



# Air pollution and depressive symptoms: Current knowledge and future directions

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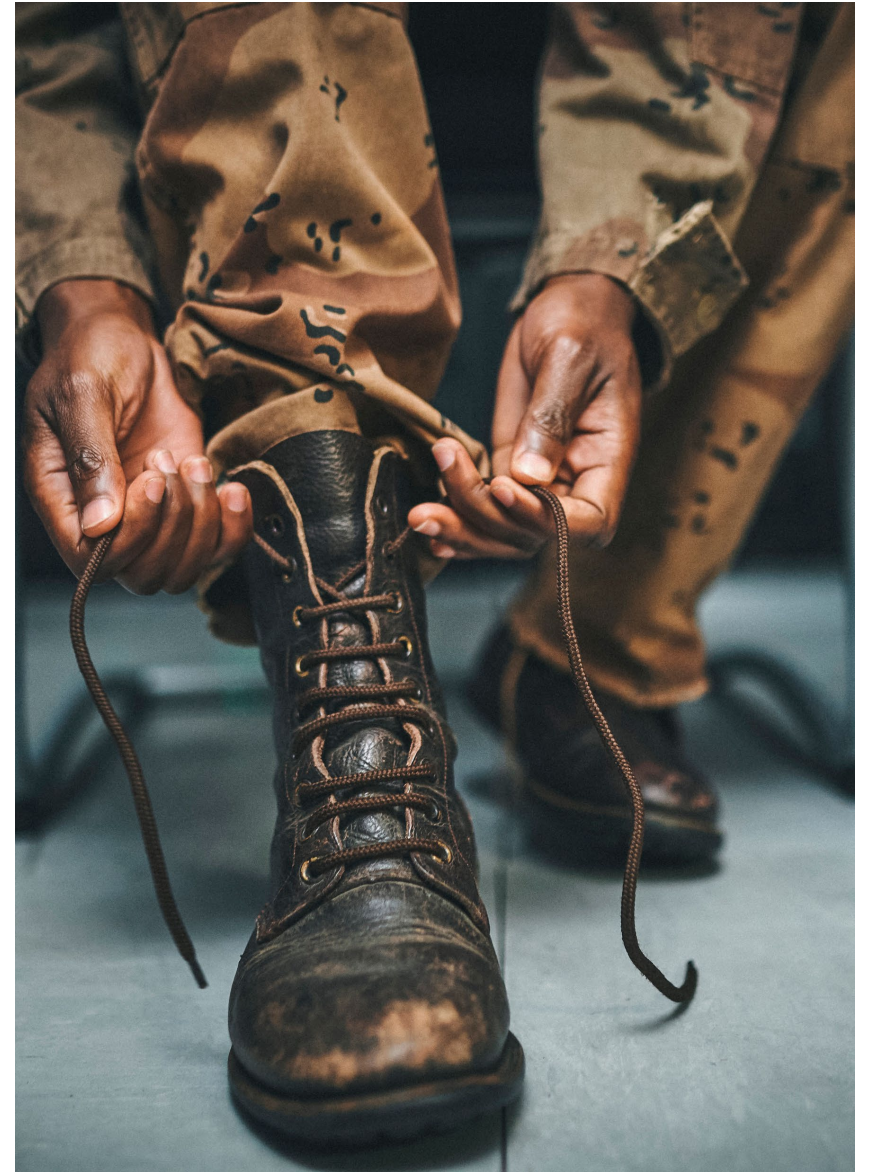
# **Depression is a major health problem.**

Depression is the leading cause of disability worldwide

Depression increases risk of suicide, substance use, and physical health  
problems

# Veterans are at increased risk

- Depression (along with PTSD) is one of the most common psychiatric diagnoses in military veterans
  - 1 in 3 veterans visiting primary care clinics experienced some depressive symptoms
- Critical to understand what may contribute to risk





# Identifying contributors to depression

- Multi-determined disorder
  - Genetics
  - Stress exposure
  - Differences in brain structure and function
  - Differences in peripheral stress biology

## However, we often overlook the *physical* environment

- Airborne toxicants as one set of potential risk factors
- Connections between air quality and physical health outcomes are well established
  - Air pollution accounts for 6% of all deaths in France, Switzerland, and Austria



Many exposures covered by the PACT Act pertain to inhalation of uncommon toxicants.

But understanding associations in common exposures can provide a model of potential risk.

# Air quality and depression

A dramatic landscape photograph featuring a large, dark, stormy cloud formation (possibly a supercell or a large cumulonimbus cloud) dominating the sky. The cloud is dark and textured, with some lighter areas where it catches the light. Below the cloud, a field of tall, golden-brown grasses is visible, swaying in the wind. The foreground is slightly out of focus, emphasizing the scale and power of the cloud above.

- Ozone is a ubiquitous exposure and a primary component of air quality indicators
- Ozone is known to activate several biological pathways previously implicated in depression
  - Immune activation
  - Cardiovascular risk
  - Neurodevelopmental processes



- Higher use of antidepressants has been found in locations with higher ozone
- Suicides and emergency department visits for mental health covary with the seasonality of ozone exposure
- Associations between other air pollutants and measures of depressive symptoms





# Gaps in the literature

Little research examining:

- *Individual level* depressive symptoms
- Change over time
- Sensitive periods/populations



# Why studying teenagers may be relevant to other groups

- Population at greater risk for the onset of depressive symptoms
- Spend more time outside than adults
- May be more biologically-sensitive to exposures

How might exposures to air pollution  
predict depressive symptoms over  
time?



## Study 1: What we know

- Results from a completed study of adolescents in California

## Study 2: Where we're going

- Overview of study in progress of families in Colorado



# Ozone and trajectories of depressive symptoms

# Overview

- 213 adolescents (ages 9-13)
- 57% female, 47% White
- Age at baseline = 11.37 years
  - Prepubertal at T1, postpubertal at T2 & T3

## Levels of ozone in sample:

- $M=.0344$  ppm,  $SD=.0039$ ; range: .0296-.0531 ppm
  - *Less than national air standard of .07 ppm*

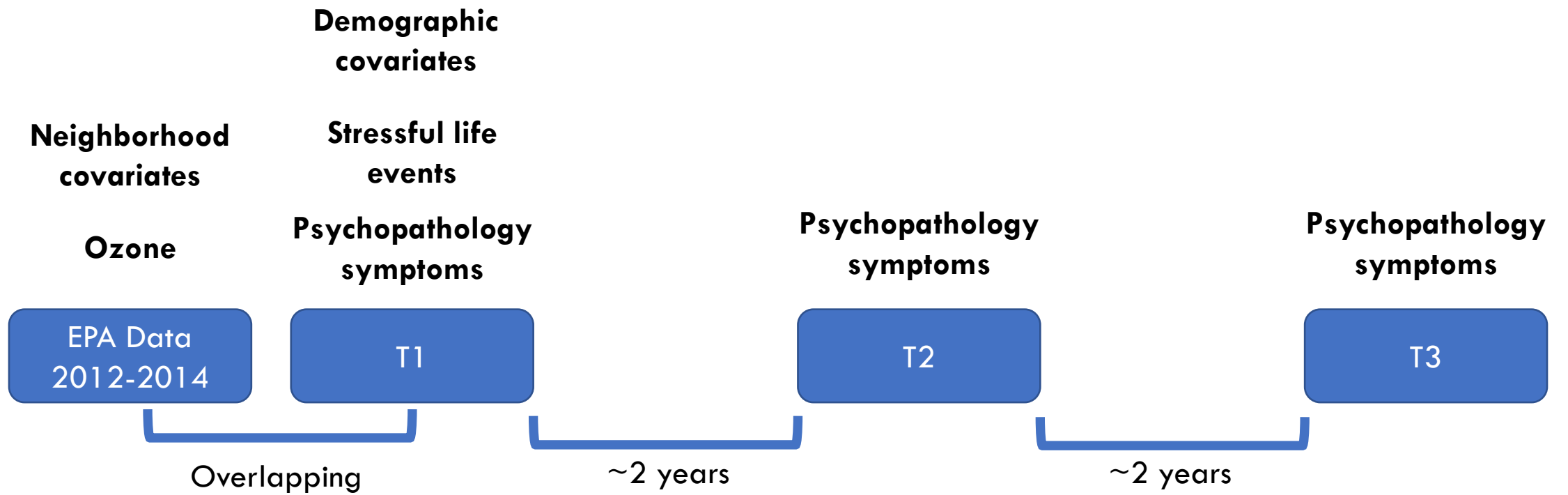
# Measures

## Symptoms:

- Child Depression Inventory (CDI; Kovacs, 1992)
- Youth Self Report (Achenbach & Rescorla, 1991)
  - Primary: Withdrawn/Depressed & Anxious/Depressed subscales
  - Secondary: All other subscales

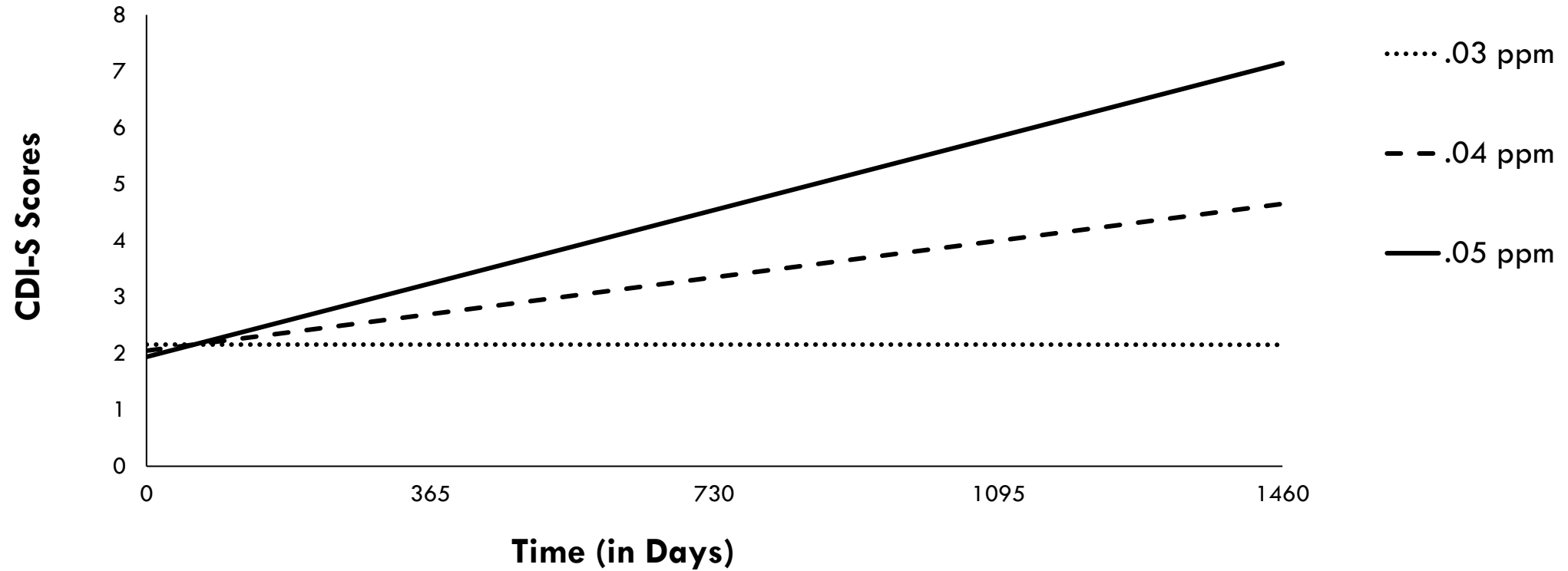
## Covariates:

- Total severe stressful life events (structured interview; Ford et al., 2002)
- Neighborhood disadvantage: % below 2x poverty line, % < HS diploma, % unemployed
- Sex, age, household income, and minority status

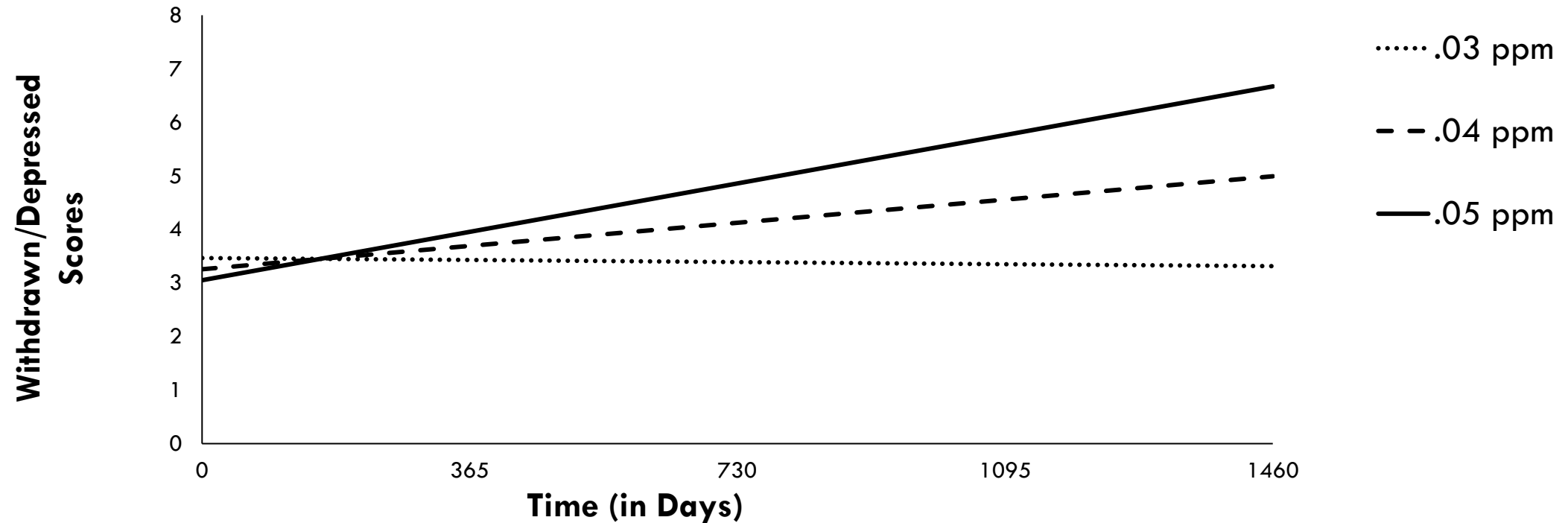




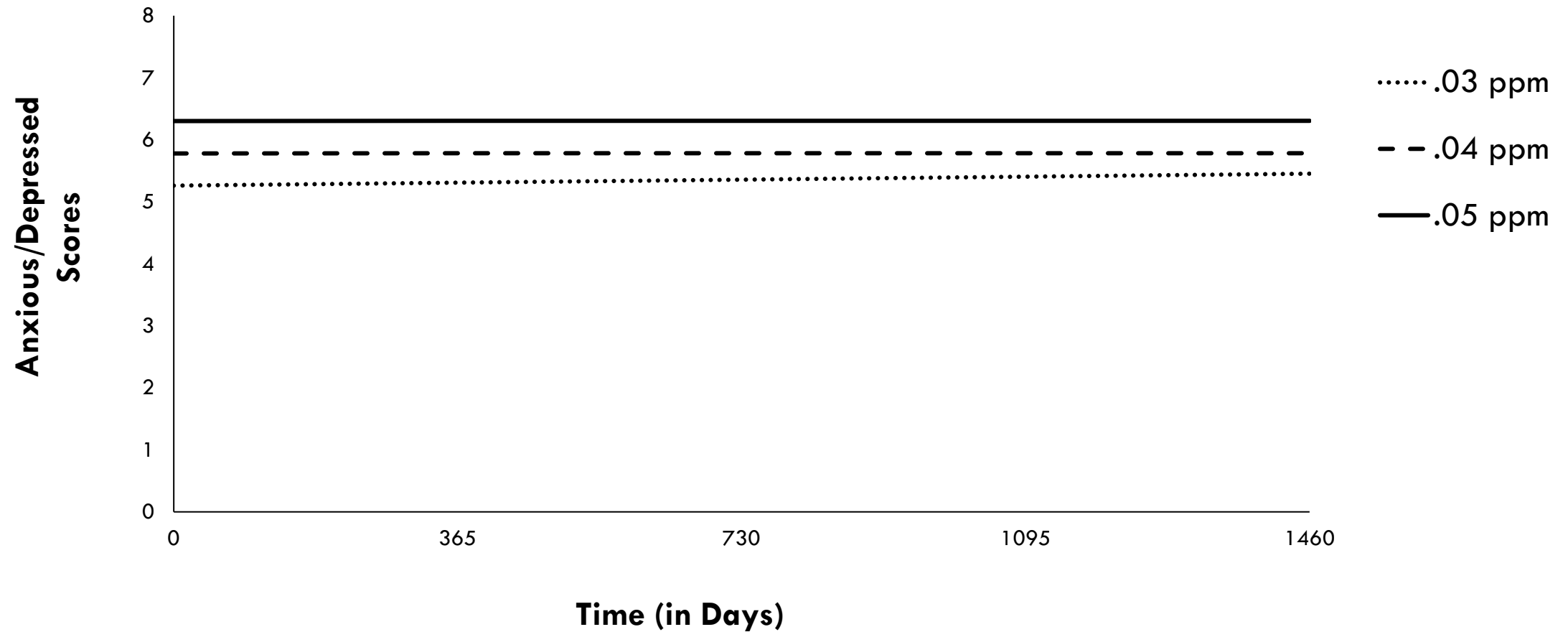
# Results: Depressive Symptoms (CDI)



# Results: Depressive Symptoms (YSR)



# Results: Anxiety Symptoms (YSR)



- Not accounted for by sex, age at baseline, minority status, income, parental education, number of stressful life events, or neighborhood disadvantage
- Exploratory analyses of other YSR subscales did not reveal any significant associations between ozone and symptom trajectories

# Summary

- Census tract ozone predicted trajectories of depressive symptoms, but no evidence for other types of psychopathology symptoms
  - Consistent with a neuroimmune mechanism
- Effects emerged above and beyond many potentially confounding community and personal factors

# Conclusions

- Proof-of-concept for correlations between ozone and adolescent depression risk
- Importance of change over time

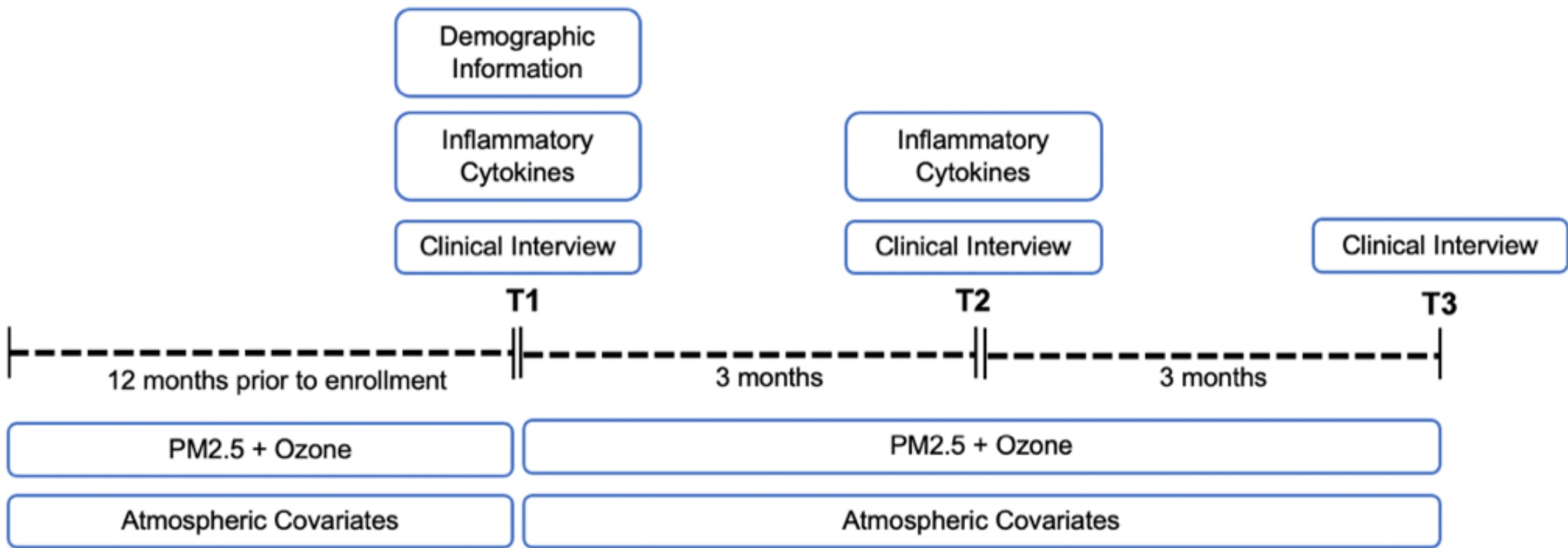
# Unanswered questions

- How do air pollutants relate to depressive symptoms across other developmental periods?
- What resolution of air pollution exposure provides the best data, both physically and temporally?
- Through what mechanisms does air pollution exposure relate to depression risk?
- What other common air pollutants are related to depressive symptoms?

# Ongoing study

- Funded by NIEHS and Brain & Behavior Research Foundation
- 120 families with teens in metro-Denver area
- Collaboration with scientists at the National Center for Atmospheric Research (NCAR)
- Creating residence-specific models of air pollution exposure at different timescales
  - One year, 6-months, 1-month, 1-week
- Following families for 6-months with repeated assessments of depressive symptoms and immune markers





# Anticipated outcomes

- Examine associations between pollutants and changes in depressive symptoms in both adults and adolescents
  - Identify dose: response across different timescales
- Test changes in pro-inflammatory cytokines as mediator of associations between pollution and depression
  - Alternative immune models (e.g., shifts in Th1 /Th2)
- Determine whether patterns differ for adults versus adolescents or on the basis of demographic factors



# What does this mean for Veterans?

- Provides proof-of-concept for associations between inhalable toxicants and depression
- Although ozone alone can cause health problems, it can also intensify the toxicity of other pollutants
- If ubiquitous exposures are related to risk, provide model for other airborne contaminants

# Thank you!

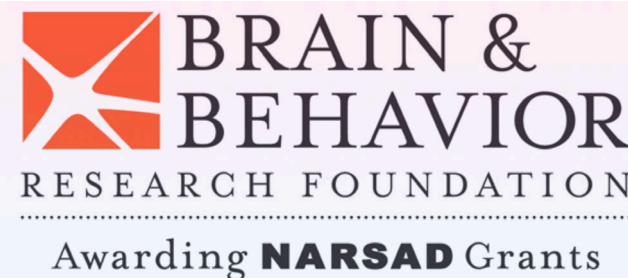


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We are grateful to all the participants and researchers who have made this research possible