

PSYCHOLOGICAL HEALTH AND SMOKING IN YOUNG ADULthood: SMOKING
TRAJECTORIES AND RESPONSIVENESS TO STATE CIGARETTE EXCISE TAXES

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ABSTRACT

Allison M. Schmidt: Psychological Health and Smoking in Young Adulthood:
Smoking Trajectories and Responsiveness to State Cigarette Excise Taxes
(Under the direction of Shelley D. Golden)

While smoking rates have significantly decreased among the general population in the past several decades, they have not significantly decreased among those with poorer psychological health. As posited by theories such as the Transactional Model of Stress and Coping, smoking may represent an important coping mechanism for individuals who experience stress or unpleasant feelings related to poorer psychological health. If poorer psychological health is experienced during young adulthood, a critical time for tobacco use experimentation and uptake, individuals may be particularly likely to become dependent on nicotine and develop longer term smoking habits. In addition, tobacco control policies that have reduced tobacco use in the general population, like raising the price of cigarettes, may be less effective among people with poorer psychological health. Using two indicators of psychological health, a continuum of psychological distress and ever diagnosis of a mental illness, this dissertation explored first, how psychological health accounts for variability within and between individuals in trajectories of smoking (status and amount) across the ages of 18 to 30, and second, whether psychological health moderates the effectiveness of cigarette excise taxes in preventing and reducing smoking. Using a longitudinal national sample across years 2007 to 2013, between-individual effects were found such that individuals with poorer psychological health were more likely to be smokers and to smoke greater numbers of cigarettes over young adulthood than those with better

psychological health (Aim 1 and Aim 2). Additionally, the positive effect of having a diagnosed mental illness on smoking amount increased with age, suggesting older young adults may be important targets for intervention (Aim 1). While the effect of cigarette excise taxes encouragingly was not shown to differ by psychological health, cigarette excise taxes showed little effect on smoking at all, perhaps suggesting taxes need to be raised higher than they have been to meaningfully impact smoking (Aim 2). Interventions should aim to target high-risk young adults with poorer psychological health to treat unpleasant psychological symptoms simultaneously with smoking prevention and cessation programs. Overall, this work helps us understand the relationships between psychological health, smoking, and tobacco control policy, with implications for interventions.

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LIST OF ABBREVIATIONS

CI	Confidence interval
ICC	Intraclass correlation coefficient
N	Sample size, entire sample
n	Sample size, subset of entire sample
OR	Odds ratio
PSID	Panel Study of Income Dynamics
SD	Standard deviation
SES	Socioeconomic status
TA	Transition to Adulthood Supplement
US	United States

CHAPTER 1: INTRODUCTION AND RESEARCH QUESTIONS

Cigarette Smoking and Psychological Health

Tobacco use continues to be the leading cause of preventable death in the U.S., responsible for the loss of 440,000 lives each year.¹ While the prevalence of tobacco use has declined in the general population in the past several decades, it has not significantly declined among those with symptoms of poorer psychological health.² Individuals with indications of poorer psychological health, including both diagnosable mental health conditions (such as depression or anxiety disorders) and high levels of psychological distress, are more likely to smoke and to experience nicotine dependence than those without any indications of poorer psychological health.^{1,3-8} Currently, the prevalence of smoking is about 18% in the general population,⁹ but is 36.1% among adults with any mental health condition.¹⁰ While those with any mental health condition comprise 28.3% of the U.S. population, they make up 41% of current smokers and nearly 60% of ever daily smokers.¹¹ Thus, there is a significant disparity in tobacco use by psychological health among adults in the U.S.

The positive relationship between psychological health and smoking persists across different types of psychological health constructs, including varying levels of psychological distress,¹² as well as several clinically diagnosed mental illnesses, such as Post-Traumatic Stress Disorder (PTSD),¹³ depression,¹⁴ and anxiety.³ In addition to being at greater risk of smoking, people with indications of poorer psychological health are less likely to successfully quit smoking than are those without such indications.¹³ Further, in smoking more over time, people

with poorer psychological health increase their susceptibility to and the severity of tobacco-related diseases, like lung cancer and cardiovascular disease.¹⁵ Thus, understanding the relationships between smoking and psychological health are important to address a critical public health disparity.

While smoking is often conceptualized in the theoretical and empirical literature as a coping response to deal with unpleasant symptoms of poorer psychological health (an explanation developed further in Chapter 2), there is some mixed research on the directionality of this relationship. Some studies suggest that smoking and its resultant withdrawal symptoms may actually exacerbate symptoms of poorer psychological health in the long term, while providing temporary relief, promoting strong nicotine addiction among those using cigarettes to avoid unpleasant withdrawal symptoms.^{5,16,17} Specifically, smokers report experiences of improvements in mood and reduced irritability and tension after smoking;¹⁶ however, while symptoms such as anxiety or depressed mood may be somewhat alleviated immediately after smoking, these symptoms may be heightened by nicotine withdrawal as an individual craves their next cigarette. Some longitudinal (although not prospective) studies have found smoking or nicotine dependence to predict depression,¹⁸⁻²⁰ while others have found the reverse.²¹

In reality, this relationship is likely bidirectional;^{22,23} for example, a 5-year longitudinal study of young adults found both that a history of major depression at baseline predicted daily smoking, and that a history of daily smoking at baseline predicted major depression.²⁴ Other research suggests that smoking initiation prior to the onset of a mental health condition may be in response to genetic predisposition that exists before recognizable symptoms of mental illness develop.²⁵ In other words, the effect of psychological health on smoking is likely due to both distal (e.g., genetic) and proximal (e.g., negative reinforcement to relieve unpleasant feelings)

factors. Overall, while smoking cigarettes, or adapting the body to the intake of nicotine, is more damaging than therapeutic over time,²⁶ it is still often used as a coping mechanism to temporarily manage symptoms of poorer psychological health.

Defining Psychological Health

One challenge to understanding the relationships between psychological health and smoking is that across studies, psychological health is defined in different ways. Two important conceptualizations of psychological health include diagnoses of particular mental health conditions that fit clinical definitions, and levels of psychological distress experienced at a particular point in time.

Psychiatric diagnosis. Perhaps most commonly, psychological health is thought of as mental health or illness, or specifically the presence or absence of a particular diagnosable condition. Conditions most commonly measured in the smoking literature include emotional disorders, such as schizophrenia,²⁵ nervous conditions, including anxiety,²⁷ and other psychiatric conditions, such as depression.²⁴ Several prior studies have demonstrated the strong link between many different types of psychiatric conditions and smoking.¹¹

Psychological distress. Separate from clinical diagnoses of mental health conditions, other often less severe indications of poorer psychological health, such as psychological distress, may also affect behavioral outcomes such as smoking.^{28,29} Psychological distress reflects a range of felt symptoms of anxiety, depression, worry, fatigue, and thoughts of death, among others, whether or not such symptoms are present at clinically significant levels.²⁸ Psychological distress further reflects both distress experienced in response to life events, such as traumatic events, and trait neuroticism, or one's proneness to experience psychological distress.³⁰ In a study of substance users (that met criteria for at least one substance abuse or substance dependence

diagnosis), trait neuroticism was shown to be associated with avoidant coping, lack of confidence in self-restraint to use substances, and reported triggers of substance use including negative emotional states, social rejection, and tension.³⁰ It has also been argued that proneness to psychological distress reflects a biological predisposition towards both depression and smoking.³¹

This concept of psychological distress, while not reflective of a clear, specific diagnosable condition, is important because it is not only severe mental illnesses that predict smoking; on a continuum, psychological distress has been shown to be positively associated with both likelihood of smoking and the number of cigarettes smoked per day.¹² Thus, distress is an important component of psychological health in the context of smoking, distinct from mental health or illness. In two separate studies, this dissertation investigated the links between psychological health, conceptualized both as the presence or absence of a mental health condition and level of psychological distress, on smoking.

Young Adulthood as a Critical Period

Smoking behaviors and symptoms of poorer psychological health often develop as adolescents transition into young adulthood, suggesting this is a critical period that shapes smoking over the life course. Approximately 80% of regular smokers initiate smoking before age 18,³² and nearly 100% before age 26.¹ Further, those who continue smoking into young adulthood are at greatest risk of being a regular smoker in later adulthood and experiencing lifetime tobacco-related diseases and premature death.^{33,34} Young adulthood is also a critical period for the emergence of indications of poorer psychological health; three quarters of all lifetime cases of mental health conditions start by age 24,³⁵ and young adults have been shown to experience higher rates of mental health conditions than older adults.¹² Continuity of symptoms

of poorer psychological health from adolescence to young adulthood has been shown to predict continued smoking in young adulthood.³⁶ Furthermore, poorer psychological health in young adulthood has been linked to both current and lifetime nicotine dependence.³⁷ Overall, young adulthood is a critical period during which to study both smoking and psychological health.

Furthermore, the impact of psychological health on smoking may not be consistent across all of young adulthood; influences on smoking may change as individuals age from 18 to 30 years over this period. For example, one study of smoking trajectories from adolescence to adulthood found that among those who sharply increased their smoking after age 18, previously protective factors (such as having a stable nuclear family and high levels of parental education) seemed to lose their effectiveness by young adulthood.³⁸ Thus, examining smoking levels at the outset of young adulthood and smoking growth rates throughout young adulthood are important to understanding the progression of smoking, also called smoking development or growth in this dissertation, and the impact of psychological health on this smoking development.

State Cigarette Excise Taxes

In tobacco control, one of the most successful and well-researched strategies to reduce smoking on a population level is to increase taxes, and therefore prices, of cigarettes.³⁹⁻⁴¹ Over the past several decades, state and federal taxes have increased; between 2002 and October 2015, 47 states and DC enacted more than 120 separate increases in state cigarette excise taxes.⁴² Since 2005, the federal cigarette excise tax has increased 3 times, including a jump from 39 cents per pack to its current rate of \$1.01 in 2009,⁴³ with a resulting decrease in smoking.⁴⁴ Cigarette taxation as a tobacco control strategy is regarded as being particularly effective among young people, who are often more price sensitive consumers than older adults.^{44,45} Studies have shown that cigarette excise taxes reduce smoking by preventing smoking initiation,^{46,47} facilitating

smoking cessation,⁴⁸ and reducing the number of cigarettes smoked among smokers^{1,41} (although not all studies have found this^{49,50}). Overall, raising the price of cigarettes through state and federal cigarette excise taxes is seen as an effective approach to reducing smoking, despite some mixed results in the literature. However, based on continuously high rates of smoking among those with poorer psychological health, it is possible that raising state cigarette excise taxes has not been as effective among this sub-population of young adults. If individuals with poorer psychological health view cigarettes as necessary for self-medication to relieve unpleasant symptoms of poorer psychological health, they may be less sensitive to price changes than their peers with better psychological health.

Research Questions and Aims

This dissertation tests how psychological health impacts smoking development, and the effect of state cigarette excise taxes on smoking behavior, in young adulthood, using longitudinal data from a national sample. Specifically, Aim 1 examined how psychological health explained variability between individuals around a mean smoking trajectory as individuals age through young adulthood, and how perturbations in psychological health within individuals over time change individual smoking trajectories as well. Aim 2 investigated the impact of state cigarette excise tax rates on young adult smoking behavior, and how psychological health moderates this relationship. In both aims, two facets of psychological health were examined: a dichotomous indicator of self-reported psychiatric diagnosis and a continuous measure of psychological distress.

Research Question 1

What is the form of the average smoking trajectory among young adults as they age from 18 to 30 years of age, and to what extent does psychological health explain differences in smoking between and within individuals over time?

Aim 1: To determine the nature of the average trajectory of smoking among young adults, and the degree to which psychological health explains differences in smoking between and within individuals throughout young adulthood.

Aim 1a: To determine the nature of change (linear or quadratic) in smoking over time on average among young adults, and whether there is random variability around the intercept and slope of this trajectory.

Aim 1b: To examine between-individual effects of self-reported diagnosis on smoking by determining whether self-reported diagnosis predicts variability between individuals in the intercept and slopes of a mean smoking trajectory over young adulthood.

Aim 1c: To examine between-individual effects of personal average psychological distress on smoking by determining whether personal average psychological distress predicts variability between individuals in the intercept and slopes around the mean smoking trajectory over young adulthood.

Aim 1d: To examine within-individual effects of distress changes on smoking by determining whether perturbations in distress from a person's average distress predict time-specific deviations from an individual's smoking trajectory.

Research Question 2

To what extent do state cigarette excise tax rates differentially impact smoking for young adults based on their psychological health?

Aim 2: To determine whether psychological health moderates the relationship between state cigarette excise tax rates and smoking among young adults.

Aim 2a: To determine whether state cigarette excise tax rates impact smoking among young adults in a national sample between 2007 and 2013.

Aim 2b: To determine whether having a self-reported psychiatric diagnosis (e.g. anxiety, depression) moderates the expected inverse relationship between state cigarette excise tax rates and smoking among young adults.

Aim 2c: To determine whether psychological distress (as measured by the Kessler 6 scale of Nonspecific Psychological Distress)⁵¹ moderates the expected inverse relationship between state cigarette excise tax rates and smoking among young adults.

Implications for Tobacco Regulatory Science and Intervention

The purpose of this research is to better understand first, how psychological health influences the trajectory of smoking behavior in young adults, and second, whether psychological health impacts the responsiveness of young adults to changes in prices of cigarettes. Both of these research questions have clear implications for tobacco regulatory science and interventions.

Despite tobacco control successes in reducing smoking among the general population over the past several decades,⁴⁰ disparities persist such that those with symptoms of poorer psychological health are far more at risk of smoking than are those without symptoms of poorer

psychological health.⁸ Much is left to be understood in terms of how psychological health impacts the development of smoking over young adulthood, a critical period for determining continued regular smoking. Understanding how psychological health affects smoking trajectories as young adults age may suggest times (for example, towards early or late young adulthood) at which psychological health and smoking cessation services may be especially needed to limit smoking over the lifetime. Furthermore, teasing apart how psychological health affects variability between individuals around a mean smoking trajectory, as well as within individuals over time, may help identify different audiences for and types of intervention strategies. Specifically, if one's average psychological health during young adulthood affects variability between individuals in smoking at the outset of young adulthood and over time, this would indicate that some individuals are predisposed to smoke more, given their generally lower levels of psychological health. This finding could suggest, for example, that guidelines for mental health practitioners include counseling for smoking prevention or cessation services as part of initial mental health diagnoses. On the other hand, if changes to individuals' smoking trajectories are observed in response to perturbations in psychological health over young adulthood, perhaps indicative of going through a particularly challenging event or situation, this suggests that individuals are reactive to changes in psychological health, independent of their overall "normal" or average level of psychological health. Smoking prevention and cessation programs could then be developed and tailored for groups or communities experiencing stressful events, such as mass layoffs or natural disasters, or in the context of stressful life transitions, like failing coursework or losing a job. Both of these results therefore point to distinct strategies for intervention approaches.

With respect to one potential tobacco control intervention strategy, state cigarette excise taxes, while prior research has established that taxing cigarettes effectively reduces population levels of smoking, it is unclear if this strategy is exacerbating disparities in smoking among young adults with poorer psychological health. If young adults are less responsive to state cigarette excise taxes when they show symptoms of poorer psychological health, it would appear that existing state tax policies are not adequately reaching this population. In fact, by raising prices on a product that people in poorer psychological health continue to purchase, such policies could unintentionally create financial hardships, a stressor that could trigger additional consumption and dependence among an already vulnerable population. Thus, understanding if the effectiveness of state taxes in reducing smoking is moderated by psychological health is key to reducing the smoking disparity by psychological health. Such results would provide evidence that additional policy approaches, and/or interventions to help young adults cope with symptoms of poor psychological health and stop smoking, are needed to protect susceptible individuals from tobacco-related disease and a lifetime of nicotine dependence. If, contrary to expectations, young adults with poor psychological health do not appear to respond differentially to state taxes, increasing state cigarette taxes may be shown as a feasible and effective strategy to reduce tobacco use in this population.

Overall, this research will address serious gaps in the literature about the relationships among smoking, psychological health, and state tobacco control policy. This research provides crucial information about the nature of the relationship between psychological health and smoking development, as well as concrete evidence of the need to pursue additional and new approaches to reduce smoking among young adults with poorer psychological health. This foundational work on a persistent health disparity helps shape the development of effective

policies and programs to prevent addiction, tobacco-related disease, and premature death among a vulnerable population.

CHAPTER 2: THEORY AND CONCEPTUAL MODEL

Transactional Model of Stress and Coping

A possible explanation for the higher rates of smoking among those with poorer psychological health is posited by the Transactional Model of Stress and Coping.⁵² In this model, feelings of stress, stemming from stressful experiences, distress, or symptoms of a mental health condition, lead to healthy or unhealthy coping responses, which may include smoking.⁵² This theory posits that stress disrupts homeostasis, or the balance within the body, affecting physical and psychological states, such as mood or emotion.⁵² The impact of a source of stress is mediated by an individual-level appraisal of the significance of the stressor (in the primary appraisal process), and next, his/her coping resources, such as social support, and perceived ability to change the situation (in the secondary appraisal process). Actual coping efforts deployed in response to these appraisals may include problem management strategies to change the stressful situation, and emotional regulation strategies to change the way one thinks or feels.⁵² Further, coping responses may be adaptive, such as seeking instrumental social support or engaging in relaxation techniques, or maladaptive, such as avoidance of the source of stress and denial.⁵³ Smoking may emerge as a maladaptive emotion regulation coping response, leading to (temporary) relief or improved mood.⁵² In this process, those with poorer psychological health are likely both to have higher exposures to significant stressors and fewer resources to change their situations, affecting the primary and secondary appraisal processes and resulting coping responses.

With respect to types of stress, exposure to stressful events is linked to both smoking and poorer mental health.⁵⁴ One study found that reporting exposure to five or more adverse childhood experiences (e.g., emotional, physical, and sexual abuse, a battered mother, parental separation or divorce, and growing up with a substance-abusing, mentally ill, or an incarcerated household member) was associated with earlier smoking initiation, and higher risks of current and ever smoking. Further, the relationship between exposure to stressful events and smoking was strong and positive with each added negative life event experienced. Additionally, current smokers showed more problems with past-year depression than nonsmokers for any number of experienced adverse childhood events, showing positive relationships among stress exposure, poorer psychological health, and likelihood of smoking.⁵⁴

In addition to being more likely to have experienced stressful events, those with poor psychological health are further likely to be disadvantaged in other ways, increasing experiences of chronic stress. These include disproportionately living in poverty,⁵⁵ experiencing discrimination, victimization, and social exclusion, and having higher risk of premature mortality from other health conditions.⁵⁶ Overall, those with poorer psychological health are exposed to greater stress than those without mental illness, stemming either from psychiatric symptoms of the illness itself (such as anxiety or depressive symptoms), or from conditions (such as stigmatization or job loss) that may coexist with it.¹¹ Thus, these higher levels of stress increase the need for coping responses among those with poorer psychological health.

While experiencing higher levels of stress, those with poorer psychological health further may be less able to cope with unpleasant symptoms than those with better psychological health, as their perceived (and actual) ability to access resources and change a situation are diminished. Those with poorer psychological health are likely to have fewer coping resources available to

them, including social support and financial security,⁵⁷ thus affecting the secondary appraisal process of the Transactional Model of Stress and Coping where resources and perceived ability to change a situation are assessed. As a result, those with indications of poorer psychological health are likely to engage in less adaptive coping strategies, increasing their risk of smoking as a coping response.⁵³

Young adults with poorer psychological health are thus more likely to have more stress, to have fewer coping skills and resources, and, as shown by empirical evidence, to turn to smoking for relief from unpleasant symptoms, than are young adults with better psychological health. Maladaptive coping strategies (e.g., avoidance, self-blame, denial) as compared to adaptive coping strategies (e.g., seeking social support) are more common among young adult smokers,⁵⁸ predictive of continued smoking among young people,⁵⁹ and repeatedly associated with depressive symptoms.^{53,60} Similarly, with respect to diagnosed mental health conditions, adaptive coping responses were less likely among people with schizophrenia with increasing symptoms severity,⁵³ and among those with a history of Major Depressive Disorder.⁶¹ Overall, this theoretical and empirical literature shows a complex relationship between stress, psychological health, and smoking.

The Transactional Model of Stress and Coping is also closely related to the tension reduction hypothesis in the substance use literature, which posits that those with indications of poorer psychological health may smoke to reduce tension and negative affect or mood.⁶² The tension reduction hypothesis is useful as it does not presuppose an external source of stress, but rather focuses on an individual's responses to experiencing unpleasant symptoms of poorer psychological health. In support of this model, negative affect has been linked to both greater lifetime smoking and failure to successfully quit smoking.⁶³ In addition, individuals prone to

experience psychological distress have also been shown to smoke more to control negative affect.⁶⁴ Young adults specifically have been shown to use substances to regulate negative affect as well.⁶² A study of college students found that the link between higher depressive symptoms and higher smoking was fully mediated by expectations that smoking would reduce nervousness, improve mood, and help cope with feelings of being upset.⁶⁵ Thus coping with stress by lowering feelings of tension and improving mood have been shown to be important motivations for smoking behavior, particularly among those with poorer psychological health.

The empirical literature showing higher exposure to stress, fewer coping resources, and the use of smoking as a coping response by those with poorer psychological health supports the Transactional Model of Stress and Coping and tension reduction hypothesis as potential explanatory models of higher smoking in this population. Research framed by both of these models shows that those with poorer psychological health are exposed to greater stress, have fewer coping resources, and are often less able to effectively regulate their negative affective experiences or unpleasant feelings in healthy ways, compared to their peers with better psychological health, and thus are more prone to smoke as a coping response.

Psychological Health and Smoking Development in Young Adulthood

Poorer psychological health may affect the development of young adult smoking in several ways, as explained by theoretical models, such as the Transactional Model of Stress and Coping and tension reduction hypothesis, and supported by empirical evidence. Smoking in general increases as individuals age through young adulthood, and tends to decrease slightly by the mid to late twenties.⁶⁶ However, among those with poorer psychological health, a leveling off or decrease may not occur, given the higher levels of stress, lower ability to cope in adaptive ways, and higher likelihood of smoking among those with poorer psychological health.⁶⁶ In

addition to levels of psychological health and smoking being associated, increases in indications of poorer psychological health may be associated with increases in smoking. Thus, psychological health may explain individual variability in smoking over young adulthood, such that those with indications of poorer psychological health, whether averaged or reflected by perturbations during young adulthood, may smoke more and increase smoking at higher rates than those without such indications. These relationships will be tested using growth curve models in Aim 1 of this dissertation (Chapter 3).

State Cigarette Excise Taxes, Economic Theory, and Smoking in Young Adulthood

One of the most well documented and effective tobacco control policies to reduce smoking in the population is taxation of cigarettes.³⁹⁻⁴¹ To explain the empirical finding of higher taxes lowering smoking among young adults, traditional economic theory posits that consumer demand for cigarettes is elastic, meaning that as prices go up, demand for cigarettes goes down.⁶⁷ Specifically, the price elasticity, or percent change in consumption from a 1 percent increase in the price, is generally found to be around 0.4 for cigarettes, indicating that for every 10% increase in the cost of cigarettes, consumption of cigarettes decreases by about 4%.⁴⁵ Overall, economic theory assumes a rational individual who makes conscious decisions about where to spend his or her financial resources to account for the inverse relationship between states excise cigarette taxes and smoking among young adults.

Economic theory explains too how young adults, compared to older adults, will be especially responsive to changes in cigarette prices,^{44,45,68} as they have fewer financial resources, and may be less addicted to cigarettes having smoked for a shorter period of time.⁶⁷ As a result, the value of money to them is high, and the value of cigarettes relatively low, compared to some other smokers, so they may be more likely to reduce or stop smoking when prices go up.

Yet the Transactional Model of Stress and Coping and tension reduction hypothesis indicate that motives for smoking are often not purely rational or driven by financial calculations; they are instead complex, involving a range of biological, cognitive, and behavioral factors.⁶⁹ Behaviorally, emotional arousal, including symptoms of mental health conditions and distress, limit one's capacity to act rationally.⁷⁰ Biologically, nicotine withdrawal symptoms promote addiction to cigarettes and prompt continued smoking, as do expectations that cigarettes will help one to cope with everyday challenges by improving mood, reducing stress and anxiety, and improving concentration and performance.⁶⁹ Thus, smoking is an addictive behavior, both physically through the effects of nicotine, and behaviorally, through its positive effects of reducing feelings of stress and negative affect.

Those with poorer psychological health may be especially prone to continued smoking, as they have been shown to be biologically predisposed to be nicotine dependent,³ have fewer cognitive and social resources to effectively cope with unpleasant mood or emotions, leading to smoking as a coping strategy,⁵⁷ and may lack the capacity to make fully rational decisions.⁷⁰ Thus the decision to continue buying cigarettes, despite price increases as a result of state cigarette excise taxes, is likely to be a biologically and emotionally driven one, more so than a rational choice about where to best spend one's resources. The impact of psychological health on the usually negative relationship between state cigarette excise taxes and young adult smoking was tested in Aim 2 of this research (see Chapter 4).

Conceptual Model and Hypotheses

Figure 1 represents a depiction of the key relationships hypothesized in this dissertation. On a societal level, state cigarette excise taxes have been shown to reduce population smoking, but individual level factors, such as age and psychological health affect smoking as well. In

general, poorer psychological health is likely to have a positive relationship with smoking status and amount. Hypotheses for each sub-aim are below; based on past research, some of these hypotheses are more specific than others.

Hypotheses: Aim 1

Aim 1a. Consistent with previous literature, the average smoking trajectory will show general increases in smoking amount over time from age 18 until the mid to late 20s, then decrease through the end of young adulthood at age 30.

Aims 1b and 1c. Psychological health (conceptualized separately as self-reported diagnosis of a mental health condition and average personal distress) will account for variability between individuals in the intercept and slope around a mean smoking trajectory, such that those with indications of poorer psychological health will smoke more at the outset of young adulthood and at higher rates over time.

Aim 1d. Perturbations in psychological health (measured by distress changes relative to personal average distress) will alter individual smoking trajectories, such that smokers will smoke more in response to “dips” in psychological health relative to their personal mean psychological health in young adulthood.

Hypotheses: Aim 2

Aim 2a. There will be an inverse relationship between state cigarette excise tax amount and smoking over young adulthood.

Aims 2b and 2c. The negative relationship of state cigarette excise tax rates and smoking will be moderated by psychological health, such that those with poorer psychological health (measured by self-reported psychiatric diagnosis and distress) will reduce their smoking behavior less than those with better psychological health, in response to higher state taxes.

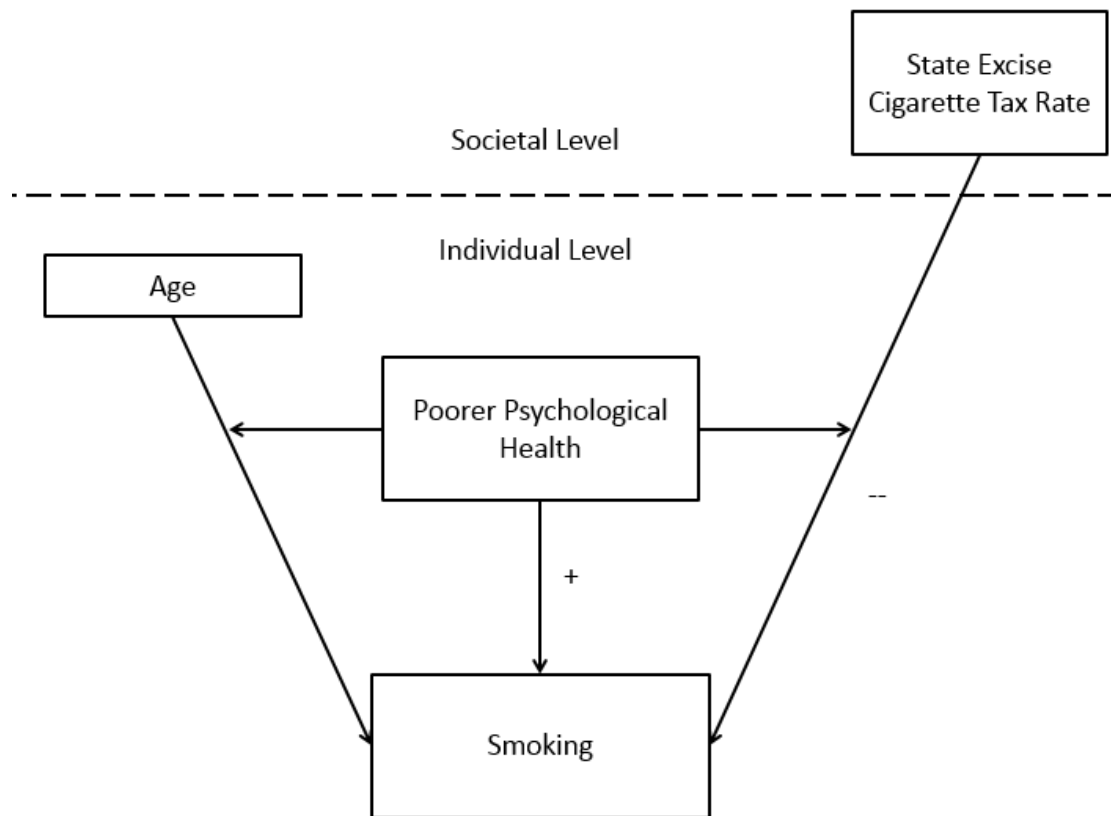


Figure 1. Full Conceptual Model

CHAPTER 3: STUDY 1 – TRAJECTORIES OF YOUNG ADULT SMOKING BY PSYCHOLOGICAL HEALTH

Introduction

Young adulthood is a critical time for determining smoking over the life course, given that individuals who continue to smoke throughout this period are likely to remain regular smokers throughout their lives, and be more susceptible to a host of tobacco-related diseases.^{15,33,34} There are striking disparities in smoking by psychological health, such that individuals with any mental health condition comprise nearly 60% of ever smokers, yet make up only 28.3% of the U.S. population.¹¹ If poorer psychological health (i.e., distress or mental illness) is experienced during young adulthood, a critical time for tobacco use experimentation and uptake, individuals may be particularly likely to become dependent on tobacco and develop longer term smoking habits. The current research investigates how psychological health affects smoking status and consumption across young adulthood using two important conceptualizations of psychological health: having a diagnosis of a particular mental health condition and level of psychological distress.

Theories such as the Transactional Model of Stress and Coping,⁵² and the tension reduction theory^{71,72} from the substance abuse literature, explain how smoking can be used as a coping response to reduce unpleasant feelings. In these models, feelings of stress, stemming from stressful experiences, distress, or symptoms of a mental health condition, lead to healthy or unhealthy coping responses, which may include smoking.⁵² Empirical research framed by both of these models shows that individuals with poorer psychological health are exposed to greater

stress,⁵⁴ have fewer coping resources,⁵⁷ and are often less able to effectively regulate their negative affective experiences or unpleasant feelings in healthy ways, compared to their peers with better psychological health, and thus are more prone to smoke as a coping response.⁵³

Overall, those with poorer psychological health are exposed to greater stress than those with better psychological health, stemming either from unpleasant symptoms (such as anxiety or depressive symptoms), or from situations (such as stigmatization or job loss) that may coexist with such symptoms.¹¹ Those with poorer psychological health are likely to have experienced more stressful events,⁵⁴ and to be disadvantaged in other ways, increasing experiences of chronic stress, such as disproportionately living in poverty,⁵⁵ experiencing discrimination, victimization, and social exclusion, and having higher risk of premature mortality from other health conditions.⁵⁶ Thus, these higher levels of stress increase the need for coping responses among those with poorer psychological health.

While experiencing higher levels of stress, young adults with poorer psychological health also may be less able to cope with unpleasant symptoms than those with better psychological health, as their perceived (and actual) ability to access resources and change a situation are diminished,⁵⁷ making them more likely to engage in less adaptive coping strategies, including smoking.⁵³ Maladaptive coping strategies (e.g., avoidance, self-blame, denial) as compared to adaptive coping strategies (e.g., seeking social support) are more common among young adult smokers,⁵⁸ predictive of continued smoking among young people,⁵⁹ and repeatedly associated with depressive symptoms^{53,60} and mental health conditions.^{53,61}

With respect to age, while many regular smokers start smoking before the age of 18, smoking prevalence continues to increase in young adulthood.³⁴ When modeled linearly, smoking amount, often measured in number of cigarettes smoked per day, has also been shown

to generally increase over young adulthood as well.¹⁵ Research that has modeled smoking over young adulthood in quadratic, not linear form, shows general patterns of increasing smoking, but also a leveling off and decreasing in smoking by the later years of young adulthood.^{66,73}

While general patterns of increasing and later decreasing smoking are observed at a population level, existing research further suggests differences in smoking progression throughout young adulthood by indicators of psychological health. Studies using growth mixture models to group individuals into a set of homogenous smoking trajectories have found different patterns of smoking among different groups of young adults. One study identified six distinct trajectories of smoking among young adults aged 13 to 23: calling the prototypical trajectory groups “nonsmokers”, “stable highs,” “early increasers,” “late increasers,” “decreasers,” and “triers.”³⁸ This work and similar studies have shown that participants who reported symptoms of poorer psychological health were disproportionately found among groups that smoked (at all) at higher rates and increase their smoking amount over young adulthood^{38,74,75} and those that initiate smoking during young adulthood.⁷⁶ From these growth mixture modeling studies, it is clear that there are distinct patterns of smoking development among different groups of individuals, and that poorer psychological health increases the likelihood of being in a group that smokes more over time.

Distinct from growth mixture modeling studies, growth curve model studies show individual differences in smoking development around a mean smoking trajectory. One previous study has used a growth curve model approach to track smoking from adolescence to young adulthood in a manner similar to was done in the current study. In this work, Fuemmeler and colleagues (2013) found that psychological health explained individual variability in the intercept (age 13) and slope (changes between ages 13 to 32) of the mean smoking status

trajectory, such that having indications of lower psychological health, in this case, the presence of depressive symptoms, were associated with greater probability of being a smoker at age 13 and reduced deceleration in the likelihood of smoking towards the end of young adulthood.⁶⁶ However, having depressive symptoms at baseline did not explain any individual variability in the intercept and slope of the mean smoking amount trajectory, measured by number of cigarettes smoked per day.⁶⁶ Overall, this study showed that having indications of poorer psychological health predicted smoking status at the outset of young adulthood and over time throughout young adulthood, both with distinct intervention implications.

While providing important evidence that psychological health explains individual differences in current smoking over young adulthood, this research leaves some limitations to be addressed in the current study. Fuemmeler and colleagues (2013) used only a dichotomous measure of the presence or absence of baseline depressive symptoms at age 13 to test whether psychological health explains individual variability around an average smoking trajectory.⁷⁷ As a result, the study failed to capture a full range of levels and types of psychological health. If other aspects of psychological health, like levels of distress, have additional incremental impacts on smoking status and amount, as previous research has found,¹² this study may have underestimated its effects. Furthermore, the one-time measurement of depressive symptoms does not allow for the assessment of changes in psychological health over time, especially important during the key developmental period of young adulthood. In contrast, longitudinal data on psychological health allows for more accurate assessment of average psychological health over young adulthood with multiple measures over time, as well as analyses of within-individual effects of how perturbations in psychological health affect changes in smoking over time.

The current study builds on and addresses limitations of this past research by using two measures of psychological health, including one that varies (and is assessed at multiple points) over time. Examining the effects of two types of psychological health allow for a more robust understanding of the types of, and extent to which, psychological health affects smoking in young adulthood. The inclusion of a time-varying measure helps distinguish effects *between* young adults and *within* young adults in smoking over time. Specifically, to assess the nature of this relationship between psychological health and smoking, psychological health was parsed into its stable, between-person component, to account for lower average levels of psychological health observed in some individuals compared to others, and its short-term, within-person component, capturing perturbations in psychological health within individuals over young adulthood. The overall research question investigated, followed by specific aims below, is: What is the form of the average smoking trajectory among young adults as they age from 18 to 30 years of age, and to what extent does psychological health explain differences in smoking between and within individuals over time?

Aim 1: To determine the nature of the average trajectory of smoking among young adults, and the degree to which psychological health explains differences in smoking between and within individuals throughout young adulthood.

Aim 1a: To determine the nature of change (linear or quadratic) in smoking over time on average among young adults, and whether there is random variability around the intercept and slope of this trajectory.

Aim 1b: To examine between-individual effects of self-reported diagnosis on smoking by determining whether self-reported diagnosis predicts variability between individuals in the intercept and slopes of a mean smoking trajectory over young adulthood.

Aim 1c: To examine between-individual effects of personal average psychological distress on smoking by determining whether personal average psychological distress predicts variability between individuals in the intercept and slopes around the mean smoking trajectory over young adulthood.

Aim 1d: To examine within-individual effects of distress changes on smoking by determining whether perturbations in distress from a person's average distress predict time-specific deviations from an individual's smoking trajectory.

Conceptual Model

Synthesizing the theoretical and empirical literatures, self-reported diagnosis of a psychiatric condition and/or psychological distress can lead to smoking as a coping strategy. From past research, smoking is expected in general to increase across most of young adulthood, and to decrease in later years. Further, for those that use smoking as a coping mechanism, psychological health may explain some variability between and within individuals in smoking status and amount over young adulthood. These relationships were tested using a growth curve model, and are shown in the conceptual model (Figure 2).

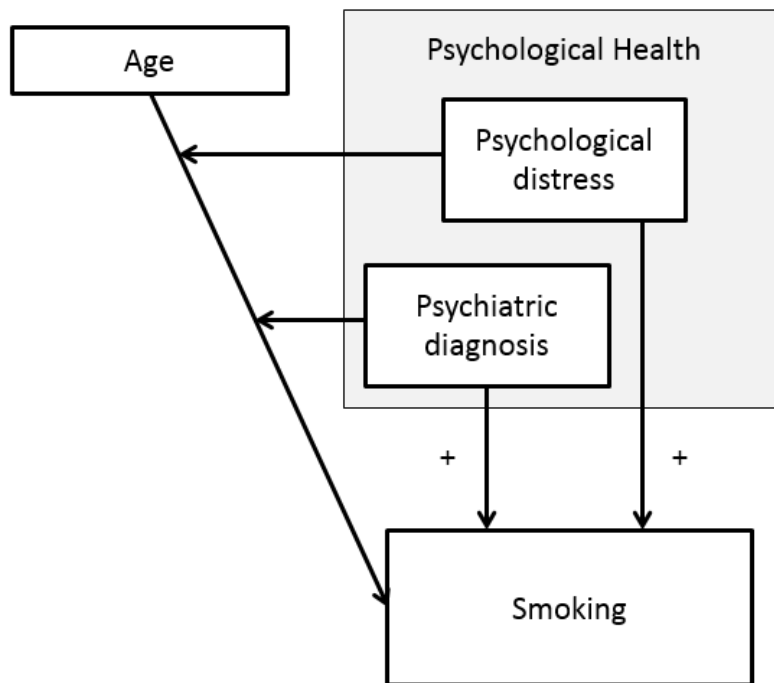


Figure 2. Aim 1 Conceptual Model

Methods

Data Source

The Panel Study of Income Dynamics (PSID) is a longitudinal panel survey that has tracked a probability sample of US families since 1968.⁷⁸ Surveys are now conducted every other year, and the sample continues to be reasonably representative of the US population today.⁷⁹ Children of the original families that form their own households are tracked as well, increasing the sample size each year, from about 5,000 families in 1968 to over 9,000 in 2013. In 1999, health behavior questions, including cigarette smoking, were added. To account for the changing demographic nature of the country, immigrant samples were added in 1990 (a Latino-only sample, dropped after 1995), 1997 (a more representative sample of 441 post-1968 immigrant families), and 1999 (an additional 70 families). In each household, only one respondent is surveyed; this respondent is either a head or partner of the household. The survey itself tracks a

range of family data as well as more extensive information on financial, employment, mental health, behavioral, and other variables on the respondent. In households with a head and partner, the respondent is asked to speak for his/her spouse's smoking status, but only respondents are asked about their own mental health. Thus, only respondents each year were tracked, whether they were designated as a head or partner in the PSID main interview.

The current research used data both from the PSID main interview and from a special supplement focused on young adults. The main interview tracks information about heads of households and their partners; the Transition to Adulthood (TA) supplement tracks information about young adults aged 18 to 24 years who are not yet heads of or partners in their own households. The TA supplement was added to the PSID in 2005 and has been conducted via telephone interview in parallel with the PSID every other year shortly after completion of the main interview. The main interview and TA supplement collect some of the same types of information, including smoking behavior and psychological health, although differ in several ways as well; the main interview collects data on areas such as education, income, employment, health, fertility, and household expenditures of the heads of household. Topics covered in the TA supplement include psychological functioning, marriage, family, responsibilities, employment and income, education and career goals, health, social environment, religiosity, and outlook on life (Panel Study of Income Dynamics, 2014). This study used smoking and psychological health data from all available waves of the PSID main interview and TA supplement beginning in 2007 (i.e., 2007, 2009, 2011 and 2013). Prior to 2007, psychological health data was not consistently collected in both surveys.

Analytical Sample

To model the impact of psychological health on two distinct smoking outcomes, current smoking status and number of cigarettes smoked, two analytical samples were created. Models of smoking amount included all eligible observations of young adults, and models of the number of cigarettes smoked included those who had reported currently smoking or ever being a smoker, before or during the study period. As most smoking initiation occurs before age 18,¹ these ever smoker individuals were thought to be most susceptible to using smoking as a coping mechanism; subsetting our sample in this way allowed us to test the impact of psychological health on smoking amount among this important subgroup.

The analytical sample includes the 2007 cohort of young adults aged 18 to 24 years, as well as any new individuals aged 18 or 19 who enter the PSID (TA or main interview) in 2009. This group was followed across years 2007, 2009, 2011, and 2013 until they were aged 22-30 by 2013. In this sample, 2,490 were respondents (i.e. heads, partners, or TA respondents) that had more than one age-eligible observation to assess change over time. To keep the sample consistent across models, observations missing on key variables were dropped (N=35, 1.4% of eligible respondents), as were any cases that did not have two or more age-eligible responses as a result (N=107, 4.3% of eligible respondents). Multiple imputation was not performed as less than 6% of eligible respondents had missing data and were dropped from analyses.

The final analytical sample size was 2,348 people who were observed collectively a total of 7,730 times (Table 1). Overall, this sample is fairly gender-balanced (55.1% female, 44.9% male), mostly made up of non-Hispanic White (45.7%) and Black (41.8%) individuals compared to Hispanic (10.4%) and “Other” (2.0%) racial groups, aged 23.5 on average, with a wide range of family incomes (mean: \$59,000), living with an average of 2.7 family unit members. Many

(82.5%) completed high school and 33.8% were married at any point during data collection. With respect to psychological health, 16.2% of the sample reported having a psychiatric diagnosis, and the mean of personal mean distress scores was 4.6 on a scale of 0 to 24. With respect to smoking status, the majority of the sample were consistent non-smokers (66.3%), 19.4% currently smoked at least one time during data collection, and 14.3% were consistent smokers.

To meaningfully assess the impact of psychological health on smoking amount among ever smokers, thought to be especially susceptible to turning to smoking as a coping response relative to those who had never smoked, a second analytical sample was created of young adults who reported ever being a smoker either prior to or during the study period. An indicator variable of ever smoking, during one of the observation periods or at a point prior to data collection, was created and used to identify the second sample. This second sample was also created also to account for the large number of consistent nonsmokers in the sample as a whole.

The analytical sample size for current or ever smokers was 1,374 individuals, observed a total 3,349 times (Table 1). Overall, this sample is fairly gender-balanced (49.3% female, 50.7% male), mostly made up of non-Hispanic White (46.4%) and Black (42.0%) individuals compared to Hispanic (9.8%) and “Other” (1.9%) racial groups, aged 24 on average, with a wide range of family incomes (mean: \$50,000), living with an average of 2.7 family unit members. Most (75.9%) completed high school and 28.3% were married at any point during data collection. With respect to psychological health, 19.5% reported having a psychiatric diagnosis, and the mean of personal mean distress scores was 4.8 on a scale of 0 to 24. With respect to smoking status, consistent non-smokers made up 42.7% of the sample, while about 33.0% currently

smoked at least one time during data collection, and 24.3% were consistent smokers. The mean number of cigarettes smoked per day was 3.6.

Table 1. Aim 1 Sample Characteristics

	Sample 1: All N=2,348	Sample 2: Ever Smokers N=1,383
	n (%) Mean (SD)	n (%) Mean (SD)
Gender:		
Female	1,294 (55.1%)	682 (49.3%)
Male	1,054 (44.9%)	701 (50.7%)
Race:		
White	1,073 (45.7%)	641 (46.4%)
Black	982 (41.8%)	581 (42.0%)
Hispanic	245 (10.4%)	135 (9.8%)
Other	48 (2.0%)	26 (1.9%)
Mean age* (years)	23.5 (2.4), range 18.5 to 29	24.0 (2.3), range 18 to 28.3
Mean family income* (in \$10,000)	5.9 (6.9), range 0.0 to 133.5	5.0 (6.8), range 0.0 to 133.5
Mean number of family unit members*	2.7 (1.3), range 1 to 13	2.6 (1.3), range 1 to 13
Completed high school+	1,938 (82.5%)	1,050 (75.9%)
Married+	794 (33.8%)	392 (28.3%)
Has psychiatric diagnosis+	380 (16.2%)	270 (19.5%)
Mean distress*	4.6 (3.1), range 0 to 20.7	4.8 (3.2), range 0 to 20
Current smoking status^:		
Consistent non-smokers	1,556 (66.3%)	591 (42.7%)
Inconsistent smokers	456 (19.4%)	456 (33.0%)
Consistent smokers	336 (14.3%)	336 (24.3%)
Mean number of cigarettes smoked per day*		3.6 (5.1), range 0 to 27.5

*Mean values refer to grand means of the sample across all years of data collection

+Refers to having reported completing high school, being married, or having a diagnosis at any wave of data collection

^As measured across available data points for each individual. Consistent non-smokers are those who were not current smokers at any point of data collection (although may have reported being an ever smoker in their lifetime). Inconsistent smokers have reported current smoking during at least one (but not all) available data points. Consistent smokers presorted current smoking at all waves at which they were observed.

Measures

To best capture the effects of psychological health on smoking behavior, this research incorporated two measures of smoking (current smoking status and smoking amount) and two

measures of psychological health (a dichotomous measure of having been diagnosed with an emotional, nervous, or psychiatric condition and a continuous measure of psychological distress).

Dependent variable: Current smoking status. Whether a participant currently smoked at each year of data available for each person was assessed with the question, “Do you smoke cigarettes?” with responses “yes” and “no”.

Dependent variable: Smoking amount. Current smoking amount was measured as the number of cigarettes smoked per day. It was based on a question asked of current smokers (in a given year) as, “How many cigarettes per day do you usually smoke?” to which a continuous whole-number response was given. If an individual did not report smoking at a particular wave, their number of cigarettes smoked was coded as “0”.

Independent variable: Age. To test how smoking develops over young adulthood, age of the respondent at the time of interview was used as an independent variable. To consider potential non-linear effects of age, a quadratic term for age (age^2) was included in the model.

Independent variable/Moderator: Self-reported diagnosis of emotional, nervous, or psychiatric condition. A binary indicator of ever self-reported diagnosis of any emotional, nervous, or psychiatric problem was used, reflected by a reported “yes” to the question, “Has a doctor or other health professional ever told you that you had any emotional, nervous, or psychiatric problems?” An affirmative response in any wave of data in the study identified participants with a self-reported clinically significant and diagnosed mental illness.

Using a measure of ever diagnosis across the years of data collected was chosen in part because one may have a psychiatric condition years before it is officially diagnosed;³⁵ this measure captures any participants who are diagnosed at any point within the six years of the observation period.

Independent variable/Moderator: Psychological distress. The Kessler-6 measure of psychosocial distress assesses the frequency with which respondents have experienced six symptoms of psychological distress in the past 30 days feeling: (1) nervous, (2) hopeless, (3) restless or fidgety, (4) so sad or depressed that nothing could cheer the respondent up, (5) that everything is an effort, and (6) worthless. Response options included “all of the time”=4, “most of the time”=3, “some of the time”=2, “a little of the time”=1, and “none of the time”=0. Scores of each item on a 4-point scale were summed. Thus, every one unit increase in this measure could indicate feeling a particular symptom more often, or the presence of a new symptom.

While some studies have used this variable as a dichotomous one, with a total score of 13 or greater as indicative of serious psychological distress,^{80,81} or a score of 5 or greater as indicative of moderate levels of distress,²⁸ other research has found a continuous relationship between smoking likelihood and amount and psychological distress score.¹² To best capture the continuum of psychological distress that may lead to smoking, the current study treated the K6 as a continuous measure, using participants’ scores from 0 to 24.

To capture variation in psychological distress across individuals (i.e., how more or less distressed a person usually is compared to others), as well as variation in psychological distress within individuals over time (i.e., how more or less distressed an individual is compared to his or her average each year), two variants of the K6 were used. An individual’s personal average distress level across all years of data collection captured between individual variation in distress, and the amount of an individual’s positive or negative deviation from this average at each year captured within-individual variation in distress over time.

Control variables: Gender, race/ethnicity, education, marital status, income, number of family unit members, and year. Covariates that may be linked with smoking and

psychological health are gender, race/ethnicity, education, marital status, income, and number of family unit members. Also, an indicator of year of data collection was added to the model to control for period effects. Income and year varied over time; all other controls were kept time-stable to be consistent across all models.

Gender was indicated dichotomously by the sex of the respondent.

To measure race, participants were asked, “What is your race? Are you white; black; American Indian or Alaska Native; Asian; Native Hawaiian or other Pacific Islander?” and allowed to mention up to three races. Interviewers could also code for “Other” race if a participant mentioned a race that was not on this list. Participants were coded as their first mentioned race, to be replaced by their second or third mention only if their first mention is missing or “Other.” As there were very small numbers of American Indians, Asians, and Pacific Islanders, these groups were collapsed and combined with the “Other” category. A fourth category was added to this race variable if participants responded that they were of Hispanic ethnicity, asked in a separate question in the survey; the other racial groups included non-Hispanic individuals only. For analyses, the reference group was non-Hispanic whites.

To capture a meaningful measure of education during a time when young adults are often in the process of obtaining higher education, an indicator of whether respondents completed high school by any wave of data collection was incorporated.

To tap into a measure of social and financial support, which can affect psychological health and smoking, marital status,⁸² measured as having been currently married during any year of data collection, was also used as a control variable.

Family income was used as an additional measure of socioeconomic status, based on measures calculated by PSID staff and included in the dataset. This family income variable

represents taxable income, transfer income, and social security income for the previous year reported by all family unit members living together in a household, coded in \$10,000 units. To account for the number of people providing for and being supported by that income amount, the number of family unit members was also included as a covariate. “Family” refers to all family unit members living together in a household, which could be a young adult’s family of origin or the family of the young adult if he/she no longer lives with the family of origin.

Analytic Approach

This research explored the use of a growth curve model over age, to model outcomes of smoking status, using logistic regression, and current smoking amount among smokers, using Poisson regression, to account for the non-normal distribution of the number of cigarettes smoked. First, the visual nature of growth trajectories was inspected by plotting the mean smoking trajectories over young adulthood across the sample and found to appear quadratic in form. Next, unconditional growth models with age and age² were fit for each of smoking outcomes and the ICC was measured. From these unconditional analyses it was determined whether to proceed with a multi-level model of observations (Level 1) nested within individuals (Level 2) over time, or to use a single level model of individuals based on the relative amount of within-individual to between-individual variation in smoking outcomes.

Time-stable and time-varying measures of psychological health were then added to the unconditional growth model as appropriate. Two time-invariant measures of psychological health (self-reported psychiatric diagnosis and average distress during young adulthood) were used to assess the degree to which psychological health affects smoking *between* individuals. In multi-level models, one time-varying measure (changes in distress relative to personal average distress) was to assess the degree to which psychological health affects smoking *within*

individuals over time. More specifically, when multi-level models were deemed appropriate, a measure of time-specific perturbations from one's personal average distress level were also added to assess the intra-individual effects of distress on smoking (i.e., if distress perturbations affect the amount smoked, independent of the effects of average distress). This method of disaggregating the distress variable, as laid out by Aiken and West (1991),⁸³ allows for the separate testing of within and between individual effects of distress on smoking. Furthermore, it can help prevent errors of inference whereby between-individual effects (e.g., individuals who smoke more tend to have more distress), are incorrectly assumed to hold at the within-individual level (e.g., individuals smoke more when they are more distressed). In the current research, while symptoms of poorer psychological health are expected to have a positive relationship with smoking, whether between or within individuals, understanding which of these two types of effects are sizeable and significant has important intervention implications for public health practitioners and policymakers preventing and reducing smoking among young adults.

Unconditional models. To determine the nature of change (linear or quadratic) in smoking over time on average among young adults, and whether there is random variability around the intercept and slope of this trajectory to warrant multilevel analyses, unconditional models (without covariates) were tested.

The unconditional models had a two-level hierarchical structure, with Level 1 representing observations of smoking within individuals over time (time-varying), denoted with a subscript i in the equations below, over ages, denoted by a subscript t , and Level 2 representing the effects of person-level characteristics that are consistent within individual over time (time-stable). The Level 1 model is represented by the following equation, with an age of 18 years

chosen as the centering constant using notation in Raudenbush and Stein (2002).⁸⁴ The random effects r are permitted to covary with one another.

$$S_{ti} = \Pi_{0i} + \Pi_{1i}(\text{AGE}_{ti}-18) + \Pi_{2i}(\text{AGE}_{ti}-18)^2 + e_{ti}$$

S_{ti} is the odds of ever being a current smoker during the study or the number of cigarettes smoked for individual i at time t ;

Π_{0i} is the intercept, specifically individual i 's mean smoking at age 18;

AGE_{ti} is the age of individual i at time t ;

e_{ti} is the level 1 error, assumed to be independent and normally distributed with common variance s^2 for all t

The unconditional Level 2, or person level, includes the following components:

$$\Pi_{0i} = \beta_{00} + r_{0i}$$

β_{00} reflects mean baseline (age 18) smoking across individuals (where all other variables in the model=0)

r_{0i} is the residual random variation of baseline (age 18) smoking with variance σ_{ε}^2

$$\Pi_{1i} = \beta_{10} + r_{1i}$$

Π_{1i} represents the instantaneous linear growth rate of smoking at age 18

β_{10} is the mean growth rate of smoking in linear form at age 18

r_{1i} is the random effect of the linear growth rate of smoking with variance σ_{ε}^2

$$\Pi_{2i} = \beta_{20} + r_{2i}$$

Π_{2i} represents an individual's acceleration of smoking

β_{20} is the mean acceleration rate of smoking

r_{2i} is the random effect of the quadratic growth rate of smoking with variance σ_{ε}^2

Models of current smoking status and smoking amount. Where sufficient within-person variation was found in the outcomes of current smoking status and smoking amount, warranting a multilevel model structure, covariates were added to the models above at the appropriate level (i.e., diagnosis and average distress at the Level 2 or person level model, and perturbations from average distress at the Level 1 or time-varying observation level model). For outcomes for which little within-person variation was found, a single level model of person-level characteristics only was used (and distress perturbation was dropped from the model).

Results

Unconditional Models

Unconditional model: Odds of being a smoker – Aim 1a. The unconditional model of the odds of smoking over young adulthood, with a random coefficient specified for age to allow the relationship between age and smoking to vary by person, showed a mean trajectory of current smoking over young adulthood that was quadratic in form. The odds of current smoking at age 18 (the intercept) was 0.02 (95% CI: 0.01, 0.03). The odds of smoking over time significantly increased by age (OR: 1.23; 95% CI: 1.06, 1.43); however, the rate of growth decreased over time (OR: 0.96; 95% CI: 0.95, 0.98).

The ICC of this model is 0.88 (95% CI: 0.85, 0.90), indicating that the vast majority of the variation in current smoking existed at the person level, or that, when including a random effect of age, there was not much variation in current smoking status over time (88% of the variation was between individuals; 12% of the variation was within individuals). Given the low level of within-individual variation in smoking status over time, to meaningfully assess how psychological health affects changes in smoking status within individuals over time (i.e., for those individuals who switched from being a smoker to nonsmoker or vice versa), the models for

odds of current smoking were analyzed as single level models with between-individual predictors only.

Unconditional model: Number of cigarettes smoked – Aim 1a. Among those that were current or ever smokers, the unconditional model of number of cigarettes smoked per day showed a mean trajectory of the number of cigarettes over young adulthood that was quadratic in form. The log of the expected number of cigarettes smoked at age 18 (the intercept) was 1.69 (95% CI: 1.36, 2.09). Smoking amount significantly increased by age, such that every one year increase in age was associated with a 1.11 factor increase in the number of cigarettes smoked (95% CI: 1.05, 1.17), and this growth rate decreased over time (IRR: 0.97; 95% CI: 0.97, 0.98).

The ICC of this model was 0.56 (95% CI: 0.49, 0.63), indicating that 56% the variation in number of cigarettes smoked was due to variation between individuals and 44% of the variation was due to variation within individuals over time. As supported by these data, in the models of number of cigarettes smoked, multilevel models were used to allow for the assessment of both between-individual and within-individual predictors of smoking amount among ever smokers.

In these models, to test how psychological health affects individual variability around mean smoking for each age (not just age 18, the intercept), an interaction term of age by psychological health (diagnosis or distress) was added. To probe significant interactions, results were plotted, for example for diagnosis, as: smoking by self-reported diagnosis at ages 18 (the minimum age), 24 (the mean age), and 30 (the maximum age), and the point estimates and significance level of the simple slope of self-reported diagnosis on smoking at each of these ages were reported.⁸⁵

Odds of Being a Smoker

Odds of being a smoker: Self-reported diagnosis – Aim 1b. The odds of a young adult with a psychiatric diagnosis also being a smoker were 2.71 times as high as the odds of a young adult without a diagnosis (95% CI: 2.12, 3.47). Being male was associated with 1.93 higher odds of being a current smoker relative to being female (95% CI: 1.59, 2.34). Covariates associated with having lower odds of being a smoker included being Black or Hispanic, relative to being White, associated with 0.73 (95% CI: 0.58, 0.91) and 0.43 (0.30, 0.61) lower odds of being a smoker respectively, having completed high school, associated with 0.25 lower odds of being a smoker (95% CI: 0.19, 0.32), being married, associated with 0.76 lower odds of being a smoker (95% CI: 0.61, 0.95), and having higher income, associated with 0.96 lower odds of being a smoker for every additional \$10,000 in income (95% CI: 0.94, 0.98). (See Table 2.)

Odds of being a smoker: Distress – Aim 1c. Higher levels of personal average distress were associated with higher odds of being a smoker, such that a one unit increase in personal average distress was associated with 1.47 higher odds of being a smoker (95% CI: 1.34, 1.62). Being of older age was associated with 1.05 higher odds of being a smoker for each additional year of age (95% CI: 1.01, 1.10), and being male was associated with 1.92 higher odds of being a current smoker (95% CI: 1.58, 2.32). Covariates associated with lower odds of being a smoker included being Black, Hispanic, or of “Other” race, compared to being White, associated with 0.62 (95% CI: 0.50, 0.78), 0.41 (95% CI: 0.28, 0.58), 0.46 (95% CI: 0.22, 0.95) lower odds of being a smoker respectively, having completed high school, associated with 0.24 lower odds of being a smoker (95% CI: 0.19, 0.31), and having higher income, associated with 0.97 lower odds of being a smoker for each additional \$10,000 in income (95% CI: 0.95, 0.99). (See Table 2.)

Table 2. Odds of Being a Current Smoker (N=2,348)

	Effect of Diagnosis			Effect of Distress		
	OR	95% CI		OR	95% CI	
Diagnosis	2.71*	2.12	3.47			
Personal average distress				1.47*	1.34	1.62
Mean age	1.03	0.99	1.08	1.05*	1.01	1.10
Individual level covariates						
Male	1.93*	1.59	2.34	1.92*	1.58	2.32
Race (ref=White)						
Black	0.73*	0.58	0.91	0.62*	0.50	0.78
Hispanic	0.43*	0.30	0.61	0.41*	0.28	0.58
Other	0.52	0.25	1.08	0.46*	0.22	0.95
Completed high school	0.25*	0.19	0.32	0.24*	0.19	0.31
Married	0.76*	0.61	0.95	0.82	0.66	1.03
Family income (in \$10,000)	0.96*	0.94	0.98	0.97*	0.95	0.99
No. family unit members	1.08	1.00	1.17	1.06	0.98	1.15

***Bold text:** 95% CI does not include 1

Number of Cigarettes Smoked

Number of cigarettes smoked: Self-reported diagnosis – Aim 1b. In a model controlling for covariates and including age as a random coefficient, with an interaction term for diagnosis*age, the effect of diagnosis did vary by age, such that the effect of diagnosis increased as age increased. Specifically, at age 18, the effect of diagnosis was not significant (IRR: 1.27, 95% CI: 0.91, 1.78), but at age 24 (the mean), the effect of diagnosis was significant and positive, such that having a diagnosis was associated with a 1.58 factor increase in the number of cigarettes smoked (IRR: 1.58, 95% CI: 1.01, 2.25). At age 32 (the maximum), the effect of having a diagnosis was even stronger, such that having a diagnosis was associated with a 2.48 factor increase in the number of cigarettes smoked (IRR: 2.48, 95% CI: 1.21, 5.08) (Figure 3). While the effect of age was not significant, it decreased by a factor of 0.98 for every one year increase in age (IRR: 0.98, 95% CI: 0.97, 0.98). (See Table 3.)

With respect to covariates, being male was associated with a 1.33 factor increase in the number of cigarettes smoked (IRR: 1.33, 95%CI: 1.07, 1.64). Covariates associated with lower

numbers of cigarettes smoked included being Hispanic, relative to being White, associated with a 0.39 factor decrease in the number of cigarettes smoked (IRR: 0.39, 95% CI: 0.26, 0.58), having completed high school, associated with a 0.31 factor decrease in the number of cigarettes smoked (IRR: 0.31, 95% CI: 0.24, 0.39), and having more family unit members, associated with a 0.95 factor decrease in the number of cigarettes smoked for every additional family unit member (IRR: 0.95, 95% CI: 0.93, 0.98).

The ICC of this model was 0.51, indicating that about half (51%) of the variation in number of cigarettes smoked occurred between individuals (95% CI: 0.44, 0.60).

Number of cigarettes smoked: Distress – Aim 1c and 1d. In a model controlling for covariates and including a random coefficient for age, without an interaction term, every one unit higher mean distress score was associated with a 1.31 factor increase in the number of cigarettes smoked (IRR: 1.31, 95% CI: 1.18, 1.45). Every one unit short-term increases (i.e., spike) in distress relative to one's personal average distress level was marginally associated with a 1.02 factor increase in the number of cigarettes smoked (IRR: 1.02, 95% CI: 1.00, 1.04). Every one year increase in age was associated with a 1.10 factor increase in the number of cigarettes smoked (IRR: 1.10, 95% CI: 1.03, 1.19), although this growth rate decreased over time (IRR: 0.98, 95% CI: 0.97, 0.98). (See Table 4.)

With respect to covariates, being male was associated with a 1.37 factor increase in the number of cigarettes smoked (IRR: 1.37, 95% CI: 1.10, 1.70), and being married was associated with a 1.37 factor increase in the number if cigarettes smoked (IRR: 1.37, 95% CI: 1.06, 1.76). Covariates associated with less smoking include being Hispanic, relative to being White, associated with a 0.35 factor decrease in the number of cigarettes smoked (IRR: 0.35, 95% CI: 0.23, 0.52), and having completed high school, associated with a 0.31 factor decrease in the

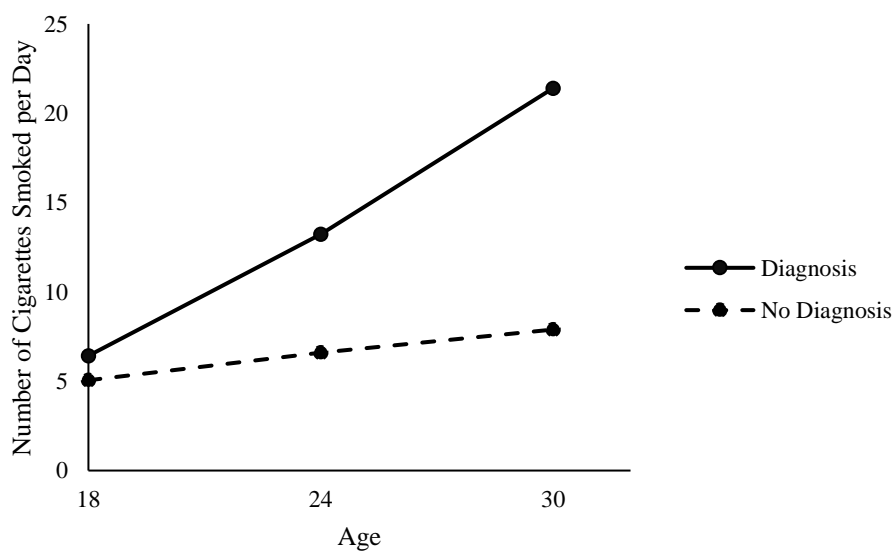
number of cigarettes smoked (IRR: 0.31, 95% CI: 0.24, 0.40). Having more family unit members was also negatively related to smoking amount such that every one additional family unit member was associated with a 0.95 factor decrease in the number of cigarettes smoked (IRR: 0.95, 95% CI: 0.92, 0.98). Being observed at wave 4, relative to wave 1, was associated with a 0.77 factor decrease in the number of cigarettes smoked (IRR: 0.77, 95% CI: 0.60, 0.99).

The ICC of this model was 0.51, indicating that about half (51%) of the variation in number of cigarettes smoked occurred between individuals (95% CI: 0.43, 0.59). An interaction term for the combined effect of age and distress was initially included, but not significant, indicating that the effect of distress did not vary by age. (Results not shown.)

Table 3. Number of Cigarettes Smoked per day among Current or Ever Smokers (N=1,383)

Predictors	Effect of Diagnosis			Effect of Distress		
	IRR	95% CI		IRR	95% CI	
Diagnosis	1.27	0.91	1.78			
Personal mean distress				1.31*	1.18	1.45
Deviation from mean distress				1.02	1.00	1.04
Age	1.07	0.99	1.15	1.10*	1.03	1.19
Age ²	0.98*	0.97	0.98	0.98*	0.97	0.98
Diagnosis*Age	1.08*	1.02	1.15			
Individual level covariates						
Male	1.33*	1.07	1.64	1.37*	1.10	1.70
Race (ref=White)						
Black	0.91	0.72	1.15	0.82	0.65	1.04
Hispanic	0.39*	0.26	0.58	0.35*	0.23	0.52
Other	0.72	0.31	1.70	0.63	0.26	1.48
Completed high school	0.31*	0.24	0.39	0.31*	0.24	0.40
Married	1.26	0.99	1.62	1.37*	1.06	1.76
Family income (in \$10,000)	1.00	0.99	1.00	1.00	0.99	1.01
No. family unit members	0.95*	0.93	0.98	0.95*	0.93	0.98
Time related covariates						
Wave (ref=wave 1)						
2	1.02	0.93	1.12	1.01	0.92	1.12
3	0.88	0.74	1.04	0.87	0.73	1.03
4	0.78	0.61	1.00	0.77*	0.60	0.99

***Bold text:** 95% CI does not include 1; indicates statistical significance

**Figure 3.** Expected Counts of the Number of Cigarettes Smoked by Diagnosis

Discussion

Overall, this research makes several unique contributions to the literature. As expected, poorer psychological health was associated with great likelihood and amount of smoking; this study showed that these effects of psychological health operated primarily between individuals, rather than within individuals over time, in that high-risk young adults with poorer psychological health were more likely to smoke at all and to smoke more over time. Both measures of psychological health exerted significant independent effects on smoking, suggesting that even incremental changes in psychological health are associated with both smoking status and cigarette consumption. Further, having a psychiatric diagnosis (although not higher levels of distress) explained variability between individuals around the slope of the mean smoking trajectory, such that the effect of diagnosis became positive, significant, and stronger as age increased.

Distinguishing between- and within-person effects of psychological health on smoking has important intervention implications. Because psychological health explained differences *between* individuals in this study, this suggests that some individuals, who have, whether by nature or environment, indications of poorer psychological health, are predisposed to smoke at all and to smoke more than others without such indications of poorer psychological health, at all times, not just when experiencing periods of high distress. Thus, individuals with indications of generally poorer psychological health should be targeted for interventions on the prevention side, to help reduce overall levels of distress and symptoms of psychiatric conditions, and on the treatment side, to successfully manage unpleasant feelings and symptoms without turning to smoking. For example, guidelines for mental health practitioners could include counseling for smoking prevention or cessation services as part of initial mental health diagnoses. If it had been

additionally shown that perturbations from one's average psychological health explained individual smoking amount within individuals, this would suggest that targeting young adult smokers for smoking reduction interventions at particularly distressing times in their lives would be important for reducing smoking consumption. Thus, knowing that the effects of psychological health on smoking operate primarily between individuals can be used to help guide effective intervention approaches.

While the strong, significant effects of psychological health on smoking occurred between individuals, this study did not find an effect of perturbations from one's average distress level on cigarette consumption, among those with a history of smoking. These results suggest that between-individual differences in psychological health (i.e. having a diagnosis or experiencing usually higher levels of distress) may matter more for determining smoking than experiencing a particularly distressing time (e.g., transitioning to college, failing a course, having relationship difficulties, starting a new job, etc.). It is also possible that the true effect of perturbations in psychological health was not able to be detected in this research. As theory suggests that smoking is used as a fairly immediate coping response to unpleasant symptoms,⁸⁶ measuring past-30-day psychological distress and current smoking ("Do you smoke cigarettes?" and, if so, "How many cigarettes per day do you usually smoke?") every two years, this research may not have fully captured the more immediate relationship between unpleasant symptoms of poorer psychological health and resulting smoking. Future research is needed with more precise and frequent measurements of both psychological health and smoking amount to better understand this relationship.

In this sample of young adults, smoking status was fairly stable, so we were unable to examine within-individual effects of psychological health on the odds of being a current smoker.

Several prior studies have found that there is relatively little smoking initiation in adulthood,⁸⁷ although this can be a period for cessation and relapse.³⁴ Other studies have found that some,⁸⁸ and increasingly more,^{89,90} smoking initiation is happening in young adulthood. Still, smoking initiation, as well as experimentation (i.e. fluctuation between being a current smoker and not a current smoker) occurs predominantly in younger age groups.¹ Future analyses with adolescents or youth, with more variation in smoking status over time, would be important to understand the role of psychological health in determining within-individual changes in smoking status.

As hypothesized, having a psychiatric diagnosis and having higher levels of personal mean distress both exerted strong independent effects on the odds of smoking and the number of cigarettes smoked. Thus, incremental changes in psychological health, not just the presence or absence of a diagnosable mental health condition, are related to smoking over young adulthood; this suggests that screening only for mental health conditions as a way to identify high-risk individuals is not sufficient, and that broader means of identifying high-risk individuals with higher levels of distress should be developed. Especially as existing interventions that incorporate psychological health and smoking components have yielded mixed results,⁶⁰ future research should investigate effective intervention approaches to screen, identify, and intervene with young adults with history or current indications of poorer psychological health to prevent current smoking or escalation in smoking amount during this critical developmental period.

In this study, it was also found that the effect of having a psychiatric diagnosis on the number of cigarettes smoked among current or ever smokers became positive and stronger as age increased. Specifically, at age 18, there was no effect of having a psychiatric diagnosis on smoking amount, but by age 24, there was significant and positive effect, which became even stronger as individuals aged through young adulthood, through the maximum age (in this

sample) of 30 years old. This effect could be because those in early young adulthood have better access to social communities, parental involvement, or access to treatment (i.e. at a college), and thus the presence of a psychiatric diagnosis may not have as large an effect on smoking; future research should seek to understand better why this effect occurs and how to best reach older young adults with psychiatric conditions to prevent smoking escalation. It could alternatively be that the measure of ever having a psychiatric diagnosis was most precise at older ages; for those diagnosed in the later years of young adulthood, it is possible that symptoms were not present or as severe at younger ages, and therefore exerted less of an impact on smoking. Our results imply that access to treatment for mental health conditions, ideally in conjunction with smoking prevention and cessation programs, are especially important for older young adults with a history of smoking to prevent increases in cigarette consumption during this critical period. Future research could assess if the effect of having a psychiatric diagnosis continues to increase in age in later adulthood as well.

Findings from this research are largely consistent with prior studies on the patterns of smoking status and amount in young adulthood that show these measures to be quadratic in form, such that smoking (the odds of current smoking and smoking amount among smokers) was shown to increase, but slow in its rate of increase, over the ages of young adulthood.⁶⁶ Also, with respect to covariates, relationships with smoking were as expected based on past research with young adults. Specifically, across models, being male, compared to female, was associated with greater smoking, consistent with past research.^{91,92} Being of Black or Hispanic race/ethnicity, relative to being White, was associated with less smoking, as found in prior studies.⁹² Having higher education, higher income, and being married have also been associated with less smoking

(although this latter effect was contradicted in one of our models, controlling for other covariates).^{9,92,93}

Overall, this study shows that both dichotomous and continuous indicators of psychological health affect smoking status and cigarette consumption over young adulthood, an important period for determining lifetime smoking. These effects of psychological health on smoking occurred mainly between individuals, rather than within individuals over time, suggesting that high-risk young adults with poorer psychological health be targeted for intervention. This research also adds to the literature a novel finding that the effect of having a psychiatric diagnosis on cigarette consumption (among current or ever smokers) is positive and stronger as age increases. Methodologically, this study addresses several limitations of past research including having longitudinal data for both psychological health and smoking, which allowed for assessment of effects between and within individuals over time, as well as more accurate measurement of variables that were aggregated at the person level. Insights from this work can be used to inform intervention and policy approaches to preventing and reducing smoking among high-risk young adults with indications of poorer psychological health.

CHAPTER 4: STUDY 2 – RESPONSIVENESS OF YOUNG ADULTS TO STATE CIGARETTE EXCISE TAXES BY PSYCHOLOGICAL HEALTH

Introduction

One especially effective tobacco control strategy to reduce smoking among the general population is raising cigarette prices through taxation to lower demand and consumption.⁴⁰ Price elasticity for cigarettes varies across studies, but has been found to be approximately 0.4, indicating that for every 10% increase in the cost of cigarettes, consumption decreases by about 4%.^{1,94} Some research further suggests this number to be even higher among young people, or that young adults are more price sensitive than older adults when buying cigarettes.^{41,44,45} An aggregation of several studies found that there was, on average, a 7.4% decrease in demand for cigarettes (including use at all and amount consumed) for every 10% increase in price among young people.⁴¹ Since young adulthood is an important period for the development of lifetime smoking and tobacco-related illnesses,³³ cigarette excise taxes may be particularly useful strategies for preventing addiction and future smoking-related illnesses.

Due in part to taxation of cigarettes and other tobacco control strategies, the prevalence of smoking has declined among the general population, but not among those with symptoms of poorer psychological health.² Individuals with indications of poorer psychological health, which includes both diagnosable mental health conditions (e.g., depression) and higher levels of psychological distress, are more likely to smoke and to experience nicotine dependence than those without any indications of poorer psychological health.^{1,3-8} The extent to which raising

state cigarette excise taxes changes the smoking behavior of young adults with poorer psychological health, however, is unknown.

Studies that show that raising the price of cigarettes through taxes decreases smoking⁴⁰ are consistent with basic economic theory that when prices rise, consumption of a product falls. Some economic perspectives, however, also indicate this effect could be attenuated for addictive substances. A common model of cigarette consumption is the “rational addiction” model, which holds that individuals recognize and voluntarily make addictive choices because the short-term gains from those choices (e.g., reduced tension) exceed the costs, assumed to be known and thoughtfully considered, of future continued addiction.⁹⁵ Thus, this model would posit that as prices rise, consumption of cigarettes would decrease, although not as much as it would for a non-addictive product.

Furthermore, the rational addiction model assumes that individuals are time-consistent, or that they consider decisions with consequences today or in the distant future of equal importance. Research however shows that individuals are time-inconsistent, and that they consider the costs and benefits of smoking today to be of greater importance than the costs and benefits of smoking in the distant future.⁹⁵ In other words, individuals are more likely to prioritize experiencing positive effects of smoking now, despite or without strong regard for, future consequences.⁹⁵ If individuals are time-inconsistent in their evaluations of the costs and benefits of smoking, cigarette prices would need to be higher to prevent continued choices to smoke than if individuals considered future spending to be just as important as spending on cigarettes today.⁹⁵ This could explain the price elasticity of cigarettes being around 0.4,⁴⁵ showing that consumption of tobacco decreases by a lower percentage amount (4%) than that by which the price is increased (10%).

While acknowledging that individuals can be time-inconsistent in their choice to smoke improves upon the original rational addiction model to explain smoking behavior in response to taxes, this model does not account for the disparities in smoking by psychological health. As evidenced in the literature on poorer psychological health and smoking, other factors may operate to produce smoking in this population. Emotional arousal, including symptoms of mental health conditions (e.g. anxiety) and feelings of distress, has been shown to reduce one's capacity to act rationally, suggesting that those with poorer psychological health are less *able* to act in rational ways.⁷⁰ The application of the Transactional Model of Stress and Coping and the tension reduction hypothesis described in earlier chapters indicates that individuals with poorer psychological health may be more likely than those with better psychological health to use smoking as a coping strategy to reduce stress and negative affect ^{64,65}. Thus, these individuals may be more invested in the short term benefits of smoking than their peers with better psychological health. Additionally, biological predisposition to experience poorer psychological health is related to nicotine dependence, such that those with poorer psychological health are often more heavily dependent on nicotine than those without such indications, helping to promote stronger addiction and continued smoking in this population.³ In sum, those with poorer psychological health may be more likely to base smoking decisions on emotional needs and biological nicotine dependence than on financial considerations, potentially dampening the effect of a tax increase on consumption compared with those with better psychological health.

Although the effect of psychological health on the relationship between taxes and smoking has not been explicitly tested, existing research suggests that those with poorer compared with better psychological health may be less responsive in their smoking behavior to state taxes that increase the price of cigarettes. One study found that between 2004 to 2011, a

period during which state (and federal) cigarette excise taxes increased, smoking rates among those with symptoms of poorer psychological health declined significantly less than those without such symptoms,⁹⁶. Further, research on smoking cessation programs has found that it is more difficult for those with poorer psychological health to quit smoking, suggesting that those with poorer psychological health may be less responsive to tobacco control initiatives in general.¹³

The current research tested whether psychological health moderates the effectiveness of state cigarette excise taxes in reducing smoking among young adults.

Aim 2: To determine whether psychological health moderates the relationship between state cigarette excise tax rates and smoking among young adults.

Aim 2a: To determine whether state cigarette excise tax rates impact smoking among young adults in a national sample between 2007 and 2013.

Aim 2b: To determine whether having a self-reported psychiatric diagnosis (e.g. anxiety, depression) moderates the expected inverse relationship between state cigarette excise tax rates and smoking among young adults.

Aim 2c: To determine whether psychological distress (as measured by the Kessler 6 scale of Nonspecific Psychological Distress)⁵¹ moderates the expected inverse relationship between state cigarette excise tax rates and smoking among young adults.

Conceptual Model: Aim 2

On a societal level, state cigarette excise tax rates have been shown to affect smoking, such that higher taxes are associated with less smoking. However, psychological health may moderate the impact of state cigarette excise tax rates, such that for those with poorer

psychological health, higher taxes may not reduce smoking as much as for those with better psychological health. The conceptual model for the current research is shown in Figure 4.

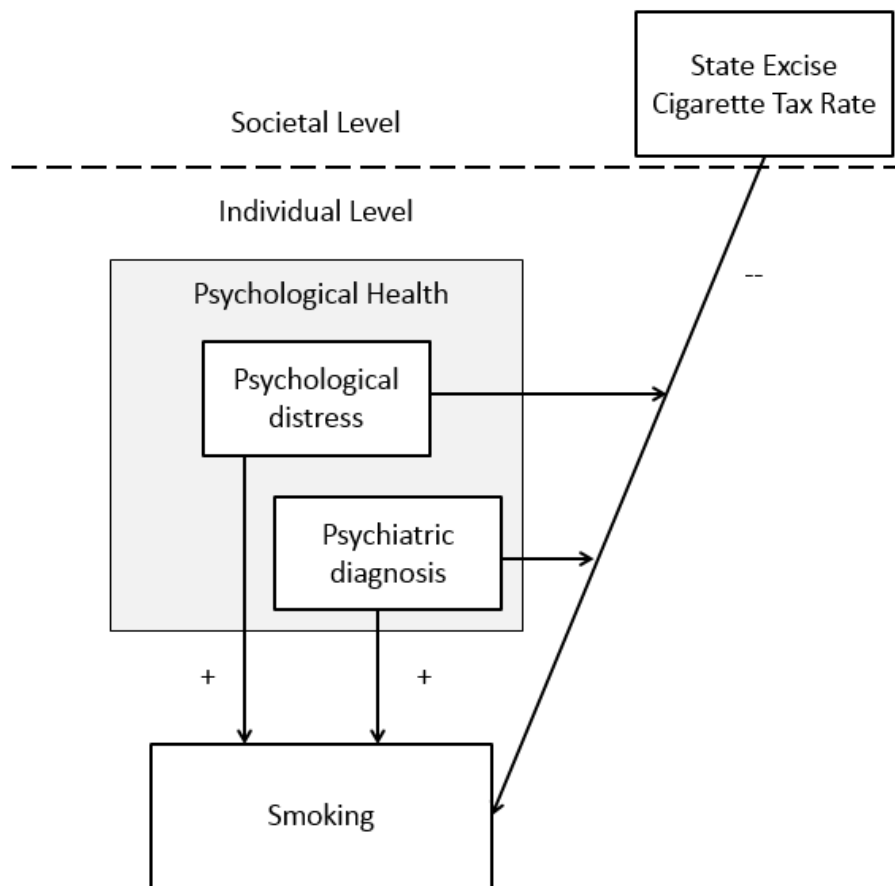


Figure 4. Aim 2 Conceptual Model

Methods

Data Sources

Two data sources were linked. Individual psychological health, tobacco use, and state residence data were drawn from young adult participants in the Panel Study of Income Dynamics (PSID). State tax data came from the State Tobacco Activities Tracking and Evaluation (STATE) database.

The Panel Study of Income Dynamics (PSID) is a longitudinal panel survey that has tracked a probability sample of US families since 1968.⁷⁸ Surveys are now conducted every other

year, and the sample continues to be reasonably representative of the US population today ⁷⁹.

The current research used data both from the PSID main interview, a survey of household heads or their partners, and from a special supplement focused on young adults, the Transition to Adulthood (TA) supplement, which tracks information about young adults aged 18 to 24 years who are not yet heads of or partners in their own households. (See Chapter 3 for more details about the PSID and TA.)

The STATE system, compiled by the Centers for Disease Control and Prevention's (CDC) Office on Smoking and Health (OSH), includes measures of state-legislated tobacco control policies, including cigarette excise tax rates, measured annually from 1995 to 2005 and then quarterly each subsequent year. Because the PSID data include state residence and interview dates as variables for each respondent, these data sets were merged such that every PSID observation included the quarterly state cigarette excise tax rate to which the respondent was exposed at the time of interview. The STATE system and the U.S. Bureau of Labor Statistics data were used to obtain two state level control variables: smoking prevalence and unemployment.

Measures

Two measures of smoking for this model were used: current smoking status, and among current or ever smokers, the number of cigarettes smoked per day. Two measures of psychological health were used: a dichotomous indicator of having been diagnosed with an emotional, nervous, or psychiatric condition and a continuous measure of psychological distress.

The intraclass correlation coefficients (ICC) of the two smoking outcome variables within individuals and within states were assessed. For both outcomes, the ICC was high within individuals (0.88 for current smoking in the whole sample, and 0.51 for number of cigarettes

smoked among smokers), indicating the need to account for dependence of observations within individuals over time, and the ICC was low within states (0.06 for current smoking in the whole sample, and 0.03 for number of cigarettes smoked among smokers). However, since there was some dependence of observations within states, we sought to control for key state level factors related to smoking and psychological health (smoking prevalence and unemployment rate) and included a state fixed effect term to control for unmeasured time invariant state level characteristics.

Dependent variable: Current smoking status. Smoking was assessed by self-reported response to the question, “Do you smoke cigarettes?,” to which responses were either “yes” or “no.”

Dependent variable: Current smoking level among current smokers. Current smoking amount among smokers was assessed by self-reported response to the question, “How many cigarettes per day do you usually smoke?,” to which a whole-number response was given.

Moderator: Self-reported diagnosis of emotional, nervous, or psychiatric condition. A binary indicator of ever self-reported diagnosis of any emotional, nervous, or psychiatric problem was used, reflected by a reported “yes” to the question, “Has a doctor or other health professional ever told you that you had any emotional, nervous, or psychiatric problems?” An affirmative response in any wave of data in the study identified participants with a clinically significant and diagnosed mental illness. Using a measure of ever self-reported diagnosis was chosen in part because one may have a psychiatric condition years before it is officially diagnosed; this measure captures any participants who are diagnosed within any year of data collection.

Moderator: Psychological distress. The Kessler-6 measure of psychological distress asks the frequency with which respondents have experienced six symptoms of psychological distress in the past 30 days: feeling (1) nervous, (2) hopeless, (3) restless or fidgety, (4) so sad or depressed that nothing could cheer the respondent up, (5) that everything is an effort, and (6) worthless. Response options included “all of the time”=4, “most of the time”=3, “some of the time”=2, “a little of the time”=1, and “none of the time”=0.⁵¹ Scores of each item on a 4-point scale were summed. To best capture the continuum of psychological distress that may lead to smoking, the K6 was treated as a continuous measure, using each participants’ average score across waves from 0 to 24.

Independent variable: Cigarette excise taxes. Quarterly state tax rates in dollars and cents from CDC’s STATE system for 2007, 2009, 2011, and 2013 corresponding to the PSID interview date were used for analyses. The September 2016 value of the Consumer Price Index for All Urban Consumers (CPI-U) was used to adjust these amounts for inflation. To capture a complete picture of tax, the federal cigarette excise tax rate (\$0.39 until early 2009, \$1.01 after), was also adjusted for inflation to be in 2016 dollars and cents, and added to the state tax rate for each observation. For analyses, state plus federal cigarette excise tax was centered at its mean of \$2.23.

Individual level control variables: Gender, race/ethnicity, education, marital status, income, number of family unit members, and age. Covariates that may be linked with smoking and psychological health are gender, race/ethnicity, education, marital status, income, number of family unit members, and age. Income and the number of family unit members varied over time; all other controls were kept time-stable to be consistent across all models.

Gender was indicated dichotomously by the sex of the respondent, with females as the referent group.

To measure race, participants were asked, “What is your race? Are you White; Black; American Indian or Alaska Native; Asian; Native Hawaiian or other Pacific Islander?” and allowed to mention up to three races. Interviewers could also code for “Other” race if a participant mentioned a race that was not on this list. Participants were coded as their first mentioned race, to be replaced by their second or third mention only if their first mention is missing or “Other.” As there were very small numbers of American Indians, Asians, and Pacific Islanders, these groups were collapsed and combined with the “Other” category. A fourth category was added to this race variable if participants responded that they were of Hispanic ethnicity, which was assessed by a separate question; the other racial groups included non-Hispanic individuals only. For analyses, the reference group was non-Hispanic whites.

To capture a meaningful measure of education during a time when young adults are often in the process of obtaining higher education, an indicator of whether respondents reported having completed high school by any wave of data collection was incorporated.

Marital status was controlled for as a measure of social and financial support shown to be associated with psychological health and smoking, and was defined as having been currently married during any year of data collection.

Family income was used as a measure socioeconomic status, based on measures calculated by PSID staff and included in the dataset. This family income variable represents taxable income, transfer income, and social security income for the previous year reported by all family unit members living together in a household, coded in \$10,000 units. To account for the number of people providing and being supported by that income amount, the number of family

unit members was also included as a covariate. “Family” refers to all family unit members living together in a household, which could be a young adult’s family of origin or the family of the young adult if he/she no longer lives with the family of origin.

Age was measured as the whole number numerical age at the time of interview.

Time-related control variables: Indicators of year and post-federal cigarette excise tax increase. An indicator variable for year was included to control for any year-specific events that occurred nationally with potential impacts on smoking and psychological health, and a separate indicator variable for one such shock, the substantial federal cigarette excise tax rate increase in the second quarter of 2009, shown to be associated with a decrease in smoking,⁴⁴ was included (coded as 1 if an observation was after the new federal cigarette excise tax rate was implemented and 0 if before the tax increase).

State level control variables: State smoking prevalence and state unemployment rate. To control for general area trends related to smoking, state adult smoking prevalence was drawn from the CDC’s STATE system. As there is not smoking prevalence data available for all years of the PSID’s data collection, smoking prevalence was entered as a time stable factor, calculated as the average of the 2006-2007 and 2010-2011 state prevalence. State unemployment rate, indicative of state economic conditions that may impact taxes as well as mental health,⁹⁷⁻⁹⁹ calculated by the US Bureau of Labor Statistics for each year of data collection, was entered as a time-varying state level control variable.

Analytical Sample

The analytical sample includes the 2007 cohort of young adults aged 18 to 24 years, as well as any new individuals aged 18 or 19 who enter the PSID (TA or main interview) in 2009. This group was followed across years 2007, 2009, 2011, and 2013 until they were aged 22-30 by

2013. In this sample, 2,490 were respondents (i.e. heads, partners, or TA respondents) that had more than one age-eligible observation to assess change over time. To keep the sample consistent across models, observations missing on key variables were dropped (N=39, 1.6% of eligible respondents), as were any cases that did not have two or more age-eligible responses as a result (N=108, 4.3% of eligible respondents). Multiple imputation was not performed as less than 6% of eligible respondents had missing data and were dropped from analyses.

The final analytical sample size was 2,333 people who were observed collectively a total of 7,579 times (Table 1). Overall, this sample was fairly gender-balanced (55.0% female, 45.0% male), mostly made up of non-Hispanic White (45.7%) and Black (42.0%) individuals compared to Hispanic (10.4%) and “Other” (2.0%) racial groups, aged 23.5 on average, with a wide range of family incomes (mean: \$59,000), living with an average of 2.7 family unit members. Many (82.6%) completed high school and 33.4% were married at any point during data collection. With respect to psychological health, 16.2% of the sample reported having a psychiatric diagnosis, and the mean of personal mean distress scores was 4.6 on a scale of 0 to 24. With respect to smoking status, the majority of the sample were consistent non-smokers (66.2%), 19.5% currently smoked at least one time during data collection, and 14.3% were consistent smokers.

The analytical sample size for current or ever smokers was 1,374 individuals, observed a total 3,298 times (Table 4). Overall, this sample is fairly gender-balanced (49.3% female, 50.7% male), mostly made up of non-Hispanic White (46.4%) and Black (42.1%) individuals compared to Hispanic (9.8%) and “Other” (1.8%) racial groups, aged 24 on average, with a wide range of family incomes (mean: \$50,000), living with an average of 2.6 family unit members. Most (75.9%) completed high school and 28.0% were married at any point during data collection.

With respect to psychological health, 19.5% of the sample reported having a psychiatric diagnosis, and the mean of personal mean distress scores was 4.8 on a scale of 0 to 24. With respect to smoking status, consistent non-smokers made up 42.7% of the sample, while 33.0% currently smoked at least one time during data collection, and 24.3% were consistent smokers. The mean number of cigarettes smoked per day was 3.6.

Table 4. Aim 2 Sample Characteristics

	Sample 1: All N=2,333	Sample 2: Ever Smokers N=1,374
	n (%) Mean (SD)	n (%) Mean (SD)
Gender:		
Female	1,283 (55.0%)	677 (49.3%)
Male	1,050 (45.0%)	697 (50.7%)
Race:		
White	1,065 (45.7%)	637 (46.4%)
Black	979 (42.0%)	578 (42.1%)
Hispanic	242 (10.4%)	134 (9.8%)
Other	47 (2.0%)	25 (1.8%)
Mean age* (years)	23.5 (2.4), range 18.5 to 29	24.0 (2.3), range 19 to 29
Mean family income* (in \$10,000)	5.9 (6.9), range 0.0 to 133.5	5.0 (6.8), range 0.0 to 133.5
Mean number of family unit members*	2.7 (1.3), range 1 to 13	2.6 (1.3), range 1 to 13
Completed high school+	1,928 (82.6%)	1,043 (75.9%)
Married+	780 (33.4%)	384 (28.0%)
Has psychiatric diagnosis+	377 (16.2%)	268 (19.5%)
Mean distress*	4.6 (3.1), range 0 to 20.7	4.8 (3.2), range 0 to 20
Current smoking status^:		
Consistent non-smokers	1,544 (66.2%)	586 (42.7%)
Inconsistent smokers	455 (19.5%)	454 (33.0%)
Consistent smokers	334 (14.3%)	334 (24.3%)
Mean number of cigarettes smoked per day*		3.6 (5.1), range 0 to 27.5

*Mean values refer to grand means of the sample across all years of data collection

+Refers to having reported completing high school, being married, or having a diagnosis at any wave of data collection

^As measured across available data points for each individual. Consistent non-smokers are those who were not current smokers at any point of data collection (although may have reported being an ever smoker in their lifetime). Inconsistent smokers have reported current smoking during at least one (but not all) available data points. Consistent smokers presorted current smoking at all waves at which they were observed.

Modeling Approach

Logistic regression was used to model the log odds of current smoking in the entire sample. A Poisson regression was used to model the count of the number of cigarettes smoked among ever smokers. Multilevel random effect models were used to account for nesting of repeated measures within individuals over time.

As mentioned previously, all models included a state fixed effect term. To measure the relationships among state cigarette excise tax rates, psychological health, and smoking, it is important to account for state level social, political, and economic factors that may affect both tax rates and smoking over time. Specifically, economic factors such as unemployment rates may inversely affect state cigarette excise taxes, as state cigarette excise taxes have been shown to increase during periods of national recession.¹⁰⁰ Additionally, tobacco producing states have been shown to have lower excise cigarette taxes than states that do not produce tobacco.¹⁰¹ The current study accounts for state level characteristics that may affect taxes and smoking by controlling for key state level factors, namely, state unemployment rates and state smoking prevalence, and for unobserved time-stable factors by adding a state fixed effects term to the model. This approach essentially enters a dummy variable in for each state, to control for all of the characteristics of that state that remain constant over time. Thus, all unmeasured state level time-stable characteristics (e.g., whether a tobacco producing state or not), effectively “drop out” of the model.¹⁰²

All analyses were conducted in Stata 14. In all equations below, each covariate also has a coefficient, but to streamline these equations, coefficients are only shown on key variables.

Aim 2a: To determine whether state cigarette excise tax rates impact smoking among young adults in a national sample between 2007 and 2013.

Model: Aim 2a. The below equation was used to assess the effect of state cigarette excise taxes on smoking with covariates, while accounting for dependence of observations within individuals and including a fixed effect for state in a mixed model:

$$S_{sit} = \alpha_0 + \beta_1 T_{sit} + y_t + c_{sit} + l_{st} + \mu_i + j_s + \varepsilon_{sit}$$

where:

S_{sit} is the log odds of smoking (logistic regression) or number of cigarettes smoked (Poisson regression) for individual i in state s at time t ;

T_{sit} is a continuous indicator of state plus federal cigarette excise tax, adjusted for inflation over time, for individual i in state s at time t ;

y_t represents time-related covariates: year and indicator of post-federal tax increase;

c_{sit} represents individual covariates: Gender, race/ethnicity, education, marital status, income, number of family unit members, and age of individual i in state s (if time-varying, at time t);

l_{st} represents time-varying state covariates: adult smoking prevalence and unemployment rate in state s (if time-varying, at time t);

μ_i represents the component of the error term for individual i that is unobserved; j_s represents the state level fixed effect, or time-invariant, unobserved state level characteristics; ε_{it} is an error term

Aim 2b: To determine whether having a psychiatric diagnosis moderates the expected inverse relationship between state cigarette excise tax rates and smoking among young adults.

Model: Aim 2b. A step-wise approach was taken such that the effects of having a psychiatric diagnosis and its interaction with tax were entered in the model, with a state level

fixed effect, first without covariates, and then with covariates included (as shown in the equation below).

$$S_{sit} = \alpha_0 + \beta_1 T_{sit} + \beta_2 P_{si} + \beta_3 (T_{sit} * P_{si}) + y_t + c_{sit} + l_{st} + \mu_i + j_s + \varepsilon_{sit}$$

where:

P_{si} is the presence or absence of self-reported diagnosis of individual i in state s ;

$T_{sit} * P_{si}$ is the interaction of tax and self-reported psychiatric diagnosis (i.e., whether the impact of taxes at time t on smoking varies by the presence or absence of a self-reported psychiatric diagnosis for individual i in state s)

Aim 2c: To determine whether psychological distress moderates the expected inverse relationship between state cigarette excise tax rates and smoking between individuals.

Model: Aim 2c. The equation below repeats the model used in Aim 2b, substituting distress for self-reported diagnosis. Again, a step-wise approach was taken such that the effects of distress and its interaction with tax were entered in the model, with a state level fixed effect, first without covariates, and then with covariates included.

$$S_{sit} = \alpha_0 + \beta_1 T_{sit} + \beta_2 D_{ti} + \beta_3 (T_{sit} * D_{ti}) + y_t + c_{sit} + l_{st} + \mu_i + j_s + \varepsilon_{sit}$$

where:

D_{ti} is the level of distress for individual i at time t

$T_{sit} * D_{ti}$ is the interaction of tax and distress (i.e., whether the impact of taxes at time t on smoking varies by level of distress for individual i in state s).

Interpretation. A significant coefficient on the interaction of tax and self-reported psychiatric diagnosis (i.e., when the 95% confidence interval did not include 1 for the odds ratios, in the case of the current smoking logistic models, and the incident rate ratios, in the case of the number of cigarettes Poisson models) would be interpreted to mean that tax differentially

affected smoking based on whether participants have ever been diagnosed with an emotional, nervous, or psychiatric condition. Informed by Preacher, Curran, and Bauer (2006), interaction effects would be probed by plotting smoking by cigarette excise tax for those with and without a diagnosis, and for those with different values on the distress scale.⁸⁵ Where interaction effects were not significant, the independent effects of psychological health on smoking were interpreted.

Results

Odds of Being a Smoker

Model 2a: Effect of state cigarette excise taxes on odds of being a current smoker. In a logit model of current smoking and tax (taking into account dependence of the data by person over time and a state level fixed effect and controlling for covariates), every one dollar increase in cigarette excise tax rate was associated with 0.69 higher odds of being a current smoker (95% CI: 0.48, 0.99) (Table 5).

Individual level covariates independently associated with being a smoker include being male, associated with 3.35 higher odds of being a smoker (95% CI: 2.23, 5.05), and being of older age, such that every one year increase in age was associated with 1.21 higher odds of being a smoker (95% CI: 1.11, 1.32). In the opposite direction, being Black, Hispanic, or of “Other” race, relative to being White, were associated with 0.32 (95% CI: 0.19, 0.53), 0.18 (95% CI: 0.08, 0.41), and 0.18 (95% CI: 0.04, 0.83) lower odds respectively of being a smoker. Having completed high school was associated with 0.02 lower odds of being a smoker (95% CI: 0.01, 0.03) and being married was associated with 0.32 lower odds of being a smoker (95% CI: 0.20, 0.52).

With respect to time-related varying covariates, participants observed in later years of the study were less likely to be current smokers; waves 2, 3, or 4, relative to wave 1 of data collection, were associated with 0.33 (95% CI: 0.11, 0.93), 0.19 (95% CI: 0.07, 0.56), and 0.11 (95% CI: 0.04, 0.31) lower odds of being a smoker respectively.

At the state level, neither state unemployment rate nor prevalence of adult cigarette use were associated with participants' odds of being a current smoker.

Model 2b: Impact of self-reported diagnosis on the relationship between taxes and odds of being a current smoker. In a model without covariates, there was no significant effect of state plus federal cigarette excise tax rate on the odds of current smoking, and distress did not moderate the impact of tax on smoking. However, having a psychiatric diagnosis exerted an independent effect, such that having a diagnosis was associated with 30.63 higher odds of being a current smoker (95% CI: 10.46, 89.66) (Table 5).

In a model with covariates, state plus federal cigarette excise tax rate did not have an effect on the odds of current smoking, and distress did not moderate the impact of tax on smoking. Having a diagnosis did exert an independent effect on smoking, such that having a diagnosis was associated with 14.74 higher odds of being a current smoker (95% CI: 5.25, 41.40).

Individual level covariates independently associated with being a smoker include being male, associated with 3.76 higher odds of being a smoker (95% CI: 2.49, 5.67), and being of older age, such that every one year increase in age was associated with 1.20 higher odds of being a smoker (95% CI: 1.10, 1.31). In the opposite direction, being Black or Hispanic race, relative to being White, were associated with 0.48 (95% CI: 0.29, 0.80) and 0.24 (95% CI: 0.11, 0.54) lower odds respectively of being a smoker. Having completed high school was associated with

0.03 lower odds of being a smoker (95% CI: 0.02, 0.04) and being married was associated with 0.36 lower odds of being a smoker (95% CI: 0.22, 0.58).

With respect to time-related varying covariates, participants observed in later years of the study were less likely to be current smokers; waves 2, 3, or 4, relative to wave 1 of data collection, were associated with 0.32 (95% CI: 0.11, 0.91), 0.19 (95% CI: 0.06, 0.55), and 0.11 (95% CI: 0.04, 0.31) lower odds of being a smoker respectively.

At the state level, neither state unemployment rate nor prevalence of adult cigarette use were associated with participants' odds of being a current smoker.

Model 2c: Impact of distress on the relationship between taxes and odds of being a current smoker. In a model without covariates, state plus federal cigarette tax rate did not exert an effect on the odds of being a current smoker, and level of psychological distress did not moderate this relationship. Psychological distress did exert an independent effect, such that every one unit higher on the K-6 Distress Scale was associated with 1.14 higher odds of being a current smoker (95% CI: 1.05, 1.23) (Table 5).

In a model with covariates, state plus federal cigarette tax rate did not exert an effect on the odds of being a current smoker, and level of psychological distress did not moderate this relationship. Psychological distress did exert an independent effect, such that every one unit higher on the K-6 Distress Scale was associated with 1.13 higher odds of being a current smoker (95% CI: 1.05, 1.22).

Similar to previous models, individual level covariates associated with being a current smoker included being male, associated with 3.50 higher odds of being a current smoker (95% CI: 2.33, 5.24), and being of older age, such that every one year increase in age was associated with 1.22 higher odds of being a current smoker (95% CI: 1.12, 1.33). In the opposite direction,

being Black, Hispanic, or of “Other” race, relative to being White, were associated with 0.32 (95% CI: 0.19, 0.53), 0.19 (95% CI: 0.08, 0.41), and 0.18 (95% CI: 0.04, 0.83), lower odds of being a smoker respectively. Having completed high school was associated with 0.02 lower odds of being a smoker (95% CI: 0.01, 0.04), and being married was associated with 0.36 lower odds of being a smoker (95% CI: 0.22, 0.57).

With respect to time-related varying covariates, participants observed in later years of the study were less likely to be current smokers; waves 2, 3, or 4, relative to wave 1 of data collection, were associated with 0.31 (95% CI: 0.11, 0.89), 0.19 (95% CI: 0.06, 0.54), and 0.11 (95% CI: 0.04, 0.31) lower odds of being a smoker respectively.

At the state level, neither state unemployment rate nor prevalence of adult cigarette use were associated with participants’ odds of being a current smoker.

Table 5. Odds of Being a Current Smoker (N=2,330)+

Variables	Model 2a: Covariates Only			Model 2b: Without Covariates			Model 2b: Full			Model 2c: Without Covariates			Model 2c: Full		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Tax	0.69*	0.48	0.99	0.84	0.66	1.06	0.75	0.52	1.09	0.83	0.63	1.09	0.72	0.48	1.07
Diagnosis				30.63*	10.46	89.66	14.74*	5.25	41.40						
Tax*Diagnosis				0.76	0.52	1.12	0.79	0.54	1.15						
Distress										1.14*	1.05	1.23	1.13*	1.05	1.22
Tax*Distress										1.00	0.96	1.03	0.99	0.96	1.03
Individual level covariates															
Income (in \$10,000)	0.99	0.98	1.01				0.99	0.98	1.01				0.99	0.98	1.00
Number of family unit members	1.01	0.92	1.11				1.02	0.93	1.12				1.02	0.93	1.12
Race (ref=White)															
Black	0.32*	0.19	0.53				0.48*	0.29	0.80				0.32*	0.19	0.53
Hispanic	0.18*	0.08	0.41				0.24*	0.11	0.54				0.19*	0.08	0.41
Other	0.18*	0.04	0.83				0.27	0.06	1.26				0.18*	0.04	0.83
Male	3.35*	2.23	5.05				3.76*	2.49	5.67				3.50*	2.33	5.24
Completed high school	0.02*	0.01	0.03				0.03*	0.02	0.04				0.02*	0.01	0.04
Married	0.32*	0.20	0.52				0.36*	0.22	0.58				0.36*	0.22	0.57
Age	1.21*	1.11	1.32				1.20*	1.10	1.31				1.22*	1.12	1.33
Time-related covariates															
Wave (ref=1)															
2	0.33*	0.11	0.93				0.32*	0.11	0.91				0.31*	0.11	0.89
3	0.19*	0.07	0.56				0.19*	0.06	0.55				0.19*	0.06	0.54
4	0.11*	0.04	0.31				0.11*	0.04	0.31				0.11*	0.04	0.31
State level covariates															
Unemployment rate	1.06	0.92	1.23				1.06	0.91	1.23				1.06	0.92	1.24
Prevalence of adult cigarette smoking	2.03	0.44	9.50				1.93	0.42	8.90				2.13	0.46	9.72

Note: Analyses included a fixed effect for state and an indicator variable of being observed after the federal tax increase from 39 cents to \$1.01.

+All 11 observations from the state of Vermont were dropped as there was no variation in current smoking (all Vermont residents were nonsmokers for all waves in which they were observed)

*95% CI does not include 1

Number of Cigarettes Smoked

Model 2a: Effect of tax on number of cigarettes smoked among current or ever smokers. In a Poisson model of the number of cigarettes smoked among current or ever smokers (using a mixed model with individual random effects (to take into account dependence of the data by person over time) and a state-level fixed effect term), cigarette excise tax was not associated with the number of cigarettes smoked, controlling for covariates (Table 6).

With respect to individual level covariates, being male was associated with a 1.31 factor increase in the number of cigarettes smoked (95% CI: 1.11, 1.55). In the opposite direction, being Black, Hispanic, or of “Other” race, relative to being White, were associated with a 0.68 (95% CI: 0.55, 0.83), 0.41 (95% CI: 0.28, 0.61), and 0.47 (95% CI: 0.25, 0.88) factor decrease respectively in the number of cigarettes smoked. Having completed high school was associated with a 0.44 factor decrease in the number of cigarettes smoked (95% CI: 0.38, 0.52).

With respect to time-related varying covariates, participants observed in later years of the study tended to smoke fewer cigarettes; being observed in waves 2, 3, or 4, relative to wave 1 of data collection, was associated with a 0.66 (95% CI: 0.47, 0.93), 0.58 (95% CI: 0.40, 0.84), and 0.57 (95% CI: 0.39, 0.83) factor decrease respectively in the number of cigarettes smoked.

At the state level, every one percentage point increase in state unemployment rate was associated with a 1.06 factor increase in the number of cigarettes smoked (95% CI: 1.01, 1.11).

Model 2b: Impact of self-reported diagnosis on the relationship between taxes and number of cigarettes smoked among smokers. In a model without covariates, state plus federal cigarette excise tax rate was not associated with the number of cigarettes smoked, and having a psychiatric diagnosis did not moderate this relationship. Having a psychiatric diagnosis did exert an independent effect, such that having a diagnosis was associated with a 2.06 factor increase in the number of cigarettes smoked (95% CI: 1.42, 3.00) (Table 6).

In a model with covariates state plus federal cigarette excise tax rate was not associated with the number of cigarettes smoked, and having a psychiatric diagnosis did not moderate this relationship. Having a psychiatric diagnosis did exert an independent effect, such that having a diagnosis was associated with a 1.84 factor increase in the number of cigarettes smoked.

On an individual level, being male was associated with a 1.35 factor increase in the number of cigarettes smoked (95% CI: 1.14, 1.59) and being married was associated with a 1.23 factor increase in the number of cigarettes smoked (95% CI: 1.01, 1.50). In the opposite direction, being Black, Hispanic, or of “Other” race, relative to being White, were associated with a 0.72 (95% CI: 0.59, 0.89), 0.43 (95% CI: 0.29, 0.63), and 0.51 (95% CI: 0.27, 0.96) factor decrease respectively in the number of cigarettes smoked. Also, having completed high school was associated with a 0.46 factor decrease in the number of cigarettes smoked.

With respect to time-related covariates, being observed in waves 2, 3, or 4, relative to wave 1, were associated with 0.66 (95% CI: 0.47, 0.93), 0.58 (95% CI: 0.40, 0.83), and 0.56 (95% CI: 0.38, 0.83) factor decreases in the number of cigarettes smoked.

At the state level, every one percentage point increase in state unemployment rate was associated with a 1.06 factor increase in the number of cigarettes smoked (95% CI: 1.01, 1.11).

Model 2c: Impact of distress on the relationship between taxes and number of cigarettes smoked among smokers. In a model without covariates, state plus federal cigarette excise tax rate did not have an independent effect on the number of cigarettes smoked. Psychological distress did not moderate this relationship, nor exert an independent effect on the number of cigarettes smoked (Table 6).

In a model with covariates, every one dollar increase in state plus federal cigarette excise tax rate was associated with a 0.83 factor decrease in the number of cigarettes smoked (95% CI: 0.70, 0.99). Psychological distress did not moderate this relationship, nor exert an independent effect on the number of cigarettes smoked.

On an individual level, being male was associated with a 1.33 factor increase in the number of cigarettes smoked (95% CI: 1.13, 1.57) and being married was associated with a 1.24

factor increase in the number of cigarettes smoked (95% CI: 1.01, 1.51), holding other covariates constant. In the opposite direction, being Black, Hispanic, or of “Other” race, relative to being White, were associated with a 0.67 (95% CI: 0.54, 0.82), 0.40 (95% CI: 0.28, 0.59), and 0.47 (95% CI: 0.25, 0.89) factor decrease respectively in the number of cigarettes smoked. Also, having completed high school was associated with a 0.45 factor decrease in the number of cigarettes smoked (95% CI: 0.38, 0.52).

With respect to time-related covariates, being observed in waves 2, 3, or 4 relative to wave 1, were associated with 0.65 (95% CI: 0.47, 0.91), 0.57 (95% CI: 0.40, 0.82), and 0.55 (95% CI: 0.38, 0.81) factor decreases respectively in the number of cigarettes smoked.

At the state level, every one percentage point increase in the state unemployment rate was associated with a 1.06 factor increase in the number of cigarettes smoked (95% CI: 1.01, 1.11).

Table 6. Number of Cigarettes Smoked per day among Current or Ever Smokers (N=1,374)+

	Model 2a: Covariates			Model 2b: Covariates			Model 2b: Full			Model 2c: Covariates			Model 2c: Full		
Variables	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Tax	0.87	0.75	1.01	0.94	0.85	1.04	0.89	0.76	1.04	0.90	0.80	1.02	0.83*	0.70	0.99
Diagnosis				2.06*	1.42	3.00	1.84*	1.25	2.71						
Tax*Diagnosis				0.92	0.79	1.08	0.94	0.80	1.10						
Distress										1.01	0.98	1.04	1.01	0.97	1.04
Tax*Distress										1.00	0.99	1.02	1.00	0.99	1.02
Individual level covariates															
Income (in \$10,000)	1.00	0.99	1.01				1.00	0.99	1.01				1.00	0.99	1.01
Number of family unit members	0.99	0.95	1.03				0.99	0.96	1.03				0.99	0.96	1.03
Race (ref=White)															
Black	0.68*	0.55	0.83				0.72*	0.59	0.89				0.67*	0.54	0.82
Hispanic	0.41*	0.28	0.61				0.43*	0.29	0.63				0.40*	0.28	0.59
Other	0.47*	0.25	0.88				0.51*	0.27	0.96				0.47*	0.25	0.89
Male	1.31*	1.11	1.55				1.35*	1.14	1.59				1.33*	1.13	1.57
Completed high school	0.44*	0.38	0.52				0.46*	0.39	0.54				0.45*	0.38	0.52
Married	1.22	1.00	1.49				1.23*	1.01	1.50				1.24*	1.01	1.51
Age	1.01	0.96	1.05				1.01	0.97	1.05				1.01	0.96	1.05
Time-related covariates															
Wave (ref=1)															
2	0.66*	0.47	0.93				0.66*	0.47	0.93				0.65*	0.47	0.91
3	0.58*	0.40	0.84				0.58*	0.40	0.83				0.57*	0.40	0.82
4	0.57*	0.39	0.83				0.56*	0.38	0.82				0.55*	0.38	0.81
State level covariates															
Unemployment rate	1.06*	1.01	1.11				1.06*	1.01	1.11				1.06*	1.01	1.11
Prevalence of adult cigarette smoking	0.99	0.61	1.61				0.95	0.60	1.51				1.02	0.63	1.65

Note: Analyses included a fixed effect for state and an indicator variable of being observed after the federal tax increase from 39 cents to \$1.01.

+All 11 observations from the state of Vermont were dropped as there was no variation in current smoking (all Vermont residents were nonsmokers for all waves in which they were observed)

*95% CI does not include 1

Discussion

The current research yields some key findings about the relationships between cigarette excise taxes, psychological health, and smoking among young adults. Among this sample of young adults, cigarette excise tax rates did not play a large role in current smoking or smoking amount. Having a psychiatric diagnosis was a stronger predictor of smoking (status and amount) than higher levels of psychological distress. Encouragingly, psychological health issues did not

affect the relationship between cigarette excise taxes and smoking, although the relationship between cigarette excise taxes and smoking was small or nonexistent in this population overall.

Cigarette excise tax rate did not have a significant effect on whether or not a young adult was a current smoker, nor often on the number of cigarettes smoked in young adulthood, regardless of what psychological health or covariates were included in the models. This suggests that taxes are not effective for everyone, although show some potential to reduce cigarette consumption among those with a history of smoking; increasing cigarette excise tax rates did reduce smoking consumption in one model for current or ever smokers (controlling for distress and covariates). This result may suggest that raising taxes could have a stronger effect in this group of vulnerable individuals with a higher smoking prevalence.

While contrary to expectations from most previous research, the finding that cigarette excise taxes do not strongly impact smoking is consistent with some past studies. While several prior studies have found young people to be particularly responsive to price in determining their smoking status,^{41,49,103} other recent, national research has not found this to be the case,⁵⁰ which could indicate that this effect is changing. Additionally, several studies have found that cigarette excise taxes affect smoking status by preventing smoking initiation^{41,46,49} and facilitating quitting⁴⁸ (although not all studies have found this),⁴⁴ but findings about lowering consumption are somewhat more mixed.^{49,50} One study of youth using a nationally representative sample found effects of cigarette excise tax on young adult smoking only in specific demographic groups,¹⁰⁴ which could account for nonsignificant effects in the population as a whole. Also, it may be that we did not observe young adults for enough time to see an impact; about 20% of the current sample had 2 or 3 (not 4) observations, meaning they were observed over a period of two to four years, which may not have been enough time to observe within-individual change in

smoking, in particular smoking status, as it can take multiple quit attempts and several years to successfully quit smoking.¹⁰⁵ While our results are consistent with some past studies, future prospective and longitudinal research on the current effect of cigarette excise taxes with young adults is needed. Overall, our findings suggest that a greater tax increase than participants in our study experienced may be needed to make a meaningful change in young adults' smoking status and cigarette consumption.

With regard to moderation, neither measure of psychological health significantly moderated the effect of cigarette excise taxes on smoking. If there actually is no moderation of the tax and smoking relationship by psychological health, this implies encouragingly that cigarette excise taxes do not have a differential effect on young adults based on their psychological health. It may alternatively be that psychological health problems do actually reduce price responsiveness, but the moderating effect of psychological health on the relationship between taxes and smoking (status and amount) is hidden for other reasons. For instance, individuals with diagnoses may be turning to other, cheaper tobacco products, or other substances, to cope with unpleasant symptoms, while reducing their cigarette consumption in response to higher cigarette taxes. Additionally, if young adults with poorer psychological health can access services that offset unpleasant symptoms (without turning to smoking as a coping mechanism), psychological health may not significantly moderate the impact of taxes on smoking. While we sought to control for factors such as income, we did not control for others, like receipt of psychological health treatment, which could either lessen unpleasant symptoms, thereby reducing the need to smoke as a coping response, or directly include smoking cessation treatment. Also, those receiving treatment for psychological health issues are more likely to be seeing a doctor and to have individual access to smoking cessation resources, which could

additionally mask the moderation of the cigarette excise tax and smoking relationship by psychological health. Increasing state cigarette excise taxes may also be a sign of other activity at the state level, which could include more funding for tobacco control programs and cessation resources available to those with psychological health issues (although the extent to which tax revenue is used for such programs is mixed across states). Further research should explore these and other potential explanations to better understand whether and how psychological health may affect responsiveness to cigarette excise taxes on cigarettes.

With respect to independent effects of psychological health on smoking, having a diagnosis was positively related to smoking, although having higher levels of distress in many cases was not. Our results are consistent with a sizeable body of research connecting having a mental health condition to smoking status.^{4,7,106} Distress levels, too, have been shown to be positively linked to smoking status,^{80,107,108} although research on distress is more limited, and the measure is often used as a dichotomous one as a proxy for severe mental illness.¹² One study found effects of distress only in some racial groups, specifically, among Whites but not among Blacks or Hispanics.¹⁰⁹ As there are differences in psychological health needs and access to treatment among racial and ethnic groups, future research could explore modification of the tax and smoking relationship by psychological health stratified by race.¹¹⁰ Additionally, as the proposed explanation of the relationship between psychological health and smoking is that one would smoke greater numbers of cigarettes in response to unpleasant symptoms of a mental health condition or higher levels of distress, time may be of great importance when assessing these relationships; measurements of ever diagnosis, distress in the past 30 days, and current smoking amount, may not have allowed for true assessment of these relationships.

As this analysis included the entire young adult population, and as smoking continues to be made less socially acceptable and less convenient to do, there may be many young adults that have never smoked and will likely remain non-smokers for their lifetime, regardless of level of distress. Future research could further explore whether non-smokers with high levels of distress employ other harmful coping responses, such as alcohol use, that were not captured by the current study.

Future research could additionally seek to better understand influences of time-related covariates on smoking. In this study, controlling for age, wave, and an indicator of observations after the sharp increase in federal cigarette excise tax rate (not interpreted), may have produced some strange independent effects of these variables on smoking. While there was justification to control for each of these concepts separately, the extent to which age and wave effects can be attributed to the entire sample aging, or something specific to this cohort, or something specific to the period of time in which participants were observed, should be explored.

Implications

The research presented here suggests that psychological health plays an important but complicated role in the effect of cigarette excise taxes on smoking among young adults. We found no association of cigarette taxes with being a current smoker when accounting for psychological health. Additionally, we found that cigarette taxes were associated with reduced consumption of cigarettes only among young adult ever smokers, when controlling for psychological distress and a host of individual, time-related, and state level covariates. Taken together, these results indicate that cigarette taxes may help reduce cigarette consumption among young adults with a history of smoking, but likely need to be implemented in conjunction with other tobacco control efforts to be effective. Since having a psychiatric diagnosis predicted

current smoking more so than having higher psychological distress, treatment for mental health conditions should be made more available and accessible to reduce unpleasant symptoms and should directly incorporate smoking cessation treatment to reduce current smoking rates and lessen cigarette consumption among young adults.

CHAPTER 5: SYNTHESIS AND DISCUSSION

Aim 1 and Aim 2: Summary, Implications, and Integration

Aim 1 tested the within-individual and between-individual effects of psychological health on smoking status and amount. Results showed that psychological health, conceptualized separately as having a diagnosis and level of psychological distress, had significant between-person effects on smoking status and amount. Additionally, the effect of having a psychiatric diagnosis on cigarette consumption became positive and stronger as age increased. This research suggests that high risk individuals, who present with indications of poorer psychological health, are more likely to smoke at all and to escalate in smoking amount during the critical period of young adulthood. These results imply that interventions should target or reach high-risk individuals with poorer psychological health to reduce the likelihood of smoking or increasing smoking amount as a coping response to manage unpleasant symptoms.

With respect to smoking status, the data did not allow for complete testing of the original research question about how “dips” in psychological distress affected the odds of being a current smoker due to low within-individual variation in the odds of being a current smoker. The lack of variation, however, shows that most initiation of smoking has happened by the outset of young adulthood; many participants in this sample were smokers or nonsmokers throughout all the years they were in the survey. Future research with individuals of younger ages, for whom there is more variation in current smoking status, should investigate the potential within-individual effects of psychological health on changes in smoking status. Additionally, the finding that the

effect of psychological health on smoking amount did not change by the ages (as shown by non-significant interactions) suggests a constant effect of psychological health across the period of young adulthood, which is also valuable information; this relationship could be further investigated with individuals of younger ages as well.

Overall, this research provides important evidence that psychological health, conceptualized in two distinct ways of having a psychiatric diagnosis and having incrementally higher levels of psychological distress, affects both smoking status and amount in young adulthood. Future research should investigate intervention approaches that effectively reach and reduce smoking among those with indications of poorer psychological health, a goal addressed in part by Aim 2.

Aim 2 showed that taxes encouragingly did not differentially affect those with and without indications of poorer psychological health, although taxes did not show much impact on smoking status or cigarette consumption in this population of young adults as a whole. Specifically, cigarette excise tax did not show any impact on the odds of being a current smoker when accounting for psychological health; however, tax was associated with reduced consumption of cigarettes (lower numbers of cigarettes smoked per day) among young adults with a history of smoking. As in Aim 1 analyses, both measures of poorer psychological health exerted independent effects on smoking in these models. These results suggest that cigarette excise taxes might contribute to reducing cigarette consumption (although not smoking status) among current or ever smokers, but likely need to be implemented as part of more comprehensive tobacco control efforts to be effective, especially for young adults with poorer psychological health.

Taken together, Aim 1 and Aim 2 show that psychological health affects smoking status across young adults nationally, and smoking amount among young adults with a history of smoking. Importantly too, these studies show that psychological health affects smoking when defined dichotomously as having a psychiatric diagnosis (as psychological health is often conceptualized) and continuously by a scale of psychological distress, which captures a large range of mild to severe psychological health issues; thus, even mild distress, for which someone would be unlikely to seek treatment, can have an impact on smoking, with critical lifelong health impacts. Raising cigarette excise taxes, an evidence-based intervention approach, does not seem to be less effective among those with psychological health issues, as initially hypothesized, but raising taxes to the extent they were raised in these waves of data collection was not enough to meaningfully reduce smoking in many cases. Intervention approaches should be designed to reach those with psychiatric diagnoses and those experiencing even relatively low levels of psychological distress.

Strengths and Weaknesses

Measurement

There were both strengths and weaknesses of the measurements chosen to capture key concepts during a period of change in many participants' lives. With respect to psychological health, a strength of this study is the use of two measures of psychological health, including a dichotomous, time-stable one to capture diagnosis of a mental health condition, as well as a continuous, time-varying measure of psychological distress, which captured a large range of psychological health levels, not just individuals with severe symptoms that were clinically diagnosable. This psychological health measure also allowed for the assessment of how changes in psychological health impacted smoking over time. However, the self-reported measure of

psychiatric diagnosis includes only those who have seen a doctor and been diagnosed, which could be limited by factors such as financial resources and health insurance, and that due to that potential stigma of having a mental illness, some may choose not to report it. Still, both measures of psychological health yielded similar results, supporting the veracity of the conclusions drawn from this research.

With respect to covariates, socio-economic status (SES) is related to both smoking and psychological health, often reflected by income and educational attainment, each of which may be difficult to meaningfully measure in young adulthood. The PSID has a strong measure of income, relative to other surveys, reflecting the compilation of taxable income, transfer income, and social security of the head, partner, and all other family unit members living together in a household. As a measure of more readily available funds that could be used to purchase cigarettes, family income was also chosen over family wealth as a covariate. However, family income may not be reflective of SES in the same way it is for an adult, as individuals may be earning less as they train or go to school in preparation for later careers, and as some may be living with their own partners and families while others remain in the home of their family of origin. Since educational attainment often happens during young adulthood, having a high school diploma was used as a measure of education, which does not capture the variation in education throughout this sample and over time. There was also not a consistent measure of college attendance across both the PSID main interview and the TA supplement, which did not allow for inclusion of higher educational attainment as a covariate.

In addition to SES, social support is a key component of understanding the relationship of psychological health and smoking as well; marital status was used in part as a measure of this, with the assumption that those who were married and experiencing symptoms of psychological

health issues may have more support for managing these symptoms in other ways than smoking.⁸² More robust measures of social support would be ideal and should be further explored in future research as well. Due to inconsistencies in measurement by year and across the two data sources within the PSID, other variables that might capture SES or social support, like current college enrollment or cohabitation (even if not married), were not able to be incorporated in analyses.

Modeling

Strengths of the random effect modeling approaches employed in this research included using longitudinal data to capture changes in individuals over time, accounting for nesting of observations using multilevel models, measuring within-individual and between-individual effects of psychological health on smoking (when the data allowed), and, in Aim 2, including a fixed effect for state to control for any time-stable, unmeasurable characteristics that may have affected psychological health and smoking.

With respect to modeling, responses to the number of cigarettes smoked were not normally distributed, violating a key assumption of linear regression that needed to be addressed in both Aim 1 and Aim 2. Several potential solutions were explored by adjusting the coding of this outcome as well as varying the modeling approach, and ultimately a Poisson model was chosen, often used with count data.

Additionally, the modeling approach in Aim 2 lays out a methodological plan that could be used to test additional population-based approaches to prevent and reduce smoking among young adults. Specifically, a similar approach could be used to test how psychological health impacts the effectiveness of tobacco control policies other than state taxes (such as banning smoking in public places, or raising the minimum age at which you can purchase cigarettes) or

other programs (such as coping and drug resistance skills trainings), to understand the most effective approaches to reducing smoking among young adults with poorer psychological health.

Future Directions

Results of both Aim 1 and Aim 2 present avenues for future research to better understand the relationships between psychological health, smoking, and tobacco control interventions among young adults. Screening measures should be designed to identify young adults with signs of psychological health issues, including both long and short-term issues, and interventions should be developed to target these individuals, either to reduce unpleasant symptoms of psychological health issues and/or to avoid smoking as a coping response. Counselors and others involved with treatment of psychological health in young adults should offer training in healthy coping strategies, as well as smoking prevention and cessation resources. Existing tobacco control approaches, which could include other state-level policies like smoke-free air laws, or more localized approaches, like a smoking prevention program on a college campus, should be assessed for the degree to which they reach and successfully prevent and reduce smoking among vulnerable young adult populations with signs of poorer psychological health.

With respect to theory, a strength of this research is its grounding in theory to inform hypotheses and understand results of how psychological health is related to smoking, using the Transactional Model of Stress and Coping and tension reduction hypothesis (developed in Chapter 2). However, this research did not explicitly test these models (i.e. the mechanisms by which psychological health affects smoking). Understanding the ways in which higher smoking rates may be produced in young adults with poorer psychological health would be valuable for future research and intervention development.

To better understand the relationships between smoking and psychological health as an individual ages throughout young adulthood, age, period, and cohort effects in this study should be further explored. This vein of research could be accomplished best with longitudinal research over a longer time period than the current research included, encompassing the transition from younger ages, when most smoking initiation happens through young adulthood.

Overall, this dissertation makes important contributions to the literature. First, it was shown that high-risk individuals with a mental health condition or higher levels of distress are more likely to be current smokers, and to smoke greater amounts of cigarettes, throughout young adulthood (Aim 1 and Aim 2). Second, the impact of having a diagnosis on smoking amount is stronger and more positive as individuals age through this critical developmental period (Aim 1). Third, encouragingly, the effect of cigarette excise taxes does not seem to differ by psychological health; however, to the extent to which they have been raised during the years of the study, cigarette excise taxes show little effect on smoking at all (Aim 2). Interventions should aim to target high-risk young adults with poorer psychological health to treat unpleasant psychological symptoms simultaneously with smoking prevention and cessation programs. Existing tobacco control approaches should be evaluated for their effects on a vulnerable population, young adults with poorer psychological health.

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