Learning is in the Air: Clean Air as an Experience Good

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Abstract

Despite the enormous costs of air pollution, willingness-to-pay (WTP) for clean air in polluted developing contexts remains low. We posit one understudied reason is that clean air is an experience good, whose value is revealed after consumption. We test this using a randomized trial, and seek to document an "experience wedge", i.e. a difference between anticipated and realized utility of consuming a good. We deploy a novel experience-based intervention, installing air monitors and purifiers, potentially a more salient treatment than traditional information in pamphlets or videos. To explore the mechanisms behind the hypothesized wedge, we implement a purifier-only treatment to distinguish between (1) knowledge about objective pollution exposure and (2) the sensory experience of breathing in clean air. This will be the first experimental evidence demonstrating how experience can shift demand for clean air, with implications for public health policy, environmental awareness campaigns, and using WTP estimates in economic evaluations.

Keywords: air pollution, willingness-to-pay, WTP, experience, information, Indonesia
JEL Codes: D12; I15; O12; O13; Q53

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Contents

1 Introduction

Airborne particulate matter of 2.5 microns or less ($PM_{2.5}$ hereafter) is the sixth highest risk factor for death around the world, claiming more than 4 million lives annually (Sang et al., 2022). The minuscule size of these particles—$PM_{2.5}$ is about 3% the diameter of a human hair—makes them particularly dangerous because they can bypass the body's natural defenses and are invisible to the naked eye. Without visible signs or immediate symptoms, it is challenging for individuals to recognize the need for protective measures, such as wearing masks or using air purifiers, making $PM_{2.5}$ a silent threat to public health.

The environmental economics literature has documented that demand for environmental quality in developing settings is often much lower than the estimated benefits (Kremer et al., 2011; Dupas and Miguel, 2017). In the case of $PM_{2.5}$, this undervaluation is consistent with its invisible and unfathomable nature. We hypothesize that clean air is an experience good, whose value is only fully revealed after consumption. We define experience in this context as both (1) knowledge about objective pollution exposure and (2) the sensory experience of breathing in polluted air. Households with little experience of "good" environmental amenities may be uncertain how to assign value to clean air. Our first goal is to rigorously test for the existence of this experience wedge.

To test for this, we will run an experiment in Jakarta, Indonesia, a mega-city whose air pollution level routinely ranks as one of the worst in the world. We randomly sort participant households into three groups: a control group, a comprehensive experience treatment, and a sensory-based treatment. Our main treatment is the comprehensive experience treatment, where households receive an air purifier and air quality monitor for three months. This treatment targets two sources fueling the experience wedge, which we documented in our pilot work: (1) lack of knowledge of own objective exposure to pollution and (2) lack of experience of the impact of clean air on health, productivity and other benefits, leading to misperceptions of the marginal utility of clean indoor air.

We will test for the presence of an experience wedge by assessing the impact of treatment on three measures of demand for clean air: willingness-to-pay (WTP) for a two month air purifier rental, elicited through a Becker-DeGroot-Marschak mechanism, a pollution avoidance behavior index, and high frequency time use survey.

A secondary, purifier-only treatment arm will dig into the mechanisms behind the experience wedge. The goal of this treatment arm is to experimentally test whether physical experience of clean air alone is enough for households to perceive and value good indoor air quality and its subsequent potential health and productivity benefits. Households in this secondary treatment, receive only an air purifier but not the visible measurements provided by the monitor. The extent through which this treatment will impact our three measures of demand for clean air will test if a sensory experience alone is sufficient to trigger household demand for clean air.

We will also carefully document the mechanisms and implications of clean air as an experience good by estimating the treatment effects on a series of other outcomes. These outcomes include accuracy of perceived indoor and outdoor air pollution levels; beliefs about impact of air pollution on own and child's health; perceived effectiveness of air purifiers; stated preferences for policies related to ambient air quality. Additionally, we will collect objective and self-reported measures of physical health, cognitive ability, and mental health to causally estimate the response functions to a partial change in indoor air quality (instrumented by the air

purifier in each of the two treatment arms).

This study makes three main contributions. First, it introduces evidence bridging the literature on demand for environmental quality in developing contexts with the concept of experience goods, offering a dynamic understanding of why there may be low willingness to pay (WTP) for environmental improvements. Greenstone and Jack (2015) put forward four hypotheses to rationalize under-investment in environmental quality. On the demand side, a large body of literature has been providing evidence for the key roles of (1) credit constraints and economic tradeoffs given the high marginal value of consumption, and (2) information frictions (Barwick et al., 2024). We argue that characterizing clean air as an experience good brings a novel, dynamic dimension to understand low measured WTP for environmental quality in developing settings. Indeed, for populations who live most of their lives in polluted environments, often without access to reliable measurements of pollution, it may be unreasonable to expect heightened concern for pollution, prior to exposure to cleaner air.

Work on experience goods is found mostly in the marketing literature, with a specific focus on private goods (Ackerberg, 2003; Israel, 2005; Bergemann and Välimäki, 2006; Bonatti, 2011; Chen et al., 2022). There is some work on environmental quality and public goods; however, the evidence has been either model-driven (Czajkowski et al., 2015) or correlational (Kahn et al., 2020). Our main contribution here is to provide rigorous empirical tests of air quality as an experience good. The results have important policy implications; clean air is a public good whose provision depends on group-level demand, and this valuation uncertainty could severely hinder the provision of the public good. Furthermore, identifying the mechanisms behind the experience wedge can improve the effectiveness of public awareness campaigns.

Second, we contribute to the literature on the impact of air pollution on health, through measuring detailed individual exposure levels and exploring the medium-term impacts of sustained pollution mitigation. Ideally, we would be able to measure an individual's level of exposure to air pollution in the space in which they spend time, that is, their dose response function. But in practice, studies often proxy for exposure by using the ambient levels of pollution in the environment, that is, the concentration response function (Currie et al., 2014; Ebenstein et al., 2016; Fuller et al., 2022). We improve on most studies, which typically estimate the concentration-response function, which is a bundle of ambient pollution levels, amount of time people spend indoors, indoor air quality levels, and avoidance behavior. By measuring indoor air pollution exposure while respondents are at home and documenting pollution behaviors, our study will yield an exposure-response function of air pollution on health.[1]

In addition, we contribute to the literature on prolonged air pollution mitigation. Most papers use sharp, unexpected changes in pollution, such as from atmospheric changes, and while these shocks provide credible estimates of causal impacts of pollution, endogeneity concerns mean we remain in the dark about how prolonged mitigation and defensive action affect the shape of the response curve. Some exceptions leverage quasi-experimental variation to estimate longer-run mitigation effects, such as studies using the Clean Air Act (Bishop et al., 2018; Isen et al., 2017; Hansman et al., 2019). These studies remain dominated by high-income settings. Our experimental design randomly gives households clean air for three months; with measurements of health, cognition, healthcare costs, and behavior, we can trace out a detailed

[1]The literature studying cookstoves and pollution exposure is an exception to this. Recent work in this literature suggests that decreasing the peak indoor pollution caused by cooking has little immediate impact on health (Clasen et al., 2022; Berkouwer and Dean, 2023)

exposure-response function on medium-run impacts of pollution.

Third, we contribute to the literature on stimulus-based learning by investigating the impact of sensory experiences. The economics literature has long identified how lack of information creates inefficiencies. However, there is a burgeoning branch of economics, mostly in finance, that emphasizes the role of stimuli beyond traditional information content (pamphlets or videos about pollution impacts). This literature suggests shifting our understanding of belief formation and choice behavior to focus more on the stimulus-based learning, beyond informational content alone.[2] Our intervention is an "experience treatment" rather than an "information treatment". Further, our purifier-only treatment is designed to test whether physical experience alone is enough to if stimuli beyond information is important to demand for clean air.

The remainder of this pre-analysis plan proceeds as follows. Section 2 provides relevant details about the research context, including insights from our pilot. Section 3 describes our experiment design. Section 4 discusses the variables we will collect. Section 5 presents our planned analyses.

2 Context

2.1 Pollution in Jakarta, the Most Populated Metropolitan Area in the World

We study demand for air quality in Jakarta, the capital city of Indonesia. A familiar story of a developing city, Jakarta's rapidly urbanizing population, industrial activities, and a growing number of vehicles on the road all contribute to elevated levels of air pollution. With an annual average of $37.8\mu g/m^3$ in 2023, Jakarta's $PM_{2.5}$ concentrations are above World Health Organization's guidelines (WHO) all year long, as seen in Figure 1.[3] As shown in Panel (a), $PM_{2.5}$ concentrations are especially high from May to October.

While spatial variation exists, high pollution levels persist throughout the entire city, as illustrated in Figure 1 Panel (b), where we visualize the average May 2023 $PM_{2.5}$ concentration across villages. According to the Air Quality Life Index, 10.7 million Jakarta residents are on track to lose 2.4 years of life expectancy on average, relative to pollution levels adherent to the WHO guidelines.

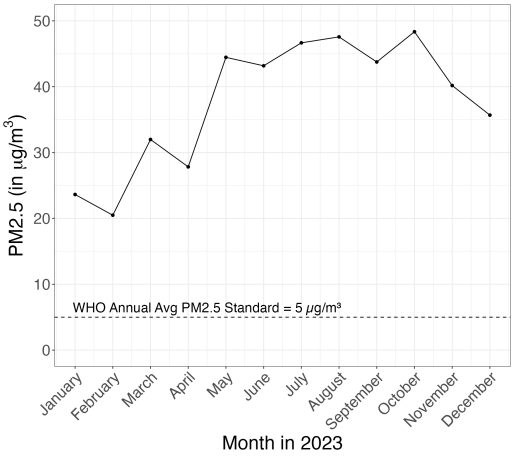
Additionally, our pilot study revealed a close correlation between indoor and outdoor air quality, implying that the majority of Jakarta residents are continuously exposed to polluted air throughout the year. In Figure 2, we illustrate the hourly variations in outdoor air quality (shown in blue) alongside indoor air quality measurements obtained from households (shown in red). While temporary spikes in indoor pollution, often attributed to cooking or smoking, may occasionally exceed outdoor levels, the overall consistency of this relationship remains evident. Coupled with the high baseline levels of outdoor pollution evident in Figure 1, this underscores the persistent exposure to poor air quality experienced by Jakarta's populace."

[2]For a review of this literature, see Malmendier (2021)

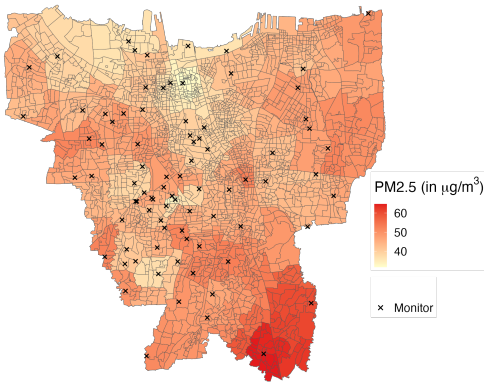
[3]This is consistent with the measurements recorded by the U.S. Embassy monitor in Central Jakarta, which reported that the annual average $PM_2.5$ concentration for 2023 was $37\mu g/m^3$ source).

Figure 1: $PM_{2.5}$ Levels in Jakarta 2023

(a) Monthly Time Series

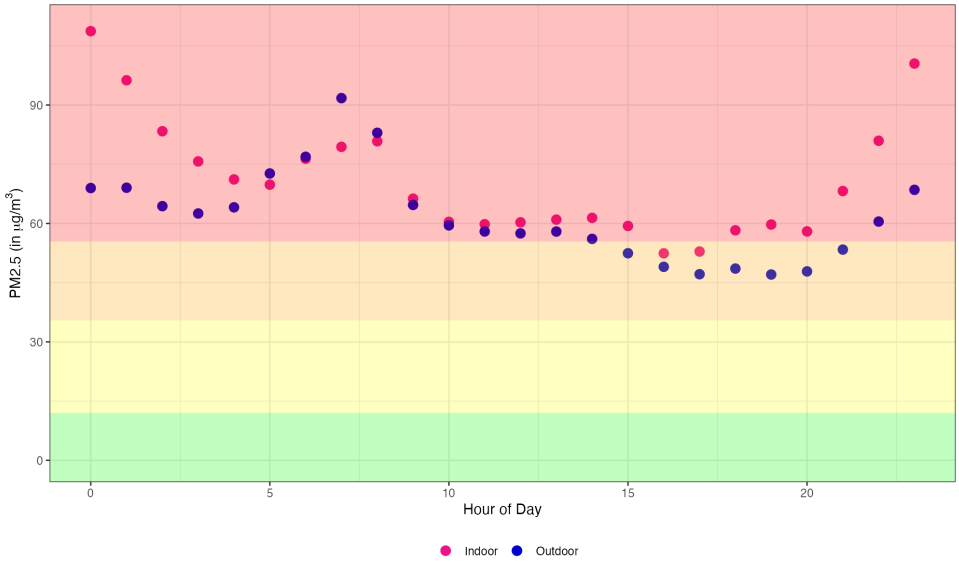


(b) Map of $PM_{2.5}$ Levels in May 2023



Notes: Data from low cost outdoor air quality sensors in Jakarta, provided by PT Cinta Alam Abadi. Panel (a) shows 2023 monthly average $PM_{2.5}$ levels in Jakarta, averaged across all sensors. Panel (b) shows village-level average $PM_{2.5}$ for May 2023. Village-level average is constructed using the three monitors closest to the village centroid, where the average is weighted by distance to each monitor.

Figure 2: Mean Hourly $PM_{2.5}$ Level, Outdoor versus Indoor



Note: This figure plots the hourly mean pollution levels that households are exposed to, without an air purifier in the home. Indoor levels were recorded by indoor air quality sensors. Outdoor levels were recorded by outdoor sensors that were closest to the respondents' homes. Colors match the US Environmental Protection Agency's Air Quality Index (AQI); red is unhealthy, orange is unhealthy for sensitive groups, yellow is moderate, and green is healthy.

2.2 A Political Turning Point?

Increasing the rate of pollution abatement is especially important in fast growing urban settings in low- and middle-income countries, where half of the world's population lives and where air quality is deteriorating. While demand for clean air remains low in many of these heavily

polluted areas (Fuller et al., 2022; Greenstone and Jack, 2015), several megacities have managed to maintain low pollution concentrations (Marlier et al., 2016). A city's path to successful air pollution abatement and mitigation often rely on increased public demand, a powerful force in promoting environmental governance (Tu et al., 2020).

Examining the intersection of public demand for cleaner air and its translation into policy action, Jakarta emerges as a compelling case study. The city appears to be at a turning point in its economic development and environmental awareness, and careful study of this moment could provide valuable insights into the dynamics of demand for clean air. This is evidenced by a growing minority of Jakarta residents advocating for enhanced ambient air quality, exemplified by a court ruling in a citizen lawsuit that found the Indonesia and Jakarta government negligent in ensuring citizens' rights to clean air. The court ordered national and city level governments to tighten regulation and demanded a plan to solving the air pollution crisis. Despite the court ruling, the subsequent government response has been marked by slow progress and resistance, highlighting the necessary role public demand will need to play to ensure accountability for the court ruling.

2.3 Pilot Work

To better understand Jakarta residents' demand for clean air and test the logistics of our research design, we conducted a pilot study with 88 households from June to September 2023. All households (treatment + control) watched a video about the impacts of air pollution, ways to protect yourself, and pollution levels and sources in Jakarta. We designed the video such that it contains widely available and easily accessible information about air pollution. One half of the households were randomly allocated to the treatment group and also received an air quality monitor and purifier in their home for three months.

2.3.1 Evidence that air purifiers improve indoor air quality

On the logistical side, our study shows that air purifiers significantly reduced indoor air pollution. Although we lack data on indoor pollution levels from a control group, we compared the levels of $PM_2.5$ before and after the purifiers were removed, while still keeping air quality monitors in the homes of the respondents. The removal of the air purifiers from respondents' home span a period of one week for logistical reasons. We leverage the staggered removal of the air purifiers and conduct the following difference-in-difference analysis to estimate the impact of the air purifiers on indoor air quality:

$$PM_{it} = \alpha_0 + \delta D_{it} + X_{it} + \alpha_i + \alpha_t + \epsilon_{it} \tag{1}$$

where PM_{it} is the mean pollution level for day t in household i, restricted to the seven days before and after the pickup of the purifier; D_{it} is an indicator for whether the purifier has been removed; X_{it} are controls for outdoor temperature and humidity, as well as outdoor $PM_{2.5}$; α_i and α_t are household and date fixed effects, respectively. Standard errors are clustered at the respondent and date levels.

The results are shown in column (3) of Table 1. We estimate a 20.07 $\mu g/m^3$ increase in indoor $PM_{2.5}$ concentration after the purifier is taken away. Comparing this to the mean $PM_{2.5}$ level without a purifier, we conclude that purifiers can reduce indoor $PM_{2.5}$ by 31% on average.

Columns (1) and (2) show that our results are robust to including different sets of controls. Note that the effect increases to 40% at night, as shown in column (5), where night is defined as the hours between 10pm-8am. We hypothesize that this is because households are more likely to close their windows and doors at night, thus increasing the effectiveness of purifiers.

Table 1: Impact of Removing Purifier on Indoor $PM_2.5$ Levels

		Full		Day	Night
Model:	(1)	(2)	(3)	(4)	(5)
Variables					
No Purifier	20.65**	24.10***	20.07***	14.74***	29.66**
	(7.664)	(6.805)	(5.523)	(3.168)	(10.72)
Outdoor Temp		1.616	9.165*	5.382	6.686
		(2.655)	(4.603)	(4.290)	(5.515)
Outdoor Humidity		0.7402*	1.873	1.153	1.538
		(0.4149)	(1.131)	(0.9416)	(1.128)
Outdoor PM		0.6969**	0.0265	-0.1038	-0.0233
		(0.2515)	(0.1727)	(0.3446)	(0.1910)
Fixed-effects					
hh	Yes	Yes	Yes	Yes	Yes
date			Yes	Yes	Yes
Fit statistics					
PM Mean - No Purifier	63.98	64.53	64.53	57.80	71.42
Observations	183	173	173	175	179

Clustered (hh & date) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

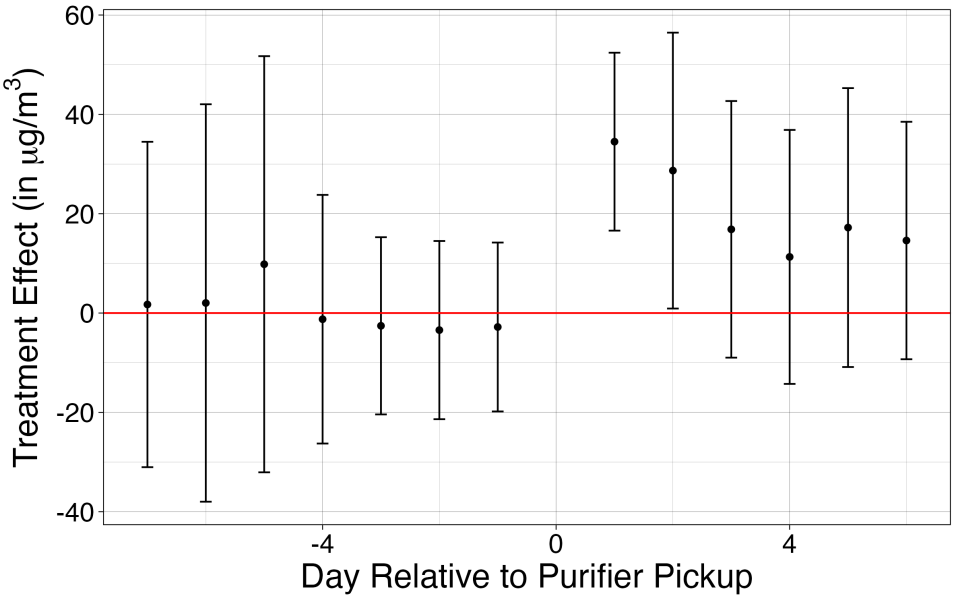
In addition, we run an event study version of Equation 1 to further test the effectiveness of the air purifiers:

$$PM_{it} = \gamma_i + \sum_{\tau=-7}^{-1} \gamma_\tau D_{i\tau} + \sum_{\tau=1}^{6} \delta_\tau D_{i\tau} + X_{it} + \varepsilon_{it} \tag{2}$$

Note that we do not include a date fixed effects, as our sample is too small, and the date fixed effect leaves us with very little variation. However, X_{it} includes outdoor temperature and humidity, and outdoor $PM_{2.5}$, which captures the most relevant common time effects.

The results of this event study are displayed on Figure 3, which plots γ_T (pre purifier pickup) and $\delta\tau$ (post purifier pickup). The figure highlights the absence of pre-trends in $PM_{2.5}$ concentrations before the purifier pickup date, and the jumps in $PM_{2.5}$ concentrations after the air purifier is picked up. Confidence intervals are wider at the start and end of our considered period because of decreasing sample size.

Figure 3: Impact of Purifier Pick-up on Indoor $PM_{2.5}$ Levels



Note: Figure reports event study estimates with 95% confidence intervals from Equation 2 using pilot results recorded in September 2023. Note, because of Wi-Fi connectivity issues during this period, only 33 of the treated households are included in this analysis. Errors are clustered at the household and date level.

2.3.2 Suggestive Evidence of Two Sources of Experience Wedges

In addition to testing the logistics of our air quality hardware, the pilot yielded suggestive evidence of two sources of experience wedges, leading to under-demand of indoor air quality at baseline.

Friction 1: Most respondents underestimate their own exposure to air pollution

Households underestimate outdoor pollution levels: During our baseline, we showed respondents a picture of the Environmental Protection Agency's Air Quality Index (AQI) and explained what the different colors mean and how it is different from the one used by the Indonesian government. We then asked households what they believed outdoor AQI levels were in the past 7 days in Jakarta. We compare this to the true measured level. As seen in Figure 4, we observe a trend of underestimation of the outdoor pollution level in Jakarta when using the AQI scale.

Households greatly underestimate indoor pollution levels: We conducted a similar analysis for indoor air pollution. It's important to note that we did not have direct measurements of indoor air pollution during the recall period. Instead, we relied on data showing indoor AQI levels from a time when households had an air quality monitor but no purifier, approximately three months after our initial measurements. This comparison is illustrated in Figure 5. Although this is not the ideal method for comparison, we do believe that households underestimate their exposure to indoor pollution, even more than they underestimate outdoor air pollution exposure.

Figure 4: Beliefs vs True Outdoor AQI Levels

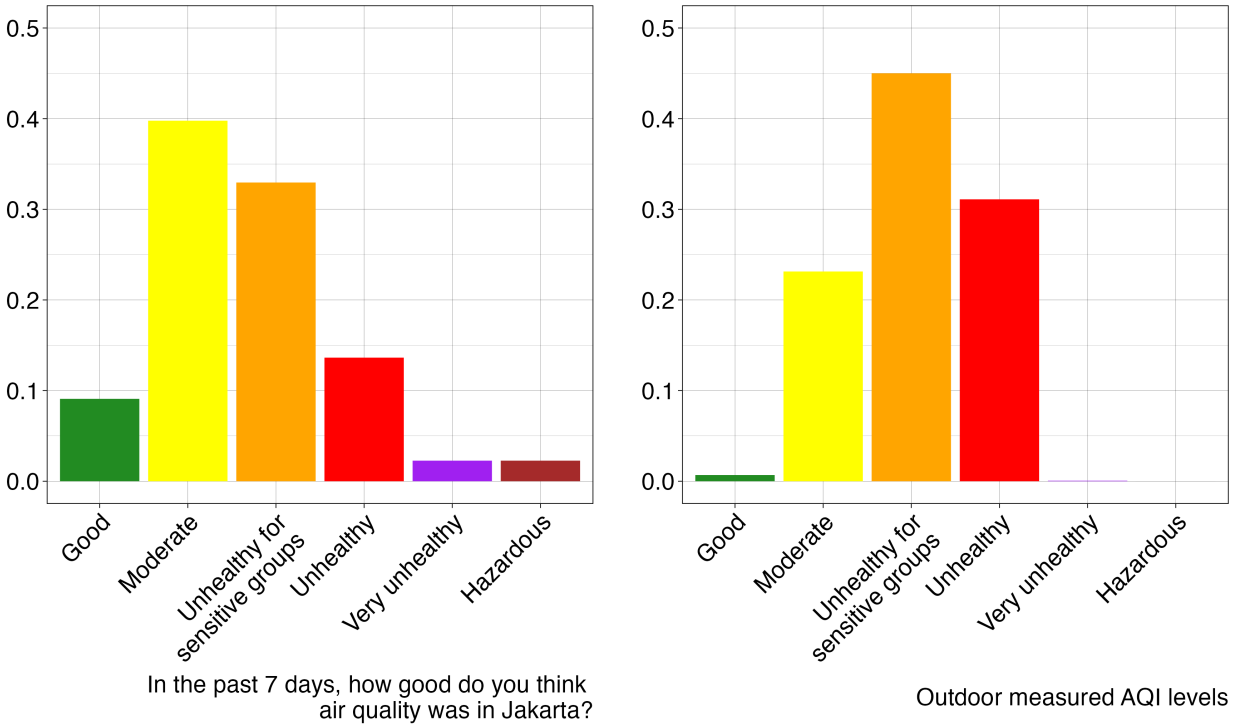
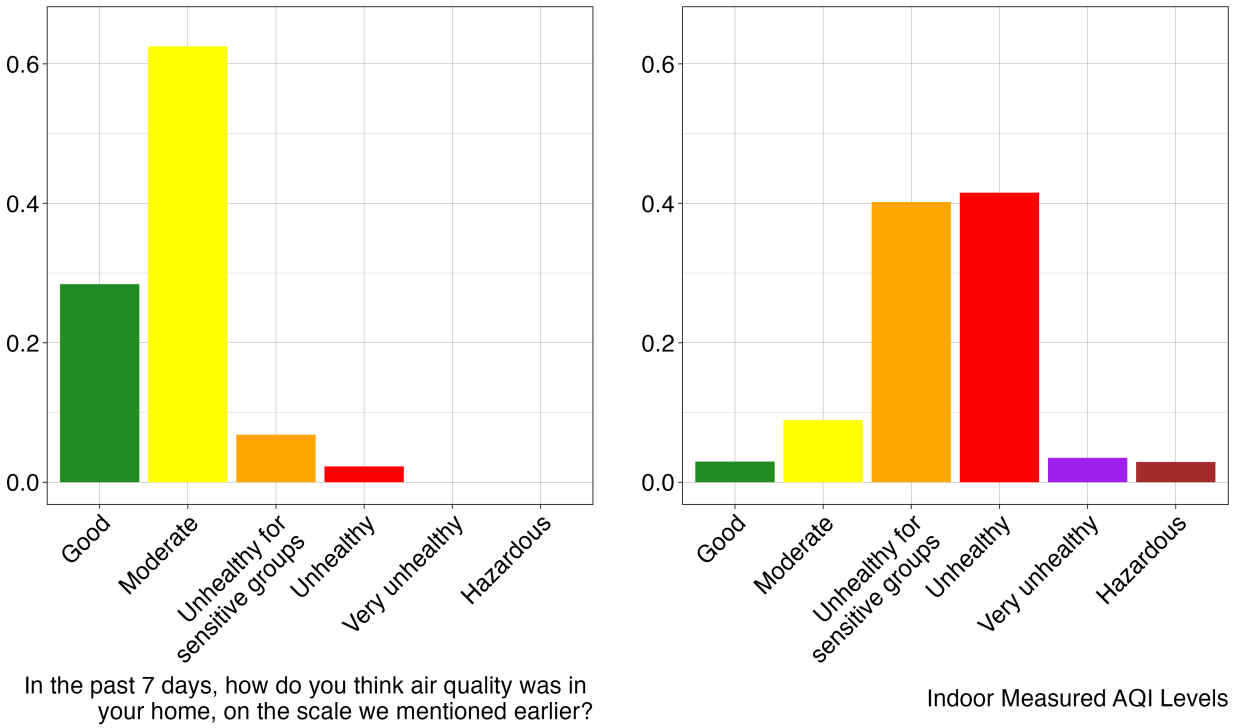
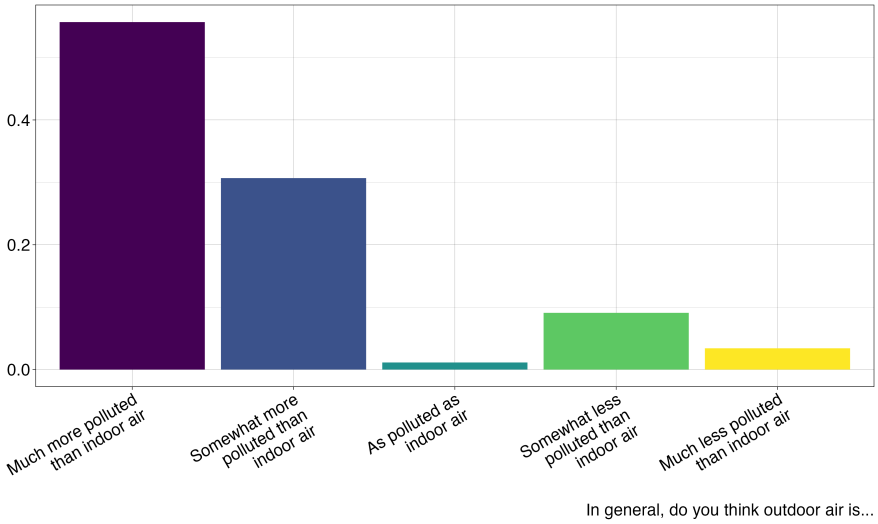


Figure 5: Beliefs vs True Indoor AQI Levels



We provide additional evidence for this underestimation of indoor pollution exposure in two ways. First, as demonstrated in Figure 2, indoor air pollution closely mirrors outdoor air pollution levels when no air purifier is used. Therefore, comparing residents' perceptions of indoor AQI with actual measurements of outdoor air pollution provides one method of assessment. Second, we asked households to compare perceived levels of outdoor and indoor air pollution. The findings, displayed in Figure 5, reveal that the majority of households believe outdoor air is more polluted than indoor air, either somewhat or significantly.[4] Altogether, this provides evidence that households are underestimating their own exposure to air pollution, especially indoor.

Figure 6: Baseline Survey: Beliefs Comparing Indoor vs Outdoor Air Pollution



Friction 2: Little Perceived Benefits of Good Indoor Air Quality

Many respondents do not believe having clean air for part of the day would improve their short- and long-term health: To ascertain whether households in our sample believe the indoor air purifier treatment would affect their health, we asked households to rate how strongly they agree with the following two statements:

1. Spending 3 hours a day in a clean air environment can significantly improve my *immediate health*, even if the air is very polluted the other 21 hours

2. Spending 3 hours a day in a clean air environment is good for my *long-term health*, even if the air is very polluted the other 21 hours.

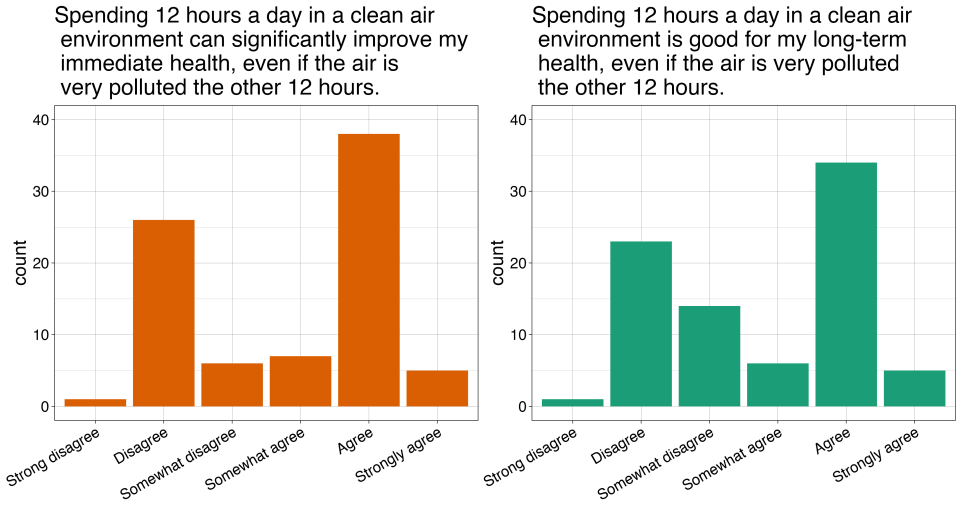
As seen in Figure 7, half of the households at least "somewhat disagree" for both statements. While we as researchers cannot know the "right" answer to this for each individual, we have some evidence that at endline, households in the treatment group increased their estimation of how clean air affects their short-term and long-term health. The regression estimates

[4]This trend persisted in our endline results. We do not show those, as we believe we did not phrase our endline question well, and pilot households in the treatment group believed we were asking them to compare indoor air quality to outdoor air quality, given their purifiers

of this treatment effect are very underpowered from our pilot, but we will address this in our full-scale.

Suggestive evidence that purifiers do in fact improve short-term health At the same time, our pilot provides suggestive evidence that purifiers do in fact improve short-term health. During our endline, when we asked whether respondents suffered from 9 air-pollution related health symptoms, respondents in the treatment group were 19 percentage points more likely to report no symptoms.[5] Again, we take this evidence as suggestive evidence, not causal, that there is scope for helping households learn about how clean air affects their personal health.

Figure 7: Baseline Survey - Beliefs on Impact of Partial Exposure to Clean Air on Health



In addition, our respondents are mostly mothers who spend a lot of time at home, even during the day, so they are the most likely to experience the benefits of the intervention.
To put things in perspective, a back of the envelope calculation building on the difference-in-differences results (Table 1) suggests that if respondents (mothers) spent half of the day at home, their average exposure would decrease by almost $17/m^3$,[6] which is roughly equivalent to going from Jakarta to Kampala (Uganda) (IQAIR 2023 Report). The night time difference of $30/m^3$ is analogous to going from Jakarta to Rome or Singapore, which we believe is a difference large enough that there is a fair chance that respondents will perceive it, as they move in and out the house.

We use these types of frictions to motivate the design of our full-scale experiment.

[5] These symptoms are: runny nose, coughing/weezing, nausea, burning eyes, dizziness, headache, shortness of breath, skin rashes, fever. We interpret this effect cautiously, as we did not test for the presence of a placebo effect coming from the treatment. In our full-scale, we will have objective measures of health as well as placebo symptoms that are unrelated to pollution, such as diarrhea.

[6] $(30/m^3 \times 10\text{h} + \frac{1}{2} \times 15/m^3 \times 14\text{h}) \ / \ 24$.

3 Experimental Design

Informed by our pilot work detailed in Section 2.3, we have designed a randomized trial with the goal of estimating an experience wedge, which we denote with ω throughout the rest of the text. We define the experience wedge as the change in demand (WTP) for the air purifier, as a result of the experience of the device.
In addition to documenting the existence of ω, we study two potential underlying mechanisms or types of frictions:

1. **Lack of knowledge of objective exposure to pollution**: ω^e, leading to misperception of the level of exposure with and without the air purifier.

2. **Lack of physical experience of clean air**: ω^s - where theoretical information cannot convey the physical (wellbeing, health and productivity) benefits of clean indoor air, leading to misperception of the marginal utility of clean air.

We will implement an experiment with two treatment arms, and build our sampling frame from parents of elementary school children in Jakarta.[7] Our main treatment is designed to estimate the wedge ω. Our secondary treatment arm focuses on the mechanisms that underlie the main treatment, and aims to experimentally assess whether the physical experience of clean air alone and its short term benefits can be perceptible by respondents.

3.1 Estimating the Experience Wedge ω

To estimate the presence and magnitude of the experience wedge, we design a "Comprehensive Experience" treatment. This was informed by pilot evidence that households are both (1) underestimating their own objective exposure to pollution, as shown in Figure 6 and (2) do not believe that having clean air for part of their day is beneficial for their health, as shown in Figure 7.

Households are randomized into the control or treatment group (as shown by Figure 8), where randomization is clustered at the classroom level:

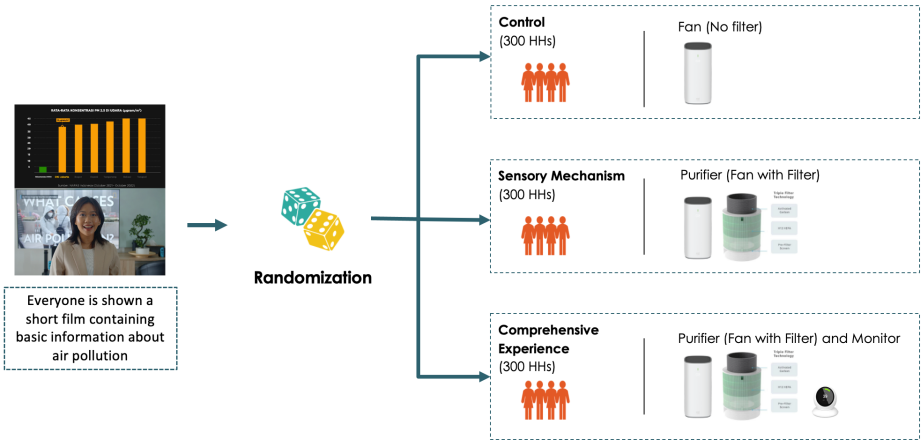
1. Control HHs (Fan): installation of a free air purifier without a filter in the bedroom of the respondent, which essentially renders the purifier as a fan. Households know this is simply a fan.

2. Main Treatment HHs (Comprehensive Experience) – Monitoring + Purifier: installation of a free air quality monitor and an air purifier with a filter in the bedroom of the respondent.

We will show all households an informational video on Jakarta's air pollution levels, health and productivity impacts of pollution, ways to protect yourself, and sources of air pollution in Jakarta.[8] We assume that after viewing the video, all households have sufficient baseline generic knowledge about air pollution for the rest of the experiment. Additionally, we will tell households in the treatment groups (who will receive an air purifier) about the average efficacy of the air purifiers we use in this experiment, and how opening windows or doors affect the

[7] More information on why we selected this sampling frame can be found in Section 3.4.
[8] The video can be found here, where subtitles can be auto-translated.

Figure 8: Experimental Design - HH-Level Treatment, Sampled from Jakarta Parents



Notes: This figure shows the design for our cluster-randomized experiment, which includes a control arm, a purifier-only treatment arm, and a comprehensive experience treatment consisting of purifier and monitor treatment. In each classroom, we will sample 1-2 households to participate in our survey and experiment

efficacy. In addition, at endline, before eliciting WTP for the air purifier, we will remind all households about the average efficacy of the air purifiers and emphasize that the devices in the BDM include a filter. This information is meant to standardize beliefs about purifier quality across treatment and control.[9]

Importantly, all the air purifiers (or fans) have built-in non-visible air quality sensor, which allows us to measure indoor $PM_{2.5}$ levels in the control group as well as the treatment group. We focus on $PM_{2.5}$ as this is the most dangerous and pervasive pollutant in Jakarta and globally.

Our control group was designed so that the only difference between treatment and control is that the treatment group receives clean air. Based on our pilot work, we believe this sweeps out two confounders. First, one of our main outcomes is WTP for clean air at endline, which we proxy for by giving all households the chance to rent an air purifier for two months at the end of the experiment. If we had not given the control group a fan (that looks just like the purifier), we would have been comparing a treatment bundled with loss aversion to a control group with no loss aversion; the fan rental instead will neutralize any potential for loss aversion to bias the experience wedge measurement upward. We will remove all devices in respondents' houses before eliciting WTP at endline, so that it is clear to all respondents that they are deciding over the rental of a standard, with filter, air purifier, rather than the device they previously had.[10] Second, our pilot work revealed that households also enjoying the cooling effect of purifiers. Our fan rental will also neutralize this cooling effect confounder. Using a similar device than the air purifier (without the air filter) allows us to minimize concerns that the strength of the air flow is different.

The main treatment, where households receive an air purifier and an air monitor to be located next to the purifier, is designed to give people the holistic experience of clean indoor

[9]We embed an experiment in our baseline survey to test for the impact of the video on knowledge and beliefs. More details on this can be found in Section 6.1

[10]In addition, as a sanity check that control households were well aware that they received a fan and not a purifier, at endline, we will ask them about the perceived impact of the device on indoor air quality.

air, in order to estimate the full experience wedge, ω. This bundled intervention is designed to improve indoor air quality and unambiguously show households their exposure levels. Note that because both groups will be shown a theoretical, generic information video about air quality, we are targeting the characteristics of clean indoor air that cannot be conveyed without the experience itself.

On the air monitor, households will see the Air Quality Index (AQI), $PM_{2.5}$ number, and the corresponding AQI color. During the baseline survey, enumerators will explain the AQI color system to households to help them comprehend indoor air quality levels. The monitor displays can be seen in Figure 9. Importantly, the fan in the control group will not display any light or indication of the AQI.

Figure 9: Air Quality Monitor Display at Various $PM_{2.5}$ Levels

To maximize the clean air experience, we want to ensure that households are learning about air quality in their homes both with and without the purifier. To do this, the air quality monitors will be installed several days before the air purifiers. This time gap allows households to observe their home's air quality before introducing a purifier, helping them understand its potential impact on their well-being. Additionally, three times throughout the course of the experiment, we will shut down the purifiers for 24 hours. We will inform the households via text that we are shutting down the purifiers during this time for software checks. This is intended to give households additional periods to learn about their indoor air quality without the presence of a purifier.

To further encourage learning about indoor air quality for the treatment group, we will send texts once a week informing households about outdoor air quality levels. Our pilot efforts showed that households are generally aware that outdoor air pollution levels are unhealthy, and thus outdoor air pollution levels can provide a reference point for respondents to internalize their indoor air quality exposure.

We will compare several measures of demand for clean air (see Section 4) for households in the treatment and control groups at endline, and interpret differences across groups as evidence of the presence of an experience wedge.[11]

3.2 Isolating the Role of Physical Experience Alone

We design a secondary treatment arm (Figure 8) to experimentally test whether the mere physical or "sensory" experience of clean air on demand for air purifiers. This secondary treatment arm only includes an air purifier. Households will experience (i) the immediate physical sensation of breathing clean air, (ii) potential short and medium terms accompanying health and productivity benefits, but without the visible measurements provided by the monitor. As per

[11]Note that when the measure of demand is WTP for air purifiers, there is the additional wedge on the efficacy of air purifiers, ω^{γ}. We discuss this more in Section 5.

fans in the control group, devices in the purifier-only group will not have lights or indicators of the AQI.

Under the hypothesis that households who only receive the purifier do not learn about the exact effectiveness of the air purifier, this secondary treatment arm only targets the role of clean air experience ω^s, and not the lack of knowledge on objective pollution exposure ^{e}. We make this hypothesis based on our piloting work, but will also test it as a part of our final results.[12]

Under this same assumption, comparison between the control group and the purifier only group will isolate the existence of a physical or sensory experience failure, leading to undervaluation of the marginal utility of clean air until one has experienced it. Comparisons between the purifier+monitor and the purifier-only group will isolate the existence of frictions coming from the lack of physical experience itself. More details will be in our analysis in Section 5.[13]

3.3 Summary: Theory of Change

Overall, we can summarize the experimental design and theory of change by the following diagram: This diagram illustrates how the different experimental arms target the different mechanisms that we hypothesize drive the experience wedge, in a way to isolate clean air-related components.

Our intervention aims to give respondents the experience of clean indoor air. Exposure to clean indoor air has potential impacts at several time horizons, all of which may compound to change WTP for air purifiers:

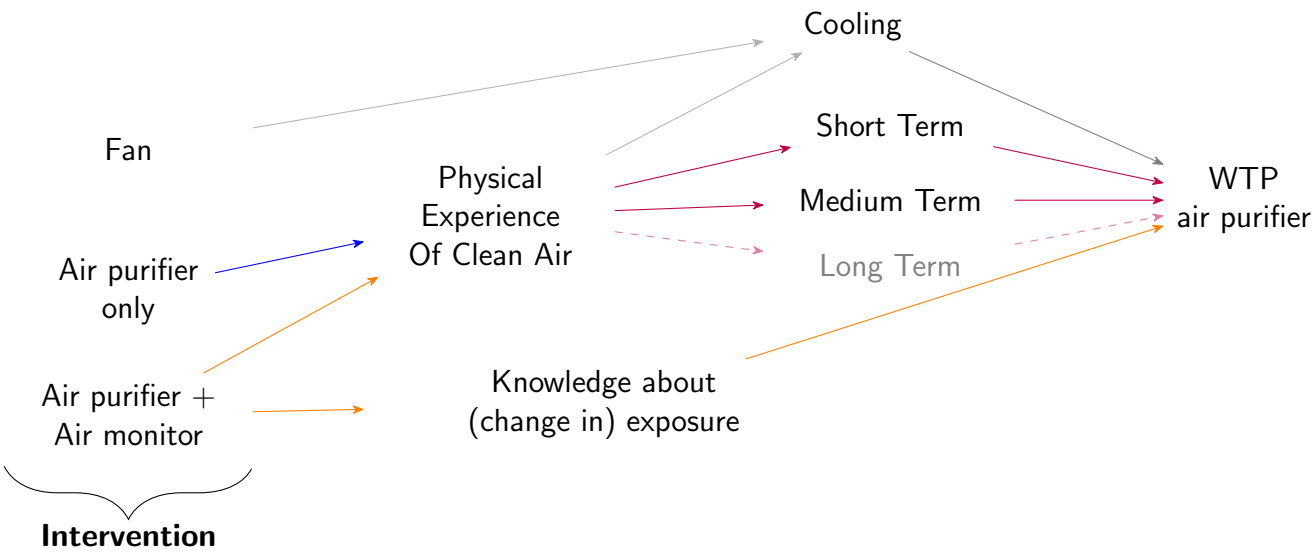
- In the short term
  - Noticing the difference in air quality through easier breathing, "clearer" air.
  - Health (e.g. lower breathing crises, clearer head, mental health)
  - Productivity (e.g. better sleep)

[12] We will formally test the assumption that the purifier-only treatment is only targeting ω^s with the following two regressions:

1. $IndoorAQI_{it} = \alpha + \pi \mathbf{1}\{\text{PurifierOnly}_{it}\} + X_i' \cdot \phi + e_{it}$: Compared to the control group, is the purifier-only treatment group better at assessing true indoor pollution levels? If $\pi > 0$, then the purifier-only treatment would also be targeting ω^{PM}.
2. $PurifierEfficacy_{it} = \alpha + \psi \mathbf{1}\{\text{Purifier+Monitor}_{it}\} + X_i' \cdot \phi + e_{it}$: Compared to the purifier-only group, is the comprehensive treatment better at assessing the efficacy of the purifiers? If $\psi > 0$, this is suggestive that the monitor is necessary for households to know the efficacy of the purifier. We unfortunately cannot test against the control group, since we do not know how effective the purifier would be in those homes.

[13] If we are sufficiently powered, by comparing the differential treatment effects between (1) Purifier+Monitor and control, (2) Purifier-onlu and control, and (3) Purifier+Monitor and Purifier-only treatment, we will also be able to test the additive separability assumption of the different wedge components.

Figure 10: Theory of Change and Experimental Design - Diagram



- In the medium term
  - Health (as above + change in blood pressure, blood oxygen)
  - Productivity (as above + change in cognitive abilities)
- In the long term[14]

Some aspects of clean indoor air may be harder to fathom than others, given the invisible nature of air quality. In that case, air monitors should give respondents helpful information to assess their clean air exposure, and better attribute changes in health and productivity to changes in air quality. We will test formally for this hypothesis.

3.4 Implementation

3.4.1 Timeline

While outdoor air pollution is sustained during the whole year, ambient levels of ambient $PM_{2.5}$ are highly seasonal in Jakarta. We target the high pollution season in Jakarta as this is when the air purifiers may be most effective and the health effects the most stringent. There are three months between the baseline and endline surveys, during which the participant households receive a free rental of fan (control), purifier + monitor (main treatment) or purifier only (secondary treatment).

Due to implementability constraints, we roll out our experiment in two waves from May to July 2024, and from August to October 2024. Each wave includes the same number of treated and control classrooms and households.

[14]Importantly, within the timeframe of the experiment, we will not be able to observe long term (LT) health impacts, but only short (ST) and medium (MT) term impacts. In the presence of long term health impacts that would also need to be experienced to be valued, our estimates of the experience wedge would be biased downwards.

3.4.2 Sampling

We collaborate with schools to use parents as a sampling frame; parents are a suitable sampling frame for three reasons. First, parents are much more collaborative with the logistics of the experiment, as compared to a random selection of households. It is integral to our design that households actually return our equipment rental. We found that in our pilot, all parents returned the rentals, most households actively assisted in resolving WiFi and hardware issues, and we experienced a low attrition rate of 5%. Second, concern for children's health, development and well-being will likely lead to higher take-up of the intervention. Third, health and productivity effects in the time frame of the experiment will likely be more pronounced amongst children.

During our pilot phase, the backing of the Education Office in Jakarta facilitated willing collaboration from schools. This support greatly aided us in constructing a sampling frame comprised of contact information of parents. We use the same strategy in our full-scale experiment. First, we obtain an updated letter of support from the Education Office. After this, our field coordinators meet with principals and administrators at 220 elementary schools (out of a possible 2,162 schools) about our project. The 220 schools are chosen to be representative of the 2,162 schools in Jakarta, and we sampled them so that we are representative across consumption expenditure and ambient pollution levels. At the meeting, we ask them to help us build our pool of potential participants.

Our target is to have 180 schools assisting in building the sampling frame by sending us contact information of parents of elementary school children. From these 180 schools, we plan to sample 950 households. With an attrition rate of 5%, we would have a total sample size of 900 households.

We randomized treatment at the classroom level, with 1-2 students in each classroom, in order to address potentials for spillovers within a classroom. Randomization was stratified by grade, baseline monthly food expenditure, and baseline pollution. Engagement with parents and treatment is administered at the homes of the participants, with no contact happening at the schools; this reduces the likelihood of across-classroom spillovers in the same school. At the study's conclusion, we will survey households to determine whether they discussed the experiment with other parents involved in the study, thereby assessing the potential for spillovers.

For our fieldwork, we are partnered with the SMERU Research Institute, who will be responsible for data collection and overseeing day-to-day research logistics. SMERU has had 20+ years of experience in evidence-based research focused on informing Indonesian policymakers at the national and regional levels and ran our pilot study. Additionally, they have frequently collaborated with the Education Office and many other government divisions.

4 Outcomes of Interest

In the endline survey conducted three months after the installation of the air quality hardware, we will cover four main outcomes of interest:

1. Indoor air quality levels
2. Beliefs about air pollution

3. Demand for air quality, with a focus on indoor air quality and air purifiers (WTP)

4. Health and productivity measures

We will also collect additional variables for heterogeneity and secondary outcomes analyses. A detailed description of the measurement procedures is included in the survey questionnaire in Section A.1. Our primary focus will be on surveying mothers, recognizing their often central role in overseeing family health and well-being. Should a mother be unavailable, we will extend the opportunity to participate in the survey to another adult member of the household.

4.1 Indoor Air Quality

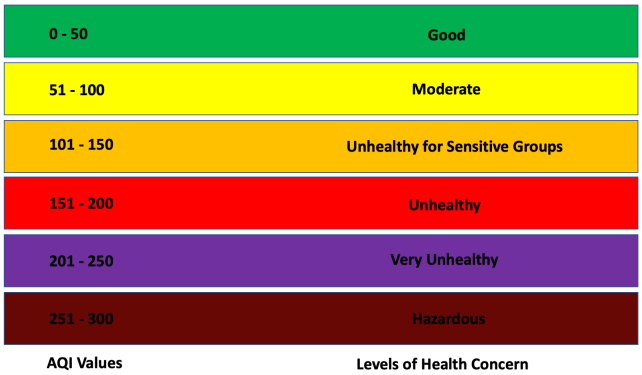
Having a substantive impact on a household's indoor air quality is the foundation for the rest of our analyses. Our air quality hardware partner, PT Cinta Alam Abadi, will be installing the hardware, providing Wi-Fi when necessary so that all installed hardware will transmit real-time $PM_{2.5}$ data to a remote server accessible to the research team. In addition, our partners will be ready to troubleshoot any technical problems.

Note that air purifiers in the control group (purifiers without filters) and the purifier-only treatment group are also equipped to record $PM_{2.5}$ levels. Thus we will have real-time data on indoor $PM_{2.5}$ in all households in the experiment. In addition, we will have real-time data on when air purifiers are turned on. This information will help us quickly fix any problems with the hardware. More importantly, it will give us real insights into how people behave in their homes in relation to air pollution, based on their actual use of these purifiers.

4.2 Beliefs on Air Pollution

Perception of Air Pollution Exposure: We first introduce the Air Quality Index (AQI) scale, shown in Figure 11, which was designed by the US Environmental Protection Agency (EPA) is used in many different countries. Our enumerators explain that the health concerns correspond to different levels of air pollution, and that the Indonesian Government uses a different scales.

Figure 11: US EPA Air Quality Index



After introducing the scale, we ask the following questions:

1. In the past 7 days, how good do you think air quality was in your home on the AQI scale?

- Responses are on a scale from 1 to 6, where 1 is good (green) and 6 is hazardous (brown).

2. In the past 7 days, how good do you think air quality was in your *neighborhood* on the AQI scale?

   - Responses are on a scale from 1 to 6, where 1 is good (green) and 6 is hazardous (brown).

3. In the past 7 days, how do you think indoor air in your home compares to outdoor air in your neighborhood?

   - Responses are coded on a scale from 1 to 5, where 1 is much more polluted than outdoor air, and 5 is much less polluted than outdoor air.

Since we have objective measures of air quality, we use these survey questions to construction three outcome variables:

1. Difference between perceived indoor air quality and true indoor air quality
2. Difference between perceived outdoor air quality and true outdoor air quality
3. Difference between perceived indoor-outdoor relationship and true indoor-outdoor relationship

Beliefs about the Health Impacts of Air Pollution: while it is impossible to observe respondent's true beliefs on their marginal utility of clean indoor air, we proxy for this belief by asking how much respondents agree with the following statements:

1. Spending 12 hours a day in a clean air environment is good for my immediate health, even if the air is very polluted the other 12
2. Spending 12 hours a day in a clean air environment is good for my long-term health, even if the air is very polluted the other 12 hours.

Beliefs About Air Purifier Effectiveness: in the case of adaptation through air purifiers, we have an additional possible wedge: misinformation about the impact of air purifier on air quality. From our pilot work, 70% of people have either never been in a room with an air purifier or do not know if they have. Additionally, most people either did not know what a purifier does or misperceived the purifiers functionalities. It this therefore possible that households misestimate the efficiency of purifiers, although we did not directly measure beliefs about efficiency in our pilot work. We discuss this possible wedge and our efforts to address it in Section 5.[15] While understanding air purifier effectiveness if not a main mechanism of interest, we seek to carefully document it. To understand if households are learning about the efficacy of air purifiers during the experiment, we ask the question, "With the windows and doors closed, how effective do you think one air purifier is at getting rid of the pollutants in your home?". Responses are multiple choice: 90%, 75%, 50%, 25%, and purifier would not have much of an effect.

[15]Previously, studies measuring demand for air purifiers treated purifier efficacy as a fixed value, ignoring potential differences between households due to heterogeneous levels of indoor-outdoor air leakage (Ito, 2020). It is unclear to us before running the experiment whether this will be important in the household's decision-making process, and we may adjust on conceptual framework depending on the results of the full-scale experiment.

4.3 Demand for Clean Air

Willingness to Pay for Air Purifiers: We will implement a BDM mechanism, building on the logistical implementations from Berry et al. (2020) and Berkouwer and Dean (2022). At endline, each respondent is randomly allocated a hidden price that is printed and sealed inside an envelope with the respondent's name on it, and remains unknown to the respondent and enumerator. The prices range from USD$1 to USD$20.

More specifically, we use an iterative multiple price list (iMPL) that essentially conducts a binary search over the range of USD$0 to USD$30. In this procedure, respondents are given a price in each step and asked if they would like to rent the purifier for two months. If the respondent says yes, the price is increased; if the respondent says no, the price is decreased.

Following Berkouwer and Dean (2022), each respondent will also complete two practice BDMs before undertaking the final purifier rental BDM; one will be for a bottle of lotion and one will be for a bottle of shampoo. Respondents are randomly assigned whether they would be offered the lotion using take it or leave it and the bottle of shampoo using BDM, or vice versa. We are still piloting our BDM script, and thus the procedure and script may change before rollout of our endline survey. The current draft can be found in Section A.1.

Pollution Avoidance Behaviors Index: A set of yes/no questions on avoidance and protection, including wearing masks, checking air pollution alerts, and avoiding outdoor areas when pollution is high. These questions will be aggregated and weighted by inverse frequency of taking this action at baseline.

High Frequency Time Use Survey: During the three months of the respondents participation, we will text a time diary form for respondents to fill out. The purpose of this is to understand whether people are changing the amount of time they spend outdoors versus inside their homes because of our treatments. We will ask respondents to record their activities from 4am the previous day to 10am today. To minimize cognitive burden and the amount of time it takes to answer the survey, the activities will be grouped into seven very general categories.

Policy Preferences: An additional measure of demand is household willingness to support policies aimed at solving public air pollution issues. This differs from the previous three measures of demand, which measure adaptation against private exposure to air pollution. We will have three measures of air pollution policy preferences:

1. Ranking of air pollution amongst other policy concerns (waste management, healthcare access, and traffic)

2. Support for policies that governments could take, measured on a Likert scale. These separate policy questions will be combined into one index that measures overall support for policies on air pollution. We will also have questions on policies unrelated to air pollution for comparison.

3. Willingness to sign a petition for the government to improve emissions control, aimed at tackling air pollution

These outcomes do give signals for demand for air pollution, but also embed collective action problems and trust in the government.We consider these outcomes to need a separate analysis, which we discuss in greater detail in Section 6.2.

4.4 Health and Productivity

Biometrics: Our enumerators will administer the following biometrics to the respondent measure objective health markers:

1. Blood pressure, measured by enumerators using a sphygmomanometer using the procedures set by the CDC NHANES

2. Blood oxygen levels, measured through a pulse oximeters. These oximeters measure hemoglobin oxygen saturation; particulate mater is found to reduce the oxygen-carrying capacity of blood.

Self-Reported Health:

- A set of yes/no questions asking whether the respondent experienced a set of symptoms in the past four weeks. These will include both pollution (i.e. cough, breathlessness) and non-pollution (placebo) related symptoms (i.e. stomachache, skin rashes).

- Quantitative questions about medical costs in the last 4 weeks, frequency of hospital visits, and number of days they missed work/daily/school activities due to health issues.

The elicited symptoms are combined into 2 indices: adult pollution symptoms, adult non-pollution symptoms. Each symptom will be weighted by the inverse mean of the number of people with the symptom at baseline.

Cognitive Ability: We will use four instruments to assess respondents' memory and attention:

1. **Word recall (working and episodic memory)**: the enumerator reads a list of 10 words and respondents verbally recalled as many words as possible. 10 minutes later in the survey, respondents are asked to recall the words from the word recall task.

2. **Serial seven (attention)**: enumerator asks respondent to subtract 7 from 100. This is repeated 5 times.

3. **Forward digit span (working memory)**: the respondent is asked to repeat a series of numbers first indicated by the enumerator, starting with three numbers. Success leads to an increase in the length of the task.

4. **Backward digit span (executive function)**: analogous to the forward digit span, the respondent is asked to repeat *backwards* a series of numbers

We will combine these four cognitive ability measures into one cognitive ability index. We do this by standardizing each of the four measures to mean 0 and standard deviation 1, and then taking the average across the outcomes.

Mental Health: We measure depression using the 10-item Center for Epidemiologic Studies-Depression Scale Revised (CESD-R-10) (Radloff, 1977). This questionnaire is commonly used to assess depressive symptoms in adults, and is the assessment used by the Indonesian Family Life Survey (IFLS). Each item has four possible answers that are rated on a Likert scale (0–3), with total scores ranging from 0 to 30. We will use both a binary measure of depression (scores 10) as well as a continuous measure from 0 to 30 (Tran et al., 2019).

Sleep quality: We measure sleep disturbance using ten indicators adopted from the Patient Reported Outcomes Measurement Information System (PROMIS), developed by the USC Center for Economic and Social Research. Again, this has been used by the IFLS, and has been evaluated against other sleep indices. Each question on disturbance was rated on a Likert scale (never, rarely, sometimes, often, and always), and we will run our analysis on the total score for each respondent, which ranges from 10 to 50.

Additionally, we will collect time-use data from the past 24 hours, for both the respondent and the child. These will allow us to infer sleep duration.

For biometrics, self-reported health, and cognitive ability, we will not only measure these outcomes for our parent respondent, but we will also measure them for the targeted child in each family.[16] For self-reported health, these will be asked to the adult, and we will create a measure of adult-reported child pollution symptoms, and adult-reported child non-pollution symptoms. We are planning a more holistic and policy-focused analysis of the impact of air purifiers on children's health in a collaborative project with the Asian Development Bank Institute. For this second paper, we may use both parental and children's health outcomes.

4.5 Power Calculations

We base our sample size on the main treatment, described in Section 3.1. All power calculations are based on a hypothesis test with a 5% significance level. From our pilot data, we found that the intracluster correlation (ICC) for our main outcomes of interest to be near zero. For a conservative estimate, we set the ICC to 0.3 in our calculations.

We consider three power calculations for selecting our sample size. First, we assessed the impact on reducing indoor air pollution. Our pilot analysis demonstrates robust statistical power in this domain; even with a limited sample size in our pilot study—comprising 43 households each provided with an air quality monitor and a purifier—we observed a statistically significant reduction in $PM_{2.5}$ concentrations. The mean levels decreased by 20 $\mu g/m^3$, corresponding to a reduction of 0.4 standard deviations. This pilot finding confirms that our full scale sample will detect meaningful changes in the environment.

Second, we study the sample size necessary to detect the effect of the experience treatment on WTP for air purifiers. All power calculations are based on a hypothesis test with a 5% significance level. We focus on power to estimate the difference between our control and our Comprehensive Experience treatment, and thus use a sample of 600 households in 810 classrooms. Comprehensive Treatment is administered to 300 households, and the other 300 are in the control group. We assume an ICC of 0.3.

As seen in Panel (a) of Figure 12, our experiment is well powered; our sample size of 600 households randomized at the classroom level gives us power to 80% to pickup a treatment effect of 0.08σ. Additionally, we will also collect baseline data to be used as controls, which will likely increase our statistical power. In addition, our treatment will be stratified by grade, baseline expenditures, and pollution levels, but for the power analysis we do not differentiate treatment effects by strata. We anticipate more strata and thus higher power to pick up heterogeneous effects with more splits.

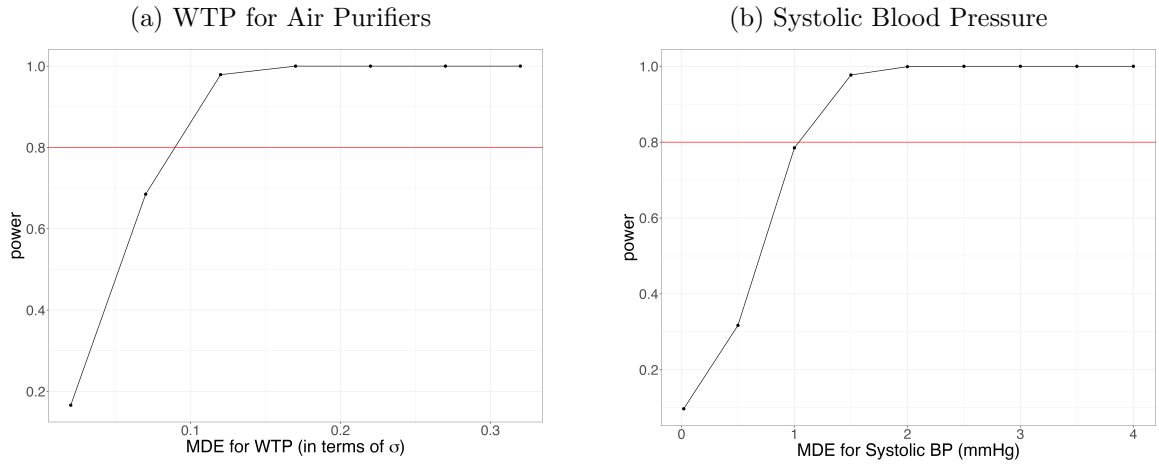
Third, we also consider the effect of reducing $PM_{2.5}$ on blood pressure by instrumenting for the pollution level with the experience treatment. We focus on systolic blood pressure,

[16] The targeted child is the elementary school child targeted by our sampling methodology.

although the results are similar for diastolic. To select our parameters, we use administrative data on health of female adults in Jakarta from the Indonesia Family Life Survey (IFLS). Based on IFLS data, the mean of systolic BP is 124.73 mmHg and standard deviation is 20.69 mmHg.

In our power calculations, shown in Panel (b) of Figure 12, we are powered to detect a very small effect of 1.1 mmHg with 600 households ($.05\sigma$). Comparing this to previous purifier experiments is difficult, as past experiments are typically in high-income settings or China, differ in duration of experiment and pollution reductions, and are limited to small sample. One review of purifier experiments find that on average, purifier use over a median 13.5-day duration was associated with a $\approx$4 mmHg reduction in systolic BP Walzer et al. (2020). We thus feel confident that we are well-powered to detect changes in blood pressure.

Figure 12: Power Calculations



Notes: This figure shows the results of the power calculations. The left panel plots power calculations for WTP for air purifiers. Design parameters for this power calculation was informed by our pilot. The right panel plots power calculations for systolic blood pressure. Design parameters were informed by summary statistics from the IFLS dataset.

5 Main Analyses

Our main analysis consists of four sets of results with our primary outcomes. We begin with the first-stage effect, or impacts of the intervention on indoor air quality. Second, we also test the first-stage impacts of our intervention on beliefs surrounding air pollution. Third, we want to understand if these first-stage effects translate to real-world outcomes, and conduct analyses on demand for clean air to test the existence of an experience wedge. Finally, if the experience wedge does exist, we investigate the two types of mechanisms that could drive the wedge:

1. Misinformation about the levels of air pollution
   (a) misinformation about own exposure to pollution
   (b) misinformation about the impact of air purifier on air quality
2. Mis-perception of marginal utility of clean indoor air, driven by the absence of previous physical experience.

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5.1 Indoor air quality

We first estimate the effectiveness of air purifiers on indoor $PM_{2.5}$ concentrations. We do so by regressing household i's average $PM_{2.5}$ concentrations (measured by our fans / purifiers) on household's treatment status. We run our analysis here at the hourly level, denoted by h

$$PM_{ih} = \alpha + \beta \mathbf{1}\{Comprehensive\}_{ct} + X_i' \cdot \phi + \nu PM_{ih}^{ambient} + e_{ih} \tag{3}$$

$\mathbf{1}\{Comprehensive\}_{ct}$ is an indicator for whether classroom c, which i is a part of, is in the Comprehensive treatment group or the control group. X_i, are controls for baseline household characteristics, school fixed effects, as well as the grade, pollution, and income strata. Across all specifications in this section, we use double-selection LASSO to select controls (Urminsky et al., 2016). We also control for ambient outdoor air pollution, $PM_{it}^{ambient}$, measured by the three closest air quality sensors.[17]

The outcome variable, PM_{iht} is a measure of household i's indoor $PM_{2.5}$ concentration. We may aggregate the hourly data into several other measures of indoor pollution:

1. Median exposure over all readings
2. Mean exposure over all readings
3. Median / mean exposure, separately for day versus night time; our pilot suggested that at night, the purifiers are most effective as many households open windows and sometimes turn off the purifier during the day.
4. Median / mean exposure, separately for readings below versus above the top 95th percentile of hourly averages. This is meant to try to distinguish between pollution from household sources (smoking, cooking, trash burning) which cause large spikes in $PM_2.5$ versus pollution from outdoor pollution leaking in.
5. Indoor pollution peaks as defined by
    - 95th percentile of household-level hourly average, which corresponds roughly to the most polluted hour in the day. This is meant to understand whether air purifiers can have an impact on the most extreme but short pollution episodes coming from smoking, cooking or trash burning.
    - Censoring algorithm from MacNeill et al. (2014): The start of an indoor peak is identified when the indoor concentration increased by at least 5 $\mu g/m^3$ compared with the previous half-hour reading or when the indoor concentration first exceeded the outdoor concentration.
    - Lunderberg et al. (2023)'s peak-finding algorithm, which leverages the intuition that peak events are marked by the speed at which pollution concentrations increase and

[17] Note that the treatment effect may be heterogeneous across treatment arms if households adopt different behaviors in response to the different treatments, which may influence indoor $PM_{2.5}$ levels (e.g. closing windows during highly polluted times). We thus do not include these survey elicitations of these behaviors in the main analyses. We will also include (measured) temperature and humidity as controls in a robustness specification, as both may impact air purifiers' effectiveness but are also influenced by households' behavior and may thus be "bad controls".

then decrease. This algorithm essentially finds bands of episodic concentration peaks by analyzing the frequency of fluctations in pollution concentration. It starts from the highest point, and moves backward in time to find the start, looking for a shift from times when the pollution wasn't increasing much (or was even decreasing) to when it consistently started to rise. Similarly, to find the end of the peak event, you move forward in time and look for a shift from times when the pollution was consistently decreasing to a time when pollution wasn't decreasing much or even start to increase.

Our main specification will be comparing our purifier+monitor treatment group to the control group. We will also run two additional version of this analysis. First, we will include the purifier-only treatment group as an additional treatment variable. Second, we will group the two treatments together into one binary variable. All errors will be clustered at the classroom level.[18]

5.2 Beliefs About Air Pollution

An additional "first stage" effect of our main treatment should be to update respondent's beliefs about (1) indoor air pollution level and (2) impact of air pollution on own health.

We compare those treated by our Comprehensive Treatment (purifier+monitor), to the control group, and expect that the Comprehensive Treatment will lead respondents to update their beliefs towards the "correct" information on (1), where the "correct" AQI level will be measured by our air quality hardware. For (2) "correct" knowledge is unobservable to researchers, but we hypothesize that respondent's knowledge of own preferences can only improve with our treatment. For each outcome, we use the following regression specification:

$$b_{it} = \alpha + \beta^{\omega} \mathbf{1}\{Comprehensive_{ct}\} + X_i' \cdot \phi + e_{it} \tag{4}$$

Here, t indexes which survey round the household participated in. Analogous to our specification in Section 5.1, we use double-selection LASSO to select controls, X_i and control for baseline measures of our outcomes when applicable. Our posterior belief outcomes, b_{it}, capture two dimensions: (1) perceptions of air pollution exposure and (2) beliefs about health impact of air pollution. These outcomes are described in more detail in Section 4.2. Given our clustered-randomization design, and the fact that we will likely have unequal cluster sizes, we will also run a set of analyses that uses weights to account for these differences in assignment propensities.

We will then run an analogous regression comparing the purifier-only treatment group to the control group. As discussed in Footnote 12, analyzing the impact of this treatment on indoor air pollution level and perceived purifier effectiveness will test our assumption that the sensory mechanism will only help respondents update their perception of the physical benefits of clean air and accompanying health and productivity benefits, but will not include information provided by the visible measurements from a monitor.

In addition, we can test whether households have baseline biases about purifier efficacy, and whether the treatment would induce learning about the purifier. Given that we do not record purifier efficacy in the control group, we use comparisons between the purifier+monitor

[18] We will run a robustness check with errors clustered at the school level.

(comprehensive) and the purifier-only treatments to evaluate this:

$$b_{it}^{post} - b_{it}^{true} = \alpha + \beta^{\omega} \mathbf{1}\{Comprehensive_{ct}\} + X_i' \cdot \phi + e_{it} \tag{5}$$

where the outcome is the difference between the household's belief in the efficacy of the purifier at endline and the objective efficacy, as measured through our continuous data.

5.3 Estimating the Experience Wedge ω

Our main Comprehensive Experience experiment is designed to estimate the experience wedge ω. We regress three different measures of demand for clean air on treatment status in order to test for the presence of an experience wedge. The first regression we run is:

$$Demand_{it} = \alpha + \beta^{\omega} \mathbf{1}\{Comprehensive_{ct}\} + X_i' \cdot \phi + e_{it}$$

Where demand is (1) WTP for a two month air purifier rental and (2) the pollution avoidance behaviors index.

Additionally, we run the higher-frequency regression with time spent inside their homes as the outcome variable:

$$\begin{aligned} Indoors_{idt} = \alpha &+ \beta_1^{\omega} \mathbf{1}\{Comprehensive_{ct}\} + \beta_2^{\omega} \left(\mathbf{1}\{Comprehensive_{ct}\} \times PM_{idt}\right) \\ &+ \beta_3 PM_{idt} + X_i' \cdot \phi + e_{it} \end{aligned}$$

where d indexes the date the time use diary was sent to respondents, as detailed in Section 4. β_1^{ω} reflects the additional value people have for staying at home due to the comprehensive experience treatment, whilst β_2^{ω} tests whether this treatment effect is a function of the level of outdoor air pollution.

Note that for our non-purifier related demand outcomes (pollution avoidance behaviors index and time spent inside house), β^{ω} is unrelated to purifier efficacy information failures. We can thus interpret β^{ω} as misperceptions in experience with air pollution.

5.4 Mechanisms: Lack of Physical Experience

As discussed in Section 3, we are focused on distinguishing between two types of mechanisms behind the experience wedge:

1. **Lack of knowledge of objective exposure to pollution**: ω^e, leading to misperception of the level of exposure, either coming from misinformation about baseline ambient air pollution levels, or from misinformation about the effectiveness of the air purifier.

2. **Lack of physical experience of clean air**: ω^s - where theoretical information cannot convey the physical (wellbeing, health and productivity) benefits of clean indoor air, leading to misperception of the marginal utility of clean air.

The second treatment arm is designed to experimentally isolate the wedge coming from the previous lack of physical experience of clean air, by giving households in the secondary treatment group an air purifier that is not paired with a (visible) air monitor. We hypothesize that this treatment does not affect ω^e but may affect ω^s if households perceive the physical

impact of clean air immediately while breathing, on their wellbeing in the short term and more generally their health. We explain how we test this assumption in Footnote 12.

To isolate this component, we run the following regression comparing our control group to both our main treatment (purifier + monitor) and our secondary (purifier only) treatment arms:

$$Demand_{it} = \alpha + \beta^{\omega}\mathbf{1}\{\text{Purifier+Monitor}_{ct}\} + \beta^{\omega^s}\mathbf{1}\{\text{PurifierOnly}_{ct}\} + X_i' \cdot \phi + e_i$$

We focus on the same three outcome variables as in Section 5.3 to measure demand for clean indoor air. We interpret β^{ω^s} as the part of the wedge coming from the physical experience alone.

Under the assumption of additive separability (no interaction), we further interpret $\beta^{\omega} - \beta^{\omega^s}$ as the part of the wedge coming from the lack of knowlege about exposure levels. This analysis allows us not only to test for the existence of both types of mechanisms driving the experience wedge, but also to quantify their relative contribution.

As mentioned in Section 4.2, for our WTP for purifier outcome, $\beta^{\omega} - \beta^{\omega^s}$ is potentially a composite of two information failures:

1. lack of knowledge of ambient air pollution levels
2. lack of knowledge of the efficacy of the air purifier

We will provide suggestive evidence for the existence (absence) of information failures of the levels of ambient air pollution by looking at non-purifier related outcomes like pollution avoidance behaviors index and time use, for which air purifier effectiveness in itself does not matter. Through the combination of our three main demand outcome variables and under the assumptions described above, we are thus able to disentangle the roles of: (1a) misinformation about ambient levels of pollution, (1b) misinformation about effectiveness of the purifier, and (2) misperception of the marginal utility of clean air (coming from quality of breathing, wellness and health impacts).

We have hypothesized above that our purifier-only treatment will only affect the ω^s component of the experience wedge. Thus, our hypothesis is that β^{ω^s} should be statistically different from 0 for the outcomes targeting learning about the impact of clean indoor air on health ω^s, but not outcomes related to air pollution exposure and purifier efficiency, as discussed in Footnote 12. In the case where this assumption is proven untrue, we will need to adjust our conceptual framework to reinterpret β^{ω^s}. We can leverage mediation analyses techniques to test for the presence of the three mechanisms we are interested in, and will follow the latest mediation analysis techniques from Imai et al. (2011); Acharya et al. (2016).

5.5 Health Impacts

We are also interested in the impact of air purifiers on respondents' health. This has two goals: (1) bringing richness to studying the mechanisms behind the treatment effects, and (2) studying the dose-response function of clean air on health.

5.5.1 Using Health Outcomes to Study Intervention Mechanisms

We first directly regress our health outcomes on our treatments:

$$Health_{it} = \alpha + \beta^{\omega} \mathbf{1}\{Treatment\}_{ct} + X_i' \cdot \phi + e_{it}$$

The dependent variable, Health_i, includes biometric measures, cognitive ability, self-reported health symptoms, and mental health. as detailed in Section 4. We refer to biometric measures and cognitive ability as objective health outcomes, and refer to self-reported health symptoms, mental health, and sleep quality as subjective health.

We will define our treatment indicator in three ways: (1) binary indicator for comprehensive treatment versus control, (2) a binary indicator for Comprehensive versus control, and a second binary indicator for purifier-only versus control, and (3) combining comprehensive and purified-only into one binary treatment variable.

How our interventions affects objective versus subjective outcomes will be important for our understanding of the impact of the intervention on the respondent's belief formation process, with the following hypotheses:

- If demand for clean air, perceived health outcomes and actual health outcomes all improve ($\beta^{\omega} > 0$), this is suggestive that people are learning about how pollution affects their well-being, and that this change is large enough to be perceptible.
- If demand for clean air increases and health outcomes do not increase, then we are not capturing some dimension of well-being that is impacted by pollution
- If demand for clean air does not increase and health outcomes do not increase, then this is suggestive that the experience wedge does not exist, and households were valuing clean air correctly before the intervention
- If demand for clean air does not increase and objective health increases, then this is suggestive that households are perhaps not causally attributing their health gains to pollution. This hypothesis can be directly tested by looking at whether perceived health improves.

The purifier-only treatment has analogous interpretations.

5.5.2 Dose-Response Function of Health Impacts

In In addition, we quantify the impact of clean indoor air itself on respondents' health by instrumenting for indoor air pollution, with the treatment status.

$$PM_{it} = \alpha' + \beta' \times \mathbf{1}\{Treatment\}_{ct} + X_i' \cdot \phi + \varepsilon_{it} \qquad \text{(1st stage)}$$

$$\text{Health}_{it} = \alpha + \beta \times \hat{PM}_{it} + X_i' \cdot \phi + e_{it} \qquad \text{(2nd stage)}$$

Our health outcomes include:

- Blood pressure
- Blood oxygen levels

- Standardized adult health index
- Standardized cognitive ability index
- Mental health index
- Sleep quality index

One of our contributions is to collect high frequency measures of sleep and mental health indicators, where we can leverage natural variation in how high pollution is that day in order to check the impact of the purifier. We believe such high frequency measures is a promising approach to understand the impacts of changes in air quality, as outcomes like sleep have been shown to be negatively affected by air pollution (Armstrong-Carter et al. (2022) focus on within-subject daily changes in $NO2$ and CO). This setting also allows us to check if impacts differ at different ranges of the dose response function.
Importantly, our intervention creates a type of air quality variation that differs from most studies using either (i) short-term exogenous changes or (ii) very long-run policy changes like the clean air act. We argue that it is especially valuable to understand how medium-term variation in air quality (as the one created by our intervention) affects health, as it corresponds to the type of variation that households may have more agency over.

In addition we conduct placebo health tests, where we identify health outcomes that are unlikely to be affected by air pollution, such as diarrhea. Again, we will define our treatment indicator in three ways: (1) binary indicator for Comprehensive treatment versus control, (2) a binary indicator for comprehensive versus control, and a second binary indicator for purifier-only versus control, and (3) combining comprehensive and purifier-only into one binary treatment variable.

5.6 Heterogeneity Analyses

We analyze heterogeneity in results along the following variables that will be collected in our baseline survey:

- Baseline WTP for purifiers, measured by stated preferences
- Baseline food expenditure, a proxy for households' wealth, as households of different wealth levels are expected to have heterogeneous liquidity constraints and levels of demand for clean air (Greenstone and Jack, 2015).
- Baseline ambient air pollution levels, as those may influence both baseline health, final exposure and the effectiveness of the air purifiers.
- Baseline self-reported health, as well as child's health and health of any elderly family members that are residing in the home
- Accuracy of baseline knowledge about air purifiers' effectiveness: by comparing respondents in the control and treatment groups with similar levels of baseline knowledge about air purifiers' effectiveness, we will be isolating the impact of the experience itself on WTP for air purifiers. Note that we will also investigate whether our treatments improve knowledge about air purifiers' effectiveness.

- Baseline WTP for purifiers, measured by stated preferences: analogous as above.
- Baseline beliefs about their household's indoor air quality and beliefs about how indoor air pollution affects household health
- Effectiveness of air purifiers on indoor air quality: we expect that air purifiers will have heterogeneous impacts on indoor air quality. We will add an interaction between a respondent's treatment status and air purifiers' effectiveness, to create different experience intensities. Under the assumption that purifiers' effectiveness is orthogonal to other, unobservable drivers of WTP for air purifiers, conditional on observable covariates that can be controlled for in the regression, we could then interpret the coefficient on this interaction as the effect of "intensive margin" experience on demand.

5.7 Multiple Hypotheses Testing

We follow two protocols to account for the fact that we are testing multiple outcomes in this experiment.

First for our our multi-dimensional health and cognitive ability outcomes, we will pool health questions into indices, as described in Section 4, following O'Brien (1984). For self-reported symptoms, we compute the average standardized effect, where we divide each variable by its standard deviation and take the average of these normalized symptoms, weighted by the inverse mean of the number of people with the symptom at baseline (Kling et al., 2007). Cognitive ability, mental health, and medical diagnoses will be similarly aggregated into indices. To explore possible mechanisms, we will also report results from the individual variables that make up the indices, but these are exploratory in nature. Additionally, our non-pollution symptoms indices will act as placebo outcomes.

Second, in addition to reporting standard p-values, we will also present Anderson's sharpened False Discovery Rate (FDR) q-values to outcomes that we measure using multiple questions, including measure of beliefs and measures of health/productivity.

6 Additional Analyses

6.1 Embedded Information Treatment Design

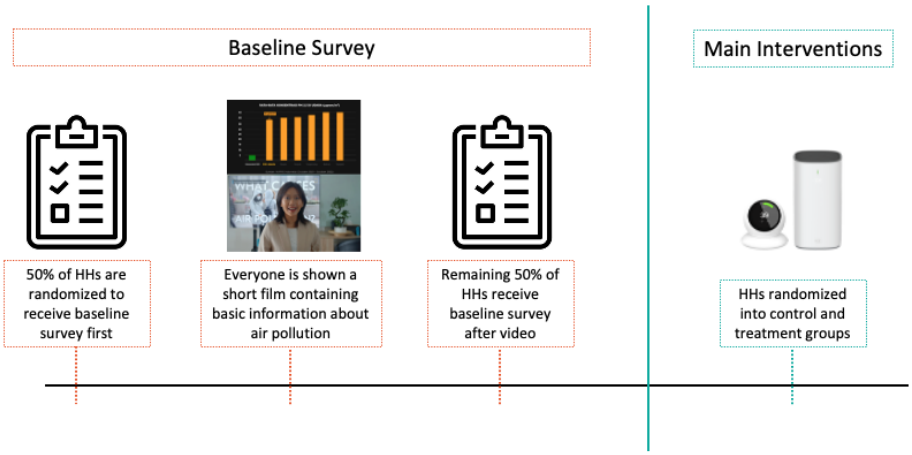
We add an additional cross-randomization in the baseline survey, illustrated in Figure 13, where we randomize whether the information video is shown before or after the baseline survey is conducted. Our survey will test household knowledge about air pollution and beliefs surrounding their personal exposure. By randomizing the timing of the informational video, we document the impact of a classic information treatment on air pollution knowledge and beliefs.

Our pilot efforts reveal two key results that were already true at baseline, before any intervention or video was administered: (1) households generally know air pollution levels in Jakarta are bad and (2) air pollution has detrimental effects on health and productivity.[19] Given the baseline knowledge level, we hypothesize that a traditional information treatment in

[19]For example, when asked the True/False question, "Air pollution affects children brain development in the long run", 89% of households answered correctly (True). When asked the True/False question, "The smaller the dust particles are, the worse they are for your health", 75% of households answered correctly (True).

our full-scale study will likely yield minimal or no effects on pollution knowledge. Considering that this form of information dissemination is commonly employed by policymakers, NGOs, and international organizations, accurately measuring its impact is important. Doing so not only provides a scale for assessing the effectiveness of our main treatment interventions but also offers valuable insights into the actual influence of these widely used methods.

Figure 13: Embedded Information Experiment Design



We test the short-term effectiveness of a generic knowledge intervention by running the following regression, analogous to our main analysis:

$$y_{it} = \alpha + \beta^{\omega} \mathbf{1}\{AfterVideo_{it}\} + X_i' \cdot \phi + e_{it}$$

where $AfterVideo_{it}$ is a binary indicator for whether the household watched the informational video before or after taking the baseline survey. Our outcomes, y_{it} will consist of the following:

- Knowledge index: a set of ten True/False questions, aggregated into a standardized index. We weight each of the questions by the inverse mean of the number of people answering correctly, thus allowing us to weight the questions by difficulty
- Beliefs: our three sets of beliefs about air quality, as described in 5 – (1) perception of air pollution exposure, (2) beliefs about health impacts of air pollution, (3) beliefs about air purifier effectiveness
- Stated willingness-to-pay for a two month air purifier rental
- Policy preferences

6.2 Public vs Private Preferences for Clean Air

Our current conceptual framework does not distinguish between indoor and outdoor air quality. However, it is possible that households think of these as two distinct goods, where the outdoor air quality is a public good suffering from collective action problems. If they are two distinct goods, and our treatment is only targeting indoor air quality, then it could have a differential

effect on demand for outdoor air. Whether demand for indoor and demand for outdoor air move in the same direction depends on whether they are complements or substitutes. We test for these effects with the following regression:

$$Policy_{it} = \alpha + \beta^{policy} \mathbf{1}\{Treatment_{it}\} + X_i' \cdot \phi + e_{it}$$

where $\mathbf{1}\{Treatment_{it}\}$ is a binary indicator for whether households are in the Comprehensive treatment or the control group. $Policy_{it}$ are measures of demand for pollution policies, described in Section 4.3. Demand for indoor air quality increases (as measured by WTP for air purifier rental) and $\beta^{policy} > 0$, this is evidence that indoor and outdoor air quality are complements; if $\beta^{policy} < 0$, this is evidence that indoor and outdoor air quality are substitutes.

7 Administrative Information

Timeline:

- April 2024: Engagement with schools to create sampling frame, hiring enumerators and training
- May 1, 2024: Roll-out of wave 1 of baseline surveys and treatment
- August 15, 2024: Wave 1 endline, and roll-out of wave 2 baseline
- November 20, 2024: Wave 2 endline

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Institutional Review Board (ethics approval): This project was approved by the IRB committees at the University of Chicago (IRB23-0310). Local ethics review in Indonesia is undergoing review from The National Research and Innovation Agency (BRIN).
Pre-registration: This project is registered on the AEA RCT registry (Identification No. AEARCTR-0013110).
Declaration of interest: None of the authors have any relevant or material financial interests that relate to this research project.

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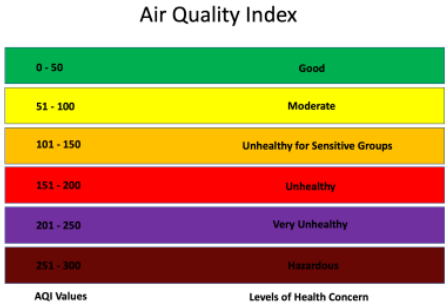
A Appendix

A.1 Survey Instruments

1. Survey questionnaire, containg both baseline and endline questions
2. BDM elicitation script

NOTE: the survey is currently being translated into Bahasa. We can upload the translated version as a revision to BRIN once completed.

	Questions	Answer Field
Beliefs	We are going to talk a lot today about air pollution, so we first want to show you a reference air pollution scale that you may have seen around. The different colors correspond to different levels of health impacts.	
		
	In the past 7 days, how good do you think air quality was in Jakarta, on the scale we just showed you?	1. Good (green) 2. Moderate (yellow) 3. Unhealthy for sensitive groups (orange) 4. Unhealthy (red) 5. Very unhealthy (purple) 6. Hazardous (Brown) -999. Doesn't know
	In your home without an air purifier, do you think that outdoor air is:	1. Much more polluted than indoor air 2. Somewhat more polluted than indoor air 3. As polluted as indoor air 4. Somewhat less polluted than indoor air 5. Much less polluted than indoor air -999. Doesn't know
	In the past 7 days, how do you think air quality was in your home, on the AQI scale we mentioned earlier?	1. Good (green) 2. Moderate (yellow) 3. Unhealthy for sensitive groups (orange) 4. Unhealthy (red) 5. Very unhealthy (purple) 6. Hazardous (Brown) -999. Doesn't know
	Rate this statement on a scale from 1 to 6, with 1 being strongly disagree and 6 being strongly agree. Spending 12 hours a day (e.g. night) in a clean air environment can significantly improve my immediate health, even if the air is very polluted the other 12 hours.	1. Strong disagree 2. Disagree 3. Somewhat disagree 4. Somewhat agree 5. Agree 6. Strongly agree -999. Does not know
	The last question was about immediate health. This is about long-term health. Rate this statement on a scale from 1 to 6, with 1 being strongly disagree and 6 being strongly agree. Spending 12 hours a day (e.g. night) in a clean air environment is good for my long-term health, even if the air is very polluted the other 12 hours.	1. Strong disagree 2. Disagree 3. Somewhat disagree 4. Somewhat agree 5. Agree 6. Strongly agree -999. Does not know
	Now think about $child_name$. Rate this statement on a scale from 1 to 6, with 1 being strongly disagree and 6 being strongly agree. Spending 12 hours a day (e.g. night) in a clean air environment can significantly improve $child_name$'s immediate health, even if the air is very polluted the other 12 hours.	1. Strong disagree 2. Disagree 3. Somewhat disagree 4. Somewhat agree 5. Agree 6. Strongly agree -999. Does not know

	Think again about $child_name$, this time about long-term health. Rate this statement on a scale from 1 to 6, with 1 being strongly disagree and 6 being strongly agree. Spending 12 hours a day (e.g. night) in a clean air environment is good for my long-term health, even if the air is very polluted the other 12 hours.	1. Strong disagree 2. Disagree 3. Somewhat disagree 4. Somewhat agree 5. Agree 6. Strongly agree -999. Does not know
	If I put an air purifier into your bedroom with the window and door closed, how effective do you think it would be at getting rid of indoor pollutants in your home?	1. Reduces pollutants by at least 90% 2. Reduces pollutants by at least 75% 3. Reduces pollutants by at least 50% 4. Reduces pollutants by at least 25% 5. It would not have a big effect on indoor air pollution
	Questions	**Answer Field**
Demand for Clean Air	In the past 7 days, did you check the levels of outdoor air pollution, using the internet, an app, or some other source of information?	1. Yes 0. No -999. Does not know -888. Refuse to answer
	In the past 7 days, where did you check the levels of outdoor air pollution:	1. Mobile App 2. Internet Website 3. Newspaper 4. Discussion with friends / relatives 5. TV program 9. Other
	In the past 7 days, did you avoid going outside because air pollution was very high?	1. Yes 0. No -999. Does not know -888. Refuse to answer
	In the past 7 days, did you avoid taking your children outside because air pollution was very high?	1. Yes 0. No -999. Does not know -888. Refuse to answer
	In the past 7 days, did you avoid exercising outside because air pollution was very high?	1. Yes 0. No -999. Does not know -888. Refuse to answer
	In the past 7 days, did you close windows when outdoor air pollution was high, to protect yourself against outdoor air pollution?	1. Yes 0. No -999. Does not know -888. Refuse to answer
	In the past 4 weeks, have you engaged in any of the following activities / done any of the following? Please select all that apply.	1. Talked about air pollution with members outside your family 2. Engaged with your neighbors about not burning garbage 3. Read articles related to air pollution in Jakarta on online / offline newspapers 4. Read articles about air pollution on social media 5. Participated to a formal gathering (e.g. lecture) related to air pollution 6. Participated to an informal gathering related to air pollution 7. Created content related to air pollution on social media 0. None of the above
	Please prioritize the following four topics according to their significance for the Jakarta government's agenda.	1. Traffic 2. Waste Management 3. Air Pollution Control 4. Health facilities and costs
	We are now going to list a series of policies that the government could take. We want you to think how much you support these policies, on a scale of 1 to 6, with 1 being not support at all, and 6 being greatly support these policies. Once again, there is no good or bad answer and your answers will be kept confidential.	

	How likely are you to support the following policy? Implementing stronger regulations on traffic, like a more stringent odd-even traffic policy, which are meant to tackle air pollution.	1. Extremely unlikely 2. Unlikely 3. Somewhat unlikely 4. Somewhat likely 5. Likely 6. Extremely likely
	How likely are you to support implementing stronger fines for garbage burning?	1. Extremely unlikely 2. Unlikely 3. Somewhat unlikely 4. Somewhat likely 5. Likely 6. Extremely likely
	How likely are you to support policies promoting the transition from coal power plants to renewable energy. Examples of renewable energy are wind and solar power.	1. Extremely unlikely 2. Unlikely 3. Somewhat unlikely 4. Somewhat likely 5. Likely 6. Extremely likely
	How likely are you to support planting more trees in your neighborhood?	1. Extremely unlikely 2. Unlikely 3. Somewhat unlikely 4. Somewhat likely 5. Likely 6. Extremely likely
	How likely are you to support better compensations for households affected by floods?	1. Extremely unlikely 2. Unlikely 3. Somewhat unlikely 4. Somewhat likely 5. Likely 6. Extremely likely
	In the last 24 hours, how many hours did you spend inside your home?	
	Questions	**Answer Field**
Self-reported Health	We are now going to ask you some questions about your health, which is meant to better understand how pollution affects people with different health concerns. We do not want to invade your privacy, and want to remind you that all answers will be kept strictly confidential. You do not have to answer anything you do not want to.	
	Including yourself, is there any member of your household / of your family in Jakarta that you would describe as with "poor health"?	
	In the past 4 weeks, have you experienced the following. Please check all that apply. [Enumerator: read the questions one by one. Pause after each option and let the respondent indicate yes or not].	**1. Headaches** **2. Dizziness** **3. Increased fatigue** **4. Coughing or wheezing** **5. Shortness of breath / chest tightness** **6. Burning eyes** **7. Fever** **8. Runny nose** **9. Vision impairment** **10. Skin rashes** 11. Joint pain 12. Numbess or tingling in the hands 13. Stomach Ache or diarrhea **14. Nausea** 15. Toothaches 16. Hearing impairment 99. Other 0. None of the above -999. Does not know -888. Refuse to answer
	What other symptoms have you experienced?	
	During the last 4 weeks, how many days have these health complaints interefered with work, school, or daily activities?	

Have a doctor/paramedic/nurse/midwife given you any of the following diagnoses? Check all that apply. [Enumerator: read the questions one by one. Pause after each option and let the respondent indicate yes or not].	`-1. Respondent has not been to a health facility 1. Asthma 2. COVID 3. Pneumonia 4. Chronic pulmonary disease 5. Tuberculosis 6. Hypertension 7. Other lung disease 8. Stroke or cardiovascular disease 9. Memory-related disease 0. None of the above (but the respondent has been to a health facility) -888. Refuse to answer
In the past 4 weeks, have you visited the doctor or nurse related to your health?	1. Yes 0. No -999. Does not know -888. Refuse to answer
In the past 4 weeks, have any adults living in this home experienced the following. Please check all that apply.	1. Headaches 2. Dizziness 3. Increased fatigue 4. Coughing or wheezing 5. Shortness of breath / chest tightness 6. Burning eyes 7. Fever 8. Runny nose 9. Vision impairment 10. Skin rashes 11. Joint pain 12. Numbess or tingling in the hands 13. Stomach Ache or diarrhea 14. Nausea 15. Toothaches 16. Hearing impairment 99. Other 0. None of the above -999. Does not know -888. Refuse to answer
What other symptoms have you experienced?	
Think of the family member that was most affected. During the last 4 weeks, how many days have these health complaints interefered with work, school, or daily activities for this person?	
Have a doctor/paramedic/nurse/midwife given any other adults in this household any of the following diagnoses? Check all that apply.	"`-1. Respondent has not been to a health facility 1. Asthma 2. COVID 3. Pneumonia 4. Chronic pulmonary disease 5. Tuberculosis 6. Hypertension 7. Other lung disease 8. Stroke or cardiovascular disease 9. Memory-related disease 0. None of the above (but the respondent has been to a health facility) -888. Refuse to answer"
In the past 4 weeks, has any other adult in your family visited a doctor or nurse related to their health?	
In the past 4 weeks, have you or your family spent any money for medication related to asthma, coughing or any other respiratory condition, for any member of the family? If yes, how much?	
We are now going to ask you some questions about your well-being, outside of physical health. We do not want to invade your privacy, and want to remind you that all answers will be kept strictly confidential. You do not have to answer anything you do not want to.	

[Enumerator: check all words mentioned by the respondent]

Now we would like to ask you some questions about your sleep in the last 7 days.	
I had trouble sleeping	1. Never 2. Rarely 3. Sometimes 4. Often 5. Always -888. Refuse to answer
My quality of sleep was…	1. Very poor 2. Poor 3. Fair 4. Good 5. Very Good -888. Refuse to answer
My sleep was refreshing	1. Not at all 2. A little bit 3. Somewhat 4. Quite a bit 5. Very much -888. Refuse to answer
I was satisfied with my sleep	1. Not at all 2. A little bit 3. Somewhat 4. Quite a bit 5. Very much -888. Refuse to answer
I had difficulty falling asleep	1. Not at all 2. A little bit 3. Somewhat 4. Quite a bit 5. Very much -888. Refuse to answer
I had a hard time concentrating because of poor sleep	1. Not at all 2. A little bit 3. Somewhat 4. Quite a bit 5. Very much -888. Refuse to answer
I had problems during the day because of poor sleep	1. Not at all 2. A little bit 3. Somewhat 4. Quite a bit 5. Very much -888. Refuse to answer
I had a hard time getting things done because I was sleeping	1. Not at all 2. A little bit 3. Somewhat 4. Quite a bit 5. Very much -888. Refuse to answer
I felt tired	1. Not at all 2. A little bit 3. Somewhat 4. Quite a bit 5. Very much -888. Refuse to answer

I felt irritable because of poor sleep	1. Not at all 2. A little bit 3. Somewhat 4. Quite a bit 5. Very much -888. Refuse to answer
Now we would like to ask some questions about how you felt in the past week.	
I was bothered by things that usually don't bother me	1. Rarely, <= 1 day 2. Some days, 1-2 days 3. Occasionally, 3-4 days, 4. Most of the time, 5-7 days
I had trouble concentrating in what I was doing	1. Rarely, <= 1 day 2. Some days, 1-2 days 3. Occasionally, 3-4 days, 4. Most of the time, 5-7 days
I felt depressed	1. Rarely, <= 1 day 2. Some days, 1-2 days 3. Occasionally, 3-4 days, 4. Most of the time, 5-7 days
I felt everything I did was an effort	1. Rarely, <= 1 day 2. Some days, 1-2 days 3. Occasionally, 3-4 days, 4. Most of the time, 5-7 days
I felt hopeful about the future	1. Rarely, <= 1 day 2. Some days, 1-2 days 3. Occasionally, 3-4 days, 4. Most of the time, 5-7 days
I felt fearful	1. Rarely, <= 1 day 2. Some days, 1-2 days 3. Occasionally, 3-4 days, 4. Most of the time, 5-7 days
My sleep was restless	1. Rarely, <= 1 day 2. Some days, 1-2 days 3. Occasionally, 3-4 days, 4. Most of the time, 5-7 days
I was happy	1. Rarely, <= 1 day 2. Some days, 1-2 days 3. Occasionally, 3-4 days, 4. Most of the time, 5-7 days
I felt lonely	1. Rarely, <= 1 day 2. Some days, 1-2 days 3. Occasionally, 3-4 days, 4. Most of the time, 5-7 days
I could not get going	1. Rarely, <= 1 day 2. Some days, 1-2 days 3. Occasionally, 3-4 days, 4. Most of the time, 5-7 days

	Questions	**Answer Field**
Cognitive Test - Child	We are going to read a list consisting of 10 words and we would like you to memorize as many as you can. We deliberately ma [Enumerator: probe whether respondent needs more explanation] [Enumerator: Read the list slowly, with interval around 2 seconds between each word] MOUNTAIN. STONE. BLOOD. CORNER. SHOES. LETTER. GIRL.HOUSE. VALLEY. CAR	

[ ] MOUNTAIN
[ ] STONE
[ ] BLOOD
[ ] CORNER
[ ] SHOES
[ ] LETTER
[ ] GIRL
[ ] HOUSE
[ ] VALLEY
[ ] CAR
[ ] None of the above
[ ] Refuse to answer

[Enumerator: check all words mentioned by the respondent]

I will read you a number of digits. Afterwards, you repeat them in th

1. Pass
0. Fail
-888. Refuse to answer

Let's start with a brief example so you can practice. I will give you th

[Enumerator: did the respondent correctly repeat 7-1-9?]

No, you would say 7-1-9. I said 7-1-9, so to say it forwards you would

1. Pass
0. Fail
-888. Refuse to answer

7-1-9. Now try these numbers. Remember, you are to say them forw

[Enumerator: did the respondent correctly repeat 3-4-8?]

Ok, now we will start the official exercise. Again, I will give you 3 nun

1. Pass
0. Fail
-888. Refuse to answer

[Enumerator: please pause for 1 second in between each number]

5 - 8 - 2

1. Pass
0. Fail
-888. Refuse to answer

6 - 9 - 4

1. Pass
0. Fail
-888. Refuse to answer

6 - 4 - 3 - 9

1. Pass
0. Fail
-888. Refuse to answer

7 - 2 - 8 - 6

1. Pass
0. Fail
-888. Refuse to answer

4 - 2 - 7 - 3 - 1

1. Pass
0. Fail
-888. Refuse to answer

7 - 5 - 8 - 3 - 6

1. Pass
0. Fail
-888. Refuse to answer

6 - 1 - 9 - 4 - 7 - 3

1. Pass
0. Fail
-888. Refuse to answer

3 - 9 - 2 - 4 - 8 - 7

1. Pass
0. Fail
-888. Refuse to answer

5 - 9 - 1 - 7 - 4 - 2 - 8

1. Pass
0. Fail
-888. Refuse to answer

4 - 1 - 7 - 9 - 3 - 8 - 6

1. Pass
0. Fail
-888. Refuse to answer

5 - 8 - 1 - 9 - 2 - 6 - 4 - 7

1. Pass
0. Fail
-888. Refuse to answer

3 - 8 - 2 - 9 - 5 - 1 - 7 - 4

1. Pass
0. Fail
-888. Refuse to answer

2 - 7 - 5 - 8 - 6 - 2 - 5 - 8 - 4

	1. Pass 0. Fail
7 - 1 - 3 - 9 - 4 - 2 - 5 - 6 - 8	-888. Refuse to answer
	1. Pass 0. Fail
2 - 2 - 9 - 8 - 3 - 4 - 5 - 4 - 2 - 1	-888. Refuse to answer
	1. Pass 0. Fail
3 - 1 - 4 - 1 - 2 - 4 - 8 - 9 - 6 - 5	-888. Refuse to answer
We will repeat the exercise from before. I will read you a number of I say 7-1-9, what would you say?	1. Pass 0. Fail -888. Refuse to answer
[Enumerator: did the respondent correctly repeat 9-1-7?]	
No, you would say 9-1-7. I said 7-1-9, so to say it backwards you wou say 9-1-7. Now try these numbers. Remember, you are to say them I	1. Pass 0. Fail -888. Refuse to answer
[Enumerator: did the respondent correctly repeat 8-4-3?]	
Ok, now we will start the official exercise. Again, I will start with 3 nu	1. Pass 0. Fail
6 - 2 - 9	-888. Refuse to answer
	1. Pass 0. Fail
4 - 1 - 5	-888. Refuse to answer
	1. Pass 0. Fail
3 - 2 - 7 - 9	-888. Refuse to answer
	1. Pass 0. Fail
4 - 9 - 6 - 8	-888. Refuse to answer
	1. Pass 0. Fail
1 - 5 - 2 - 8 - 6	-888. Refuse to answer
	1. Pass 0. Fail
6 - 1 - 8 - 4 - 3	-888. Refuse to answer
	1. Pass 0. Fail
5 - 3 - 9 - 4 - 1 - 8	-888. Refuse to answer
	1. Pass 0. Fail
7 - 2 - 4 - 8 - 5 - 6	-888. Refuse to answer
	1. Pass 0. Fail
8 - 1 - 2 - 9 - 3 - 6 - 5	-888. Refuse to answer
	1. Pass 0. Fail
4 - 7 - 3 - 9 - 1 - 2 - 8	-888. Refuse to answer
	1. Pass 0. Fail
9 - 4 - 3 - 7 - 6 - 2 - 5 - 8	-888. Refuse to answer
	1. Pass 0. Fail
7 - 2 - 8 - 1 - 9 - 6 - 5 - 3	-888. Refuse to answer
	1. Pass 0. Fail
8 - 2 - 3 - 7 - 5 - 3 - 9 - 2 - 1	-888. Refuse to answer
	1. Pass 0. Fail
3 - 7 - 5 - 4 - 9 - 8 - 2 - 6 - 5	-888. Refuse to answer
Let's try some subtraction of numbers now. What is 100 minus 7 equal to?	
and minus 7 from that?	
and minus 7 from that?	
and minus 7 from that?	

	and minus 7 from that?	
		[ ] MOUNTAIN [ ] STONE [ ] BLOOD [ ] CORNER [ ] SHOES [ ] LETTER [ ] GIRL [ ] HOUSE [ ] VALLEY [ ] CAR
	A short while ago, we read a list of words to you and you have tried t [Enumerator: check all words mentioned by the respondent]	[ ] None of the above [ ] Refuse to answer
	Questions	**Answer Field**
Adult Reported Child Health	We are now going to ask you some questions about your children's health	
	What is your relation to the children in the household?	1. Mother 2. Father 3. Grandparent 4. Aunt/Uncle 5. Other -888. Refuse to answer
	Please answer questions below about [child_name]	
	In the past 4 weeks, has [child_name] experienced the following. Please check all that applies. [Enumerator: read the questions one by one. Pause after each option and let the respondent indicate yes or not].	1. Headaches 2. Dizziness 3. Increased fatigue 4. Coughing or wheezing 5. Shortness of breath / chest tightness 6. Burning eyes 7. Fever 8. Runny nose 9. Vision impairment 10. Skin rashes 11. Joint pain 12. Numbess or tingling in the hands 13. Stomach Ache or diarrhea 14. Nausea 15. Toothaches 16. Hearing impairment 99. Other 0. None of the above -999. Does not know -888. Refuse to answer
	What other symptoms has [child_name] experienced?	
	During the last 4 weeks, how many days have these health complaints interfered with [child_name]'s school, or daily activities?	
	Compared with [child_name]'s health 3 months ago, would you say that the child's health is now	
	Did [child_name] have any of these diseases or illnesses during his/her childhood. That is, from when he/she was born up to now. Check all that apply: [Enumerator: Read each option one by one, stopping after each option to allow the participant to indicate yes or no.]	`-1. Respondent has not been to a health facility 1. Asthma 2. COVID 3. Pneumonia 4. Chronic pulmonary disease 5. Tuberculosis 6. Hypertension 7. Other lung disease 8. Stroke or cardiovascular disease 9. Memory-related disease 0. None of the above (but the respondent has been to a health facility) -888. Refuse to answer
	What other diseases/illnesses did [child_name] have?	

	b. In the past 4 weeks, has [child_name] seen the doctor / nurse related to his/her health?	1. Yes 0. No -999. Does not know -888. Refuse to answer
	Questions	**Answer Field**
Knowledge	I am going to ask you 6 True / False questions about air pollution. Please answer True or False. If you do not know the answer, please still answer True or False to the best of your knowledge.	Randomly allocate 6
	The smaller the dust particles are, the worse they are for your health.	
	Air pollution can cause respiratory diseases but not heart disease	
	Air pollution can decrease my children's test scores at school.	
	Indoor air is always safer than outdoor air.	
	Green spaces and trees are effective at absorbing all dangerous pollutants	
	Having lots of plants indoors can absorb most dangerous pollutants	
	More than 50% of air pollution in Jakarta comes from dust and forest fires.	
	Vehicles are a major source of air pollution in Jakarta	
	Air conditioners also removes pollutants from indoor air.	
	Non-HEPA air purifiers are the most efficient at removing the most dangerous indoor pollutants	
	Garbage burning is a source of harmful air pollution in Jakarta	
	Exercising outdoor during high air pollution times makes you more immune against outdoor air pollution	
	Questions	**Answer Field**
Blood Press	Please sit on a chair and keep your back straight	Enumerator check: [ ] Subject is sitting on a chair [ ] Subject is leaning against the back of the chair. If the chair does not have a back, the subject is sitting up straight
	Please put your feet flat on the flood and do not cross your legs	Enumerator check: [ ] Feet are flat on the floor [ ] Legs are not crossed
	Please put your left arm on a flat surface. Keep your upper arm at your heart level	Enumerator check: [ ] Subject's arm is supported [ ] Subject's upper arm is at heart level [ ] Subject is using left arm [ ] Subject does NOT have clothes over the bend of the elbow. If subject does not want to take clothes off that cover the bend, leave this unchecked but proceed with the measurement
	Can I wrap the cuff above the bend of your elbow?	
	Please turn your palm upwards and slightly flex your elbow. Now please wait and remain silent for a minute while the blood pressure machien is working. This will ensure that the measurement is accurate.	
	Enter diastolic pressure	Diastolic pressure should be within likely range of 60-100.
	Enter systolic pressure	Systolic pressure should be wtihin likely range of 90-140 and higher than diastolic pressure.
	Take picture of screen	
	Repeat steps above on right arm	
	Repeat steps above one more time, randomly on either right or left arm	
	Questions	**Answer Field**

Blood Oxyg	Please sit on a chair and keep your back straight	Enumerator check: [ ] Subject is sitting on a chair [ ] Subject is leaning against the back of the chair. If the chair does not have a back, the subject is sitting up straight
	Are you hands warm? If they are not warm, please rub your hands until they are warm	
	Please place your right hand below the level of your heart and relax	
	[Enumerator: you will place the clip on the right middle finger. If they have nail polish, choose any finger on the right hand that does not have nail polish. Otherwise, choose finger on left hand]	
	Now I will place the clip on your [X] finger	
	Now I will start the measurement. We will wait until the reading stops changing. Please do not move while the device is measuring.	
	Enter result of measurement	Must be between 20 and 100
	Take picture of screen	
	Questions	**Answer Field**
HH Controls	In order to better understand how different people think about clean air, I will now ask you some questions about your life. We do not want to invade your privacy and want to remind you that all your answers will be kept strictly confidential.	
	[Enumerator: please do NOT ask this question aloud if possible] What is your gender	
	Can you provide your family ID card, and indicate your month and year of birth?	
	What is the highest level of school you attended?	
	In the last month, are you employed?	
	Would you say that your job is:	1. Fully indoor 2. Mostly indoor 3. Mostly outdoor
	What was your household's total food expenditure in the past 4 weeks (in IDR)?	1. < Rp. 200.000 2. Rp. 200.000 - Rp. 599.999 3. Rp. 600.000 - Rp. 999.999 4. Rp. 1.000.000 - Rp. 1.999.999 5. Rp. 2.000.000 - Rp. 2.999.999 6. Rp. 3.000.000 - Rp. 3.999.999 7. > Rp. 4.000.000
	What was your household's total non-food expenditure in the past month? (in IDR)	1. < Rp. 200.000 2. Rp. 200.000 - Rp. 599.999 3. Rp. 600.000 - Rp. 999.999 4. Rp. 1.000.000 - Rp. 1.999.999 5. Rp. 2.000.000 - Rp. 2.999.999 6. Rp. 3.000.000 - Rp. 3.999.999 7. > Rp. 4.000.000
	What was your household's total income n the past month (in IDR)? This includes cash transfers from the government	1. <Rp 1.000.000 2. Rp 1.000.000 - Rp 2.999.999 3. Rp 3.000.000 - Rp 4.999.999 4. Rp 5.000.000-Rp 7.999.999 5. Rp 8.000.000 - Rp 9.999.999 6. Rp 10.000.000 - Rp12.999.999 7. >13.000.000 -999. Does not know
	In the past 7 days, how many times did you see trash being burned in your neighborhood?	
	How often do you experience drops in your WiFi connection?	1. Rarely, once a month or less 2. Several times a month 3. Several times a week 4. Several times a day 5. I do not have WiFi at home -999. Doesn't know
	Questions	**Answer Field**

Stated WTP	Finally, we are going to ask you a few questions about air purifiers. These questions are hypothetical.	
	Hypothetically, would you be willing to lease an air purifier for two months for Rp 150,000? After 2 months, the purifier would be returned to the air quality company.	1. Yes 0. No -999. Does not know -888. Refuse to answer
	Hypothetically, would you be willing to lease an air purifier for two months for Rp 75,000 ? After 2 months, the purifier would be returned to the air quality company.	1. Yes 0. No -999. Does not know -888. Refuse to answer

	Questions	Answer Field
Child's Bloo	Please sit on a chair and keep your back straight	Enumerator check: [ ] Subject is sitting on a chair [ ] Subject is leaning against the back of the chair. If the chair does not have a back, the subject is sitting up straight
	Please put your feet flat on the flood and do not cross your legs	Enumerator check: [ ] Feet are flat on the floor [ ] Legs are not crossed
	Please put your left arm on a flat surface. Keep your upper arm at your heart level	Enumerator check: [ ] Subject's arm is supported [ ] Subject's upper arm is at heart level [ ] Subject is using left arm [ ] Subject does NOT have clothes over the bend of the elbow. If subject does not want to take clothes off that cover the bend, leave this unchecked but proceed with the measurement
	Can I wrap the cuff above the bend of your elbow?	
	Please turn your palm upwards and slightly flex your elbow. Now please wait and remain silent for a minute while the blood pressure machien is working. This will ensure that the measurement is accurate.	
	Enter diastolic pressure	Diastolic pressure should be within likely range of 60-100.
	Enter systolic pressure	Systolic pressure should be wtihin likely range of 90-140 and higher than diastolic pressure.
	Take picture of screen	
	Repeat steps above on right arm	
	Repeat steps above one more time, randomly on either right or left arm	

	Questions	Answer Field
Child's Bloo	Please sit on a chair and keep your back straight	Enumerator check: [ ] Subject is sitting on a chair [ ] Subject is leaning against the back of the chair. If the chair does not have a back, the subject is sitting up straight
	Are you hands warm? If they are not warm, please rub your hands until they are warm	
	Please place your right hand below the level of your heart and relax	
	[Enumerator: you will place the clip on the right middle finger. If they have nail polish, choose any finger on the right hand that does not have nail polish. Otherwise, choose finger on left hand]	
	Now I will place the clip on your [X] finger	
	Now I will start the measurement. We will wait until the reading stops changing. Please do not move while the device is measuring.	
	Enter result of measurement	Must be between 20 and 100
	Take picture of screen	

	Questions	Answer Field
Cognitive Test - Child	We are going to read a list consisting of 10 words and we would like you to memorize as many as you can. We deliberately ma	
	[Enumerator: probe whether respondent needs more explanation]	
	[Enumerator: Read the list slowly, with interval around 2 seconds between each word]	
	MOUNTAIN. STONE. BLOOD. CORNER. SHOES. LETTER. GIRL.HOUSE. VALLEY. CAR	
		[ ] MOUNTAIN [ ] STONE [ ] BLOOD [ ] CORNER [ ] SHOES [ ] LETTER [ ] GIRL [ ] HOUSE [ ] VALLEY [ ] CAR [ ] None of the above
	[Enumerator: check all words mentioned by the respondent]	[ ] Refuse to answer
	I will read you a number of digits. Afterwards, you repeat them in th	1. Pass 0. Fail
	Let's start with a brief example so you can practice. I will give you th	-888. Refuse to answer
	[Enumerator: did the respondent correctly repeat 7-1-9?]	
	No, you would say 7-1-9. I said 7-1-9, so to say it forwards you would	1. Pass
	7-1-9. Now try these numbers. Remember, you are to say them forw	0. Fail
		-888. Refuse to answer
	[Enumerator: did the respondent correctly repeat 3-4-8?]	
	Ok, now we will start the official exercise. Again, I will give you 3 nun	1. Pass
		0. Fail
	[Enumerator: please pause for 1 second in between each number]	-888. Refuse to answer
	5 - 8 - 2	
		1. Pass 0. Fail
	6 - 9 - 4	-888. Refuse to answer
		1. Pass 0. Fail
	6 - 4 - 3 - 9	-888. Refuse to answer
		1. Pass 0. Fail
	7 - 2 - 8 - 6	-888. Refuse to answer
		1. Pass 0. Fail
	4 - 2 - 7 - 3 - 1	-888. Refuse to answer
		1. Pass 0. Fail
	7 - 5 - 8 - 3 - 6	-888. Refuse to answer
		1. Pass 0. Fail
	6 - 1 - 9 - 4 - 7 - 3	-888. Refuse to answer
		1. Pass 0. Fail
	3 - 9 - 2 - 4 - 8 - 7	-888. Refuse to answer
		1. Pass 0. Fail
	5 - 9 - 1 - 7 - 4 - 2 - 8	-888. Refuse to answer
		1. Pass 0. Fail
	4 - 1 - 7 - 9 - 3 - 8 - 6	-888. Refuse to answer
		1. Pass 0. Fail
	5 - 8 - 1 - 9 - 2 - 6 - 4 - 7	-888. Refuse to answer

	1. Pass 0. Fail
3 - 8 - 2 - 9 - 5 - 1 - 7 - 4	-888. Refuse to answer
	1. Pass 0. Fail
2 - 7 - 5 - 8 - 6 - 2 - 5 - 8 - 4	-888. Refuse to answer
	1. Pass 0. Fail
7 - 1 - 3 - 9 - 4 - 2 - 5 - 6 - 8	-888. Refuse to answer
	1. Pass 0. Fail
2 - 2 - 9 - 8 - 3 - 4 - 5 - 4 - 2 - 1	-888. Refuse to answer
	1. Pass 0. Fail
3 - 1 - 4 - 1 - 2 - 4 - 8 - 9 - 6 - 5	-888. Refuse to answer
We will repeat the exercise from before. I will read you a number of I say 7-1-9, what would you say?	1. Pass 0. Fail -888. Refuse to answer
[Enumerator: did the respondent correctly repeat 9-1-7?]	
No, you would say 9-1-7. I said 7-1-9, so to say it backwards you wou say 9-1-7. Now try these numbers. Remember, you are to say them I	1. Pass 0. Fail -888. Refuse to answer
[Enumerator: did the respondent correctly repeat 8-4-3?]	
Ok, now we will start the official exercise. Again, I will start with 3 nu	1. Pass 0. Fail
6 - 2 - 9	-888. Refuse to answer
	1. Pass 0. Fail
4 - 1 - 5	-888. Refuse to answer
	1. Pass 0. Fail
3 - 2 - 7 - 9	-888. Refuse to answer
	1. Pass 0. Fail
4 - 9 - 6 - 8	-888. Refuse to answer
	1. Pass 0. Fail
1 - 5 - 2 - 8 - 6	-888. Refuse to answer
	1. Pass 0. Fail
6 - 1 - 8 - 4 - 3	-888. Refuse to answer
	1. Pass 0. Fail
5 - 3 - 9 - 4 - 1 - 8	-888. Refuse to answer
	1. Pass 0. Fail
7 - 2 - 4 - 8 - 5 - 6	-888. Refuse to answer
	1. Pass 0. Fail
8 - 1 - 2 - 9 - 3 - 6 - 5	-888. Refuse to answer
	1. Pass 0. Fail
4 - 7 - 3 - 9 - 1 - 2 - 8	-888. Refuse to answer
	1. Pass 0. Fail
9 - 4 - 3 - 7 - 6 - 2 - 5 - 8	-888. Refuse to answer
	1. Pass 0. Fail
7 - 2 - 8 - 1 - 9 - 6 - 5 - 3	-888. Refuse to answer
	1. Pass 0. Fail
8 - 2 - 3 - 7 - 5 - 3 - 9 - 2 - 1	-888. Refuse to answer

1. Pass
0. Fail
-888. Refuse to answer

3 - 7 - 5 - 4 - 9 - 8 - 2 - 6 - 5

Let's try some subtraction of numbers now. What is 100 minus 7 equal to?

and minus 7 from that?

and minus 7 from that?

and minus 7 from that?

and minus 7 from that?

A short while ago, we read a list of words to you and you have tried t
[Enumerator: check all words mentioned by the respondent]

[ ] MOUNTAIN
[ ] STONE
[ ] BLOOD
[ ] CORNER
[ ] SHOES
[ ] LETTER
[ ] GIRL
[ ] HOUSE
[ ] VALLEY
[ ] CAR
[ ] None of the above
[ ] Refuse to answer

BDM Script

SECTION 1: PRACTICE TIOLI WITH [item1]

Households are randomly assigned into one of the following two groups:

Group 1: item1 = soap item2 = lotion

Group 2: item1 = lotion item2 = soap

Each household is also randomly assigned a price for the TIOLI item [pracprice1] and a price for the BDM item [pracprice2].

READ

> We will first give you the opportunity to buy a lotion and a soap. After that, we will sell the air purifier. You will not have to spend any more for these items than you want to. If you decide you want to buy the lotion or soap, you will need to pay us on the spot, and we will give you the good.
>
> Do you have any questions?

Pause to take any questions.

Show the [item1] to the respondent

READ

> Let's start with [item1]. Would you like to buy this [item1] for Rp [pracprice1]? If you say 'yes', you will pay [pracprice1] and receive the [item1]. If you say 'no', you will not receive it and not pay anything.
>
> Would you like to buy this item?

Record the response. If the participant responded "yes" to purchasing [item1], hand over [item1].

SECTION 2: PRACTICE BDM WITH [item2]

Please take 1 blank piece of paper that says: PRICE: RP _____

WITHOUT SHOWING THE RESPONDENT, WRITE DOWN THE PRICE ON THE PIECE OF PAPER: [pracprice2].

FOLD THE PAPER CLOSED. WRITE DOWN "[item2]" on the OUTSIDE. Then, put the FOLDED paper on the table. Just to confirm, please write down the price that you just wrote on the piece of paper: _____

READ

> The process for buying the [item2] and the air purifier today will be a little bit different from [item1]. Before we play for the purifier, we will practice with [item2].
>
> First, you and I will figure out the highest price that you are willing to pay. Then, we will together open a secret piece of paper to look at the price. If the secret price is higher than what you said you are willing to

pay, then you will NOT be able to buy [item2] from us today. If you named a price that was the same or higher as the price that is on the paper, then you will be able to purchase [item2] from us today. You would then pay the price written on the piece of paper. This may be even lower than the price you chose! You will not have to pay anything more than you want to.

Since this is complicated, we will first make a plan for which price you would like to pay. I will ask you whether you would be willing to pay several prices and you will tell me "yes" or "no" for each price. After we are done, you will not be able to change your plan. You will only be able to buy the [item2] if you are willing to pay more than the secret price.

This offer is available for today only. If you do not get [item2] today, you will not be able to get it tomorrow. Do you understand?

If the respondent does not understand, please re-explain or answer their questions].

READ

This offer is for your household only. This offer cannot be used by anyone else.

Show the [item2] to the respondent

READ

Let's start by doing a practice exercise for this [item2]. The price of this good is written on this piece of paper

SHOW THE FOLDED PIECE OF PAPER BUT KEEP IT CLOSED

READ

Afterwards, we will do the same for the air purifier. We will use a different secret price for the air purifier. Do you have any questions?

Note: For this next section, the quantity in each question depends on the answer immediately prior. If the prior answer is “no”, the subsequent price will be lower. If the prior answer is “yes”, the subsequent price will be higher. This process proceeds with a binary search.

READ

If the price was 75 Rp, would you want to buy the [item2]?

If the price was [prac_x1] Rp, would you want to buy it?

If the price was [prac_x2] Rp, would you want to buy it?

If the price was [prac_x3] Rp, would you want to buy it?

If the price was [prac_x4] Rp, would you want to buy it?

If the price was [prac_x5] Rp, would you want to buy it?

If the price was [prac_x6] Rp, would you want to buy it?

Record respondent's final bid, [prac_wtp1].

Confirmation section

READ

So the most you are willing to pay to buy the [item2] is [prac_wtp1]?

So how much is the most you are willing to pay?

Just to make sure you understand, what happens if the price ends up being [prac_wtp1_p5]?

[If not correct:]

READ

This is not correct! If you are willing to pay [prac_wtp1] and the price turns out to be [prac_wtp1_p5] then you would NOT be able to buy the air purifier from us! You previously said that you were not willing to pay [prac_wtp1_p5]. Do you understand?

And what happens if the price ends up being [prac_wtp1_m5]?

[If not correct:]

READ

This is not correct! If you are willing to pay [prac_wtp1] and the price turns out to be [prac_wtp1_m5] then you SHOULD buy the [item2] from us! You previously said that you were willing to pay [prac_wtp1_m5]. Do you understand?

Just to double check, if the price ends up being [prac_wtp1_p5], would you want to buy the [item2] for [prac_wtp1_p5]?

[If yes:]

READ

So the most you are willing to pay to buy the [item2] is [prac_wtp2]?

[If no:]

READ

So how much is the most you are willing to pay?

READ

Just to make sure you understand, what happens if the price ends up

being [prac_wtp2_p5]?

Note: the Confirmation Section can happen up to 4 times. If the respondent still changes their mind, the field officer will start again from the beginning.

READ

Great! So the final highest price you will pay is [prac_finwtp]. We have figured out that the maximum amount that you are willing to pay for the [item2] is [prac_finwtp] Rp. We will now open the piece of paper to see the price.

Give the respondent the piece of paper and ask them to read the number.

[If win:]

READ

Congratulations! The price is [pracprice2] Rp which is less than you said you were willing to spend ([prac_finwtp] Rp).You may have this [item2] after you pay [pracprice2] Rp right now.

DO NOT LET THE RESPONDENT CHANGE THEIR MIND AT THIS POINT!!!

[If lose:]

READ

Unfortunately, the price is [pracprice2] Rp which is more than you said you were willing to spend ([prac_finwtp] Rp). You will not be able to buy the [item2] today.

DO NOT LET THE RESPONDENT CHANGE THEIR MIND AT THIS POINT!!!

READ

Do you have any questions?

Did the respondent want to change their mind? Did the respondent argue? What was the respondent's argument?

Section 3: ACTUAL BDM WITH AIR PURIFIER

PLACE THE AIR PURIFIER PRICE SCRATCH CARDIN FRONT OF YOU. KEEP IT CLOSED.

READ

We are now going to use the same method that we used for the [item2] to see what price you would like to pay for buying the air purifier. The secret price of the air purifier for you is inside this envelope. I do not know what the price is. It was randomly chosen using a computer by one of my colleagues. As you can see, the scratch card is new. The price may be lower than the price in the stores!

The price inside this envelope was selected by a random lottery. This means that every participant in our study has a different price inside their envelope, and the prices were selected by random chance. Therefore, the price inside your scratchcard will be DIFFERENT from the prices that are written inside the scratchcard of other people who also participate in the study. Everybody has a different price.

Remember: - If the price on the scratchcard is higher than the most you said you were willing to pay, then you will NOT be able to buy the air purifier today. You cannot change your mind later, and you cannot get another chance tomorrow. This offer is for today only, and it is for you only. - If you are willing to pay the amount in the envelope, then you SHOULD buy the air purifier from us today. In practice, this means that we will use the [remaining compensation from the study], and we will ask you to pay directly for the remaining amount, if the total price is greater than [remaining compensation from the study]. You SHOULD then pay the price that is in the envelope TODAY.

To purchase the air purifier, you will need to have the money to pay us via GoPay TODAY. We understand that if we came back in one week, perhaps you will have more money available. For now, we would like you to just think only about the cash that you have available RIGHT NOW, to spend on GoPay. Only think of the money that you have that you can use to buy the air purifier TODAY.

Give respondent some time to think.

READ

We are not affiliated with the air purifier company and to us it does not matter whether you would like to buy the air purifier or not. We are not sales people: we are researchers and we are just trying to learn about people like you. If you do not want to buy the air purifier today, or if you think the price is too high, that is okay. It does not matter to us whether you buy the air purifier or not.

We will do our best to keep all our answers completely confidential. We will not share your name or individual information with anyone, and none of your neighbors, family, or friends will ever be able to see your answers. When you are answering the questions, please answer honestly. We are simply trying to learn from the people we are interviewing.

There is no such thing as "too low" or "too high", and there are no right or wrong answers. Throughout this process, you will be able to look at this screen to see the different prices.

Do you have any other questions? Let's begin.

Decision Section

READ

If the price of the air purifier is [x0] Rp would you want to buy it? Select yes or no:

Note: The Decision Section is repeated 12 times, until the respondent has stated their WTP to the nearest 1 Rp.

Confirmation section

[If yes:]

READ

So the most you would be willing to pay for the air purifier is [wtp1]?

[If no:]

READ

So how much is the most you are willing to pay?

For confirmation:

READ

Just to make sure you understand, what happens if the price ends up being [wtp1_p5]?

[If incorrect:]

READ

This is not correct! If you are willing to pay [wtp1] and the price turns out to be [wtp1_p5] then you would NOT be able to buy the air purifier from us! You previously said that you were not willing to pay [wtp1_p5]. Do you understand?

For confirmation:

READ

And what happens if the price ends up being [wtp1_m5]?

[If incorrect:]

READ

This is not correct! If you are willing to pay [wtp1] and the price turns out to be [wtp1_m5] then you SHOULD buy the air purifier from us for [wtp1_m5]. Do you understand?

Note: the Confirmation Section can happen up to 4 times. If the respondent still changes their mind or does not understand, the field officer will start again from the beginning.

READ

We have figured out that the maximum amount that you are willing to pay for the air purifier is [finwtp]. We will now open the envelope to see the price. Remember, if the price on the envelope is higher than [finwtp], then you will NOT be able to buy the air purifier today. If the price is less than or the same as [finwtp], you SHOULD buy the air purifier today. You will pay the price in the envelope.

Just to make sure you understand, if the price ends up being [finwtp], do you agree to buy the air purifier and pay [finwtp]?

[If no:] The respondent does not understand! Please repeat the rules again.]

READ

And what happens if the price ends up being [checkFinal]?

[If incorrect:] The respondent does not understand! Please repeat the rules again. If they change their mind, that is okay. Please go back and re-do the BDM BEFORE they scratch the scratchcard.

Outcome Section

Please give the respondent the scratchcard and ask them to scratch and read the price.

[If lose:] FO: DO NOT LET THE HOUSEHOLD PURCHASE THE AIR PURIFIER

READ

Unfortunately the price (Rp [price]) is higher than you are willing to pay (Rp [finwtp]). You will not be able to purchase the air purifier today. You may still buy an air purifier at the regular price of Rp 2,990 in major supermarkets.

FO: Did the respondent argue when they found out they could not buy the air purifier?

[If win:]

READ

Congratulations! The price is less than you are willing to pay. You may now purchase the air purifier for [price].

```
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\@tempa=\box91
\@tempa=\box92
\@tempa=\box93
\@tempa=\box94
\@tempa=\box95
\@tempa=\box96
\@tempa=\box97
\@tempa=\box98
\@tempa=\box99
\c@minrows=\count294
\c@columnbadness=\count295
\c@finalcolumnbadness=\count296
\last@try=\dimen187
\multicolovershoot=\dimen188
\multicolundershoot=\dimen189
\mult@nat@firstbox=\box100
\colbreak@box=\box101
\mc@col@check@num=\count297
) (c:/texlive/2023/texmf-dist/tex/latex/listings/listings.sty
\lst@mode=\count298
\lst@gtempboxa=\box102
\lst@token=\toks33
\lst@length=\count299
\lst@currlwidth=\dimen190
```

```
\lst@column=\count300
\lst@pos=\count301
\lst@lostspace=\dimen191
\lst@width=\dimen192
\lst@newlines=\count302
\lst@lineno=\count303
\lst@maxwidth=\dimen193
(c:/texlive/2023/texmf-dist/tex/latex/listings/lstpatch.sty
File: lstpatch.sty 2024/02/21 1.10 (Carsten Heinz)
) (c:/texlive/2023/texmf-dist/tex/latex/listings/lstmisc.sty
File: lstmisc.sty 2024/02/21 1.10 (Carsten Heinz)
\c@lstnumber=\count304
\lst@skipnumbers=\count305
\lst@framebox=\box103
) (c:/texlive/2023/texmf-dist/tex/latex/listings/listings.cfg
File: listings.cfg 2024/02/21 1.10 listings configuration
))
Package: listings 2024/02/21 1.10 (Carsten Heinz)
(c:/texlive/2023/texmf-dist/tex/latex/tools/longtable.sty
Package: longtable 2023-11-01 v4.19 Multi-page Table package (DPC)
\LTleft=\skip65
\LTright=\skip66
\LTpre=\skip67
\LTpost=\skip68
\LTchunksize=\count306
\LTcapwidth=\dimen194
\LT@head=\box104
\LT@firsthead=\box105
\LT@foot=\box106
\LT@lastfoot=\box107
\LT@gbox=\box108
\LT@cols=\count307
\LT@rows=\count308
\c@LT@tables=\count309
\c@LT@chunks=\count310
\LT@p@ftn=\toks34
) (c:/texlive/2023/texmf-dist/tex/latex/threeparttable/threeparttable.sty
Package: threeparttable 2003/06/13  v 3.0
\@tempboxb=\box109
) (c:/texlive/2023/texmf-dist/tex/latex/caption/subcaption.sty
Package: subcaption 2023/07/28 v1.6b Sub-captions (AR)
Package caption Info: New subtype `subfigure' on input line 238.
\c@subfigure=\count311
Package caption Info: New subtype `subtable' on input line 238.
\c@subtable=\count312
) (c:/texlive/2023/texmf-dist/tex/latex/float/float.sty
Package: float 2001/11/08 v1.3d Float enhancements (AL)
\c@float@type=\count313
\float@exts=\toks35
\float@box=\box110
\@float@everytoks=\toks36
\@floatcapt=\box111
) (c:/texlive/2023/texmf-dist/tex/latex/pgf/utilities/pgfpages.sty
Package: pgfpages 2011/01/05 ver 0.02
```

```
(c:/texlive/2023/texmf-dist/tex/latex/pgf/basiclayer/pgfcore.sty
(c:/texlive/20
23/texmf-dist/tex/latex/pgf/systemlayer/pgfsys.sty
(c:/texlive/2023/texmf-dist/
tex/latex/pgf/utilities/pgfrcs.sty (c:/texlive/2023/texmf-
dist/tex/generic/pgf/
utilities/pgfutil-common.tex
\pgfutil@everybye=\toks37
\pgfutil@tempdima=\dimen195
\pgfutil@tempdimb=\dimen196
) (c:/texlive/2023/texmf-dist/tex/generic/pgf/utilities/pgfutil-latex.def
\pgfutil@abb=\box112
) (c:/texlive/2023/texmf-dist/tex/generic/pgf/utilities/pgfrcs.code.tex
(c:/tex
live/2023/texmf-dist/tex/generic/pgf/pgf.revision.tex)
Package: pgfrcs 2023-01-15 v3.1.10 (3.1.10)
)) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/systemlayer/pgfsys.code.tex
Package: pgfsys 2023-01-15 v3.1.10 (3.1.10)
(c:/texlive/2023/texmf-dist/tex/generic/pgf/utilities/pgfkeys.code.tex
\pgfkeys@pathtoks=\toks38
\pgfkeys@temptoks=\toks39

(c:/texlive/2023/texmf-
dist/tex/generic/pgf/utilities/pgfkeyslibraryfiltered.co
de.tex
\pgfkeys@tmptoks=\toks40
))
\pgf@x=\dimen197
\pgf@y=\dimen198
\pgf@xa=\dimen199
\pgf@ya=\dimen256
\pgf@xb=\dimen257
\pgf@yb=\dimen258
\pgf@xc=\dimen259
\pgf@yc=\dimen260
\pgf@xd=\dimen261
\pgf@yd=\dimen262
\w@pgf@writea=\write3
\r@pgf@reada=\read2
\c@pgf@counta=\count314
\c@pgf@countb=\count315
\c@pgf@countc=\count316
\c@pgf@countd=\count317
\t@pgf@toka=\toks41
\t@pgf@tokb=\toks42
\t@pgf@tokc=\toks43
\pgf@sys@id@count=\count318
(c:/texlive/2023/texmf-dist/tex/generic/pgf/systemlayer/pgf.cfg
File: pgf.cfg 2023-01-15 v3.1.10 (3.1.10)
)
Driver file for pgf: pgfsys-pdftex.def
(c:/texlive/2023/texmf-dist/tex/generic/pgf/systemlayer/pgfsys-pdftex.def
File: pgfsys-pdftex.def 2023-01-15 v3.1.10 (3.1.10)
```

```
(c:/texlive/2023/texmf-dist/tex/generic/pgf/systemlayer/pgfsys-common-
pdf.def
File: pgfsys-common-pdf.def 2023-01-15 v3.1.10 (3.1.10)
)))
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/systemlayer/pgfsyssoftpath.code.tex
File: pgfsyssoftpath.code.tex 2023-01-15 v3.1.10 (3.1.10)
\pgfsyssoftpath@smallbuffer@items=\count319
\pgfsyssoftpath@bigbuffer@items=\count320
)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/systemlayer/pgfsysprotocol.code.tex
File: pgfsysprotocol.code.tex 2023-01-15 v3.1.10 (3.1.10)
)) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcore.code.tex
Package: pgfcore 2023-01-15 v3.1.10 (3.1.10)
(c:/texlive/2023/texmf-dist/tex/generic/pgf/math/pgfmath.code.tex
(c:/texlive/2
023/texmf-dist/tex/generic/pgf/math/pgfmathutil.code.tex)
(c:/texlive/2023/texm
f-dist/tex/generic/pgf/math/pgfmathparser.code.tex
\pgfmath@dimen=\dimen263
\pgfmath@count=\count321
\pgfmath@box=\box113
\pgfmath@toks=\toks44
\pgfmath@stack@operand=\toks45
\pgfmath@stack@operation=\toks46
) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/math/pgfmathfunctions.code.tex)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/math/pgfmathfunctions.basic.code.te
x)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/math/pgfmathfunctions.trigonometric
.code.tex)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/math/pgfmathfunctions.random.code.t
ex)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/math/pgfmathfunctions.comparison.co
de.tex)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/math/pgfmathfunctions.base.code.tex
)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/math/pgfmathfunctions.round.code.te
x)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/math/pgfmathfunctions.misc.code.tex
)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/math/pgfmathfunctions.integerarithm
etics.code.tex) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/math/pgfmathcalc.co
```

```
de.tex) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/math/pgfmathfloat.code.tex
\c@pgfmathroundto@lastzeros=\count322
)) (c:/texlive/2023/texmf-dist/tex/generic/pgf/math/pgfint.code.tex)
(c:/texliv
e/2023/texmf-dist/tex/generic/pgf/basiclayer/pgfcorepoints.code.tex
File: pgfcorepoints.code.tex 2023-01-15 v3.1.10 (3.1.10)
\pgf@picminx=\dimen264
\pgf@picmaxx=\dimen265
\pgf@picminy=\dimen266
\pgf@picmaxy=\dimen267
\pgf@pathminx=\dimen268
\pgf@pathmaxx=\dimen269
\pgf@pathminy=\dimen270
\pgf@pathmaxy=\dimen271
\pgf@xx=\dimen272
\pgf@xy=\dimen273
\pgf@yx=\dimen274
\pgf@yy=\dimen275
\pgf@zx=\dimen276
\pgf@zy=\dimen277
)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcorepathconstruct.cod
e.tex
File: pgfcorepathconstruct.code.tex 2023-01-15 v3.1.10 (3.1.10)
\pgf@path@lastx=\dimen278
\pgf@path@lasty=\dimen279
)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcorepathusage.code.te
x
File: pgfcorepathusage.code.tex 2023-01-15 v3.1.10 (3.1.10)
\pgf@shorten@end@additional=\dimen280
\pgf@shorten@start@additional=\dimen281
) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcorescopes.code.tex
File: pgfcorescopes.code.tex 2023-01-15 v3.1.10 (3.1.10)
\pgfpic=\box114
\pgf@hbox=\box115
\pgf@layerbox@main=\box116
\pgf@picture@serial@count=\count323
)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcoregraphicstate.code
.tex
File: pgfcoregraphicstate.code.tex 2023-01-15 v3.1.10 (3.1.10)
\pgflinewidth=\dimen282
)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcoretransformations.c
ode.tex
File: pgfcoretransformations.code.tex 2023-01-15 v3.1.10 (3.1.10)
\pgf@pt@x=\dimen283
```

```
\pgf@pt@y=\dimen284
\pgf@pt@temp=\dimen285
) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcorequick.code.tex
File: pgfcorequick.code.tex 2023-01-15 v3.1.10 (3.1.10)
) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcoreobjects.code.te
x
File: pgfcoreobjects.code.tex 2023-01-15 v3.1.10 (3.1.10)
)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcorepathprocessing.co
de.tex
File: pgfcorepathprocessing.code.tex 2023-01-15 v3.1.10 (3.1.10)
) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcorearrows.code.tex
File: pgfcorearrows.code.tex 2023-01-15 v3.1.10 (3.1.10)
\pgfarrowsep=\dimen286
) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcoreshade.code.tex
File: pgfcoreshade.code.tex 2023-01-15 v3.1.10 (3.1.10)
\pgf@max=\dimen287
\pgf@sys@shading@range@num=\count324
\pgf@shadingcount=\count325
) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcoreimage.code.tex
File: pgfcoreimage.code.tex 2023-01-15 v3.1.10 (3.1.10)
)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcoreexternal.code.tex
File: pgfcoreexternal.code.tex 2023-01-15 v3.1.10 (3.1.10)
\pgfexternal@startupbox=\box117
) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcorelayers.code.tex
File: pgfcorelayers.code.tex 2023-01-15 v3.1.10 (3.1.10)
)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcoretransparency.code
.tex
File: pgfcoretransparency.code.tex 2023-01-15 v3.1.10 (3.1.10)
)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcorepatterns.code.tex
File: pgfcorepatterns.code.tex 2023-01-15 v3.1.10 (3.1.10)
) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/basiclayer/pgfcorerdf.code.tex
File: pgfcorerdf.code.tex 2023-01-15 v3.1.10 (3.1.10)
)))
\pgf@logicalpages=\count326
\pgf@firstshipout=\count327
\pgf@lastshipout=\count328
\pgf@currentshipout=\count329
\pgf@cpn=\count330
\pgf@shipoutnextto=\count331
```

```
\pgfphysicalheight=\dimen288
\pgfphysicalwidth=\dimen289
\pgfpages@shipoutbox=\box118
) (c:/texlive/2023/texmf-dist/tex/latex/pgf/frontendlayer/tikz.sty
(c:/texlive/
2023/texmf-dist/tex/latex/pgf/basiclayer/pgf.sty
Package: pgf 2023-01-15 v3.1.10 (3.1.10)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/modules/pgfmoduleshapes.code.tex
File: pgfmoduleshapes.code.tex 2023-01-15 v3.1.10 (3.1.10)
\pgfnodeparttextbox=\box119
) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/modules/pgfmoduleplot.code.tex
File: pgfmoduleplot.code.tex 2023-01-15 v3.1.10 (3.1.10)
)
(c:/texlive/2023/texmf-dist/tex/latex/pgf/compatibility/pgfcomp-version-
0-65.st
y
Package: pgfcomp-version-0-65 2023-01-15 v3.1.10 (3.1.10)
\pgf@nodesepstart=\dimen290
\pgf@nodesepend=\dimen291
)
(c:/texlive/2023/texmf-dist/tex/latex/pgf/compatibility/pgfcomp-version-
1-18.st
y
Package: pgfcomp-version-1-18 2023-01-15 v3.1.10 (3.1.10)
)) (c:/texlive/2023/texmf-dist/tex/latex/pgf/utilities/pgffor.sty
(c:/texlive/2
023/texmf-dist/tex/latex/pgf/utilities/pgfkeys.sty
(c:/texlive/2023/texmf-dist/
tex/generic/pgf/utilities/pgfkeys.code.tex)) (c:/texlive/2023/texmf-
dist/tex/la
tex/pgf/math/pgfmath.sty (c:/texlive/2023/texmf-
dist/tex/generic/pgf/math/pgfma
th.code.tex)) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/utilities/pgffor.code
.tex
Package: pgffor 2023-01-15 v3.1.10 (3.1.10)
\pgffor@iter=\dimen292
\pgffor@skip=\dimen293
\pgffor@stack=\toks47
\pgffor@toks=\toks48
)) (c:/texlive/2023/texmf-
dist/tex/generic/pgf/frontendlayer/tikz/tikz.code.tex
Package: tikz 2023-01-15 v3.1.10 (3.1.10)

(c:/texlive/2023/texmf-
dist/tex/generic/pgf/libraries/pgflibraryplothandlers.co
de.tex
File: pgflibraryplothandlers.code.tex 2023-01-15 v3.1.10 (3.1.10)
\pgf@plot@mark@count=\count332
\pgfplotmarksize=\dimen294
)
\tikz@lastx=\dimen295
```

```
\tikz@lasty=\dimen296
\tikz@lastxsaved=\dimen297
\tikz@lastysaved=\dimen298
\tikz@lastmovetox=\dimen299
\tikz@lastmovetoy=\dimen300
\tikzleveldistance=\dimen301
\tikzsiblingdistance=\dimen302
\tikz@figbox=\box120
\tikz@figbox@bg=\box121
\tikz@tempbox=\box122
\tikz@tempbox@bg=\box123
\tikztreelevel=\count333
\tikznumberofchildren=\count334
\tikznumberofcurrentchild=\count335
\tikz@fig@count=\count336
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/modules/pgfmodulematrix.code.tex
File: pgfmodulematrix.code.tex 2023-01-15 v3.1.10 (3.1.10)
\pgfmatrixcurrentrow=\count337
\pgfmatrixcurrentcolumn=\count338
\pgf@matrix@numberofcolumns=\count339
)
\tikz@expandcount=\count340

(c:/texlive/2023/texmf-
dist/tex/generic/pgf/frontendlayer/tikz/libraries/tikzli
brarytopaths.code.tex
File: tikzlibrarytopaths.code.tex 2023-01-15 v3.1.10 (3.1.10)
))) (c:/texlive/2023/texmf-dist/tex/latex/adjustbox/adjustbox.sty
Package: adjustbox 2022/10/17 v1.3a Adjusting TeX boxes (trim, clip, ...)
(c:/texlive/2023/texmf-dist/tex/latex/xkeyval/xkeyval.sty
Package: xkeyval 2022/06/16 v2.9 package option processing (HA)
(c:/texlive/2023/texmf-dist/tex/generic/xkeyval/xkeyval.tex
(c:/texlive/2023/te
xmf-dist/tex/generic/xkeyval/xkvutils.tex
\XKV@toks=\toks49
\XKV@tempa@toks=\toks50
)
\XKV@depth=\count341
File: xkeyval.tex 2014/12/03 v2.7a key=value parser (HA)
)) (c:/texlive/2023/texmf-dist/tex/latex/adjustbox/adjcalc.sty
Package: adjcalc 2012/05/16 v1.1 Provides advanced setlength with
multiple back
-ends (calc, etex, pgfmath)
) (c:/texlive/2023/texmf-dist/tex/latex/adjustbox/trimclip.sty
Package: trimclip 2020/08/19 v1.2 Trim and clip general TeX material
(c:/texlive/2023/texmf-dist/tex/latex/collectbox/collectbox.sty
Package: collectbox 2022/10/17 v0.4c Collect macro arguments as boxes
\collectedbox=\box124
)
\tc@llx=\dimen303
\tc@lly=\dimen304
\tc@urx=\dimen305
\tc@ury=\dimen306
```

```
Package trimclip Info: Using driver 'tc-pdftex.def'.
(c:/texlive/2023/texmf-dist/tex/latex/adjustbox/tc-pdftex.def
File: tc-pdftex.def 2019/01/04 v2.2 Clipping driver for pdftex
))
\adjbox@Width=\dimen307
\adjbox@Height=\dimen308
\adjbox@Depth=\dimen309
\adjbox@Totalheight=\dimen310
\adjbox@pwidth=\dimen311
\adjbox@pheight=\dimen312
\adjbox@pdepth=\dimen313
\adjbox@ptotalheight=\dimen314
(c:/texlive/2023/texmf-dist/tex/latex/ifoddpage/ifoddpage.sty
Package: ifoddpage 2022/10/18 v1.2 Conditionals for odd/even page
detection
\c@checkoddpage=\count342
) (c:/texlive/2023/texmf-dist/tex/latex/varwidth/varwidth.sty
Package: varwidth 2009/03/30 ver 0.92;  Variable-width minipages
\@vwid@box=\box125
\sift@deathcycles=\count343
\@vwid@loff=\dimen315
\@vwid@roff=\dimen316
)) (c:/texlive/2023/texmf-dist/tex/latex/enumitem/enumitem.sty
Package: enumitem 2019/06/20 v3.9 Customized lists
\labelindent=\skip69
\enit@outerparindent=\dimen317
\enit@toks=\toks51
\enit@inbox=\box126
\enit@count@id=\count344
\enitdp@description=\count345
) (c:/texlive/2023/texmf-dist/tex/latex/appendix/appendix.sty
Package: appendix 2020/02/08 v1.2c extra appendix facilities
\c@@pps=\count346
\c@@ppsavesec=\count347
\c@@ppsaveapp=\count348
) (c:/texlive/2023/texmf-dist/tex/latex/doublestroke/dsfont.sty
Package: dsfont 1995/08/01 v0.1 Double stroke roman fonts
) (c:/texlive/2023/texmf-dist/tex/latex/natbib/natbib.sty
Package: natbib 2010/09/13 8.31b (PWD, AO)
\bibhang=\skip70
\bibsep=\skip71
LaTeX Info: Redefining \cite on input line 694.
\c@NAT@ctr=\count349
) (c:/texlive/2023/texmf-dist/tex/latex/hyperref/hyperref.sty
Package: hyperref 2024-01-20 v7.01h Hypertext links for LaTeX
(c:/texlive/2023/texmf-dist/tex/latex/kvsetkeys/kvsetkeys.sty
Package: kvsetkeys 2022-10-05 v1.19 Key value parser (HO)
) (c:/texlive/2023/texmf-dist/tex/generic/kvdefinekeys/kvdefinekeys.sty
Package: kvdefinekeys 2019-12-19 v1.6 Define keys (HO)
) (c:/texlive/2023/texmf-dist/tex/generic/pdfescape/pdfescape.sty
Package: pdfescape 2019/12/09 v1.15 Implements pdfTeX's escape features
(HO)
(c:/texlive/2023/texmf-dist/tex/generic/ltxcmds/ltxcmds.sty
```

```
Package: ltxcmds 2023-12-04 v1.26 LaTeX kernel commands for general use
(HO)
) (c:/texlive/2023/texmf-dist/tex/generic/pdftexcmds/pdftexcmds.sty
Package: pdftexcmds 2020-06-27 v0.33 Utility functions of pdfTeX for
LuaTeX (HO
)
(c:/texlive/2023/texmf-dist/tex/generic/infwarerr/infwarerr.sty
Package: infwarerr 2019/12/03 v1.5 Providing info/warning/error messages
(HO)
)
Package pdftexcmds Info: \pdf@primitive is available.
Package pdftexcmds Info: \pdf@ifprimitive is available.
Package pdftexcmds Info: \pdfdraftmode found.
)) (c:/texlive/2023/texmf-dist/tex/latex/hycolor/hycolor.sty
Package: hycolor 2020-01-27 v1.10 Color options for hyperref/bookmark
(HO)
) (c:/texlive/2023/texmf-dist/tex/latex/auxhook/auxhook.sty
Package: auxhook 2019-12-17 v1.6 Hooks for auxiliary files (HO)
) (c:/texlive/2023/texmf-dist/tex/latex/hyperref/nameref.sty
Package: nameref 2023-11-26 v2.56 Cross-referencing by name of section
(c:/texlive/2023/texmf-dist/tex/latex/refcount/refcount.sty
Package: refcount 2019/12/15 v3.6 Data extraction from label references
(HO)
) (c:/texlive/2023/texmf-
dist/tex/generic/gettitlestring/gettitlestring.sty
Package: gettitlestring 2019/12/15 v1.6 Cleanup title references (HO)
(c:/texlive/2023/texmf-dist/tex/latex/kvoptions/kvoptions.sty
Package: kvoptions 2022-06-15 v3.15 Key value format for package options
(HO)
))
\c@section@level=\count350
) (c:/texlive/2023/texmf-dist/tex/latex/etoolbox/etoolbox.sty
Package: etoolbox 2020/10/05 v2.5k e-TeX tools for LaTeX (JAW)
\etb@tempcnta=\count351
)
\@linkdim=\dimen318
\Hy@linkcounter=\count352
\Hy@pagecounter=\count353
(c:/texlive/2023/texmf-dist/tex/latex/hyperref/pd1enc.def
File: pd1enc.def 2024-01-20 v7.01h Hyperref: PDFDocEncoding definition
(HO)
Now handling font encoding PD1 ...
... no UTF-8 mapping file for font encoding PD1
) (c:/texlive/2023/texmf-dist/tex/generic/intcalc/intcalc.sty
Package: intcalc 2019/12/15 v1.3 Expandable calculations with integers
(HO)
)
\Hy@SavedSpaceFactor=\count354
(c:/texlive/2023/texmf-dist/tex/latex/hyperref/puenc.def
File: puenc.def 2024-01-20 v7.01h Hyperref: PDF Unicode definition (HO)
Now handling font encoding PU ...
... no UTF-8 mapping file for font encoding PU
)
Package hyperref Info: Hyper figures OFF on input line 4179.
```

```
Package hyperref Info: Link nesting OFF on input line 4184.
Package hyperref Info: Hyper index ON on input line 4187.
Package hyperref Info: Plain pages OFF on input line 4194.
Package hyperref Info: Backreferencing OFF on input line 4199.
Package hyperref Info: Implicit mode ON; LaTeX internals redefined.
Package hyperref Info: Bookmarks ON on input line 4446.
\c@Hy@tempcnt=\count355
LaTeX Info: Redefining \url on input line 4784.
\XeTeXLinkMargin=\dimen319
(c:/texlive/2023/texmf-dist/tex/generic/bitset/bitset.sty
Package: bitset 2019/12/09 v1.3 Handle bit-vector datatype (HO)
(c:/texlive/2023/texmf-dist/tex/generic/bigintcalc/bigintcalc.sty
Package: bigintcalc 2019/12/15 v1.5 Expandable calculations on big
integers (HO
)
))
\Fld@menulength=\count356
\Field@Width=\dimen320
\Fld@charsize=\dimen321
Package hyperref Info: Hyper figures OFF on input line 6063.
Package hyperref Info: Link nesting OFF on input line 6068.
Package hyperref Info: Hyper index ON on input line 6071.
Package hyperref Info: backreferencing OFF on input line 6078.
Package hyperref Info: Link coloring OFF on input line 6083.
Package hyperref Info: Link coloring with OCG OFF on input line 6088.
Package hyperref Info: PDF/A mode OFF on input line 6093.
(c:/texlive/2023/texmf-dist/tex/latex/base/atbegshi-ltx.sty
Package: atbegshi-ltx 2021/01/10 v1.0c Emulation of the original atbegshi
package with kernel methods
)
\Hy@abspage=\count357
\c@Item=\count358
\c@Hfootnote=\count359
)
Package hyperref Info: Driver (autodetected): hpdftex.
(c:/texlive/2023/texmf-dist/tex/latex/hyperref/hpdftex.def
File: hpdftex.def 2024-01-20 v7.01h Hyperref driver for pdfTeX
(c:/texlive/2023/texmf-dist/tex/latex/base/atveryend-ltx.sty
Package: atveryend-ltx 2020/08/19 v1.0a Emulation of the original
atveryend pac
kage
with kernel methods
)
\Fld@listcount=\count360
\c@bookmark@seq@number=\count361
(c:/texlive/2023/texmf-dist/tex/latex/rerunfilecheck/rerunfilecheck.sty
Package: rerunfilecheck 2022-07-10 v1.10 Rerun checks for auxiliary files
(HO)
(c:/texlive/2023/texmf-dist/tex/generic/uniquecounter/uniquecounter.sty
Package: uniquecounter 2019/12/15 v1.4 Provide unlimited unique counter
(HO)
)
Package uniquecounter Info: New unique counter `rerunfilecheck' on input
line 2
```

```
85.
)
\Hy@SectionHShift=\skip72
) (c:/texlive/2023/texmf-dist/tex/latex/bookmark/bookmark.sty
Package: bookmark 2023-12-10 v1.31 PDF bookmarks (HO)
(c:/texlive/2023/texmf-dist/tex/latex/bookmark/bkm-pdftex.def
File: bkm-pdftex.def 2023-12-10 v1.31 bookmark driver for pdfTeX and
luaTeX (HO
)
\BKM@id=\count362
)) (c:/texlive/2023/texmf-dist/tex/latex/subfig/subfig.sty
Package: subfig 2005/06/28 ver: 1.3 subfig package
\c@KVtest=\count363
\sf@farskip=\skip73
\sf@captopadj=\dimen322
\sf@capskip=\skip74
\sf@nearskip=\skip75
\sf@top=\skip76
\sf@bottom=\skip77
)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/libraries/pgflibraryarrows.meta.cod
e.tex
File: pgflibraryarrows.meta.code.tex 2023-01-15 v3.1.10 (3.1.10)
\pgfarrowinset=\dimen323
\pgfarrowlength=\dimen324
\pgfarrowwidth=\dimen325
\pgfarrowlinewidth=\dimen326
)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/frontendlayer/tikz/libraries/tikzli
brarypositioning.code.tex
File: tikzlibrarypositioning.code.tex 2023-01-15 v3.1.10 (3.1.10)
)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/frontendlayer/tikz/libraries/tikzli
braryshapes.geometric.code.tex
File: tikzlibraryshapes.geometric.code.tex 2023-01-15 v3.1.10 (3.1.10)

(c:/texlive/2023/texmf-
dist/tex/generic/pgf/libraries/shapes/pgflibraryshapes.g
eometric.code.tex
File: pgflibraryshapes.geometric.code.tex 2023-01-15 v3.1.10 (3.1.10)
))
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/frontendlayer/tikz/libraries/tikzli
brarydecorations.pathreplacing.code.tex
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/frontendlayer/tikz/libraries/tikzli
brarydecorations.code.tex
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/modules/pgfmoduledecorations.code.t
ex
\pgfdecoratedcompleteddistance=\dimen327
```

```
\pgfdecoratedremainingdistance=\dimen328
\pgfdecoratedinputsegmentcompleteddistance=\dimen329
\pgfdecoratedinputsegmentremainingdistance=\dimen330
\pgf@decorate@distancetomove=\dimen331
\pgf@decorate@repeatstate=\count364
\pgfdecorationsegmentamplitude=\dimen332
\pgfdecorationsegmentlength=\dimen333
)
\tikz@lib@dec@box=\box127
)
(c:/texlive/2023/texmf-
dist/tex/generic/pgf/libraries/decorations/pgflibrarydec
orations.pathreplacing.code.tex)) (c:/texlive/2023/texmf-
dist/tex/latex/geometr
y/geometry.sty
Package: geometry 2020/01/02 v5.9 Page Geometry
(c:/texlive/2023/texmf-dist/tex/generic/iftex/ifvtex.sty
Package: ifvtex 2019/10/25 v1.7 ifvtex legacy package. Use iftex instead.
)
\Gm@cnth=\count365
\Gm@cntv=\count366
\c@Gm@tempcnt=\count367
\Gm@bindingoffset=\dimen334
\Gm@wd@mp=\dimen335
\Gm@odd@mp=\dimen336
\Gm@even@mp=\dimen337
\Gm@layoutwidth=\dimen338
\Gm@layoutheight=\dimen339
\Gm@layouthoffset=\dimen340
\Gm@layoutvoffset=\dimen341
\Gm@dimlist=\toks52
)
Package hyperref Info: Option `colorlinks' set `true' on input line 49.
(c:/texlive/2023/texmf-dist/tex/latex/l3backend/l3backend-pdftex.def
File: l3backend-pdftex.def 2024-02-20 L3 backend support: PDF output
(pdfTeX)
\l__color_backend_stack_int=\count368
\l__pdf_internal_box=\box128
) (./jde_submission.aux)
\openout1 = `jde_submission.aux'.

LaTeX Font Info:    Checking defaults for OML/cmm/m/it on input line 56.
LaTeX Font Info:    ... okay on input line 56.
LaTeX Font Info:    Checking defaults for OMS/cmsy/m/n on input line 56.
LaTeX Font Info:    ... okay on input line 56.
LaTeX Font Info:    Checking defaults for OT1/cmr/m/n on input line 56.
LaTeX Font Info:    ... okay on input line 56.
LaTeX Font Info:    Checking defaults for T1/cmr/m/n on input line 56.
LaTeX Font Info:    ... okay on input line 56.
LaTeX Font Info:    Checking defaults for TS1/cmr/m/n on input line 56.
LaTeX Font Info:    ... okay on input line 56.
LaTeX Font Info:    Checking defaults for OMX/cmex/m/n on input line 56.
LaTeX Font Info:    ... okay on input line 56.
LaTeX Font Info:    Checking defaults for U/cmr/m/n on input line 56.
```

```
LaTeX Font Info:    ... okay on input line 56.
LaTeX Font Info:    Checking defaults for PD1/pdf/m/n on input line 56.
LaTeX Font Info:    ... okay on input line 56.
LaTeX Font Info:    Checking defaults for PU/pdf/m/n on input line 56.
LaTeX Font Info:    ... okay on input line 56.
(c:/texlive/2023/texmf-dist/tex/context/base/mkii/supp-pdf.mkii
[Loading MPS to PDF converter (version 2006.09.02).]
\scratchcounter=\count369
\scratchdimen=\dimen342
\scratchbox=\box129
\nofMPsegments=\count370
\nofMParguments=\count371
\everyMPshowfont=\toks53
\MPscratchCnt=\count372
\MPscratchDim=\dimen343
\MPnumerator=\count373
\makeMPintoPDFobject=\count374
\everyMPtoPDFconversion=\toks54
) (c:/texlive/2023/texmf-dist/tex/latex/epstopdf-pkg/epstopdf-base.sty
Package: epstopdf-base 2020-01-24 v2.11 Base part for package epstopdf
Package epstopdf-base Info: Redefining graphics rule for `.eps' on input
line 4
85.
(c:/texlive/2023/texmf-dist/tex/latex/latexconfig/epstopdf-sys.cfg
File: epstopdf-sys.cfg 2010/07/13 v1.3 Configuration of (r)epstopdf for
TeX Liv
e
))
Package caption Info: Begin \AtBeginDocument code.
Package caption Info: subfig package v1.3 is loaded.
Package caption Info: float package is loaded.
Package caption Info: hyperref package is loaded.
Package caption Info: listings package is loaded.
Package caption Info: longtable package is loaded.
(c:/texlive/2023/texmf-dist/tex/latex/caption/ltcaption.sty
Package: ltcaption 2021/01/08 v1.4c longtable captions (AR)
)
Package caption Info: rotating package is loaded.
Package caption Info: threeparttable package is loaded.
Package caption Info: End \AtBeginDocument code.
\c@lstlisting=\count375
Package hyperref Info: Link coloring ON on input line 56.
! Undefined control sequence.
<argument> \sf@counterlist

l.56 \begin{document}

The control sequence at the end of the top line
of your error message was never \def'ed. If you have
misspelled it (e.g., `\hobx'), type `I' and the correct
spelling (e.g., `I\hbox'). Otherwise just continue,
and I'll forget about whatever was undefined.

*geometry* driver: auto-detecting
```

```
*geometry* detected driver: pdftex
*geometry* verbose mode - [ preamble ] result:
* driver: pdftex
* paper: <default>
* layout: <same size as paper>
* layoutoffset:(h,v)=(0.0pt,0.0pt)
* modes:
* h-part:(L,W,R)=(57.81621pt, 484.2088pt, 72.26999pt)
* v-part:(T,H,B)=(72.26999pt, 664.88379pt, 57.81621pt)
* \paperwidth=614.295pt
* \paperheight=794.96999pt
* \textwidth=484.2088pt
* \textheight=664.88379pt
* \oddsidemargin=-14.45378pt
* \evensidemargin=-14.45378pt
* \topmargin=-37.0pt
* \headheight=12.0pt
* \headsep=25.0pt
* \topskip=12.0pt
* \footskip=30.0pt
* \marginparwidth=44.0pt
* \marginparsep=10.0pt
* \columnsep=10.0pt
* \skip\footins=10.8pt plus 4.0pt minus 2.0pt
* \hoffset=0.0pt
* \voffset=0.0pt
* \mag=1000
* \@twocolumnfalse
* \@twosidefalse
* \@mparswitchfalse
* \@reversemarginfalse
* (1in=72.27pt=25.4mm, 1cm=28.453pt)

LaTeX Font Info:    Trying to load font information for U+msa on input
line 59.

(c:/texlive/2023/texmf-dist/tex/latex/amsfonts/umsa.fd
File: umsa.fd 2013/01/14 v3.01 AMS symbols A
)
LaTeX Font Info:    Trying to load font information for U+msb on input
line 59.

(c:/texlive/2023/texmf-dist/tex/latex/amsfonts/umsb.fd
File: umsb.fd 2013/01/14 v3.01 AMS symbols B
) [1

{c:/texlive/2023/texmf-
var/fonts/map/pdftex/updmap/pdftex.map}{c:/texlive/2023/
texmf-dist/fonts/enc/dvips/cm-super/cm-super-ts1.enc}]
(./jde_submission.toc)
\tf@toc=\write4
\openout4 = `jde_submission.toc'.

[2]
```

Package natbib Warning: Citation `sang_global_2022' on page 3 undefined
on inpu
t line 73.

Package natbib Warning: Citation `kremer_spring_2011' on page 3 undefined
on in
put line 75.

Package natbib Warning: Citation `dupas_impacts_2017' on page 3 undefined
on in
put line 75.

Package natbib Warning: Citation `greenstone_envirodevonomics_2015' on
page 3 u
ndefined on input line 85.

Package natbib Warning: Citation `barwick_fog_2024' on page 3 undefined
on inpu
t line 85.

[3]

Package natbib Warning: Citation `ackerberg_advertising_2003' on page 4
undefin
ed on input line 88.

Package natbib Warning: Citation `israel_services_2005' on page 4
undefined on
input line 88.

Package natbib Warning: Citation `bergemann_dynamic_2006' on page 4
undefined o
n input line 88.

Package natbib Warning: Citation `bonatti_menu_2011' on page 4 undefined
on inp
ut line 88.

Package natbib Warning: Citation `chen_experience_2022' on page 4
undefined on
input line 88.

Package natbib Warning: Citation `czajkowski_effects_2015' on page 4
undefined

on input line 88.

Package natbib Warning: Citation `kahn_clean_2020' on page 4 undefined on input
 line 88.

Package natbib Warning: Citation `currie_what_2014' on page 4 undefined on inpu
t line 90.

Package natbib Warning: Citation `ebenstein_long-run_2016' on page 4 undefined
on input line 90.

Package natbib Warning: Citation `fuller_pollution_2022' on page 4 undefined on
 input line 90.

Package natbib Warning: Citation `clasen_liquefied_2022' on page 4 undefined on
 input line 90.

Package natbib Warning: Citation `berkouwer_private_2023' on page 4 undefined o
n input line 90.

Package natbib Warning: Citation `bishop_hazed_2018' on page 4 undefined on inp
ut line 92.

Package natbib Warning: Citation `isen_every_2017' on page 4 undefined on input
 line 92.

Package natbib Warning: Citation `hansman_interlinked_2019' on page 4 undefined
 on input line 92.

Package natbib Warning: Citation `malmendier_exposure_2021' on page 4 undefined
 on input line 94.

```
LaTeX Warning: Reference `sec:design' on page 5 undefined on input line
96.


LaTeX Warning: Reference `sec::outcomes' on page 5 undefined on input
line 96.


LaTeX Warning: Reference `sec::analysis' on page 5 undefined on input
line 96.


! LaTeX Error: No counter 'subfigure@save' defined.

See the LaTeX manual or LaTeX Companion for explanation.
Type  H <return>  for immediate help.
 ...

l.108     \subfloat
                   [\centering Monthly Time
Series]{\includegraphics[width=....

Your command was ignored.
Type  I <command> <return>  to replace it with another command,
or  <return>  to continue without it.


LaTeX Warning: File `figures/outdoor_sensor_timeseries.png' not found on
input
line 108.


! Package pdftex.def Error: File `figures/outdoor_sensor_timeseries.png'
not fo
und: using draft setting.

See the pdftex.def package documentation for explanation.
Type  H <return>  for immediate help.
 ...

l.108 ...{figures/outdoor_sensor_timeseries.png} }
                                                  %
Try typing  <return>  to proceed.
If that doesn't work, type  X <return>  to quit.


! LaTeX Error: No counter 'subfigure@save' defined.

See the LaTeX manual or LaTeX Companion for explanation.
Type  H <return>  for immediate help.
 ...

l.110     \subfloat
```

```
                  [\centering Map of PM$_{2.5}$ Levels in May
2023]{\includ...

Your command was ignored.
Type  I <command> <return>  to replace it with another command,
or  <return>  to continue without it.


LaTeX Warning: File `figures/outdoor_sensor_map_may_3closest.png' not
found on
input line 110.


! Package pdftex.def Error: File
`figures/outdoor_sensor_map_may_3closest.png'
not found: using draft setting.

See the pdftex.def package documentation for explanation.
Type  H <return>  for immediate help.
 ...

l.110 ...res/outdoor_sensor_map_may_3closest.png}}
                                                  %
Try typing  <return>  to proceed.
If that doesn't work, type  X <return>  to quit.


Package caption Warning: \setcaptionsubtype
(caption)                outside box or environment on input line 112.
See the caption package documentation for explanation.


Package caption Warning: \subcaption
(caption)                outside box or environment on input line 112.
See the caption package documentation for explanation.

Package hyperref Info: bookmark level for unknown subfigure defaults to 0
on in
put line 113.

LaTeX Warning: `!h' float specifier changed to `!ht'.


LaTeX Warning: File `figures/hourFE_nopurifier.png' not found on input
line 120
.


! Package pdftex.def Error: File `figures/hourFE_nopurifier.png' not
found: usi
ng draft setting.

See the pdftex.def package documentation for explanation.
Type  H <return>  for immediate help.
```

```
 ...

l.120 ...textwidth]{figures/hourFE_nopurifier.png}

Try typing  <return>  to proceed.
If that doesn't work, type  X <return>  to quit.


Package caption Warning: \setcaptionsubtype
(caption)                outside box or environment on input line 122.
See the caption package documentation for explanation.


Package caption Warning: \subcaption
(caption)                outside box or environment on input line 122.
See the caption package documentation for explanation.


LaTeX Warning: `!h' float specifier changed to `!ht'.


Package natbib Warning: Citation `fuller_pollution_2022' on page 5
undefined on
 input line 127.


Package natbib Warning: Citation `greenstone_envirodevonomics_2015' on
page 5 u
ndefined on input line 127.


Package natbib Warning: Citation `marlier_extreme_2016' on page 5
undefined on
input line 127.


Package natbib Warning: Citation `tu_mass_2020' on page 5 undefined on
input li
ne 128.

[5] [6] [7]

LaTeX Warning: Reference `tab:pilot_pm' on page 8 undefined on input line
145.


Underfull \hbox (badness 10000) in paragraph at lines 141--146

 []


! LaTeX Error: File `figures/pickup_dd.tex' not found.

Type X to quit or <RETURN> to proceed,
```

```
or enter new name. (Default extension: tex)

Enter file name:
! Emergency stop.
<read *>

l.151     \input{figures/pickup_dd}
                                    ^^M
*** (cannot \read from terminal in nonstop modes)


Here is how much of TeX's memory you used:
 28668 strings out of 474121
 534135 string characters out of 5747949
 1939190 words of memory out of 5000000
 50512 multiletter control sequences out of 15000+600000
 569588 words of font info for 80 fonts, out of 8000000 for 9000
 1141 hyphenation exceptions out of 8191
 81i,12n,80p,1352b,637s stack positions out of
10000i,1000n,20000p,200000b,200000s
!  ==> Fatal error occurred, no output PDF file produced!
```

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Authors: Budy Resosudarmo, Jeanne Sorin, and Yixin Sun