Powering Electricity, Weakening Minds? Coal Plant Exposure and Mental Health

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Abstract

Coal-fired power plants are a major source of ambient air pollution in India, yet little is known about their long-run mental health consequences. We combine plant-level data on coal plant commissioning and capacity with individual-level information from the Longitudinal Aging Study in India (LASI) to examine how life-course exposure to coal combustion affects cognition and mental health among older adults. Our identification strategy exploits variation in the timing and intensity of coal plant expansion across districts, measuring exposure both in terms of cumulative years of operation and average generating capacity. We find that long-term exposure to coal plants is associated with lower cognitive scores and significantly higher incidence of depressive symptoms and clinical depression, even after controlling for individual and household characteristics. These results highlight the mental health costs of India's reliance on coal-based energy and underscore the importance of considering life-course exposures in environmental health policy.

1 Introduction

With increased urbanization and rapid population growth, air pollution remain a major source of health issues in low-and-middle-income countries (LMICs). The contribution of coal–fired power generation to such pollution has been large [Barreca et al., 2014]. Particularly with expansion of energy system expansion over the past half century there is an increased reliance on the coal-fired generated electricity. The growth of coal–based power has out–run the growth of any other form of electricity generation. Specifically, in this study's context, India has coal as the primary fuel for almost 75 percent all electricity generated [Barrows et al., 2019, Shearer et al., 2017].

Coal units in India often do not meet emission standards or other guidelines that are common in the developed world [Chan et al., 2014]. This has exacerbated the health, economic and environmental consequences of relying on this mode of energy generation. The true negative externalities are likely to be higher when impact on morbidity, physical health and mental health will be taken into account [Gupta and

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Spears, 2017]. In past temperature and pollution has linked to a range of mental health problems, including anxiety and depression yet its long-run mental health consequences, particularly among infants and older populations are unknown [Sardana et al., 2024, Clay et al., 2024].

So far studies using coal plant driven pollution have looked at mortality effects on infants and physical health [Vyas, 2025, Datt et al., 2023, Clay et al., 2024, Gupta and Spears, 2017]. Ours is a first study that takes into account the long term exposure to coal plant and later life mental health outcomes. In this study we undertake three questions: (1) Does long-term exposure to coal-fired power plant emissions affect mental health and cognitive outcomes among older adults in India? (2) How do timing, duration, and intensity of exposure across the life course influence ageing-related mental outcomes? (3) Can distance from coal plant pollution estimates enhance our understanding of environmental determinants of mental health?

Our work brings methodological and substantive innovation to ageing-climate-health research. We develop life-course exposure metrics that reflect not just presence but intensity and timing of coal plant emissions over a respondent's life span. To do so, we link geo-referenced administrative data on coal plant commissioning years, capacity and carbon dioxid emission from the Central Electricity Authority [1] with detailed national representative microdata from the Longitudinal Ageing Study in India (LASI). All the geocoded coal power plant locations were merged with each LASI respondent's district using official coordinates, to compute distances between residences and the nearest coal-fired plant(s). This enables construction of distance-weighted exposure indicators that capture environmental exposure gradients both continuously and categorically, such as proximity thresholds within 0-50 km, 50-75 km, and 75-100 km.

Our main findings, shows robust evidence that long-run exposure to coal-fired power plants is associated with poorer mental health outcomes among older adults in India. Individuals residing in districts with greater cumulative years of coal plant operation and within the proximity of 50 km from plant, exhibit significantly higher rates of depressive symptoms and clinical depression. Moreover, exposure to larger installed plant capacity is linked to lower cognitive performance and elevated psychological distress, even after controlling for demographic and household characteristics. While the magnitude of cognitive effects is modest, the depression results are both statistically and economically meaningful, pointing to mental health costs of coal combustion that compound over the life course. These findings underscore the importance of moving beyond short-run air quality shocks to consider how structural features of India's energy system shape long-term health trajectories.

This study offers a novel contribution to the ageing-climate-health nexus by tracing how historical exposure to coal combustion emissions contributes to psychological distress, cognitive decline, and eventually dementia in later life. In doing so, it provides critical insights on long term pollution exposure can explain later life mental health outcomes. This study has two main contributions in the ageing-climate-health nexus. First, the pollution impacts physical health of the adult which then crops up in the form of depression,

[1] Central Electricity Authority of India's CO2 Baseline Database for the Indian Power Sector.Accessed from https://cea.nic.in/cdm-co2-baseline-database/?lang=en

anxiety and even dementia in some cases. Second, the effect of living in the vicinity of the coal plant not only substantiate the evidence the effects on the current generation but also presents evidence on future generations and their later life health outcomes.

Our approach advances generating high-quality, public-use data with codes on long-term pollution exposure histories, enabling follow-on work across disciplines. By integrating social and environmental data at high temporal and spatial resolution, we help catalyse a broader shift towards climate vulnerability in ageing societies.

2 Literature Review

Recent work links ambient pollution exposure to cardiovascular and respiratory health, but studies on mental health and cognition are fewer. Research from the U.S. and China [Power et al., 2015, Zhang et al., 2018] finds associations between long-term PM2.5 exposure and depression or dementia risk. In India, most studies focus on short-run pollution effects in urban settings [Greenstone and Hanna, 2014, Dey et al., 2020].

Early work such as Barrows et al. [2019] highlights the mortality and morbidity consequences of coal-fired power plants in India, using detailed plant-level data linked to population health. Their results show that emissions from coal combustion are a major contributor to premature mortality, establishing coal as a dominant source of adverse health externalities. Building on this, Greenstone and Hanna [2014] use a national household panel to examine health externalities of India's coal expansion and document that exposure to coal plant emissions significantly worsens household health outcomes across multiple dimensions, including respiratory and cardiovascular disease. These findings underscore the systemic health risks associated with coal-based energy.

More recent studies have begun to explicitly connect air pollution to mental health. Sardana et al. [2024] provide one of the first nationally representative studies for India, linking ambient pollution to depression and psychological distress. Using survey-based measures of mental health, they show that short-run variation in particulate matter concentration raises the incidence of depression and anxiety, with especially large effects among vulnerable populations. These findings align with international evidence from China and the U.S. showing that fine particulate matter ($PM_{2.5}$) exposure is associated with higher risks of depression, cognitive decline, and dementia [Power et al., 2015, Zhang et al., 2018].

Taken together, the literature establishes a clear set of stylized facts: coal combustion is the primary driver of ambient air pollution in India; pollution exposure has well-documented physical health effects; and emerging evidence shows substantial consequences for mental health as well. However, important gaps remain. In particular, there is limited evidence on the *long-run, life-course impacts* of coal plant exposure on mental health outcomes. Prior studies primarily exploit short-run variation in air quality or focus on physical health endpoints. This project extends the literature by linking detailed coal commissioning and capacity data to life-course measures of exposure and assessing their effects on cognition, depression, and clinical psychiatric diagnoses in later life.

3 Data

We use individual-level data from LASI Wave 1 (2017–2019)[2], a nationally representative survey of over 73,000 adults aged above 45 years [Perianayagam et al., 2022]. It adapted measures on mental health outcomes that covers cognition, depression and dementia outcomes from Health and Retirement Survey, China Health and Retirement Longitudinal Study [Blankson and McArdle, 2014, Lee et al., 2020]. It measures depression scores, cognitive performance, and reported neurological using internationally validated and comparable tools: the CES-D scale [Radloff, 1977] and the CIDI-SF scale [Kessler et al., 1998]. While the original CES-D scale is a 20-item scale, LASI implemented a shortened 10-item scale with four scale option categories was used in the LASI. The 10 items included seven negative symptoms (trouble concentrating, feeling depressed, low energy, fear of something, feeling alone, bothered by things, and everything is an effort), and three positive symptoms (feeling happy, hopeful, and satisfied) [Roychowdhury, 2024]. The CIDI-SF scale is designed to produce psychiatric diagnoses for a major depressive episode, in accordance with the Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association (detailed questions shown in section 8).

Next, we compile annual-district-level coal plant data (location, commissioning year, capacity, emission in CO_2) from the Central Electricity Authority in India. Each LASI respondent is matched to the districts of their adulthood where they have spent most of their lifetime to capture long term effect of the coal plant exposure on mental health outcomes. Most of the studies lack this matching due to unavailability of such data and rely on place of interview or birth district. This matching allows us to measure the extent of exposure of coal fired plant both in terms of years and average capacity (in Mega Watt (MW)).

4 Descriptive Statistics

4.1 Demographic and Household Characteristics by Exposure

Table 1 compares demographic and household characteristics of our sampled respondents residing in coal plant–exposed districts with those in unexposed districts. These differences in the sample statistics shows that individual characteristics slightly differ between exposed and unexposed districts. However, there is no bearing of such difference on our analysis. [3]

Household-level indicators further highlight disparities. Exposure to indoor air pollution (could be from smoking, burning of wood etc.) is significantly higher in coal plant districts (93% versus 88%), while access

[2] Accessed from www.iipsindia.ac.in/lasi

[3] This is because of the selection of individuals into exposed and unexposed districts is assumed to be random Of course, there can be issues such as more employment in the exposed districts because of higher electricity generation. However, previous studies have shown that these individual level variables do not have significant bearing on the mental health outcomes. Even our analysis suggest that even after controlling for these variables, mental health outcomes are worst in exposed districts.

to improved sanitation is lower (69% versus 73%). Agricultural work is also less prevalent in exposed areas. On the other hand, households in exposed districts report somewhat better access to clean cooking fuels, though electricity access is nearly universal in both groups.

These differences in the sample do not a priori invalidate the identification assumption because the main analyses identify effects from variation within districts over time and therefore control for both observed and unobserved fixed district characteristics. More on this in section 5.

Table 1: Summary statistics

Variable	**Mean (Unexposed)** **1**	**Mean (Exposed)** **2**	**Difference** **1-2**
Female	0.55	0.75	-0.201***
Male	0.44	0.24	-0.20***
Age (years)	58.03	56.58	1.46***
Not literate & below primary	0.56	0.59	-0.03***
Primary & upper primary/middle	0.23	0.21	0.02***
Secondary & higher secondary	0.138	0.128	0.010*
Diploma, graduation & above	0.05	0.06	-0.001
Indoor pollution exposure	0.88	0.93	-0.05***
General Caste	0.26	0.33	-0.07***
Scheduled Caste	0.16	0.20	-0.03***
Scheduled Tribe	0.19	0.05	0.13***
Other Backward Caste	0.37	0.39	-0.02***
Hindu	0.72	0.82	-0.10***
Muslim	0.11	0.10	0.10***
Other Religion	0.04	0.05	-0.001***
Agricultural Worker	0.20	0.13	0.07***
Access to electricity	0.942	0.941	–0.001
Access to drinking water source	0.935	0.927	–0.008**
Improved sanitation	0.73	0.69	–0.04***
Clean cooking fuel	0.537	0.612	0.075***

Note: * p<0.1, ** p<0.05, *** p<0.01. Source: Author's compilation based on LASI Wave 1.

4.2 Difference in Health Conditions by Coal Plant Exposure

Table 2 reports differences in major health conditions across exposed and unexposed districts. While the prevalence of chronic lung disease is similar across the two groups, individuals in coal plant–exposed districts are significantly more likely to report asthma. More strikingly, the prevalence of psychiatric issues and Alzheimer's/dementia is nearly twice as high in exposed districts, with differences both statistically significant and substantively meaningful.

These descriptive patterns suggest that populations in coal-exposed districts not only face higher risks of physical ailments linked to air pollution, such as asthma, but also experience elevated rates of neurological and psychiatric disorders. This motivates our focus on mental health outcomes, which have received far less attention in the coal and air pollution literature despite their growing importance for ageing populations.

Table 2: Health Conditions by Coal Plant Exposure

Health Condition	**Mean (Unexposed)** **1**	**Mean (Exposed)** **2**	**Difference** **1-2**
Ever had lung disease	0.0196	0.0198	-0.0002
Ever had asthma	0.0359	0.0412	-0.005**
Ever had psychiatric issue	0.0073	0.0120	-0.0046***
Ever had Alzheimer's/dementia	0.0051	0.0099	-0.0048***

Note: * p<0.1, ** p<0.05, *** p<0.01. Source: Author's compilation based on LASI Wave 1.

5 Econometric Framework

5.1 Effect of Exposure

We estimate the following equation to estimate the long term impact of the exposure to coal plant for individuals who have spent their adulthood (significant amount of time) in the district where there are functional coal plant(s):

$$y_i = \alpha + \beta_1 Exposed_i + \gamma' X_i + \lambda_t + \varepsilon_i \tag{1}$$

where y_i denotes a mental health outcome for individual i (e.g., CESD score, CIDI score, or cognition index). $Exposed_i$ is a binary variable indicating whether the individual lived in a district with an operational coal plant during any year of their adulthood (age 18 to survey year). This captures whether any exposure occurred, regardless of the number of plants or years. X_i is a vector of individual and household-level covariates including age, gender, caste, religion, education, household wealth index, use of clean cooking fuels, electrification status, source of drinking water. λ_t is the survey year fixed effects. Standard errors are clustered at the district level.

5.2 Proximity to Coal Plant

Several studies have used distance from coal plant as an exposure variable [Clay et al., 2024, Vyas, 2025]. The threshold is that coal plant should be within 50 km of the respondent's proximity. Therefore, we estimate our results using this computed distance of a geo-referenced coal plant and merged it with the district in which the individual has spent most of their adulthood. We computed the distance of coal plants from the centroid of the districts that overlaps with the individual's districts. This created different bins of distance 0-50 km, 50-75 km and above. Then we merged this distance with individual's district name that assigned different individuals with their nearest distance from a coal plant.

$$y_i = \alpha + \beta_1 Distancebins_i + \gamma' X_i + \lambda_t + \varepsilon_i \tag{2}$$

where y_i denotes a mental health outcome for individual i (e.g., CESD score, CIDI score, or cognition index). $Distancebins_i$ is a categorical variable where it takes value 1 if nearest coal plant is in 0-50 km distance from individual's district, 2 if it is 50-75 km and 3 if the distance is 75-10 km and 0 (omitted category) if the district is not exposed. Rest of the specification is same as described above.

5.3 Intensity of Exposure: Years of Exposure

Using a life-course cumulative exposure measure that captures the numbers of years of exposure to the coal plant over the respondent's adult lifetime:

$$y_i = \alpha + \beta_1 YearsofExposure_i + \gamma' X_i + \lambda_t + \varepsilon_i \tag{3}$$

where $YearsofExposure_i$ measures the unique calendar years an individual was exposed to at least one active coal plant, regardless of the number of plants in the district. If a district has 1 or 10 active plants in a given year, it counts as 1 year of exposure for that year. This avoids inflating exposure counts due to multiple plants and sums unique years across all life stages (birth, childhood, adulthood). For example, living in a district with 10 plants in 2010 and 5 plants in 2011 contributes 2 distinct years.

5.4 Intensity of Exposure: Coal Plant Capacity

Using a life-course cumulative exposure measure that captures the total intensity of coal plant exposure over the respondent's adult lifetime:

$$y_i = \alpha + \beta_1 AverageCapacityExposure_i + \gamma' X_i + \lambda_t + \varepsilon_i \tag{4}$$

where $AverageCapacityExposure_i$ is calculated as the Mega Watt (MW) capacity of all coal-fired power plants operating in the respondent's adulthood district(s) divided by distinct exposure years. If distinct exposure years = 0, it is set to 0. For example, 3000 MW-years over 2 distinct years yields 1500 MW/year. This normalizes exposure intensity by unique years, reflecting average annual exposure. This captures varying intensity of coal plant capacity impact on mental health outcomes.

6 Main Results

6.1 Effect of Exposure

Table 3 presents the estimates of equation (2), where the treatment variable captures whether the respondent lived in a district with a coal-fired power plant during adulthood. We consider three outcome variables captured in LASI survey for mental health. Across specifications, we consistently find evidence of adverse effects of coal plant exposure on mental health outcomes.

In the OLS specification without year fixed effects, an additional year exposure to coal plants is associated with a 0.027 points decline in cognitive factor scores. The inclusion of year fixed effects attenuates the effect of exposure to coal plants. Nonetheless, the results point to a persistent cognitive penalty of coal-related pollution.

The effects on depression are more pronounced. An additional year of exposure increases CES-D scores above the clinical threshold by 8.4 percentage points and by 11.5 percentage points once year fixed effects are included. The logit specification confirms this pattern, with exposure increasing the probability of reporting depressive symptoms by 3.4 percentage points. The clinical depression as measured by the CIDI instrument, we find that exposure increases the probability of diagnosis by 3.7 percentage points in the baseline OLS model and 5.1 percentage points when controlling for year fixed effects. The logit estimates again corroborate these findings, with a marginal effect of 0.8 percentage points.

These results suggest that long-term exposure to coal plant emissions is associated with worse cognitive outcomes and substantially higher risk of depression among older adults. The pattern of results is robust across estimation methods and becomes particularly striking when we consider depression-related outcomes, where the magnitudes are economically meaningful. These findings provide the first large-scale evidence from India that coal-related pollution affects not only physical but also mental health, with implications for both ageing and labor market productivity.

Table 3: Effect of Exposure On Cognitive and Mental Health Outcomes

	OLS	OLS	Logit
Cognitive factor score	-0.027***	-0.014*	-0.004
	(0.008)	(0.008)	(0.005)
Depression Symptoms	0.084***	0.115***	0.034***
	(0.021)	(0.021)	(0.005)
Clinical Depression	0.037*	0.051**	0.008**
	(0.019)	(0.019)	(0.003)
Individual Characteristics	Yes	Yes	Yes
Household Characteristics	Yes	Yes	Yes
Year Fixed Effects	No	Yes	Yes
Observations	67,049	67,534	67,049

Source: Administrative data from Central Electricity Authority in India and LASI wave-1 data. For logit specification we have created binary variables based on thresholds. Cognitive factor <0 indicates poor cognition. CES-D 10 >4 out of 10 indicates depression, CIDI- Symptoms >3 out of 7 indicates clinical depression [Banerjee et al., 2023]. $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

6.2 Effect of Proximity

Table 4 reports estimates from the distance-based specification. The results show a clear gradient in mental health outcomes with proximity to coal plants. For cognition, individuals residing 50–75 km from a coal plant display significantly lower scores relative to those unexposed, with effects robust across OLS and logit models. The coefficients for 75–100 km also suggest cognitive decline, though weaker and less consistent.

For depression outcomes, the adverse effects are even more pronounced. Living within 50 km of a coal plant raises the probability of reporting depressive symptoms by around 1.5 percentage points in the logit specification, while exposure at 50–75 km and 75–100 km is associated with significantly higher CES-D scores. Clinical depression outcomes follow a similar pattern: the probability of diagnosis increases by 1.3 percentage points for those within 50 km and by 1.6 percentage points for those 50–75 km away.

Overall, the proximity results underscore that mental health burdens are not limited to immediate plant districts but extend well beyond, highlighting the diffuse spatial reach of coal-related pollution.

Table 4: Effect of Proximity to Coal Plants on Cognitive and Mental Health Outcomes

	OLS	OLS	Logit
Cognitive factor score (Base category: No exposure)			
0-50 km	0.001	-0.003	0.0004
	0.007	0.007	0.004
50-75 km	0.034***	0.027**	0.0135**
	0.009	0.009	0.005
75-100 km	0.027**	0.007	0.007
	0.013	0.013	0.007
Depression Symptoms (Base category: No exposure)			
0-50 km	0.023	0.031	0.015 ***
	0.019	0.019	0.005
50-75 km	0.089***	0.075***	0.004
	0.024	0.024	0.006
75-100 km	0.108***	0.094**	0.001
	0.033	0.033	0.008
Clinical Depression (Base category: No exposure)			
0-50 km	0.085***	0.083***	0.013 ***
	0.017	0.017	0.003
50-75 km	0.139***	0.127***	0.016***
	0.022	0.022	0.004
75-100 km	0.040	0.025	-0.004
	0.030	0.030	
Individual Characteristics	Yes	Yes	Yes
Household Characteristics	Yes	Yes	Yes
Year Fixed Effects	No	Yes	Yes
Observations	67,049	67,049	66,993

Source: Administrative data from Central Electricity Authority in India and LASI wave-1 data. For logit specification we have created binary variables based on thresholds. Cognitive factor <0 indicates poor cognition. CES-D 10 >4 out of 10 indicates depression, CIDI- Symptoms >3 out of 7 indicates clinical depression [Banerjee et al., 2023]. $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

6.3 Effect of Years of Exposure

Table 5 reports the effect of cumulative years of exposure to coal-fired power plants on cognitive and mental health outcomes. The treatment variable measures the overlap between the commissioning year of coal plants in a respondent's adulthood district and the years lived in that district.

We find that longer exposure is associated with statistically significant deterioration in mental health outcomes. For cognition, the OLS specification without year fixed effects shows that each additional year of exposure reduces the cognitive factor score by 0.0006 units (significant at the 5% level). Although this effect appears small in magnitude, it compounds over long durations of exposure: twenty years of exposure correspond to a reduction of roughly 0.012 units in cognition, which is non-trivial relative to the mean of the distribution. Once year fixed effects are included, the coefficient is smaller in magnitude (–0.0002) and statistically insignificant, suggesting that part of the variation is absorbed by temporal shocks.

By contrast, the effects on depression-related outcomes are robust and economically meaningful. Each year of exposure increases the likelihood of exceeding the CES-D threshold for depressive symptoms by 0.3–0.5 percentage points across specifications. In the logit model, the marginal effect is 0.1 percentage points per year. Over 20 years, this implies a 2–10 percentage point higher risk of depression, relative to a baseline prevalence of around 20 percent in the sample.

The results for clinical depression, as measured by the CIDI-SF, also point to adverse consequences of cumulative exposure. The OLS specification with year fixed effects indicates that each year of exposure raises the probability of clinical depression by 0.13 percentage points, while the logit estimates suggest an effect of 0.02 percentage points. Although smaller in magnitude, these results remain statistically significant and substantively relevant when aggregated over decades of exposure.

Table 5: Effect of Years of Exposure on Cognitive and Mental Health Outcomes

	OLS	OLS	Logit
Cognitive factor score	-0.0006**	-0.0002	-0.00007
	(0.0002)	(0.0002)	(0.001)
Depression Symptoms	0.003***	0.005***	0.001***
	(0.0006)	(0.0006)	(0.0001)
Clinical Depression	0.0008	0.0013 **	0.0002 ***
	(0.002)	(0.006)	(0.000)
Individual Characteristics	Yes	Yes	Yes
Household Characteristics	Yes	Yes	Yes
Year Fixed Effects	No	Yes	Yes
Observations	67,049	67,049	66,993

Source: Administrative data from Central Electricity Authority in India and LASI wave-1 data. For logit specification we have created binary variables based on thresholds. Cognitive factor <0 indicates poor cognition. CES-D 10 >4 out of 10 indicates depression, CIDI- Symptoms >3 out of 7 indicates clinical depression [Banerjee et al., 2023]. $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

6.4 Effect of Average Capacity

Table 6 presents the estimates of Equation (4), where exposure is measured by the log of average installed coal capacity in a respondent's adulthood district. This specification captures the intensity of exposure by weighting districts not just by the presence of coal plants but also by their generating capacity.

We find strong and consistent evidence that higher capacity exposure is negatively associated with cognitive outcomes. Across specifications, respondents in districts with larger coal-fired capacity exhibit significantly lower cognitive factor scores. In the OLS models, a one-unit increase in logged capacity is associated with a 0.03–0.035 point reduction in cognition, while the logit specification confirms this effect with a marginal decrease of 0.012. Although these magnitudes may appear modest, they represent meaningful declines when accumulated over decades of exposure and are comparable to the effects of key socioeconomic determinants such as education or wealth.

For depression, the results indicate a statistically significant positive relationship between capacity exposure and depressive symptoms. The OLS estimates imply that a one-unit increase in logged capacity raises CES-D depression scores by approximately 0.047 points. However, this effect does not carry over to the binary logit specification, where the marginal impact on the probability of clinical depression is small and statistically insignificant. This suggests that while exposure may increase the intensity of depressive symptoms on average, it does not necessarily translate into sharp threshold crossings that define clinical depression.

Indeed, for the clinical depression outcome based on CIDI-SF thresholds, the coefficients are negative, small in magnitude, and statistically indistinguishable from zero across all models. This points to heterogeneity in how pollution exposure affects mental health. While it consistently worsens cognitive function and elevates subclinical depressive symptoms, the evidence for effects on clinically diagnosed depression is weaker.

Taken together, these findings suggest that exposure to higher coal plant capacity exerts persistent and measurable effects on mental health, especially through reduced cognitive functioning and elevated depressive symptoms.

Table 6: Effect of Average Capacity (in MW) of Coal Plant on Cognitive and Mental Health Outcomes

	OLS	OLS	Logit
Cognitive factor score	-0.035***	-0.030***	-0.012***
	(0.008)	(0.008)	(0.004)
Depression Symptoms	0.0468**	0.047**	0.004
	(0.02)	(0.02)	(0.005)
Clinical Depression	-0.012	-0.007	-0.001
	(0.020)	(0.020)	(0.003)
Individual Characteristics	Yes	Yes	Yes
Household Characteristics	Yes	Yes	Yes
Year Fixed Effects	No	Yes	Yes
Observations	6,675	6,628	6,627

Source: Administrative data from Central Electricity Authority in India and LASI wave-1 data. Log transformation is used for the average capacity exposure (in MW). For logit specification we have created binary variables based on thresholds. Cognitive factor <0 indicates poor cognition. CES-D 10 >4 out of 10 indicates depression, CIDI- Symptoms >3 out of 7 indicates clinical depression [Banerjee et al., 2023]. $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

7 Conclusion

This study provides new evidence on the long-run mental health consequences of coal-fired power plant exposure in India. By linking detailed plant-level commissioning and capacity data with nationally representative microdata from LASI, we show that cumulative exposure to coal plants is associated with worse cognitive performance and higher incidence of depressive symptoms among older adults. The findings underscore the broader health externalities of coal combustion, which extend beyond respiratory and cardiovascular disease to encompass mental health outcomes that are increasingly relevant in an ageing society.

Our results highlight the need for energy and environmental policies that account for the intergenerational health costs of coal dependence. Reductions in coal reliance and improvements in emission standards may yield not only physical health benefits but also sizable mental health gains.

8 Appendix

8.1 Cognitive Factor Score (CFS) list

1. Report the interview's date correctly, including the day of the month, the month, the year, and the day of the week, respectively
2. Report about interview place such as a living room, house, apartment, hospital, market, and so on, name the street number, colony name, landmark, or neighbourhood of their address, village, town, or city and district of their address
3. Ability to immediate word recall
4. Ability of verbal fluency:animal/bird naming
5. Ability of respondent to identify 2 random objects that the interviewer pointed to such as cell phones, gloves, hats, rings, and umbrella
6. Ability of respondent to successfully count backwards from 20
7. Ability to answer the number of correct subtractions in the serial 7's test. This test asks the individual to subtract 7 from the prior number, beginning with 100 for five trials
8. Ability to do a specified computation. The respondent was given the following word problem to solve: "A shop is having a sale and selling all items at half price. Before the sale, a sari costs 300 Rs. How much will it cost in the sale?
9. Ability to read a sentence aloud and act the action out.
10. Ability to write a sentence about how he/she was feeling on the interview day or about that day's weather
11. Ability to do 3-stage task (folding paper)
12. Ability to draw overlapped pentagons

8.2 Depressive Symptoms (CES-D list)

1. Had trouble concentrating
2. Felt depressed
3. Everything an effort
4. Felt tired or low energy
5. Was happy
6. Felt lonely
7. Felt overall satisfied

8. Felt afraid of something
9. Felt hopeful about the future
10. Bothered by little things

All these questions were provided with 4 options and final score > 4 shows presence of depressive symptoms
(1) rarely or never (< 1 day)
(2) Sometimes (1-2 days)
(3) Often (3-4 days)
(4) Most or all of the time (5-7 days)

8.3 Clinical Depression (CIDI list)

1. Feeling of sad, blue, or depressed for two weeks or more in a row in the past 12 months- screening for dysphoria
2. Worsening of the feelings of being sad, blue
3. Frequency of feeling of being sad, blue, or depressed (feelings lasted all day long, most of the day, about half the day, or less than half the day during the two-week period)
4. lost interest in most things - screening for anhedonia
5. felt more tired out or low in energy than is usual
6. change in appetite (either lost appetite or increased appetite
7. had more trouble falling asleep than usual
8. had a lot more trouble concentrating than usual
9. felt down on themselves, and no good or worthless
10. thought a lot about death, either their own, someone else's, or death in general

References

Abhijit Banerjee, Esther Duflo, Erin Grela, Madeline McKelway, Frank Schilbach, Garima Sharma, and Girija Vaidyanathan. Depression and loneliness among the elderly in low-and middle-income countries. *Journal of Economic Perspectives*, 37(2):179–202, 2023.

Alan Barreca, Karen Clay, and Joel Tarr. Coal, smoke, and death: bituminous coal and american home heating. Technical report, National Bureau of Economic Research, 2014.

Geoffrey Barrows, Teevrat Garg, and Akshaya Jha. The health costs of coal-fired power plants in india. 2019.

A Nayena Blankson and John J McArdle. A brief report on the factor structure of the cognitive measures in the hrs/ahead studies. *Journal of Aging Research*, 2014(1):798514, 2014.

Hei Sing Chan, Maureen L Cropper, and Kabir Malik. Why are power plants in india less efficient than power plants in the united states? *American Economic Review*, 104(5):586–590, 2014.

Karen Clay, Joshua Lewis, and Edson Severnini. Canary in a coal mine: Infant mortality and tradeoffs associated with mid-20th century air pollution. *Review of Economics and Statistics*, 106(3):698–711, 2024.

Gaurav Datt, Pushkar Maitra, Nidhiya Menon, and Ranjan Ray. Coal plants, air pollution and anaemia: Evidence from india. *The Journal of development studies*, 59(4):533–551, 2023.

Subhrendu K Dey, S Ghosh, et al. Ambient and household pm2.5 pollution and adverse perinatal outcomes: A meta-regression and analysis of recent birth cohorts in india. *Environmental Health Perspectives*, 128 (6):067006, 2020.

Michael Greenstone and Rema Hanna. Environmental regulations, air and water pollution, and infant mortality in india. *American Economic Review*, 104(10):3038–72, 2014.

Aashish Gupta and Dean Spears. Health externalities of india's expansion of coal plants: evidence from a national panel of 40,000 households. *Journal of environmental economics and management*, 86:262–276, 2017.

Ronald C Kessler, Gavin Andrews, Daniel Mroczek, Bedirhan Ustun, and Hans-Ulrich Wittchen. The world health organization composite international diagnostic interview short-form (cidi-sf). *International journal of methods in psychiatric research*, 7(4):171–185, 1998.

Jinkook Lee, Pranali Y Khobragade, Joyita Banerjee, Sandy Chien, Marco Angrisani, Arokiasamy Perianayagam, David E Bloom, and Aparajit B Dey. Design and methodology of the longitudinal aging study in india-diagnostic assessment of dementia (lasi-dad). *Journal of the American Geriatrics Society*, 68: S5–S10, 2020.

Arokiasamy Perianayagam, David Bloom, Jinkook Lee, Sulabha Parasuraman, TV Sekher, Sanjay K Mohanty, Aparajita Chattopadhyay, Dipti Govil, Sarang Pedgaonkar, Sangeeta Gupta, et al. Cohort profile: the longitudinal ageing study in india (lasi). *International Journal of Epidemiology*, 51(4):e167–e176, 2022.

Melinda C Power, Marianthi-Anna Kioumourtzoglou, Jaime E Hart, Olivia I Okereke, Francine Laden, and Marc G Weisskopf. The relation between past exposure to fine particulate air pollution and prevalent anxiety: observational cohort study. *BMJ*, 350:h1111, 2015.

Lenore Sawyer Radloff. The ces-d scale: A self-report depression scale for research in the general population. *Applied psychological measurement*, 1(3):385–401, 1977.

Punarjit Roychowdhury. Social identity and depression among the elderly: Evidence from india. Technical report, GLO Discussion Paper, 2024.

Kavita Sardana, Jamie T Mullins, and Onupurba Das. Temperature, particulate matter, and mental health in india. 2024.

Christine Shearer, Robert Fofrich, and Steven J Davis. Future co2 emissions and electricity generation from proposed coal-fired power plants in india. *Earth's Future*, 5(4):408–416, 2017.

Sangita Vyas. The child health impacts of coal: Evidence from india's coal expansione. *Journal of Human Resources*, 60(2):496–537, 2025.

Xinzheng Zhang, Xi Chen, and Xiaobo Zhang. Air pollution and cognitive performance: Evidence from china. *Proceedings of the National Academy of Sciences*, 115(37):9193–9197, 2018.