobacco measures and those excluded from this analysis.

2.3.2 Self-reported Tobacco Use

Of the 173 individuals with complete data, 167 (96.5%) self-reported tobacco use that was consistent with their classification by the LC/MS/MS test. Among the 137 individuals biochemically identified as tobacco users, 135 reported using tobacco products giving a sensitivity of 98.5%. The individuals with conflicting results both reported being former smokers. One reported quitting tobacco use upon entering into prison. The concentration of cotinine in his saliva was 17 ng/ml. The second reported having smoked early in his incarceration, but having quit cigarettes 3 weeks prior to the interview. His saliva contained 41 ng/ml as measured by the LC/MS/MS test. Among the 36 individuals classified as non-tobacco users by the LC/MS/MS test 4 (11.1%) reported using tobacco products, yielding a specificity of 88.9% for self-reported tobacco use. Three of the misclassified individuals reported only smoking cigarettes during 1 or 2 days each week. The final individual reported smoking about 4 cigarettes each day and had a marginal LC/MS/MS cotinine level of 14 ng/ml. At the prevalence of tobacco use in the sample, the positive predictive value of the test was 97.1% and the negative predictive value was 94.1%.

2.3.3 Carbon Monoxide Breath Test

The ROC curve for the CO breath test is presented in Figure 2.1. The area under the curve (AUC) was 0.922 (95% CI: 0.882-0.962), indicating excellent discrimination according to the criteria given by Hosmer and Lemeshow. A maximum Youden
<table>
<thead>
<tr>
<th></th>
<th>In sample (n = 173)</th>
<th>Excluded (n = 27)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (σ)</td>
<td>33.4 (10.2)</td>
<td>36.0 (10.2)</td>
<td>0.231</td>
</tr>
<tr>
<td>Race, %</td>
<td></td>
<td></td>
<td>0.794</td>
</tr>
<tr>
<td>Non-hispanic white</td>
<td>58.4</td>
<td>66.7</td>
<td></td>
</tr>
<tr>
<td>Non-hispanic black</td>
<td>32.4</td>
<td>25.9</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>2.9</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>6.4</td>
<td>7.4</td>
<td></td>
</tr>
<tr>
<td>Education, %</td>
<td></td>
<td></td>
<td>0.547</td>
</tr>
<tr>
<td>Less than HS</td>
<td>34.1</td>
<td>37.0</td>
<td></td>
</tr>
<tr>
<td>G.E.D.</td>
<td>17.9</td>
<td>18.5</td>
<td></td>
</tr>
<tr>
<td>HS Graduate</td>
<td>25.4</td>
<td>33.3</td>
<td></td>
</tr>
<tr>
<td>At least some college</td>
<td>22.5</td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>Most serious offense, %</td>
<td></td>
<td></td>
<td>0.084</td>
</tr>
<tr>
<td>Crimes against persons (not sex)</td>
<td>24.3</td>
<td>40.7</td>
<td></td>
</tr>
<tr>
<td>Sex offenses</td>
<td>2.3</td>
<td>7.4</td>
<td></td>
</tr>
<tr>
<td>Burglary offenses</td>
<td>11.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous property offenses</td>
<td>23.1</td>
<td>25.9</td>
<td></td>
</tr>
<tr>
<td>Drug offenses</td>
<td>26.6</td>
<td>18.5</td>
<td></td>
</tr>
<tr>
<td>Motor vehicle offenses</td>
<td>0.6</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Fraud offenses</td>
<td>2.9</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Firearm offenses</td>
<td>2.3</td>
<td>7.4</td>
<td></td>
</tr>
<tr>
<td>Offenses against public admin</td>
<td>6.9</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Violent offense, %</td>
<td></td>
<td></td>
<td>1.000</td>
</tr>
<tr>
<td>Violent offense, %</td>
<td>28.3</td>
<td>29.6</td>
<td></td>
</tr>
<tr>
<td>Prison tobacco use, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cigarette smoking</td>
<td>79.2</td>
<td>85.2</td>
<td>0.609</td>
</tr>
<tr>
<td>Cigar smoking</td>
<td>3.5</td>
<td>3.7</td>
<td>1.000</td>
</tr>
<tr>
<td>Smokeless tobacco</td>
<td>29.5</td>
<td>44.4</td>
<td>0.125</td>
</tr>
</tbody>
</table>

*T-test for continuous variables, Fisher’s exact test for categorical data.

bPercent of prisoners reporting current use of the tobacco product during incarceration.

Table 2.1: Sample demographic and tobacco use characteristics by availability of biomarker data.
Figure 2.1: Receiver operating characteristics curve showing the performance, at all possible cut points, of a carbon monoxide breath test for tobacco use relative to the gold standard, salivary cotinine concentration measured by liquid chromatography tandem mass spectrometry with a cut point of $\geq 15$ ng/ml (area under the ROC curve = 0.922).

Index ($J = 0.771$) was obtained with a cut point of $\geq 4$ ppm. Using this optimum cut point the CO breath test had a sensitivity of 85.4% with 117 out of 137 tobacco users correctly identified. The specificity of the test at the optimum cut point was 91.7% with 33 of 36 individuals correctly categorized as nonusers. At the prevalence of tobacco use in the sample, the CO test had a positive predictive value of 97.5% and a negative predictive value of 62.3% with 86.7% of participants classified correctly.

Performance of the CO test improved when the 4 individuals who reported exclusively using smokeless tobacco products during incarceration were removed from
the analysis (AUC = 0.932, 95% CI: 0.895-0.970). The optimum cut point remained unchanged at $\geq 4$ ppm ($J = 0.789$), however the sensitivity (87.2%), negative predictive value (66.0%), and percentage of participants correctly classified (88.2%) all increased.

Data from the 122 individuals who did not report using smokeless tobacco were used to calculate the correlation between CO test and LC/MS/MS salivary cotinine measures. Figure 2.2 compares breath CO concentrations with salivary cotinine as measured by LC/MS/MS. The correlation coefficient was 0.8310, indicating that 69.1% of the variability in LC/MS/MS values could be accounted for by the CO test results.

### 2.3.4 Enzyme Immunoassay for Salivary Cotinine

Figure 2.3 displays the ROC curve for salivary cotinine analyzed using EIA. The area under the curve is 0.971 (95% CI: 0.951-0.991) indicating excellent discrimination. All 36 participants identified as non-users by the LC/MS/MS test had an EIA test reporting $< 10$ ng/ml salivary cotinine, the minimum detectable level for the test. There were also 8 individuals with positive LC/MS/MS results who had the minimum EIA test result. Seven of these men self-reported using tobacco products and one was a former smoker that reported quitting at the time he entered prison. The next highest EIA test was 21 ng/ml. There were no participants in the sample with an EIA measured cotinine level between 10 and 21 ng/ml, therefore it can only be stated that the optimum cut point for use of the test in incarcerated populations lies somewhere in that range. Using $\geq 10$ ng/ml, the EIA test has a sensitivity of 94.2%, a specificity of 100.0%, a positive predictive value of 100.0% and negative predictive
Figure 2.2: Scatterplot of exhaled carbon monoxide concentrations versus salivary cotinine concentrations measured by liquid chromatography tandem mass spectrometry for incarcerated men excluding users of smokeless tobacco ($r = 0.8310$).
Figure 2.3: Receiver operating characteristics curve showing the performance, at all possible cut points, of an enzyme immunoassay for salivary cotinine relative to the gold standard, salivary cotinine concentration measured by liquid chromatography tandem mass spectrometry with a cut point of $\geq 15$ ng/ml (area under the ROC curve = 0.971).

value of 81.8% at the prevalence of tobacco use in the sample. The EIA test correctly classified 95.4% of participants in the sample.

Data from 164 individuals were used to calculate the correlation between the EIA and LC/MS/MS salivary cotinine results; 9 individuals with EIA readings reported as “$> 500$ ng/ml” were excluded. The scatter plot comparing EIA and LC/MS/MS measures of salivary cotinine is shown in Figure 2.4. The correlation coefficient was 0.8602, indicating that 74.0% of variability in the LC/MS/MS values was explained by EIA cotinine values.
Figure 2.4: Scatterplot of salivary cotinine concentrations measured by enzyme immunoassay versus salivary cotinine concentrations measured by liquid chromatography tandem mass spectrometry ($r = 0.8602$).
The kappa calculations yielded similar results whether using absolute or relative categories. For the absolute categories there was 92.65% agreement, well above the 59.38% expected from chance. The kappa value was $\kappa = 0.8191 \ (p < 0.0001)$. For the relative categories there was 92.05% agreement, with 59.34% agreement expected by chance. The kappa value was $\kappa = 0.8045 \ (p < 0.0001)$.

2.4 Discussion

2.4.1 Self-Reported Tobacco Use

A comparison of self-reported tobacco use with levels of the tobacco biomarker cotinine as assessed by LC/MS/MS indicates accurate reporting of tobacco use by prisoners with 96.5% agreement between the measures. Three of the 6 individuals whose self-reports conflicted with the LC/MS/MS cotinine results reported sporadic tobacco use. When individuals use tobacco only 1 or 2 days per week, it is likely that salivary cotinine levels will drop below the cut point between smoking episodes.

This underscores a limitation of the “gold standard” used here; while cotinine is a good measure of average tobacco use over a 3-4 day period, it cannot assess use outside of that window. In the prison setting, the high cost of tobacco relative to prisoner income appears to lead many prisoners to cut back on tobacco consumption. For some prisoners who smoke this means going several days at a time without a cigarette. To avoid false negative results when using cotinine to detect tobacco use, it may be desirable to collect two samples several days apart. This could be done without increasing testing costs by pooling an individual’s samples and running a single test. The practice of pooling saliva samples for cotinine testing has been used in other contexts to good results. Another strategy for reducing false negative tests
is to collect samples within 3 days of the time a prisoner visits the commissary. At most facilities prisoners have limited opportunities to make purchases, with a single scheduled visit to the commissary once every 1-2 weeks. Incarcerated individuals, especially those with limited financial resources, are most likely to have access to and use tobacco around this time.

The fact that 2 inmates reported having quit tobacco but had positive cotinine tests is evidence of some underreporting of smoking behaviors, though given the high prevalence of smoking the prevalence of misreporting was low (sensitivity = 98.5%). It is unclear whether the participants who misreported were regular tobacco users during incarceration or if the positive tests are indicative of one-time relapse events. In future studies, the validity of self-reported tobacco use may be improved by including specific questions about smoking relapse for prisoners reporting tobacco cessation. These “one-time” events could be viewed as unimportant by prisoners and might otherwise go unreported.

Generally, self-reported tobacco use appears, under the study conditions, to provide an accurate measure of tobacco use in prisons with an indoor tobacco ban. Several factors could explain the the accuracy of self-reported tobacco use. In populations where there is strong social pressure to underreport tobacco use, the knowledge that a biological sample will be collected to confirm self-reports has been observed to increase the accuracy of reporting in what is known as the bogus pipeline effect. In the current study, participants were informed during the consent process that collection of biomarkers was one aspect of the study. They were also, however, told that providing the samples was optional and that they could take part in the rest of the study without doing so. The knowledge that their responses could be checked
against an objective measure may have promoted more accurate reporting; however, with the option of refusing the biomarker tests this effect was probably minimal. A second, and potentially more dominant, contributor to the high validity of prison self-reporting is the lack of social pressure to misreport tobacco use in a prison with an indoor tobacco ban. Prisoners are allowed to purchase tobacco products through the commissary and can smoke freely outside of buildings. Furthermore, smoking can be regarded as the social norm in a facility where more than three-quarters of the inmates report smoking. In such an environment most prisoners would have little reason to intentionally misreport their tobacco use.

The generalizability of these results to incarcerated populations under other tobacco policies remains unclear. Specifically, further work is needed to determine the accuracy of self-reports in prisons where all tobacco use is banned. In such settings, prisoners may be reluctant to provide information that they believe could result in punishment, despite assurances of confidentiality. Whether a researcher informs participants of an intention to confirm self-reports with biomarker data may play a larger role in shaping the validity of self reported tobacco use in prisons with a total ban. There may be greater pressure to underreport smoking, inducing a bogus pipeline effect. It should be noted that participants were asked about indoor smoking (in violation of prison policy) during the current study. The fact that a majority of smokers admitted to violating the policy may indicate openness among prisoners to share information with researchers, even about sensitive topics.
2.4.2 Carbon Monoxide Breath Test

Carbon monoxide breath testing was the least effective of the tested methods for measuring tobacco use when used as a one-time test. The previously mentioned study among female inmates, carried out in a facility without an indoor smoking ban, also found that using a low cut point ($\geq 3$ ppm), well below the generally recommended range of 8-10 ppm, provided the best performance, though the authors reported better performance of the CO test as a marker for smoking in their sample (sensitivity: 98.1% vs. 85.4%, specificity: 95.8% vs 91.7%). Differences in the performance of the test in the two studies may be attributable to different tobacco use behaviors between the two samples, due in part to differences in tobacco policy. As noted above, the high cost of tobacco relative to prisoner salaries has led many prisoners in the current sample to cut back on the amount of tobacco they use. Limitations on when and where inmates are allowed to smoke further contribute to irregular patterns of tobacco use. As a result of these inconsistencies CO, with its relatively short half-life, is not an ideal indicator of tobacco smoking in prison when employed as a one-time test. Since the half-life of CO is impacted by physical activity, problems with detecting irregular smoking may be exacerbated among the subgroup of prisoners who use exercise as their primary means of passing time during their incarceration.

These limitations do not, however, eliminate the utility of CO breath testing in prison research. Breath testing is inexpensive and has a low subject burden, and the regression analysis did show a strong correlation between cotinine and CO values. The rapid clearance of CO from the body can be countered by more frequent testing. While the performance of the test may be insufficient for epidemiological studies gathering information during a single visit, CO testing could offer a valuable means
of monitoring abstinence from smoking during cessation trails with regular follow-up. When repeated measures are needed, the low cost and instantaneous feedback offered by the CO breath test may outweigh its disadvantages. Further work should be done to evaluate whether more frequent testing can improve the validity of exhaled CO concentration as a test for smoking among prisoners in a facility with an indoor tobacco ban.

2.4.3 Enzyme Immunoassay for Salivary Cotinine

The EIA test was strongly correlated with the LC/MS/MS results and the two tests consistently showed good agreement with both methods of calculating $\kappa$; however, the current study suggests that there are some differences in the performance of the two cotinine tests. While the EIA test performed quite well overall, correctly classifying 95.4% of all participants, there was a problem with the test producing false negative values. This may be explained by errors in the automated process by which the test is run. During transfer of an aliquot from the sample tube to reaction chamber it is possible that the instrument may fail to acquire a full sample. During the LC/MS/MS procedure pipetting is done by hand, so a laboratory technician can visually confirm that the full sample is delivered. Out of 137 individuals with LC/MS/MS values above 15 ng/ml, 8 people (5.8%) had EIA tests with the minimum value of $<10$ ng/ml. All but one of these participants reported using tobacco products during their interviews, supporting the LC/MS/MS results.

When testing interventions, researchers are most often concerned with confirming abstinence. The negative predictive value of the EIA test (81.8%) may not be sufficient for these purposes, however in large epidemiological studies where the researcher
is looking to biologically confirm tobacco use status for smokers and non-smokers alike, the high sensitivity and overall accuracy of the test may provide a means of biomarker confirmation that is more economically feasible than LC/MS/MS testing. In populations with a high prevalence of smoking like that found in prisons, many of the smokers could be screened out during a first cotinine test using the EIA test with its high specificity. All samples testing negative in the first stage could then be retested using the more expensive LC/MS/MS test to identify false negatives. In populations where the prevalence of smoking exceeds 64%, a common reality in the prison setting, using a two-stage screening strategy would save money over a one-stage strategy using the LC/MS/MS test on all samples.

2.4.4 General Conclusions

This study has employed biomarker data to demonstrate the validity of self-reported tobacco use by prisoners in a facility with an indoor tobacco ban. Directly asking prisoners about their tobacco use is not only accurate but also inexpensive and provides researchers with detailed information about variations in tobacco use that cannot be obtained using traditional biological indicators. These variations may be especially important in the prison population where the high cost of tobacco relative to prisoner pay may lead to erratic patterns of tobacco use. This irregular tobacco use has the potential to negatively impact the validity of biomarker tests, especially those with shorter half-lives such as CO breath tests. One tobacco biomarker not examined in the current study is thiocyanate, a combustion byproduct detectable in urine, blood, or saliva samples. It may merit further study for use in the prison setting due to its long half-life of 3-14 days. While a longer half-life will facilitate
the detection of sporadic tobacco use, this advantage may be offset by the marker’s limited ability to detect light smoking due to dietary sources of thiocyanate.[60]

When researchers are interested in biological confirmation of self-reported tobacco use, our findings indicate that, for a test conducted at a single point in time, cotinine testing using LC/MS/MS is the best option when economically viable. CO testing had the poorest performance as a stand-alone test, though the validity of the test may be able to be improved by increasing the frequency of testing. False negative results from the EIA test limit its utility as a stand-alone test, however as a component of a two-stage screening process EIA may offer a means of increasing the affordability of biomarker confirmation. This study has described the performance of key measures of tobacco use in prisons with indoor tobacco bans. Given current policy trends in U.S. prison systems there is a need for similar work to be conducted in facilities with total tobacco bans.
CHAPTER 3

TOBACCO USE BY MALE PRISONERS UNDER AN INDOOR SMOKING BAN

3.1 Background

As Chapter 1 described, mass incarceration presents a major challenge to the United States, both socially and financially. More than 1.5 million people are currently held in U.S. prisons, and each year some 13 million people pass through American jails.1, 2 All told, more than 1% of American adults are incarcerated at any given time.3 The cost of caring for the residents of these facilities falls to the states. As of 2008, annual state expenditures on corrections were $49 billion, a cost expected to climb to nearly $75 billion by 2011.4 Despite the scale of the problem, it too often receives little attention. Prisons are disproportionately located in rural areas, away from the public view.5 In the political realm, the issue of incarceration has become one more weapon in the quest for reelection. The claim that opponents are “weak on crime” remains a powerful political tool.6, 7 These and other factors have contributed to more than three decades of steadily increasing prison populations, overcrowded facilities, and climbing correctional costs within the United States.
Those held in American correctional institutions are not a representative subset of the general population. Higher rates of offending by men gives rise to a disproportionately male population, while sentencing disparities have led to an over-representation of racial and ethnic minorities.\textsuperscript{5, 13, 71} Prisoners also tend to be sicker and more poorly educated than the general population, and exhibit higher rates of some negative health behaviors like high-risk sexual behaviors, drug use, and smoking.\textsuperscript{22, 23, 26} Consequently jails and prisons may act as “epidemiological pumps,” wherein disease and disease-causing behaviors are transmitted between individuals who then carry them back to their communities.\textsuperscript{22} As gathering points of high-risk individuals, prisons offer a prime setting for public health interventions benefiting not only prisoners, but also the communities to which they return.

The state is legally and ethically obligated to safeguard the health of prisoners. The financial cost of prisoner health care is substantial, and the prison population is expanding and aging.\textsuperscript{29, 30} Without targeted efforts to improve prisoner health the cost to taxpayers will continue to increase. The prison system needs preventive health efforts to reduce disease burdens and lower future healthcare spending. As the coming pages describe, tobacco control has an important role to play in any effort to improve the health of incarcerated populations.

3.1.1 Tobacco in Prisons

As noted above, many negative health behaviors are highly prevalent among prisoners, including smoking and other tobacco use. Smoking rates have traditionally been quite high among prison and jail inmates, with between 60\% and 85\% of prisoners choosing to smoke cigarettes.\textsuperscript{31} This is 3-4 times the prevalence of smoking
for the non-institutionalized U.S. population. One factor contributing to the popularity of tobacco is its long history in prison culture. In many areas, tobacco was a traditional part of prisoners’ rations and supplied free of charge. An account from the late 1800s documents how contractors purchased prison labor by supplying prisoners’ tobacco. The distribution of free tobacco has now stopped, however one need not look to the distant past to find examples of the practice. As recently as the mid 1980s a survey of U.S. prison systems found that about half were still distributing free or reduced-rate tobacco to their prisoners. Tobacco’s use as currency in the underground prison economy has also played a role in driving its popularity among inmates. Tobacco is durable, easily portable, divides into natural units (cigarettes, packs, cartons), and carries an intrinsic value for prisoners (e.g., it can be smoked or traded). These factors all make it an ideal medium of exchange.

The high prevalence of smoking among the incarcerated has a major impact on the air quality of prisons. A study conducted in a prison with no indoor smoking restrictions found that the concentration of secondhand smoke in prisoner living quarters averaged 1.5 to 5 times greater than the average concentration in smokers’ homes, and in one area the rates were found to be more than 12 times greater. The negative health impacts of exposure to environmental tobacco smoke have been well documented. Unwanted exposure to tobacco smoke led to complaints and litigation from non-smoking inmates. One such case, Helling v. McKinney, resulted in a ruling by the Supreme Court of the United States that secondhand smoke exposure could constitute cruel and unusual punishment. This ruling, combined with concerns over the increasing cost of inmate healthcare, has led many prison systems to implement tobacco restrictions for prisoners in the form of smokefree living areas,
indoor smoking bans, or total tobacco bans in their institutions. A recent survey of prison tobacco policies in American prisons found that 60% of prison systems have total bans and an additional 27% ban smoking inside buildings.\[41\] This marks a dramatic change in prison tobacco policies, as less than a quarter of prison systems provided smokefree living areas and none reported tobacco bans prior to 1993. Yet despite the high prevalence of tobacco smoking among inmates and a swiftly changing regulatory landscape, prison tobacco use remains an understudied topic. Prison tobacco policies are rapidly changing, yet little is being done to examine the impact of these changes or to assess if they are effective in meeting correctional departments’ stated goals.

3.1.2 The STOP Project

To begin to address these issues, a study was undertaken to examine Smoking and Tobacco in Ohio Prisons (STOP Project). Housing more than 50,000 inmates, Ohio has the 7th largest state prison population in the United States.\[1\] At the time the project was undertaken, the Ohio Department of Rehabilitation and Correction (ODRC) had banned the use of tobacco products in and around the entrances of all buildings on prison grounds.\[52\] Shortly after completion of data collection for the project, it was decided that the prisons within the system would be going completely tobacco free in March 2009.\[51\] To date, indoor tobacco bans have not been evaluated in the prison setting.

The STOP Project was designed to evaluate the impact of admission into a prison with an indoor tobacco ban on an individual’s tobacco use behaviors. The project included two components: 1) the Tobacco Use Survey used quantitative methods to
measure tobacco use prior to and during incarceration, and 2) the Tobacco Policy Interview used qualitative methods to explore the role of tobacco in prison, examine prisoners’ attitudes about prison tobacco restrictions, and evaluate the demand for cessation assistance in the prison setting. The current paper provides the results of the Tobacco Use Survey and explores the implications of these findings from a public health perspective.

### 3.2 Methods

#### 3.2.1 Setting

The Tobacco Use Survey was conducted with recently arrived, low-to-medium security prisoners in Ohio facilities. The study was limited to those facilities housing male inmates. More than 86% of prisoners in Ohio are male and the state has only one facility which houses women. Consequently any effort to examine gender effects would have been confounded by institution-level effects. Five prisons located within an hour of The Ohio State University College of Public Health, where the study was centered, were considered for inclusion in the study. Three facilities declined to take part due to ongoing or recently completed research projects in their institutions at the time the study started. The remaining two facilities are identified hereafter as Institution A and Institution B.

Institution A has continuously served as a prison since it was founded in 1924. Located in west central Ohio, the prison rests on about 3,000 acres of land. In addition to the main prison compound within the fence, the facility includes a correctional camp outside the fence and an active farm on which some prisoners work to acquire skills and produce food for Ohio’s correctional system. When the study
was conducted the facility housed approximately 2,500 minimum and medium security inmates overseen by about 430 staff members including some 220 security staff. In accordance with the ODRC policy, no smoking is allowed inside any building on the prison grounds.

Institution B originally served as a home for troubled youth. Starting in 1857, delinquent boys lived at the facility where they were trained in trades or worked on the institution’s farm. Since 1980, the site has housed adult prisoners and juvenile offenders were moved to other locations. Inmates are housed in several dormitory buildings located around the compound. Located in a county directly adjacent to Ohio’s Appalachian region, the facility houses many prisoners of Appalachian origin. At the time of the study about 1,600 inmates resided in the facility, overseen by about 375 staff members, around 190 of whom were security staff. In addition to the indoor ban mandated by the state department of corrections, administrators at Facility B eliminated the sale of materials for hand-rolled cigarettes through the commissary. A comparison of the tobacco-related products available at the two facilities is presented in Figure 3.1.

3.2.2 Participants

Prison populations are dynamic, with new inmates arriving daily and others leaving as they complete their sentences. To select a sample which was representative of incoming inmates, the study employed consecutive sampling. A list of inmates admitted to the system starting 14 weeks prior to the first day of interviewing was generated by the ODRC central office. Inmates on the list were invited, in order of admission, to take part in the study. Recruitment was carried out individually as part
### Institution A

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black &amp; Mild cigars (1 pack)</td>
<td>$2.35</td>
</tr>
<tr>
<td>Camel non-filtered cigarettes (1 pack)</td>
<td>$4.74</td>
</tr>
<tr>
<td>Camel filtered cigarettes (1 pack)</td>
<td>$4.74</td>
</tr>
<tr>
<td>Generic non-filtered cigarettes (1 pack)</td>
<td>$3.10</td>
</tr>
<tr>
<td>Generic filtered cigarettes (1 pack)</td>
<td>$3.50</td>
</tr>
<tr>
<td>Generic menthol filtered cigarettes (1 pack)</td>
<td>$3.51</td>
</tr>
<tr>
<td>Generic menthol 100's cigarettes (1 pack)</td>
<td>$3.14</td>
</tr>
<tr>
<td>Kool cigarettes (1 pack)</td>
<td>$4.89</td>
</tr>
<tr>
<td>Marlboro cigarettes (1 pack)</td>
<td>$4.65</td>
</tr>
<tr>
<td>Newport cigarettes (1 pack)</td>
<td>$4.76</td>
</tr>
<tr>
<td>Pall Mall cigarettes (1 pack)</td>
<td>$4.76</td>
</tr>
<tr>
<td>Kayak long cut straight snuff (1 can)</td>
<td>$1.82</td>
</tr>
<tr>
<td>Kayak long cut wintergreen snuff (1 can)</td>
<td>$1.82</td>
</tr>
<tr>
<td>Timber Wolf straight snuff (1 can)</td>
<td>$3.21</td>
</tr>
<tr>
<td>Timber Wolf wintergreen snuff (1 can)</td>
<td>$3.21</td>
</tr>
<tr>
<td>Red Man chewing tobacco (1 pouch)</td>
<td>$3.42</td>
</tr>
<tr>
<td>A &amp; C little cigars (1 pack)</td>
<td>$3.64</td>
</tr>
<tr>
<td>Bugler rolling papers (100 leaves)</td>
<td>$0.46</td>
</tr>
<tr>
<td>Bugler tobacco (1 can)</td>
<td>$8.19</td>
</tr>
<tr>
<td>Bugler tobacco (1 pouch)</td>
<td>$1.05</td>
</tr>
<tr>
<td>Captain Black tobacco (1 pouch)</td>
<td>$3.80</td>
</tr>
<tr>
<td>Cherry Blend tobacco (1 pouch)</td>
<td>$2.41</td>
</tr>
<tr>
<td>Kite tobacco (1 can)</td>
<td>$8.19</td>
</tr>
<tr>
<td>Kite tobacco (1 pouch)</td>
<td>$1.05</td>
</tr>
<tr>
<td>Nicotine gum (25 pieces)</td>
<td>$21.51</td>
</tr>
<tr>
<td>Nicotine patches, available in Steps 1-4 (14 patches)</td>
<td>$48.26</td>
</tr>
</tbody>
</table>

### Institution B

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marlboro Ultra light 100's cigarettes (1 pack)</td>
<td>$4.84</td>
</tr>
<tr>
<td>Marlboro Ultra light Menthol cigarettes (1 pack)</td>
<td>$4.84</td>
</tr>
<tr>
<td>GPC Ultra light Regular cigarettes (1 pack)</td>
<td>$3.95</td>
</tr>
<tr>
<td>GPC Ultra light Menthol cigarettes (1 pack)</td>
<td>$3.95</td>
</tr>
<tr>
<td>Grizzly long cut straight snuff (1 can)</td>
<td>$1.84</td>
</tr>
<tr>
<td>Grizzly wintergreen snuff (1 can)</td>
<td>$1.84</td>
</tr>
<tr>
<td>Kayak long cut straight snuff (1 can)</td>
<td>$1.32</td>
</tr>
<tr>
<td>Kayak wintergreen snuff (1 can)</td>
<td>$1.32</td>
</tr>
<tr>
<td>Kayak apple snuff (1 can)</td>
<td>$1.32</td>
</tr>
<tr>
<td>Kodiak snuff (1 can)</td>
<td>$4.50</td>
</tr>
<tr>
<td>Nicotine gum (25 pieces)</td>
<td>$21.40</td>
</tr>
<tr>
<td>Nicotine patches, available in Steps 1-4 (14 patches)</td>
<td>$37.45</td>
</tr>
</tbody>
</table>

Figure 3.1: Commissary price lists for tobacco products at STOP Project sites.
of the initial meeting with a potential participant. To be eligible, individuals had to be over 18 years of age, speak English well enough to complete the instrument, and be residing in the general population of the facility at the time of the interview. Individuals held in segregation (solitary confinement) or undergoing medical care during the study period were not included in the study. Additionally, those not being held in the prison during the study due to an outside court appearance or having already been released were excluded. If an individual was eligible and agreed to take part in the study, the consent process and interview commenced immediately. This eliminated the need to schedule a second meeting, reducing the burden on participants and institution staff. This process continued until 100 participants from each facility agreed to participate. In compliance with state law, no incentives were offered to prisoners to encourage their participation in the study.

3.2.3 Survey Instrument

The interviews were conducted on site at the prisons using a computer-assisted personal interview (CAPI) system developed in Microsoft® Access 2000 (Microsoft Corporation, Redmond, WA). In addition to standard demographic information, the interview queried inmates about tobacco use prior to and during incarceration using modified versions of the questions developed for the National Health and Nutrition Survey. Questions covered the use of cigarettes, pipe tobacco, cigars, snuff, and chewing tobacco. Participants were asked if they used tobacco indoors while incarcerated, their opinion on total tobacco bans in prison, and how difficult they believed it would be to obtain tobacco in a facility with a total ban. Questions on quit attempts were also included based on those utilized in the National Health Interview
Survey questionnaire. Other tobacco-related measures collected were the Fagerström Test for Nicotine Dependence and a 20-item decisional balance scale.\cite{77, 78} A modified version of Cohen’s Perceived Social Stress scale was used to assess stress prior to and during incarceration.\cite{79} An audio computer-assisted self interview (A-CASI) system was used to collect information on participants’ exposure to adverse childhood experiences.\cite{80} A detailed description of the A-CASI system is presented in Chapter 4.

To maintain consistency all interviews were conducted by the same researcher who had prior experience with data collection in the prison setting. Interviews were conducted in a private classroom or office with only the interviewer and participant present. Each interview took approximately 30 minutes to complete including the consent process and biomarker collection. The collection of biomarker samples was described in detail in Chapter 2.

### 3.2.4 Definitions of Tobacco Use

This analysis uses prisoners’ self-reports to categorize their patterns of tobacco use. The findings presented in Chapter 2 demonstrated the validity of self-reported tobacco use. Because biomarker confirmation was not available for the prisoners’ retrospective reports of tobacco use prior to arrest, classification was based solely on prisoner self-report. Adjusting categorizations of tobacco use during imprisonment based on cotinine test results without having any means of similarly adjusting the classification of pre-arrest tobacco use could result in differential misclassification of smoking status, introducing bias into the results.
Standard definitions of smoking behaviors were used to classify participants at two points: prior to their arrest and during incarceration. At each time point and for each tobacco product, participants were classified as ever users if they had used at least threshold amounts of a product during their life prior to that point: smoked 100 cigarettes, smoked a pipe 20 times, smoked a cigar 20 times, used snuff 20 times, or used chewing tobacco 20 times. Individuals who had never used the threshold amount of the product were termed never users. Ever users were then further divided into groups based on the frequency with which they reported tobacco use; those who reported using a product “every day” or “some days” (≥1 day per week) were current users. This classification of infrequent users as current users is consistent with the coding of individuals in the NHANES survey. In the most recent data available, 4.1% of current smokers reported using cigarettes ≤1 time per week.[81] Those using “not at all” at the time in question were former users. This allowed each participant’s tobacco use to be coded as a set of 5 three-level variables (current, former, or never user for each type of tobacco product) for each of the two time points.

To provide a clearer picture of patterns of tobacco use, these categories were condensed further. Cigarette, cigar, and pipe smoking were condensed into a single smoking status variable, participants were assigned the highest value from any of the three categories. That is to say, if the participant was a current smoker of any kind of tobacco, they were labeled as a current smoker, if they were a former smoker of one or more products but were not a current smoker of any they were labeled a former smoker, and if they had never used any of the products above the threshold level they were labeled a never smoker. The snuff and chewing tobacco variables were similarly condensed to form a smokeless status variable.
These two variables, smoking and smokeless status, were then used to assign participants to a pattern of tobacco use category at each time point (see Figure 3.2). Five categories were used: 1) never users, 2) former users, 3) current only smokers, 4) current only smokeless users, and 5) current dual users. The general term non-users refers to members of groups 1 and 2, while groups 3 through 5 are called tobacco users.

### 3.2.5 Statistical Analysis

The current study is primarily descriptive in nature. Because tobacco policies are implemented at the institutional level, any analysis of the impact of a tobacco policy must be carried out at that level. The scope and design of the current study do not allow for such an analysis. Both facilities examined in the current study had an indoor tobacco ban; there are no data to compare these findings with from facilities without tobacco restrictions or with complete tobacco bans. Instead, this paper seeks to examine how tobacco use changes following incarceration in a facility with an
indoor tobacco ban. It provides a detailed overview of tobacco use by participants prior to and during their incarceration.

Data from an ODRC survey of incoming inmates provided the basis for assessing the generalizability of the sample by comparing sample demographics with the characteristics of incoming inmates from across Ohio. The sizes of the two samples allow for the detection of differences that are not of practical significance, rendering statistical comparison of the groups unhelpful. Instead of assessing the statistical significance of differences between the study sample and the 2007 Ohio prison intake cohort, the distribution of demographic factors within the two groups were visually compared to identify points of deviation that were of potential practical significance.

Past studies of non-institutionalized populations have found the prevalence of tobacco use behaviors to be higher in Ohio Appalachia than other parts of the state, so Fisher’s exact test was used to check for differences in the distribution of smoking behaviors between prisoners sentenced from Appalachian and non-Appalachian counties. Comparisons were conducted for tobacco use behaviors both prior to and during incarceration.

Fisher’s exact test was also used to examine the impact of past tobacco behavior (never smoking vs. ever smoking) on prison tobacco initiation among non-users and to compare the likelihood of increased tobacco consumption between independent groups defined by demographic factors (race/ethnicity and region of sentencing county). Comparing changes in the prevalence of smoking behaviors in a single sample prior to and during incarceration does not meet the independence assumption required for Fisher’s exact test to be valid, so McNemar’s test for paired data was
used to look for changes in the prevalence of non-use, current smoking, current smokeless use, and dual use associated with the transition to prison.

Changes in the intensity of tobacco use during incarceration were examined in several ways. A paired t-test was used to examine changes in cigarette consumption as measured in average cigarettes per day (cpd). Average cigarette consumption was calculated by dividing the reported number of cigarettes smoked during a period by the number of days in that period, therefore it was possible for individuals to have non-integer values for average cpd. A Wilcoxon signed-rank test was used to assess changes in the frequency of smokeless tobacco use (ordinal variable: every day, some days, not at all) following entry into prison.

3.3 Results

3.3.1 Sample Characteristics

Figure 3.3 shows the movement of individuals through the study. A total of 322 potential participants were reviewed to identify the 200 participants. There were 40 individuals who were ineligible to participate due to their being in segregation ($n = 17$), already having been released ($n = 9$), being out of the facility for a court appointment ($n = 9$), receiving medical care ($n = 2$), or having insufficient English skills to complete the interview ($n = 3$). At Institution A, 145 people were invited to take part in the study before 100 participants were obtained, giving a response rate of 69.0%. At Institution B there were 137 individuals asked to participate before the full sample was obtained, yielding a response rate of 73.0% for the facility and 70.9% for the study overall. If a person agreed to take part in the study, separate consent was obtained for collecting the biomarker data. At Institution A, 85.0% of
participants provided biomarker samples, while 88.0% of participants at Institution B did the same, giving an overall consent rate of 86.5%. Interviews were conducted an average of $89.8 \pm 14.0$ days ($\mu \pm \sigma$; range: 62-120 days) after a participant’s admission into the prison system.

A comparison of the study sample with a representative sample of Ohio inmates admitted in 2007 is presented in Table 3.1. The average age of participants in
the study was 33.8 ± 10.2 years, which is functionally equivalent to the mean age of all incoming Ohio inmates of 32.3 ± 10.2 years. There were more white participants (63.5% vs. 48.7%) and less black participants (35.0% vs. 48.6%) in the study sample than would be expected from the 2007 admission cohort. Individuals sentenced from Appalachian counties were over-represented in the sample (22.0%) compared with the 2007 ODRC admission cohort (9.0%). Though the sample was slightly more educated than the admission cohort, the levels of education for the two groups appear comparable. The distribution of marital status among the study participants closely reflects that of all incoming inmates. The classification of the most serious offense for which study participants were sentenced also appears to be generally well matched to the Ohio admission cohort, with slight over-representation of property crime and under-representation of drug and sex offenses in the sample.

3.3.2 Pre-Incarceration Tobacco Use

The first column of Table 3.2 displays the prevalence of various smoking behaviors in the sample prior to their incarceration. Table 3.3 compares tobacco use by region of sentencing county, providing information from a representative sample of Ohio residents for comparison. There was no significant difference in the pattern of cigarette smoking \( (p = 0.105) \), however there was significant regional variation in the use of cigars \( (p = 0.030) \) and smokeless tobacco products \( (p < 0.001) \).

Prior to their incarceration, 74.0% of the participants were current cigarette smokers. The vast majority of current cigarette smokers (90.5%, 67.0% of the sample) smoked every day. These daily cigarette smokers consumed an average of about 1 pack \( (23.1 ± 14.4 \text{ cpd}) \) of cigarettes per day. Ever cigarette smokers had a mean age
Table 3.1: Sample characteristics compared with all eligible inmates and a representative sample of inmates admitted to the Ohio correctional system in 2007.
### Table 3.2: Participant tobacco use prior to and during incarceration.

<table>
<thead>
<tr>
<th>Type of Tobacco Use</th>
<th>Pre-arrest, %</th>
<th>During Incarceration, %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cigarette smoking</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily smokers</td>
<td>67.0</td>
<td>65.5</td>
</tr>
<tr>
<td>Some day smokers</td>
<td>7.0</td>
<td>13.5</td>
</tr>
<tr>
<td>Former smokers</td>
<td>4.5</td>
<td>5.0</td>
</tr>
<tr>
<td>Never smokers</td>
<td>21.5</td>
<td>16.0</td>
</tr>
<tr>
<td><strong>Cigar smoking</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily smokers</td>
<td>6.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Some day smokers</td>
<td>9.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Former smokers</td>
<td>31.0</td>
<td>42.5</td>
</tr>
<tr>
<td>Never smokers</td>
<td>54.0</td>
<td>54.0</td>
</tr>
<tr>
<td><strong>Smokeless tobacco</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily users</td>
<td>3.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Some day users</td>
<td>14.0</td>
<td>14.5</td>
</tr>
<tr>
<td>Former users</td>
<td>18.5</td>
<td>8.0</td>
</tr>
<tr>
<td>Never users</td>
<td>64.5</td>
<td>60.5</td>
</tr>
</tbody>
</table>

at initiation of 15.8 ± 4.3 years old (range: 7-35). The average age of current cigarette smokers at the time of the interview was 34.0 ± 10.4 years (range: 18-58).

The majority of ever cigarette smokers (64.3%) had made a 24-hour quit attempt at least once in their life before the arrest that brought them to prison. Participants reported the method or methods they used during quit attempts; the most commonly reported were stopping cold turkey (n = 78, 77.2%), switching to smokeless tobacco (n = 15, 14.9%), gradually reducing cigarette consumption prior to quitting (n = 12, 11.9%), and the use of nicotine patches (n = 11, 10.9%).

Though less common than cigarette smoking, cigar use was also prevalent among participants. This was especially true among African Americans due to the popularity of “Black and Mild” little cigars. There were 92 individuals in the sample (46.0%) who reported having smoked at least 20 cigars in their entire life, though nearly two-thirds
<table>
<thead>
<tr>
<th>Type of Tobacco Use</th>
<th>Prison Sample</th>
<th>Ohio Sample</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Appalachian</td>
<td>Other</td>
<td>Appalachian</td>
<td>All Ohio</td>
</tr>
<tr>
<td></td>
<td>(n=44)</td>
<td>(n=156)</td>
<td>(n=887)</td>
<td>(n=8402)</td>
</tr>
<tr>
<td><strong>Cigarette smoking, %</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>86.4</td>
<td>70.5</td>
<td>26.2</td>
<td>21.8</td>
</tr>
<tr>
<td>Former smoker</td>
<td>2.3</td>
<td>5.1</td>
<td>27.2</td>
<td>28.9</td>
</tr>
<tr>
<td>Never smoker</td>
<td>11.4</td>
<td>24.4</td>
<td>46.6</td>
<td>49.3</td>
</tr>
<tr>
<td><strong>Cigar smoking, %</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>11.4</td>
<td>16.0</td>
<td>11.3</td>
<td>9.1</td>
</tr>
<tr>
<td>Former smoker</td>
<td>47.7</td>
<td>26.3</td>
<td>46.7</td>
<td>41.9</td>
</tr>
<tr>
<td>Never smoker</td>
<td>40.9</td>
<td>57.7</td>
<td>42.0</td>
<td>49.0</td>
</tr>
<tr>
<td><strong>Smokeless tobacco, %</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current user</td>
<td>38.6</td>
<td>10.9</td>
<td>9.5</td>
<td>3.6</td>
</tr>
<tr>
<td>Former user</td>
<td>27.3</td>
<td>16.0</td>
<td>20.5</td>
<td>17.6</td>
</tr>
<tr>
<td>Never user</td>
<td>34.0</td>
<td>73.1</td>
<td>70.0</td>
<td>78.8</td>
</tr>
<tr>
<td><strong>Dual tobacco use, %</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current dual user</td>
<td>36.4</td>
<td>9.6</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Not current dual user</td>
<td>63.6</td>
<td>90.4</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*a* Pre-arrest tobacco use  
*c* Data not available.

Table 3.3: Pre-incarceration tobacco use by region of sentencing county and comparison with a representative sample of Ohio residents.
(n = 59, 64.1%) of these ever-users reported never smoking cigars regularly. Prior to their arrest 12 participants (6.0%) were daily cigar smokers. These daily cigar smokers represented 11.4% and 3.1% of black and white participants, respectively. There were also 18 participants (9.0%) who were some day smokers, including 12.9% of black participants and 7.1% of white participants. The majority of current cigar smokers (86.7%) reported also being current cigarette smokers during the period prior to their arrest. Current cigar smokers had a mean age at initiation of 19.5 ± 7.8 years (range: 12-45). The average age of current cigar smokers at the time of the interview was 29.2 ± 10.5 years (range: 18-54).

Pipe smoking was uncommon in the sample prior to incarceration (results not shown). There were 13 participants (6.5%) who reported having smoked a tobacco pipe at least 20 times in their entire life, though 10 of these stated that they had never used a pipe regularly. Only 2 participants (1.0%) were current pipe smokers at the time of their arrest, and both reported smoking a pipe only occasionally. Both participants using a pipe were non-Hispanic whites who reported concurrent cigarette smoking.

A total of 71 participants (35.5%) were ever smokeless tobacco users at the time of their arrest. At that time 34 participants (17.0%) were current smokeless users, with 6 (3.0% of sample) using smokeless tobacco products on a daily basis and 28 (14.0% of sample) using smokeless tobacco products only on some days. An additional 37 individuals (18.5%) were former smokeless users, 24 of whom had never used regularly. Current smokeless users started using the smokeless tobacco products at a mean age of 18.3 ± 10.3 years (range: 4-54). At the time of the interview, the average age of the current smokeless tobacco users was 30.4 ± 8.9 years (range: 19-55). The majority of
current smokeless users used only snuff (85.3%), with the remainder using chewing tobacco alone (5.9%) or both snuff and chew (8.8%). Users of smokeless tobacco tended to be non-Hispanic whites (88.2%), and half were sentenced from Appalachian counties \( n = 17, 50.0\% \). Those sentenced from Appalachia were significantly more likely to be current smokeless users (38.6% vs. 10.9%, \( p < 0.001 \)).

Prior to their arrest, 31 participants (15.5%) reported being current dual users of smoked and smokeless tobacco products. These current dual users tended to be non-Hispanic, white men \( n = 27, 87.1\% \) sentenced from Appalachian counties \( n = 16, 51.6\% \). Participants sentenced from Appalachian counties were significantly more likely to be current dual users (36.6% vs. 9.62%, \( p < 0.001 \)). Dual users had a mean age of 30.6 ± 9.2 years (range: 19-55) at the time of the interview and had started to use tobacco by an average age of 13.3 ± 3.3 years (range: 4-18).

### 3.3.3 Prison Tobacco Use

The second column of Table 3.2 displays tobacco use by the study participants during their incarceration. There were 163 participants (81.5%) who reported having smoked cigarettes, even once, since their arrival at the facility and 156 participants (78.0%) who were current smokers at the time of the interview, including 129 (82.7%, 64.5% of sample) who were daily cigarette smokers and 27 (17.3%, 13.5% of sample) some day smokers. While in prison, current cigarette smokers in the sample used an average of about half a pack of cigarettes (10.6 ± 10.6 cpd) on days when they smoked, with daily cigarette smokers consuming an average of 12.5 ± 10.6 cpd. At the time of the interview, the mean age of the current cigarette smokers was 33.2 ± 10.1
(range: 18-58), with daily cigarette smokers averaging 33.9±10.3 years old (range: 18-58). There were 3 current cigarette smokers (1.5% of sample) who reported smoking cigarettes less than 1 day per week during their incarceration; 2 were never cigarette smokers before coming to prison and the other was a some-day cigarette smoker prior to his arrest.

The type of cigarettes used by prisoners differed significantly at the two facilities ($p < 0.001$). Administrators at Facility B eliminated the sale of hand-rolled cigarettes, allowing only manufactured cigarettes to be purchased from the commissary. As a result, all 82 current cigarette smokers (100.0%) at Facility B smoked manufactured cigarettes during their incarceration. By contrast, at Facility A only 2 of the current cigarette smokers (2.7%) smoked manufactured cigarettes, while 72 (97.3%) used hand-rolled cigarettes.

Counting those that went on to successfully quit smoking, more than a quarter of current cigarette smokers ($n = 47, 29.1\%$) made at least one 24-hour quit attempt (made an effort to quit smoking that included at least 24 hours of abstaining from cigarettes) after their arrival in prison. When asked what method or methods they used to try quitting, the participants reported stopping cold turkey ($n = 36, 76.6\%$), switching to smokeless tobacco ($n = 12, 25.5\%$), and gradually reducing cigarette consumption in advance of the attempt ($n = 5, 10.6\%$). No participants reported using nicotine replacement therapy (NRT) or other medications (e.g., varenicline, bupropion) since arriving at the facility, and none had taken part in tobacco cessation programming offered by the facilities. From the group of 47 who tried to quit smoking cigarettes during their time in prison there were 5 (10.6\%) who reported success in their efforts, including 2 who continued to use smokeless tobacco following cessation.
of cigarette use. There were 2 additional participants who quit smoking cigarettes during the period between their arrest and admission into the prison system.

Participants rarely reported current cigar smoking during incarceration. Only 6 individuals (3.0%) reported some-day cigar smoking and just 1 person (0.5%) smoked cigars on a daily basis. There were an additional 22 participants who had smoked a cigar at least once during their imprisonment, but who smoked less than 1 cigar each week. The majority of current cigar smokers ($n = 4, 57.1\%$) were black, while most of those smoking less than 1 cigar per week while in prison were white ($n = 14, 63.6\%$).

All prison smokers used either cigarettes or cigars. Tobacco pipes and related paraphernalia are not available through the commissary and are banned from prison grounds. No participants reported smoking a tobacco pipe during their incarceration.

A total of 74 (37.0\%) participants reported having ever used smokeless tobacco products since arriving at their current facility, including 34 (46.0\%, 17.0\% of sample) daily smokeless users and 29 (39.2\%, 14.5\% of sample) some-day smokeless users. The remaining 11 participants had used smokeless tobacco less than once per week since arriving at the facility. The majority of smokeless tobacco users used only snuff ($n = 71, 95.9\%$), while a smaller proportion used both snuff and chewing tobacco ($n = 3, 4.1\%$). The mean age of regular smokeless tobacco users in the sample was $30.0 \pm 8.8$ years (range: 19-55). The majority of regular smokeless users were non-Hispanic whites ($n = 54, 85.7\%$). The prevalence of smokeless tobacco use was significantly higher in individuals sentenced in Appalachian counties ($56.8\%$ vs. $24.4\%, p < 0.001$).

There were 58 (29.0\%) individuals who reported dual use of smoked and smokeless tobacco during their time in prison. Dual users made up more than a third of regular
smokers (36.9%) and 92.1% of regular smokeless tobacco users. The dual users tended to be non-Hispanic whites \((n = 50, 86.2\%)\) and a large portion were sentenced in an Appalachian county \((n = 24, 41.4\%)\). Participants sentenced from Appalachia were significantly more likely to be dual users (54.6%) than those participants who were not (21.8%, \(p < 0.001\)).

### 3.3.4 Indoor Tobacco Use

All participants reporting tobacco use during their time in prison were asked to report the frequency with which they used the tobacco product indoors. Table 3.3 shows the frequency with which participants reported using tobacco products within prison buildings. The smoking of cigarettes and cigars is banned inside of buildings by prison policy, however more than half of the cigarette smokers \((n = 84, 51.2\%)\) reported having violated the indoor smoking ban since they arrived at the facility, including more than a third \((n = 56, 34.1\%)\) who smoked indoors on a daily basis. Less than a quarter of cigar smokers (20.7%) reported ever using cigars indoors, and all who reported doing so said they rarely smoked cigars indoors.

Ohio’s prisoners are permitted to use smokeless tobacco in most buildings, consequently most smokeless users \((n = 67, 90.5\%)\) reported using smokeless tobacco products inside during their incarceration. Half of the smokeless tobacco users \((n = 37, 50.0\%)\) reported using smokeless products indoors on a daily basis. Among the current dual users, 40.0% reported using only smokeless tobacco products indoors, including nearly a third of dual users \((n = 10, 31.3\%)\) who started using smokeless tobacco after arriving in prison. Nearly all of the smokers who became dual users after arriving in prison \((n = 30, 93.8\%)\) reported using smokeless tobacco products indoors.
<table>
<thead>
<tr>
<th>Frequency of using product indoors</th>
<th>Facility A</th>
<th>Facility B</th>
<th>Full Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td><strong>Cigarettes (n = 163 users)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily</td>
<td>29 (37.2)</td>
<td>27 (31.8)</td>
<td>56 (34.4)</td>
</tr>
<tr>
<td>Weekly</td>
<td>0 (0.0)</td>
<td>2 (2.4)</td>
<td>2 (1.2)</td>
</tr>
<tr>
<td>Rarely</td>
<td>14 (17.9)</td>
<td>12 (14.1)</td>
<td>26 (16.0)</td>
</tr>
<tr>
<td>Never</td>
<td>35 (44.9)</td>
<td>44 (51.8)</td>
<td>79 (48.5)</td>
</tr>
<tr>
<td><strong>Cigars (n = 29 users)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Weekly</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Rarely</td>
<td>5 (20.0)</td>
<td>1 (25.0)</td>
<td>6 (20.7)</td>
</tr>
<tr>
<td>Never</td>
<td>20 (80.0)</td>
<td>3 (75.0)</td>
<td>23 (79.3)</td>
</tr>
<tr>
<td><strong>Smokeless Tobacco (n = 74 users)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily</td>
<td>10 (45.5)</td>
<td>27 (51.9)</td>
<td>37 (50.0)</td>
</tr>
<tr>
<td>Weekly</td>
<td>2 (9.1)</td>
<td>5 (9.6)</td>
<td>7 (9.5)</td>
</tr>
<tr>
<td>Rarely</td>
<td>8 (36.4)</td>
<td>15 (28.8)</td>
<td>23 (31.1)</td>
</tr>
<tr>
<td>Never</td>
<td>2 (9.1)</td>
<td>5 (9.6)</td>
<td>7 (9.5)</td>
</tr>
</tbody>
</table>

Table 3.4: Frequency of self-reported indoor tobacco use by product type and facility.

### 3.3.5 Tobacco Knowledge and Desire to Quit

Despite a high prevalence of smoking within the sample, participants seemed aware of the negative health effects of smoking and many expressed a desire to quit using tobacco products. Participants were asked to respond to statements about the health effects of tobacco use. A majority agreed with the statements that smoking is a cause of lung cancer (96.0%) and heart disease (75.4%). Participants were also aware, though to a lesser degree, that secondhand smoke could cause lung cancer (83.4%) or heart disease (48.2%). Nearly all participants recognized that use of tobacco can be addicting or habit forming (97.5%). Among those participants who were using tobacco at the time the study was conducted, a strong majority (70.0%) reported a
desire to quit using tobacco products, while 63.0% indicated that it was likely or very likely they would try giving up tobacco within the next year.

### 3.3.6 Patterns of Tobacco Use

Understanding the ways in which tobacco use changes during entry into the prison system was the primary interest of the STOP project. Figure 3.4 examines four patterns of tobacco use, non-users (composed of never and former tobacco users), current only smokers (daily and some-day cigarette, cigar, and pipe smokers not using other types of tobacco), current only smokeless users (daily and some-day snuff and chew users not using other types of tobacco), and current dual users (those currently using both smoked and smokeless tobacco). Prior to their arrest a majority of the sample were current smokers (60.5%), while the remainder were nonusers (22.5%), current dual users (15.5%), or current smokeless users (1.5%). During the transition to prison life, more than a quarter of participants (28.0%) changed their tobacco use. The most common change was the transition from being a current smoker to being a current dual tobacco user. A total of 31 individuals, 25.6% of the current smokers in the sample, started using smokeless products in addition to their smoking after arriving in prison. Use of McNemar’s test for paired data indicated that there were significant changes in the prevalence of current smokeless ($p < 0.001$) and current dual ($p < 0.001$) tobacco use, however changes in the prevalence of current smoking and non-use of tobacco were not statistically significant ($p = 0.090$ and $p = 0.108$, respectively).

Most non-users continued to abstain from tobacco (71.1%), however more than a quarter did take up smoking ($n = 10, 22.2$%), smokeless tobacco ($n = 2, 4.4$%),
Figure 3.4: Patterns of tobacco use prior to arrest and during incarceration. Arrows display movement between groups. Weights of lines corresponds to the number of participants.
or both \((n = 1, 2.2\%)\). Former tobacco users were significantly more likely than never users to become tobacco users during their incarceration (69.2\% vs. 12.5\%, \(p < 0.001\)). Only 6 current tobacco users quit using tobacco during their transition to prison life, with 5 quitting smoking and 1 ceasing to use smokeless tobacco.

### 3.3.7 Tobacco Consumption

Individuals changed not only the types of tobacco that were used, but also the amount of tobacco used (see Figure 3.5). Cigarette consumption was used to evaluate the intensity of smoking since cigarettes were the most common type of smoked tobacco used, and the most easily quantifiable. There were 152 study participants (76.0\%) who were regular cigarette smokers prior to incarceration, including 73 in the sample from Institution A and 75 in the sample from Institution B. Participants in the study consumed an average of 15.7 ± 15.9 cpd, counting non-smokers in the denominator. During incarceration the number of smokers at both facilities increased to 74 at Institution A and 82 at Institution B, for a total of 156 cigarette smokers or 78\% of the sample, though the average number of cigarettes consumed per day fell to 8.6 ± 10.6 cpd. This 7.1 cpd decline in consumption was statistically significant \((p < 0.001)\). The t-test is robust even if there are deviations from the normality assumption if sample sizes are equal. Use of a Wilcoxon signed-rank test, the nonparametric equivalent of the t-test, returned a similar result \((p < 0.001)\), confirming that there was a significant change in cigarette consumption following incarceration.

Prior to their incarceration, the participants from Institution A smoked an average of 15.6 ± 17.8 cpd when including non-smokers in the average. Despite an increase in the number of individuals smoking cigarettes, the average number of cigarettes
consumed per day fell during incarceration to $10.3 \pm 12.3$ cpd, a statistically significant decline ($p < 0.01$). Nearly half (47%) of the sample from Institution A decreased their cigarette consumption, with an average decrease of 13.4 cpd (range: 0.2-60 cpd). There were 11 individuals that decreased their consumption by a pack or more of cigarettes per day. Only 13% increased their cigarette consumption. Among those who increased consumption the mean increase was 7.4 cpd (range: 0.3-38 cpd). Five people increased their consumption by half a pack a day, with 1 increasing by more than a pack per day.

At Institution B, participants smoked an average of $15.8 \pm 13.8$ cpd prior to arrest. Again the average number of cigarettes consumed during incarceration fell, this time to $6.9 \pm 8.4$ cpd. This decline was also statistically significant ($p < 0.01$). Cigarette consumption decreased among 60% of participants at Institution B, with an average
decline of 16.4 cpd (range: 1.7-40 cpd). There were 16 participants from the facility that reported decreasing their consumption by a pack or more of cigarettes per day. At Institution B there were 19 participants that increased their tobacco consumption, with a mean increase of 4.5 cpd (range: 0.1-10 cpd). Five individuals increased their tobacco consumption by half a pack a day.

Unlike cigarettes, there was a significant increase in smokeless tobacco consumption as measured by frequency of use, with 52 participants (26.0%) increasing their smokeless use following incarceration and only 5 (2.5%) decreasing it ($p < 0.001$). The frequency of smokeless tobacco consumption increased at both facilities. In Institution A there were 11 individuals who increased their frequency of usage and only 4 that used smokeless products less frequently ($p = 0.068$). Prior to incarceration 4 individuals were daily users and 8 some-day users of smokeless tobacco. Following incarceration the number of daily smokeless users increased to 10, while 7 people were some-day users. At Institution B the increase was even more pronounced, with 41 participants increasing the frequency of their smokeless tobacco use and only 1 person decreasing it ($p < 0.001$). Prior to imprisonment there were 2 daily smokeless users and 20 some-day users. Once in prison, 24 participants used smokeless tobacco daily and 22 used it on some days.

Increased consumption of smokeless tobacco was independently associated with race/ethnicity ($p < 0.001$) and region of sentencing county ($p = 0.002$). Non-Hispanic whites were more likely to have increased their frequency of smokeless tobacco use during incarceration (36.2%) than participants from other racial or ethnic groups (8.2%). Men sentenced from Appalachian counties were more likely to have increased
their frequency of smokeless tobacco use (45.5%) compared with those who were not sentenced in Appalachia (20.5%).

3.4 Discussion

Prior to the advent of jail and prison smoking bans, incarcerated populations were consistently found to have a high prevalence of tobacco use, up to 85%. The current study indicates that an indoor smoking ban does little to change this pattern. The prevalence of tobacco use reported in this sample was high prior to their arrest; 77.5% reporting current tobacco use, including 76.0% of the sample who were current smokers. During incarceration the prevalence of use climbed to 82.0% for current tobacco use and 78.5% for current smoking. By comparison, the 2006 Ohio Adult Tobacco Survey found that 22.3% of Ohio adults were current cigarette smokers, and the prevalence of current tobacco use was 28.4% when all tobacco products were considered. It is likely that residents of Ohio Appalachia, a region known for having a high prevalence of tobacco use, are overrepresented in the sample given the high proportion of participants in Facility B sentenced from Appalachian counties. However the prevalence of tobacco in the sample far surpasses that in Appalachia even among residents not sentenced from Appalachian counties (See Table 3.3).

Though the prevalence of tobacco use was high in the sample, most participants were aware of the negative consequences of using tobacco products, and a majority of participants who used tobacco (70.0%) stated that they were interested in quitting. This closely mirrors the 74% of general population smokers who reported an interest in quitting in one recent national poll. Furthermore, more than a quarter of cigarette smokers (28.1%) reported having at least one 24-hour quit attempt since their arrival
in prison. Despite their intentions and efforts, few participants succeeded in actually quitting. Participants’ lack of success may be attributable to the methods they are using to quit. Participants did not take part in group sessions or receive medical counseling but instead tried to go-it-alone with most (80.0%) attempting to quit cold turkey. There is no reason to suspect that group sessions will inherently be unappealing to prison inmates. The facilities in which the study was carried out have active Alcoholics Anonymous and Narcotics Anonymous groups, yet similar programs for tobacco have yet to develop.

Examinations of the prison environment provide further insights into why cessation may be challenging in the prison environment. Social scientists have repeatedly found that the social structure of prison can be damaging to the physical, mental, and social wellbeing of inmates. Amidst the deprivations of prison, tobacco may come to serve as a prisoner’s “lifeline;” offering a little bit of control in an otherwise powerless life. A qualitative study of tobacco use conducted among Polish inmates inquired about factors contributing to the high prevalence of smoking in prisons. Prisoners cited the stress of leaving behind family and friends, lost freedom, and the boredom of prison life as primary reasons for tobacco use. Other stressors reported included remorse associated with past crimes, conflicts with inmates and staff, concerns about legal affairs and life on the outside, and forced abstinence from sex, alcohol, and drugs.

The vast majority of unaided attempts to quit are unsuccessful, therefore current guidelines recommend the use of nicotine replacement products or medications to assist with smoking cessation. Nicotine replacement products are available to inmates through the prison commissary, however the cost is prohibitive for many
prisoners. Apart from the small proportion of inmates who can earn $60 a month working for Ohio’s Penal Industries program, prisoners in Ohio earn an average wage of $18 per month.\[89\] This money must be made to cover the cost of commissary purchases, including toiletries and non-cafeteria food. It is not surprising, then, that prisoners decide not to purchase NRT when nicotine gum costs more than a month’s wages and nicotine patches more than double that (see Figure 3.1).

Financial pressures may also help to explain another aspect of prison tobacco use. Despite an increase in the number of tobacco users, per-capita tobacco consumption in the sample actually decreased during incarceration. Average cigarette consumption dropped from 15.7 to 8.6 cpd following imprisonment. The high cost of tobacco relative to prisoner salaries limits the amount of tobacco prisoners can afford to purchase. The current study is not structured to examine differences between facilities, however variations in tobacco policy as implemented at the two study sites creates an opportunity for an exploratory examination of how small policy changes, here restricting the types of tobacco sold in the commissary, might impact tobacco use behaviors upon entering prison. The decrease in cigarette consumption was greater at Facility B (8.9 cpd), where only ultra light manufactured cigarettes were available, compared with Facility A (5.3 cpd) where most inmates (97.4%) used Bugler and Kites, the unfiltered, hand-rolled cigarettes available for a fraction of the cost of manufactured cigarettes. Economic examinations of tobacco consumption have confirmed that, as one might expect, demand for cigarettes decreases with increasing cost.\[90\] This is likely to play a large role in shaping tobacco use when expenditures on tobacco constitute such a large proportion of an individual’s budget.
A limitation of the current project is that this exploratory study could only be conducted in two facilities. Tobacco policies are implemented at the institutional level, making that the correct level of analysis for any examination on the impact of tobacco policies. The fact that the two prisons implemented different policies, with one severely restricting the types of tobacco sold, effectively provides two groups of size \( n=1 \). As a result, we are unable to draw conclusions about whether the observed differences in tobacco consumption are the effects of policy differences or attributable to other institutional-level factors.

The health impact that the observed reductions in cigarette consumption might have is not clear. Measuring tobacco consumption in cigarettes smoked per day may overestimate reductions in tobacco smoke exposure due to compensatory smoking behaviors. Both human and animal studies have found that some individuals compensate for reduced duration of exposure by increasing intensity.\(^91\)\(^92\) For smokers this may mean taking more or deeper puffs from each cigarette.

A review of studies examining the effects of reduced tobacco consumption found evidence that a reduction of 50% or more in tobacco consumption may lead to small improvements in health, including reductions in markers of cardiovascular risk and a decline in respiratory symptoms.\(^93\) Though early results were mixed, recent studies indicate that reducing tobacco consumption can reduce the risk of lung cancer by around 25%.\(^93\) There was, however, no evidence of improved lung function and insufficient evidence to determine if smoking reduction reduces mortality.\(^93\) Among prisoners the picture is further clouded by the prevalent use of unfiltered, hand-rolled cigarettes during incarceration. In the facility where they were available more than 97% of participants opted for this cheaper alternative to manufactured cigarettes.
The smoking of unfiltered cigarettes has been associated with an increased risk of developing lung cancer, greater than that associated with the smoking of filtered cigarettes.\textsuperscript{[94]}

As noted above, the reduction in cigarette consumption during transition to the prison environment was not accompanied by tobacco cessation. Only 4 individuals (2%, 2.6% of regular tobacco users) stopped using tobacco products after arriving in prison, while 13 (6.5%, 28.9% of non-smokers) took up the behavior. Though many prisoners expressed a desire to quit, participants had not taken part in tobacco cessation programming offered by ODRC. Prisoner perspectives on tobacco cessation programming may help to explain these low participation rates. The second component of the STOP Project, the Tobacco Policy Interview, was designed to address this and related topics. At the time of this writing, analyses of the Tobacco Policy Interview data were ongoing.

Indoor tobacco bans are only effective to the degree in which those under the ban comply. In the prison setting, compliance with tobacco bans is certainly not perfect. Despite the ban on smoking inside the buildings of Ohio correctional facilities, 51.2% of smokers (42.0% of prisoners) reported smoking indoors at least once, with 34.1% (28.0% of all participants) using tobacco products inside on a daily basis. Due to restrictions on indoor smoking, prisoners may have been reluctant to accurately report policy violations. These self-reports likely underestimate the scope of the problem. Still, according to conversations with inmates during the course of the study, the smoking policy is enforced and it appears likely that the indoor restrictions dramatically reduce non-smoking inmates’ exposure to secondhand smoke, as has been observed previously.\textsuperscript{[38]}
Several strengths and weaknesses of the current study merit discussion. The utility of an exploratory study is directly related to its generalizability; unless findings have external validity, they are of no use in shaping future policy decisions. Response rate is one important indicator of how representative a sample is. In the current study 70.9% of the individuals invited to take part agreed to do so despite a prohibition on providing incentives to participants in Ohio prisons and strong protections to ensure that prisoners are not coerced into participating in studies. Individual recruitment appears to have been a successful strategy to promote participation. The strong response rate, combined with interviewing consecutively admitted inmates, provides a sample representative of recently arrived inmates at the facilities under study.

A separate issue is the degree to which prisoners at the two facilities represent all Ohio inmates. As both sites are low-to-medium security facilities, caution should be taken in applying these findings to high security settings. The ODRC practice of placing prisoners in facilities located as close to their home or family as possible contributes to variations in prison populations based on geographic location. This is clearly seen in the excess of Appalachian residents at Facility B, which is located in a county bordering Ohio Appalachia. Appalachian residents were more likely to use smokeless tobacco products prior to incarceration than other prisoners (38.6% vs. 10.9%) and were also more likely to be dual tobacco users (36.4% vs. 9.6%). The same patterns were observed during incarceration, with higher prevalences of smokeless tobacco (56.8% vs. 24.4%) and dual tobacco (54.5% vs. 23.1%) use among men sentenced from Appalachia. The smaller increases in smokeless tobacco use observed among the non-Appalachian participants are likely more representative of
the situation for prisoners from areas where smokeless tobacco products may have lower familiarity and social acceptability.

Indoor smoking bans appear to be an effective way to reduce the number of cigarettes that incarcerated smokers consume and to promote cleaner indoor air for smokers and non-smokers alike, however the potential health benefits of reduced tobacco consumption may be offset somewhat by compensatory smoking and increased use of unfiltered cigarettes during incarceration. The study indicates that an indoor smoking ban does little to promote smoking cessation. Additional policies or programming are needed if the goal of improving prisoners’ long-term health is to be achieved.
CHAPTER 4

ADVERSE CHILDHOOD EXPERIENCES IN INCARCERATED POPULATIONS: A PRELIMINARY EXAMINATION

4.1 Background

At the start of the 20th century, infectious diseases were the primary causes of death for Americans. Through public health measures and medical advances including the development of antibiotics, death rates due to infection have fallen dramatically. In their place chronic diseases have become the leading causes of death. These chronic diseases are largely attributable, in turn, to individuals’ health behaviors, sometimes termed the actual causes of death. Three behaviors in particular play a major role in shaping the health of Americans. In 2000, tobacco use, poor diet/physical inactivity, and alcohol consumption were calculated to be responsible for 18%, 15%, and 3.5% of deaths in the U.S., respectively.

Recent work has examined events still further up the causal pathway. In the mid 1990s, a theory was proposed to link adverse childhood experiences (ACEs), like abuse and a troubled home life, to disease and disability during adulthood. The ACE pyramid presents a schematic representation of the ACE theory (see Figure 4.1). The theory employs a whole life perspective, attempting to link events starting at
birth to health behaviors and outcomes throughout a person’s life. According to
the model, adverse experiences early in life can lead to social, emotional, and cog-
nitive impairment. These experiences may include sexual abuse, persistent physical
or emotional abuse, or negative aspects of the home environment. Eight categories
of adverse childhood experiences and their operational definitions are presented in
Table 4.1. Individuals may adopt negative health behaviors as a means of coping
with the impairments associated with these events. Examples of health-risk behav-
iors employed as a coping mechanism include the use of obesity to deter unwanted
sexual attention and self-medication with alcohol, tobacco, or illicit drugs. [80, 98]

A large retrospective cohort study, the ACE Study, was conducted among enrollees
of the Kaiser Permanente Health Plan designed to test the theory that ACEs could
lead to risky behaviors and negative health outcomes later in life. [80] In that sample
<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional Abuse</td>
<td>Often or very often a parent or other adult in the household swore at, insulted, or put down participant and/or sometimes, often or very often acted in a way that made participant think he or she might be physically hurt.</td>
</tr>
<tr>
<td>Physical Abuse</td>
<td>Sometimes, often, or very often pushed, grabbed, slapped, or had something thrown at him or her and/or was ever hit so hard that he or she had marks or were injured.</td>
</tr>
<tr>
<td>Sexual Abuse</td>
<td>An adult or person at least 5 years older ever touched or fondled participant in a sexual way, and/or had him or her touch their body in a sexual way, and/or attempted oral, anal, or vaginal intercourse with him or her and/or actually had oral, anal, or vaginal intercourse with him or her.</td>
</tr>
<tr>
<td>Mother Treated Violently</td>
<td>Participant’s mother or stepmother was sometimes, often, or very often pushed, grabbed, slapped, or had something thrown at her and/or sometimes often, or very often kicked, bitten, hit with a fist, or hit with something hard, and/or ever repeatedly hit over at least a few minutes and/or ever threatened or hurt by a knife or gun.</td>
</tr>
<tr>
<td>Household Substance Abuse</td>
<td>Participant lived with anyone who was a problem drinker or alcoholic and/or anyone who used street drugs.</td>
</tr>
<tr>
<td>Household Mental Illness</td>
<td>A household member was depressed or mentally ill and/or a household member attempted suicide.</td>
</tr>
<tr>
<td>Incarcerated Household Member</td>
<td>A household member went to prison.</td>
</tr>
<tr>
<td>Parental Separation or Divorce</td>
<td>The participant’s parents were ever separated or divorced.</td>
</tr>
</tbody>
</table>

*Not included in initial description of ACE theory (Felitti, 1998) or current study.

Table 4.1: Operational definitions of adverse childhood experiences used in the Adverse Childhood Experiences (ACE) Study. To qualify as a childhood event, the criteria for that experience needed to occur during the first 18 years of the participant’s life. Source: Anda, 1999.
drawn from the general population there were consistent, dose-response relationships between ACEs and many negative health behaviors. Exposure to a higher number of adverse events was related to higher rates of smoking, alcoholism, drug abuse, risky sexual behaviors, obesity, physical inactivity, and suicide attempts.\[80\] ACEs were also associated with poorer health outcomes in adulthood including depression, diabetes, heart disease, stroke, cancer, and lower self-rated health.\[80\]

The belief that adverse events early in life could have repercussions throughout the life course is not a new one, however most prior work has focused on behavioral or psychological outcomes rather than addressing physical health and its determinants. In the field of criminology, family environment has been proposed as a cause of adolescent deviant behavior and adult criminality, so it would be anticipated that the prevalence of ACEs would be high among incarcerated populations.\[99, 100\] Prisoners are known to have poorer health and higher rates of negative health behaviors than the general population,\[22, 23, 26\] yet to date there has been no examination of how ACEs may contribute to these disparities. The current paper provides a first look at the prevalence of childhood adversity in an incarcerated population. It examines the distribution of ACEs in a sample of prison inmates drawn from two Ohio facilities and explores the association between early adverse events and adult tobacco use behaviors in an incarcerated population.

4.2 Methods

4.2.1 Participants and Setting

A total of 200 male inmates were interviewed at two low-to-medium security Ohio prisons as part of the Smoking and Tobacco in Ohio Prisons (STOP) Project. At
each facility, recently admitted inmates were invited to take part in the study in the order in which they entered the prison system. Recruitment continued until 100 participants were obtained from the facility. The recruitment process was delayed for at least two months following admission into the prison system to allow participants time to establish their normal prison routine. Interviews were conducted 62-120 days after participants arrived in the facility. Eligibility criteria for the study were that the participants were 18 years of age or older, spoke sufficient English to complete the interview, and were residents of the general population of the facility at the time of the interview. Due to logistical constraints and prison policies, participants being held in solitary confinement, those receiving medical care, and those off compound for an outside court appearance were not invited to take part in the study. Individuals released from prison prior to their recruitment were also excluded.

4.2.2 Adverse Childhood Experiences

Participants were questioned about the occurrence of adverse experiences during their first 18 years of life. An audio computer-assisted self-interview (A-CASI) system, designed using Microsoft® Access 2000 (Microsoft Corporation, Redmond, WA), was used to provide participants with privacy when answering the sensitive ACE questions. Participants listened to audio recordings of the questions and possible responses over headphones and entered their responses using a customized color-coded data entry device built by modifying a number pad. A sample question was used to ensure that the headset volume was at an appropriate level for the participant and that he understood how to use the equipment. Once this example was completed, the interviewer moved out of sight of the computer screen to maximize the participant’s
privacy. To illustrate the user’s experience with the system, while the computer displayed the text of the first question and possible responses on screen the participant would hear the following audio over headphones:

Sometimes parents or other adults hurt children. While you were growing up, that is, during your first 18 years of life, how often did a parent, step-parent, or adult living in your home swear at you, insult you, or put you down? If never, press red. If once or twice, press orange. If sometimes, press yellow. If often, press green. If very often, press blue. To skip this question, press black. To hear it again, press white.

Once the respondent made a selection the program would ask the participant to confirm their response. If, for example, the participant had never experienced the event, they would press the red button and hear the prompt, “You chose ‘never.’ If this is correct, press black. To change your answer, press white.” Those choosing to change their answer would have the question and response options repeated. If participants confirmed their response, the next question would be displayed on screen and the corresponding audio file would begin to play. This process was repeated for all items on the questionnaire. Following confirmation of the final response, the program played an audio recording instructing the participant to notify the interviewer and the personal interview was resumed.

ACE questions were divided into seven categories, identified by the originators of the ACE theory: 1) Emotional Abuse, 2) Physical Abuse, 3) Sexual Abuse, 4) Mother Treated Violently, 5) Household Substance Abuse, 6) Household Mental Illness, and 7) Incarcerated Household Member. Definitions of these categories are present in Table 4.1. A summary measure, the ACE score, is defined as the number of categories to which a person was exposed. Possible scores range from 0 (no exposure to ACEs) to 7 (exposure to all ACE categories).
4.2.3 Definitions of Smoking Behaviors

Individuals’ self reported tobacco use and demographic data were collected using a computer-assisted personal interview system. During the interview, which took place 2-4 months after admission to the prison system, participants were asked about their smoking status at two points: prior to arrest and during their incarceration. Details of the questionnaire were presented in Chapter 2. The standard definitions of smoking behavior used in this study are the same as those used in a previously published examination of adverse childhood experiences and tobacco use in a sample from the general population.\textsuperscript{101} Participants who started smoking cigarettes regularly by age 14 are defined as having early smoking initiation. Ever smokers were those who reported having smoked at least 100 cigarettes in their entire life, while never smokers had smoked less than 100 cigarettes. Based on their self reported tobacco use at each time period (pre-arrest and during incarceration) ever smokers were further classified as either current smokers, smoking on at least some days at the time in question, or former smokers, who had smoked at least 100 cigarettes in their lifetime but did not smoke at all at the time being assessed. Individuals smoking at least a pack a day ($\geq 20$ cigarettes per day) were termed heavy smokers.

4.2.4 Statistical Analyses

To maintain comparability with studies of this topic in the general population,\textsuperscript{101} individuals with insufficient information about an event to determine their exposure were considered not to have had that event. Since adverse childhood experiences are expected to increase the likelihood of adopting the smoking behaviors under study any
bias should be toward the null. To examine the effect of the missing data, analyses were repeated excluding individuals with missing data.

Logistic regression was used to calculate the odds ratios (ORs) and 95% confidence intervals (CIs) relating ACEs to smoking behaviors while controlling for demographic factors. The variables controlled for in all models were age (< 35 or ≥ 35 years old), race (white or other), and education (less than high school graduate, G.E.D., high school graduate, or at least some college). Due to regional variations in tobacco use, the region of a participant’s sentencing county (Appalachian or non-Appalachian) was also included as a covariate in the models. For each ACE category, a set of models was built to examine its independent association with the smoking behaviors after adjusting for potential confounders. A separate group of models was also constructed examining the relationship between the ACE score, treated as a 6-level categorical variable (0, 1, 2, 3, 4, and ≥ 5, with 0 serving as the referent) and the smoking behaviors.

Model stability becomes a concern when the number of outcome events per predictor variable in a logistic regression model is small. Controlling for the appropriate demographic factors caused the number of parameters estimated to approach the recommended limits of what the data could support, so special caution was taken during the analysis to examine each model for signs of instability such as dramatic changes in the standard errors for parameter estimates. No indications of instability were observed in the models presented here.
4.3 Results

4.3.1 Sample Characteristics

Recruitment of subjects was carried out in order of their admission to the prison system and was continued until the target sample size was achieved. A total of 322 prisoners were reviewed to obtain the sample of 200. Forty of these failed to meet one or more of the eligibility criteria, leaving a response rate of 70.9% among those eligible to participate. Of the 200 men in the final sample, 191 (95.5%) provided complete responses to all items in the ACE questionnaire and 2 (1.0%) declined to answer one question but provided sufficient information to determine ACE exposure for all categories. There were 5 individuals (2.5%) who declined to answer a question or questions that made it impossible to determine their exposure to one ACE category. An additional 2 participants (1.0%) declined to complete the ACE questionnaire and were assumed, for the purpose of this analysis, to have no exposure to ACEs. Response rates for individual questions range from 97.5% to 99.0% (median = 99.0%). A sensitivity analysis was conducted, dropping all individuals with incomplete data from the sample (not shown). This made no appreciable change in the results; therefore findings including the full sample are presented here. Details of the sample demographics are presented in Chapter 3. Briefly, the sample had a mean age of 33.8 years. Majorities of the participants were white (63.5%), were single or co-habiting (66.0%), and had no college education (79%). Around a quarter (22%) were sentenced from counties in the Appalachian region of Ohio.

Table 4.2 provides an overview of cigarette smoking behaviors among the participants. A strong majority of participants (83.5%) had at least one parent who smoked cigarettes. More than a quarter of participants (26%) had initiated smoking by 14
years of age. Nearly three-quarters (74.0%) were current smokers at the time of their arrest, with 45% of all participants smoking at least a pack of cigarettes a day. The prevalence of smoking increased during incarceration (79.0%), however the prevalence of heavy smoking declined to 15% of the sample.

Adverse childhood experiences were widely reported by participants (see Table 4.2). The most commonly reported ACEs were household substance abuse (56.5%) and violent treatment of the mother (29.5%). Around a quarter of participants experienced physical (23.5%) or emotional (24.0%) abuse or had a household member who was mentally ill (24.0%) or incarcerated (25.5%). Sexual abuse, though still affecting 15.5% of the sample, was the least commonly reported adverse event. Only a quarter of residents (25.5%) did not report exposure to any category of adverse experiences, while nearly half (49.5%) reported experiencing two or more ACE categories. Figure 4.2 compares the distribution of ACE scores in the current incarcerated sample with a sample of males from the general population. Incarcerated men were much more likely to have experienced adverse events than their general population counterparts. These differences were greatest at the extremes of the ACE spectrum. Though only about a quarter of prisoners (25.5%) in the current study reported not experience any of the ACE categories, more than half of those in the general population (53.7%) had an ACE score of 0. Men experiencing four or more categories of adverse experiences comprised only 3.9% of the non-institutionalized sample but made up 24.5% of men in prison.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Prevalence, % (n = 200)</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of parental smoking</td>
<td>83.5</td>
</tr>
<tr>
<td>Early smoking initiation (≤14 years old)</td>
<td>26.0</td>
</tr>
<tr>
<td><strong>Pre-arrest smoking status</strong></td>
<td></td>
</tr>
<tr>
<td>Never smoked</td>
<td>21.5</td>
</tr>
<tr>
<td>Former smoker</td>
<td>4.5</td>
</tr>
<tr>
<td>Current smoker</td>
<td>74.0</td>
</tr>
<tr>
<td><strong>Prison smoking status</strong></td>
<td></td>
</tr>
<tr>
<td>Never smoked</td>
<td>16.0</td>
</tr>
<tr>
<td>Former smoker</td>
<td>5.0</td>
</tr>
<tr>
<td>Current smoker</td>
<td>79.0</td>
</tr>
<tr>
<td><strong>Heavy smokers (≥20 cigarettes per day)</strong></td>
<td></td>
</tr>
<tr>
<td>Pre-arrest</td>
<td>45.0</td>
</tr>
<tr>
<td>During incarceration</td>
<td>15.0</td>
</tr>
<tr>
<td><strong>ACE</strong></td>
<td></td>
</tr>
<tr>
<td>Emotional abuse</td>
<td>24.0</td>
</tr>
<tr>
<td>Physical abuse</td>
<td>23.5</td>
</tr>
<tr>
<td>Sexual abuse</td>
<td>15.5</td>
</tr>
<tr>
<td>Mother treated violently</td>
<td>29.5</td>
</tr>
<tr>
<td>Household substance abuse</td>
<td>56.5</td>
</tr>
<tr>
<td>Mental illness in household</td>
<td>24.0</td>
</tr>
<tr>
<td>Incarcerated household member</td>
<td>25.5</td>
</tr>
<tr>
<td><strong>Number of ACE exposures</strong></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>25.5</td>
</tr>
<tr>
<td>1</td>
<td>25.0</td>
</tr>
<tr>
<td>2</td>
<td>18.0</td>
</tr>
<tr>
<td>3</td>
<td>7.0</td>
</tr>
<tr>
<td>4</td>
<td>12.5</td>
</tr>
<tr>
<td>≥ 5</td>
<td>12.0</td>
</tr>
</tbody>
</table>

Table 4.2: Selected tobacco use characteristics and the distribution of adverse childhood experiences in a sample of consecutively admitted, male inmates from two Ohio prisons.
Figure 4.2: Prevalence of adverse childhood experiences in samples of men from an incarcerated population \((n = 200)\) and the general population \((n = 3,859)\). Source for general population numbers: Felitti et al., 1998.

### 4.3.2 Adverse Childhood Experiences and Smoking

Table 4.3 displays the prevalence of each ACE category by smoking behavior (early initiation of smoking, current smoking prior to arrest, heavy smoking prior to arrest, and current smoking in prison) and the association between the ACE categories and smoking behaviors when controlling for demographic factors. Odds ratios relating the ACE categories to early smoking initiation ranged from 0.8 to 2.5 (median OR: 1.1). Only one category of ACE, emotional abuse, was significantly associated with early smoking initiation \((OR = 2.5, 95\% CI: 1.1-5.7)\), however the prevalence of early smoking initiation was higher among exposed individuals for five of the seven categories. While none of the differences were statistically significant, for all ACE categories exposure was associated with a higher prevalence and increased odds of
current smoking at the time of arrest, controlling for demographic factors (range of ORs: 1.1-1.9, median OR: 1.5). When current smoking following incarceration was examined, the pattern was repeated. No odds ratios were significantly elevated, however the prevalence of current smoking in prison was higher in all ACE categories among those who were exposed and six of the seven categories had odds ratios greater than 1.0 when controlling for demographic factors.
<table>
<thead>
<tr>
<th>Category of ACE</th>
<th>Prevalence %</th>
<th>(95% CI)</th>
<th>Early smoking initiation</th>
<th>Prevalence %</th>
<th>(95% CI)</th>
<th>Current smoking (Pre-arrest)</th>
<th>Prevalence %</th>
<th>(95% CI)</th>
<th>Current smoking (Prison)</th>
<th>Prevalence %</th>
<th>(95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotional abuse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>23.68</td>
<td>1.0 (referent)</td>
<td>72.37</td>
<td>1.0 (referent)</td>
<td>77.63</td>
<td>1.0 (referent)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>33.33</td>
<td>2.5(^a) (1.1, 5.7)</td>
<td>79.17</td>
<td>1.6 (0.7, 3.6)</td>
<td>83.33</td>
<td>1.5 (0.6, 3.7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical abuse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>25.49</td>
<td>1.0 (referent)</td>
<td>71.90</td>
<td>1.0 (referent)</td>
<td>77.78</td>
<td>1.0 (referent)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>27.66</td>
<td>1.5 (0.6, 3.4)</td>
<td>80.85</td>
<td>1.9 (0.8, 4.5)</td>
<td>82.98</td>
<td>1.5 (0.6, 3.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sexual abuse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>27.22</td>
<td>1.0 (referent)</td>
<td>73.37</td>
<td>1.0 (referent)</td>
<td>78.11</td>
<td>1.0 (referent)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>19.35</td>
<td>0.8 (0.3, 2.3)</td>
<td>77.42</td>
<td>1.3 (0.5, 3.4)</td>
<td>83.87</td>
<td>1.8 (0.6, 5.1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Battered mother</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>23.40</td>
<td>1.0 (referent)</td>
<td>71.63</td>
<td>1.0 (referent)</td>
<td>78.72</td>
<td>1.0 (referent)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>32.20</td>
<td>1.9 (0.9, 4.0)</td>
<td>79.66</td>
<td>1.5 (0.7, 3.4)</td>
<td>79.66</td>
<td>1.0 (0.5, 2.2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household substance abuse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>22.99</td>
<td>1.0 (referent)</td>
<td>71.26</td>
<td>1.0 (referent)</td>
<td>74.71</td>
<td>1.0 (referent)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>28.32</td>
<td>1.1 (0.6, 2.4)</td>
<td>76.11</td>
<td>1.1 (0.6, 2.3)</td>
<td>82.30</td>
<td>1.3 (0.6, 2.7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household mental illness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>25.66</td>
<td>1.0 (referent)</td>
<td>73.03</td>
<td>1.0 (referent)</td>
<td>78.95</td>
<td>1.0 (referent)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>27.08</td>
<td>1.0 (0.4, 2.1)</td>
<td>77.08</td>
<td>1.1 (0.5, 2.4)</td>
<td>79.17</td>
<td>0.9 (0.4, 2.1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household incarceration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>26.85</td>
<td>1.0 (referent)</td>
<td>73.15</td>
<td>1.0 (referent)</td>
<td>76.51</td>
<td>1.0 (referent)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>23.53</td>
<td>0.9 (0.4, 2.2)</td>
<td>76.47</td>
<td>1.7 (0.7, 4.0)</td>
<td>86.27</td>
<td>2.1 (0.8, 5.4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) _p < 0.05_

Table 4.3: Relationship between adverse childhood experiences and selected smoking behaviors in a sample of recently admitted male prisoners. Odds ratios are adjusted for age, race, education, and sentencing from an Appalachian county.
An examination of the number of ACE categories individuals were exposed to, or ACE score, and its relation to the smoking behaviors showed non-significant trends toward a higher prevalence of tobacco use with increasing ACE exposure for all outcomes: early smoking behavior, current smoking prior to arrest, heavy smoking prior to arrest, and current smoking during incarceration (see Figure 4.3). After controlling for demographic variables, addition of ACE score did not significantly improve the fit of any of the logistic regression models for the smoking behaviors examined, however the adjusted odds ratios tended to increase with higher numbers of ACE categories reported. For each behavior, individuals who had experienced five or more ACE categories had around twice the odds of tobacco use compared to individuals with no ACE exposures (see Table 4.4).
Figure 4.3: Prevalence of smoking behaviors by reported number of categories of adverse childhood experiences.
<table>
<thead>
<tr>
<th>Number of ACE categories reported</th>
<th>Early smoking initiation (OR (95% CI))</th>
<th>Current smoking (Pre-arrest) (OR (95% CI))</th>
<th>Heavy smoking (Pre-arrest) (OR (95% CI))</th>
<th>Current smoking (Prison) (OR (95% CI))</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.0 (referent)</td>
<td>1.0 (referent)</td>
<td>1.0 (referent)</td>
<td>1.0 (referent)</td>
</tr>
<tr>
<td>1</td>
<td>1.2 (0.4, 3.2)</td>
<td>0.4 (0.2, 1.1)</td>
<td>1.2 (0.5, 3.0)</td>
<td>0.8 (0.3, 2.0)</td>
</tr>
<tr>
<td>2</td>
<td>0.8 (0.3, 2.4)</td>
<td>0.8 (0.3, 2.4)</td>
<td>0.8 (0.3, 2.2)</td>
<td>0.4 (0.2, 1.3)</td>
</tr>
<tr>
<td>3</td>
<td>1.3 (0.3, 5.6)</td>
<td>1.6 (0.3, 8.5)</td>
<td>2.7 (0.7, 10.1)</td>
<td>2.5 (0.3, 22.6)</td>
</tr>
<tr>
<td>4</td>
<td>1.4 (0.4, 4.7)</td>
<td>1.4 (0.4, 5.2)</td>
<td>1.3 (0.5, 3.9)</td>
<td>1.2 (0.3, 4.7)</td>
</tr>
<tr>
<td>≥5</td>
<td>2.2 (0.6, 7.4)</td>
<td>1.9 (0.9, 4.1)</td>
<td>1.9 (0.6, 5.8)</td>
<td>1.9 (0.5, 7.9)</td>
</tr>
</tbody>
</table>

Table 4.4: Relationship between the number of adverse childhood experience categories reported and selected smoking behaviors in a sample of recently admitted male prisoners. Odds ratios are adjusted for age, race, education, and sentencing from an Appalachian county.
4.4 Discussion

Given current understandings of the relationships between ACE and deviance\textsuperscript{99, 100} and ACE and health behaviors,\textsuperscript{80, 101} there is a clear need for research into how exposure to adverse experiences during the first 18 years of life may affect the health and health behaviors of prisoners years later. This study presents a preliminary look at the prevalence of adverse childhood experiences in an incarcerated population using the standard definitions put forward in the ACE study.\textsuperscript{80} Describing adverse childhood experiences in an incarcerated population was a secondary outcome of the STOP Project, from which the current data are drawn. The study was powered to accurately estimate the prevalence of smoking among inmates in medium security facilities, a less demanding task than the multivariate modeling employed in the current analysis. Consequently, the sample size did not prove sufficient to detect changes in effect of the magnitude associated with exposure to adverse childhood events. Using the current study as pilot data, a sample size calculation for a univariate logistic regression analysis of ACE and current tobacco use in prisoners was carried out. Detecting an odds ratio of 1.5, the same magnitude that was observed in the current study, with 80\% power and a 5\% type I error rate would require a sample more than 5 times the size of the current study (see Appendix A). Examined another way, the minimum odds ratio detectable by a study of the current size with a 5\% type I error rate and 80\% power is 2.0. Despite this limitation, an examination of trends in the current data can provide insights into how exposure to adverse events in childhood may impact the health of imprisoned adults.
When interpreting the results presented here it is important to take into account the clustering of individuals within facilities, since violation of the assumption of independent errors can lead to underestimation of the variance. Design effects were calculated for several of the comparisons to evaluate the potential impact of the clustering. These are presented in appendix Appendix B. Most of the design effects were very small, indicating that the clustering had little impact on the current conclusions.

One important goal of this project was to evaluate the feasibility of using the ACE questionnaire in the prison setting. Much of the published work on adverse childhood experiences makes use of data collected from paper surveys mailed to participants. Prisoners tend to be less educated than the general population and are therefore more likely to have limited literacy. This raises concerns about using traditional paper-and-pencil questionnaires in prisons, as a subset of prisoners may be unable to read and understand questions or properly record their responses. Personal interviews address this problem by allowing the interviewer to read items directly to participants and record their verbal responses, however research has demonstrated that participants are less willing to share information on sensitive topics when surveys are interviewer-administered. Technology, in the form of A-CASI systems, allows for self-administration of a survey while circumventing the issue of illiteracy. Unfortunately many prisoners have little experience using computers, creating a potential technical barrier. The A-CASI system used in the current study was designed to also address the issue of computer literacy by using a custom data input device consisting only of seven color-coded buttons. This simple design proved to be successful. One participant who reported having no computer experience said after completing the
ACE questionnaire that he had no trouble using the system. Furthermore, no participants refused the ACE questions on the basis of discomfort with the questionnaire format.

Participants’ response rates provide an indication of their comfort with answering sensitive questions in the A-CASI format. The response rate was greater than 97% for all questions on the ACE questionnaire, indicating that participants found sharing sensitive information in the self-interview format acceptable. Though nearly every participant provided responses, this is only beneficial if the data they are reporting is correct. No objective, comprehensive records are available which would allow the validity of these responses to be tested. The Ohio Department of Rehabilitation and Correction (ODRC) does make an effort to collect information on an inmate’s past during the admission process.[82] ODRC data on childhood abuses assembled from “self admissions, social and criminal history records” indicate that 8.1% and 4.8% of male inmates experienced childhood physical and sexual abuse, respectively.[82] Participants in the current study reported three times the prevalence of both physical (23.5%) and sexual (15.5%) abuse using the ACE questionnaire and A-CASI system. Differences in abuse definitions, underreporting due to interviewer-administration of ODRC surveys, and limitations in public record data may explain part or all of this discrepancy, however further work is clearly needed to validate the ACE questionnaire in the prison setting. One positive indicator of response validity is the absence of excessive numbers of extreme observations (ACE score of 0 or 7) that would be expected in the case of severe over- or underreporting. Further study should be undertaken to assess validity and other performance measures, including the test-retest reliability of prisoner-reported ACEs.
In addition to providing information on the logistics of using the ACE questionnaire in prisons, these results provide a first picture of prisoners’ adverse childhood experiences assessed using standard definitions. The high prevalence of ACE exposure among prisoners is striking. These incarcerated men were much more likely to have experienced adverse events during their first 18 years of life than their general population counterparts. More than half of the men in the general population sample reported no history of ACEs compared with only about a quarter of prisoners in the current study.\[80\] At the other extreme, there was a similar divergence; less than 4% of the general population reported exposure to 4 or more categories of ACE, by contrast nearly a quarter of prisoners had more than 3 types of childhood adversity.\[80\]

As noted above, the study did not have sufficient power to make definitive statements about the relationship between ACE and the smoking behaviors of prisoners. Despite this limitation, an examination of patterns in the data can still provide guidance for future work on the topic. For all smoking behaviors there was a general pattern of (non-significant) elevations in risk associated with ACE exposure. A continuation of the ACE Study described earlier examined adverse childhood experiences in a larger sample of non-institutionalized men and added an eighth ACE category “parental separation and divorce” (Table 4.1). In this more detailed analysis, there was found to be a median 95% increase in the odds of early smoking initiation associated with exposure to an ACE category.\[101\] In the current study, the median OR for early initiation and exposure to an ACE category was smaller, 1.1, with 5 of 7 ACE categories having an OR > 1.0. Exposures to ACE categories had a weaker effect on current smoking in the general population sample from the ACE Study, increasing the odds of being a current smoker by a median of 35%. Among the prisoners, current
smoking was evaluated both prior to their arrest and during their incarceration. The odds ratios associated with current smoking prior to arrest were all greater than 1.0 (median OR = 1.5), as were all but one of the ORs for current smoking in prison (median OR = 1.5). Though not statistically significant, these effect sizes are similar to those observed in the general population.

Previous studies have found a dose-response relationship between the number of categories of ACEs a person is exposed to and likelihood of smoking behaviors. A similar pattern was observed in the current data examining early smoking initiation, current and heavy smoking prior to arrest, and current smoking in prison. While not statistically significant, there was a trend toward a greater prevalence of each tobacco use behavior with increasing ACE score. For all behaviors, participants with an ACE score \( \geq 5 \) had around twice the odds of exhibiting the smoking behaviors as someone with no ACE exposures after controlling for potential confounders. Given the much smaller sample size there was more variability in these estimates than those from the ACE study, and the associations seen here were not as strong as those observed in the general population sample, however the direction of the trend presents preliminary evidence that the association between ACEs and smoking behavior does impact prison populations.

A large-scale study is needed to confirm that the observed trends are not merely an artifact of random variations. However if these preliminary findings are borne out by future work, there are several conclusions which can be drawn. First, the high prevalence of adverse childhood experiences among prisoners relative to the general population supports the conventional wisdom that abuse in childhood can lead to deviance and criminality in adulthood. The fact that it also contributes to other
negative health outcomes only underscores the need for stronger societal efforts to reduce child abuse and mitigate its negative impacts as early as possible. Doing this may have the potential to reduce the social and economic burdens of both smoking and mass incarceration. Even if we can reduce future problems by reducing the occurrence of abuse, there is also the separate issue of today’s adults whose lives have been impacted by adverse events in their childhood. The scope of the problem is staggering. If the exposure rates observed here are extrapolated to the nation as a whole, we can expect that there are more than 1.1 million people currently held in U.S. prisons who that experienced at least 1 adverse event and some 470,000 who have experienced 3 or more of these ACEs. The fact that many prisoners may, consciously or unconsciously, be using nicotine as a form of self-medication also has implications for the treatment tobacco use in the prison setting. Helping these people to understand the source of the issue and offering alternative, healthy treatments for the damage that childhood trauma has caused may empower prisoners to overcome their nicotine addiction. This means ensuring adequate funding for prisons’ psychological service departments and providing prisoners with access to medical cessation aids such as nicotine replacement products and antidepressants.

In summary, exposure to adverse childhood experiences was not a significant predictor of prisoner smoking behaviors in this study, however non-significant trends in the data appear to support previous findings that exposure to adverse events in childhood can impact tobacco use later in life. The study does demonstrate the feasibility of using an A-CASI system to collect information from prisoners on their exposure to adverse childhood experiences. High response rates demonstrate
that incarcerated men find this method of collecting sensitive information acceptable; however differences between the rates of abuse reported here and those given in ODRC admission reports underscore the need for further validation of the ACE survey in this setting.\textsuperscript{82} Adverse childhood experiences have been shown elsewhere to be strongly related to tobacco use later in life.\textsuperscript{101} While this study does not provide conclusive proof that the same relationship is at play in incarcerated populations, it does support further study of adverse childhood experiences in this high risk population.
CHAPTER 5

THE STOP PROJECT TOBACCO USE SURVEY:
KEY FINDINGS AND FUTURE DIRECTIONS

The previous chapters have described findings from the STOP Project Tobacco Use Survey, a quantitative study of the tobacco-related behaviors of 200 recently arrived, low-to-medium security male inmates from two Ohio prisons. Three major topics were covered: 1) the measurement of tobacco use in incarcerated populations, 2) patterns of tobacco use by prisoners prior to their arrest and during incarceration, and 3) the relationship between adverse childhood experiences and smoking by prisoners. This chapter highlights key findings from the studies, discusses their significance, and, in closing, suggests directions for future research on tobacco use in prisons.

5.1 Measuring Prisoners’ Tobacco Use

Prior to the STOP Project, only one paper examined the performance of tobacco use measures in prison populations, seeking to identify an appropriate cut point for carbon monoxide breath testing using self-reported tobacco use as the gold standard. The researchers in that study found that CO testing was an accurate means of assessing prisoner tobacco use, however two factors limit the generalizability
of their findings: it included only female inmates and was conducted in a facility without an indoor tobacco ban. The current study collected four measures of tobacco use: 1) prisoner self-reports, 2) exhaled carbon monoxide, 3) salivary cotinine measured by enzyme immunoassay (EIA), and 4) salivary cotinine measured by liquid chromatography tandem mass spectrometry (LC/MS/MS). These measures were then compared using LC/MS/MS measured cotinine as the gold standard for comparisons.

A summary of the test performance is presented in Table 5.1. A comparison with LC/MS/MS results demonstrated the validity of self-reported tobacco by prisoners. Self-reported tobacco use has a high sensitivity and specificity, and can provide researchers with information about variations in tobacco use that may be especially important in the prison setting. These findings should generalize to other correctional settings where smoking is allowed on the grounds, however further studies are needed to determine the validity of self-reports in prisons with total tobacco bans.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Optimum cut point</th>
<th>Sensitivity %</th>
<th>Specificity %</th>
<th>AUC&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-reported tobacco use</td>
<td>N/A&lt;sup&gt;b&lt;/sup&gt;</td>
<td>98.5</td>
<td>88.9</td>
<td>N/A</td>
</tr>
<tr>
<td>Carbon monoxide breath test</td>
<td>≥4 ppm</td>
<td>85.4</td>
<td>91.7</td>
<td>0.922</td>
</tr>
<tr>
<td>Salivary cotinine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enzyme immunoassay</td>
<td>10-21 ng/ml</td>
<td>94.2</td>
<td>100.0</td>
<td>0.971</td>
</tr>
<tr>
<td>LC/MS/MS</td>
<td>≥15 ng/ml&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
<td></td>
<td>— gold standard —</td>
</tr>
</tbody>
</table>

<sup>a</sup> Area under the receiver operating characteristic curve.

<sup>b</sup> Not applicable.

<sup>c</sup> Liquid chromatography tandem mass spectrometry

<sup>d</sup> Cut point recommended by SRNT Subcommittee on Biochemical Verification, 2002.

Table 5.1: Performance of tobacco use measures in a sample of male prisoners. All tests compared to salivary cotinine testing by liquid chromatography tandem mass spectrometry (gold standard).
Of the three measures being tested, the CO breath test had the poorest performance as a standalone test. This is likely due to the brief half-life of CO and irregular pattern of smoking by some in the sample. This does not, however, indicate that breath testing is useless in the prison setting. To the contrary, as a quick, economical, and non-invasive means of measuring tobacco use it could prove very useful for studies in which repeated assessments of smoking can or must be taken; for example, when seeking to confirm abstinence in smoking cessation trials. Adjusting the method of sampling may also help to improve the performance of the measure in future studies. In the current trial, sampling was conduct at varied times throughout the day and the week. By targeting testing at those times soon after participants are likely to have had access to tobacco, for example shortly after meals on the days immediately following commissary visits, the performance of the test may be improved.

EIA testing offers a less-expensive alternative to LC/MS/MS analysis of cotinine samples, however the current study found that this economic savings comes with a cost. While the EIA test performed well overall and correctly identified all non-smokers in the sample, the sensitivity of the test was under 95%, creating a problem with false negative results. This raises serious concerns, as the intention of cotinine testing is often to confirm reported abstinence. It appears that, where economically feasible, cotinine testing using LC/MS/MS is still preferred, however in certain situations, when the prevalence of tobacco use is high and a researcher is seeking biological confirmation of the tobacco use status of users and non-users alike, employing a two stage testing procedure using a first pass with EIA then confirming negative tests results with LC/MS/MS may provide cost savings over testing all samples with LC/MS/MS while not sacrificing any accuracy.
5.2 The Impact of Incarceration on Tobacco Use

Tobacco has long held a special place in U.S. prisons.\(^{33,34,35}\) Tobacco products were often the last luxury left to prisoners. Their durability, portability, and the high demand for cigarettes often made them the de facto currency in the underground prison economy.\(^{36}\) The centrality of tobacco in prison life likely contributes to the high prevalence of smoking observed in incarcerated populations. Past studies have found that up to 85% of male inmates choose to smoke.\(^{31}\) The STOP Project has demonstrated that tobacco use continues to be widespread among the men who make up prison populations, both prior to their arrest and during their incarceration.

The prevalence of current tobacco use among the participants in the Tobacco Use Survey was 77.5% prior to arrest and climbed to 82.0% following incarceration. Smoking was the most common form of tobacco consumption; 76.0% of participants were current smokers before their arrest and 78.5% smoked while in prison. Though the number of smokers increased, per-capita cigarette consumption actually dropped from 15.7 cigarettes per day (cpd) to 8.6 cpd, a decline of more than a third of a pack of cigarettes. Smokeless tobacco was used by 17% of the sample prior to entering prison and 31.5% of participants during incarceration. At both time points most of the smokeless tobacco users were current dual tobacco users, using both smokeless and smoked tobacco products. During incarceration 29% of the sample were current dual users.

As the numbers presented above indicate, entry into the prison system induced dramatic changes in the participants’ patterns of tobacco use. More than a quarter (28.9%) of participants who were not using tobacco prior to their arrest had become current tobacco users by the time they were interviewed, 2-4 months after
entering prison. Adoption of smoking behaviors during incarceration was especially high among those who were former tobacco users when arrested. Former users had a 69.2% chance of resuming tobacco use during incarceration, while only 12.5% of never tobacco users acquired the behavior.

Despite the high prevalence of smoking and other forms of tobacco use, the current study has found signs that prisoners are interested in change. The study included a number of questions about the health effects of smoking. Individuals’ responses to these questions showed an awareness of the negative consequences of using tobacco. When asked about their interest in cessation, 70.0% of participants reported a desire to quit using tobacco. This is comparable to the 74% of non-institutionalized smokers who reported an interest in quitting tobacco in a recent national survey. More than a quarter of the current smokers (29.1%) had made at least 1 quit attempt that lasted 24 hours or longer during their time in prison, however only 5 smokers (10.6%) successfully quit cigarettes. One reason for the low rates of success may be the methods prisoners are using to quit. Rather than seeking medical assistance or behavioral counseling as current guidelines would recommend, most prisoners opt to try to quit smoking cold turkey. Prisoners desiring cessation assistance do have access to nicotine replacement therapies through the commissary, however a single box of nicotine gum or patches costs more than a month’s wages. It is no wonder, then, that no prisoners reporting using these products during their attempts to quit.

This survey of prisoner tobacco use provides the most complete picture to date of changes in individuals’ tobacco use following admission into the U.S. prison system. It has also provided the first look at tobacco use inside prisons with indoor tobacco bans. One clear message that these results convey is the need for comprehensive efforts
to support prisoner tobacco cessation distinct from prison tobacco policy. Indoor tobacco bans, like those in place in the prisons under study, have been shown to improve the quality of indoor air. The current study showed a decrease in average cigarette consumption during incarceration that may be due, in part, to limitations on smoking resulting from the indoor ban. These are certainly positive developments, however they do not tell the entire story. It remains unclear whether reductions in cigarette consumption truly represent reduced exposure or if they are offset by compensatory smoking behaviors. The indoor ban did not prevent the prevalence of smoking and smokeless tobacco use from climbing during incarceration. Also it has been demonstrated in prior research that forced abstinence is not the same as true cessation. Individuals who are forced to quit smoking during their stay in prison are likely to return to former patterns of behavior once released. Prison tobacco policy reforms will play an important role in improving prisoner health during incarceration, but in order to accomplish the larger goals of improving population health and reducing the burden of tobacco-related disease, U.S. prison systems should invest in making comprehensive cessation assistance freely available to all prisoners who are seeking to quit.

### 5.3 Childhood Adversity and Prison Tobacco Use

Exposure to adverse childhood experiences (ACEs) such as abuse and household dysfunction has been found to be strongly related to a variety of negative health behaviors and health outcomes in a general population sample. Adversity early in life has also been linked to deviance and criminality later in the life course. Taken together, these two facts suggest a possible explanation for a third fact:
prisoners tend to have worse health than the general population, with high rates of negative health behaviors like smoking, drug abuse, and risky sexual behaviors.\cite{22,23,26} To explore what role ACEs might play in shaping prisoners’ health behaviors and outcomes an audio computer-assisted self-interview (A-CASI) version of the ACE questionnaire was included in the STOP Project Tobacco Use Survey.

The exploration of ACEs was a secondary objective for the project; the Tobacco Use Survey was powered to accurately estimate the prevalence of smoking in the prisons under study. Though the study does not have sufficient power to provide conclusive evidence of the role of adverse childhood experiences in shaping the tobacco use behaviors of adult prisoners, it provides several compelling reasons to pursue further research into this topic. First, the STOP Project demonstrated the feasibility of using an A-CASI system to collect sensitive information from inmates. Item response rates for even the most sensitive questions on the ACE questionnaire were very high (>97%). Second, the non-significant trends in the data reflect those seen in studies of ACEs and smoking in the general population.\cite{80,101} People exposed to ACEs tended to have a higher odds of smoking behaviors than those with no exposure. Though not statistically significant, the data also suggest a dose-response relationship of increasingly prevalent smoking behaviors with exposure to greater numbers of ACEs. These findings support the theory that childhood adversity plays a role in shaping prisoner tobacco use and call for further study of the topic.

### 5.4 Future Directions

The STOP Project was envisioned not as an attempt to be the final word on prisoner tobacco use, but rather as a preliminary study laying the groundwork for future
research into this important topic. At several points this document has outlined the incredible scope of the prison tobacco problem: 1.5 million people are being held in U.S. prisons with a smoking prevalence of around 70%, annual state correctional expenditures are nearing $50 billion annually, and it remains unknown whether rapidly changing prison tobacco policies are meeting their stated goals of improving prisoner health and reducing the costs of incarceration. The need for more research is clear. The STOP Project has illuminated several promising paths for future studies to pursue.

First, by gathering accurate measures of tobacco use in recently arrived inmates under an indoor tobacco ban, the STOP Project provides baseline data for an assessment of the impact of the total tobacco ban recently implemented in Ohio prisons. The implementation of total tobacco bans in prisons has occurred rapidly enough, and the length of time it takes to gain the approvals necessary for conducting prison research is long enough, that researchers have little time to collect baseline data before policies are put into place. A lack of baseline data has made formal evaluation of new prison tobacco policies impossible. As a result of this problem there have been no studies published on how prisoners’ tobacco use changes under a total tobacco ban. The STOP Project provides an opportunity to fill this gap in knowledge. A project evaluating the impact of a total smoking ban on prisoner tobacco use behaviors is long overdue given the current trend toward total tobacco bans in U.S. prisons. Key research questions to be answered include: 1) How do the smoking behaviors of incarcerated individuals change with the onset of a total tobacco ban? 2) How do the smoking behaviors of individuals newly admitted to a prison with a total tobacco ban
change? and 3) How are these changes different from those experienced by people admitted to prisons with only an indoor smoking ban?

As the previous section suggests, another important topic for study is the role of adverse childhood experiences in shaping prisoner health. The STOP Project has demonstrated the feasibility of collecting ACE data from prisoners using A-CASI systems and provided preliminary data supporting the generalization of ACE theory to prison populations. What is needed now is a much larger study capable of supplying more conclusive evidence in support of or opposition to generalization of the ACE theory to prison populations. Such a study should incorporate pilot work confirming the validity and reliability of prisoners’ self-reported exposure to ACEs. In addition to collecting information on childhood adversity, the survey should gather information on the varied health behaviors (e.g., smoking, drug abuse, risky sexual behaviors, diet and exercise) and health outcomes (e.g., heart disease, pulmonary dysfunction, depression) that have been linked to ACEs in the general population. In the longer term, the focus should be on translational research, applying the theory to improve population health. Simply understanding the causes of health behaviors, without determining practical applications, does little good for anyone. It is only once ACE theory begins to impact our treatment and prevention efforts that its full promise will be realized.

A third course of study meriting pursuit is an examination of the health impact of prison tobacco policies. A major limitation of the current study is its limited scope; the STOP project has focused solely on the impact of incarceration on smoking behaviors. While tobacco exposure is a well-documented risk factor for numerous
diseases, there are limits to the conclusions that can be drawn based solely on exposure information. For health researchers in the U.S., the state prison systems offer a unique opportunity: here are well-defined populations with universal healthcare coverage and with single payer systems in place documenting outcomes and economic expenditures. Variations in state policies create the natural experiments that are the heart of observational research. It may not be possible to gain access to individual prisoner medical records, however mortality studies will soon be made possible by the Deaths in Custody Reporting Program (DCRP).[104] The DCRP was created by the Death in Custody Reporting Act of 2000 and collects data on every inmate death occurring during their custody in a state prison facility. The data are not currently available to the public, however staff at the National Archive of Criminal Justice Data are in the process of finalizing a data dissemination plan, which will allow for access to the information by the late spring or early summer of 2009.[105] The DCRP data could be combined with longitudinal data on prison tobacco policies and the availability of tobacco cessation programming to assess whether there are changes in the cause specific or overall mortality rates following implementation of an indoor or total tobacco ban. A study showing a dramatic drop in the rate of acute myocardial infarction in Helena, Montana following implementation of a public smoking ban changed many peoples’ perspectives on the potential benefits of public smoking restrictions.[106] However, limitations of the observational study, especially relating to the small study size and mobility between exposed and unexposed groups, cast doubt on the findings.[107] A study of prison tobacco policy, which could easily offer a large sample size and well defined exposure groups, could provide some much
needed clarity on the true health effects of public tobacco restrictions, both inside prisons and out.

5.5 Concluding Thoughts

The scale of the problems surrounding the issue of incarceration in the United States is daunting. Despite more than a quarter century of steadily climbing incarceration rates there seems to be no end in sight, and this is accompanied by ballooning financial demands on budgets already hit hard by tough economic times. Even within the very narrow issue of prisoner tobacco use the problem can seem insurmountable. While rates in the general population have fallen to record lows, the prevalence of smoking among prisoners has remained stubbornly high. Efforts by prison administrators’ to improve prisoner health by restricting access to tobacco are undermined by black market sales. The problem is big, certainly, but there is much that can be done.

I have come to believe that a major reason for the scope of the prison tobacco problem is neglect. Within America’s crowded prisons the psychiatric services are often overburdened leaving prisoners to self-medicate with tobacco or other drugs, while tight budgets mean few resources are directed toward the treatment of prisoners’ tobacco addiction. The scientific community has also neglected prisoners. Special protections for prisoners as research subjects are surely necessary after past abuses, however the perceived barriers those requirements impose have led to a scarcity of quality research into prisoner health. As of this writing, a Pub Med search for “prison smoking cessation” returns only 20 hits, a third of which have been published in the past year and none of which date to earlier than 8 years ago. The field is ripe for
advancement. Yes, the problems are great, but it is my hope that the STOP Project Tobacco Use Survey has taken the first steps on the road to a solution.
APPENDIX A

SAMPLE SIZE AND POWER CALCULATIONS FOR LOGISTIC REGRESSION ANALYSIS OF ADVERSE CHILDHOOD EVENTS

Exposure to adverse childhood experience was observed to increase the odds of current smoking by around 50% in both current study and prior research (See Chapter 4, Figure 4.3). We can determine the sample size needed for a univariate logistic regression analysis to detect a change of this magnitude using the equation given by Hosmer and Lemeshow.

\[
n = \left( \frac{z_{1-\alpha} \sqrt{2\hat{P}(1-\hat{P})} + z_{1-\theta} \sqrt{\hat{P}_0(1-\hat{P}_0) + \hat{P}_1(1-\hat{P}_1)}}{(P_1 - P_0)^2} \right)^2 \]  

(A.1)

where \( P_0 \) = probability of current smoking in those unexposed to an adverse childhood experience, \( P_1 \) = probability of current smoking in those exposed to an adverse childhood experience, and \( \hat{P} = (P_0 + P_1)/2 \).

From Figure 4.3 we find that the average prevalence of current smoking prior to arrest among those without ACE exposure is \( P_0 = 0.724 \). The prevalence of smoking among the exposed that would yield an odds ratio of 1.5 can be calculated as

\[
P_1 = \frac{\text{OR} \times P_0}{(1 - P_0) + \text{OR} \times P_0} = \frac{1.5 \times 0.724}{(1 - 0.724) + 1.5 \times 0.724} = 0.797 \]  

(A.2)
a prevalence similar to that observed in the current study. We can now calculate
\[ P = \frac{(0.724 + 0.797)}{2} = 0.761. \]
Combining these numbers with the values for a two sided test with \( \alpha = 0.05 \) and 80% power Equation A.1 becomes

\[
n = \frac{\left(1.96\sqrt{2} \cdot 0.761 \cdot 0.239 + 0.842 \sqrt{(0.724)(0.276) + (0.797)(0.203)}\right)^2}{(0.797 - 0.724)^2} = 534.97
\]

or 535 people per group for a total sample size of around 1070 to detect an OR of 1.5 with 80% power and a 5% type I error rate.

Equation A.1 can be used to determine the minimum detectable OR for a given sample size \( n \) by stating \( P \) in terms of \( P_0 \) and \( P_1 \), plugging in the known values and solving for \( P_1 \). Doing this we find that for a sample size of 200, with 80% power and a 5% type I error rate, the exposed group would have to have a smoking prevalence of around 84%, the equivalent of an odds ratio of 2.0.
APPENDIX B

DESIGN EFFECTS OF CLUSTERING WITHIN SITE

In the current study participants were drawn from two facilities. The clustering of individuals within facilities can result in intraclass correlations, that is to say, individuals in the same facility are likely to be more alike than two individuals randomly sampled from the population under study. Correlations among covariates within individuals from the same cluster (the intraclass correlations or ICC) can lead to underestimation of variances when using the formulas assuming independent errors. The impact of a clustered sample design on variance estimates can be gauged using a formula for the design effect ($DEFF$).\[^{109}\]

\[ DEFF = 1 + (m - 1) \times (ICC_y) \times (ICC_x) \]  \hspace{1cm} (B.1)

where $m$ is the number of observations within each group, $ICC_x$ is the intraclass correlation for the dependent variable, and $ICC_y$ is the intraclass correlation for the dependent variable. Table B.1 displays the design effects for various tests calculated using Equation B.1. Design effects were generally very small and would not impact the conclusions of the statistical tests conducted in this exploratory analysis of adverse childhood experiences and their impact on prisoner smoking behaviors.

114
Table B.1: Design effects for selected tests of the impact of exposure to adverse childhood experiences on smoking outcomes.
BIBLIOGRAPHY


