Does Environmental Information Provision Deliver? Experimental Evidence from Chinese Schools

Tong Liu* Kaiping Peng† Wei Yan‡

Abstract

Public provision of environmental information is becoming prevalent worldwide to promote public awareness of environmental risks to protect health, but there is a lack of causal evidence on its effectiveness. This study examines how the provision of air quality information affects the behaviors, health, and academic performance of students in Chinese secondary schools, who are at a critical stage of human capital cumulation with significant mental challenges and susceptibility to air pollution. We conduct a large-scale experiment which randomly selects over 16,000 students into multiple interventions, including information on ambient air pollution, advisories on defensive measures, and their respective effects. First, students do not respond to information on pollution or its mortality impacts. Second, in sharp contrast, information on the adverse impact of air pollution on test scores with behavioral advisories triggers a 2pp (0.05 SD) increase in air purifier adoption at home within one month, with no observable changes in other avoidance behaviors such as mask and window usage, indoor and outdoor activities, and time use. The effect is driven by students in higher grades, upper-middle level students ranked by test scores, regions with stronger competition in college admission, families with better communication and joint decision-making between the children and parents, and boys in areas with stronger son preference, suggesting consistent risk perception and spillover in the household with gender bias. The treatment also increases the environmental awareness and planning of students and parents. Third, the advisories on defensive measures offer a critical choice set, without which students will only close the window with pollution, which is much less effective than an air purifier. Fourth, reassuringly, the information treatment has no direct impact on students' mental health. Fifth, the responses are more prominent for the loss-framed score impact than the gain-framed version, revealing loss aversion and attention in a high-stakes setting. Lastly and remarkably, air purifier adoption improves the mental health of students by 0.1 SD, as measured by mental well-being, life satisfaction, depression and anxiety. It further increases math scores by 0.1 SD, but has no impact on English or Chinese scores, consistent with the physiological impact of pollution. The findings provide novel measurements on the willingness to pay for clean air for the understudied adolescents and their parents, offer useful insights into information provision, risk perceptions and behaviors, and highlight the importance of tailored behavioral advisories in ensuring the effectiveness of information programs on air quality and beyond.

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* National University of Singapore. Email: tongliu@nus.edu.sg.

† Tsinghua University.

‡ Stanford University.

I. Introduction

Air pollution is a pressing concern globally, affecting billions of people in developing and developed countries. A growing strand of literature exploits natural experiments or quasi-experiments to reveal substantial social costs of pollution (see Graff Zivin and Neidell 2013 and Aguilar-Gomez et al. 2022 for two recent reviews), calling for policies on mitigation and adaptation to protect public health. While mitigation policies aim to lower pollution levels through emission abatement, adaptation encompasses the dissemination of pollution information to motivate behavioral changes to reduce pollution exposure. In general, the information design would include pollutant concentrations, air quality standards and indices, health or behavioral advisories. Unfortunately, such information programs remain absent or limited in 73% of countries (Rosales et al. 2024), and little is known about the effectiveness of existing programs and the roles of different components. One major issue is that information and pollution levels covary, and unobservable constraints in time and resources may hinder behavioral responses. It is also demanding to track individual behaviors and further link them with human capital outcomes to measure the welfare impacts.

To address these challenges above, this paper conducts a large-scale randomized controlled trial (RCT) to evaluate a canonical information program on air quality in Chinese secondary schools. This setting is important for several reasons. First, the RCT design allows us to causally examine the role of the information program, its components, and mechanisms. It can support the design of information programs and will provide important policy and welfare implications. Second, adolescence is a critical yet challenging phase for human capital formation and accumulation. The mental health of adolescents is a major issue in many countries including the United States and China, but existing research focuses more on non-environmental factors and adults. Third, the school system allows us to track both behaviors and human capital outcomes including health and academic performance. Fourth, air pollution remains a critical social issue in China despite significant improvements in recent years.

Specifically, our experiment randomly selects over 16,000 students in Chinese secondary schools into multiple information interventions. The interventions include information on ambient air quality, adverse impacts of air pollution, defensive measures against air pollution and the potential benefits. Compared with the control group, students in the first treatment group (Treatment Group 1) receive information on air quality during the past year, together with the

national average to assist the comprehension of pollution levels. On top of this pure pollution information, students in the second or third treatment group (Treatment Group 2 or 3) receive additional information on the impact of air pollution on health or academic performance, which are borrowed from two relevant studies on the causal impact of air pollution on mortality and performance in the National College Entrance Exam (NCEE) in China (He et al. 2020; Graff Zivin et al. 2020). Based on the research findings, we mention that "Scientific research has shown that a 10-unit increase in air pollution will increase the mortality rate by about 3%", or "Scientific research has shown that a 10-unit increase in air pollution will lower the NCEE scores by about 2 points". Since these estimates are novel and recent, we expect that such information should be new to most students, perhaps surprising, particularly for the impact on NCEE scores. The NCEE is among the most competitive settings in the world, and a 1-point difference could indicate thousands of students in rank for college admission. As such, the information can be disconcerting to students and their parents. That said, it is unclear *ex-ante* whether or which information would be effective in changing behaviors.

In addition to the information on the pollution levels and their impacts above, we further introduce one subset of treatment arms with behavioral advisories against air pollution. In each treatment group, some students randomly receive information on defensive measures that can be taken to reduce pollution exposure (Treatment Group 1), which may further improve health (Treatment Group 2) or test scores (Treatment Group 3). The defensive measures include using an air purifier indoors, closing windows indoors, wearing a facial mask outdoors, and reducing outdoor activities when there is air pollution. These advisories follow the standard practice of information provision programs, which can offer a useful choice set, especially for those who are not fully aware of the options to reduce pollution exposure.

The interventions are conducted through a comprehensive baseline survey in September/October of 2022 after the start of the fall semester in the schools, followed by an endline survey within one month in November/December before the end of the semester. Air pollution follows a seasonal pattern in China, with higher (or lower) levels in winter (or summer). The surveys measure a variety of characteristics and outcomes, including demographics, attitudes, behaviors, mental health, and recent test scores from standard exams. We then compare student outcomes before and after the interventions to examine their effects.

We have six major findings. First, students are not responsive to pure information on air

quality in Treatment Group 1, as measured by the four types of defensive behaviors. They also do not respond to the behavioral advisories to reduce pollution exposure. All of the estimates are small and insignificant with large standard errors. Although our message can help students interpret pollution levels as relatively higher or lower than the national average, they do not change any measured behaviors. It suggests that such information on air quality and its differences may still be abstract to interpret, and the impacts of air pollution on students are not mentioned explicitly and may not be inferred directly, which could hinder further actions.

Second, students in the Treatment Group 2 with additional information on the mortality impacts of air pollution also do not behave differently compared with the control group. Adding behavioral advisories also makes no difference. Students may not interpret the mortality impacts of pollution as directly relevant to themselves, as the death outcome is rare in the distant future and can be heavily discounted with high time preferences. It is also plausible that students are not very concerned about the health impacts of pollution, since they are not perceived as susceptible as the elderly or the infants. The result indicates that general health information in existing programs may have overlooked "unsusceptible" groups including the adolescents and young adults, thus it may not be able to nudge and protect them compared with the susceptible groups, though they also suffer from air pollution.

Third, there are remarkable increases in behavioral responses due to additional information on the score impacts of air pollution in Treatment Group 3, and behavioral advisories play an important role in driving the behaviors. When students know about the air pollution levels and the score impacts without behavioral advisories, they reportedly close the window more when there is air pollution, but do not change other behaviors. The impact on air purifier adoption becomes larger but remains statistically insignificant. However, when the behavioral advisories are added, students significantly shift to air purifier adoption and increase the adoption rate by around 2pp (0.05 SD) within one month after the intervention. Around 32% of the students have an air purifier at home before the intervention, and the impact on the extensive margin is economically meaningful. The advisories on avoidance measures indeed offer a critical choice set, as closing the window is much less effective than using an air purifier, although the latter is much more expensive. In comparison, there is no significant change in the usage of existing air purifiers on the intensive margin. In terms of other avoidance behaviors, including the adoption and usage of air masks, window-closing behaviors, reducing outdoor activities, as well as time use, the impacts of this

information treatment become larger and positive but remain statistically insignificant. It is consistent with the fact that student activities are mostly routine with limited flexibility in China, and masks are commonly used due to COVID-19. In addition, there is also no response from the usage of water filters and dispensers, which serves as a falsification test.

The results above suggest that information should be tailored to specific groups to motivate behavioral changes, and there are notable spillovers from students to their parents in air purifier adoption. To explore the mechanisms, we conduct a battery of heterogeneity analyses and measure important factors in the family decision-making process. We find that the effect is driven by students in Grades 9 to 11, who are aged between 14 to 16, whereas there is no impact on the lowest grades (Grade 7-8) in junior high schools or the highest grade (Grade 12) in senior high schools. The responses are also stronger for upper-middle level students ranked by baseline test scores and for regions with more competition in college admission. These differences are consistent with the timing and pressure of exams, the time and room available to improve test scores, and the salience of NCEE scores and the information treatment. Regarding family spillovers, the effect is prominent for families with better communication and joint decision-making between the children and parents. Students and their parents also report better environmental awareness and consider air pollution and forecasts in activity planning. This pattern suggests risk perception and spillovers in the household. Strikingly, the effect is loaded on boys in areas with stronger son preference. Given the same level of communication between boys, girls, and their parents, this result reflects gender bias that persists till the present.

Fourth, we further introduce loss aversion to explore whether framing the same information differently as loss or gain would have any impact on the behaviors of students/parents. Specifically, the loss (gain) version mentions behaviors that increase (reduce) pollution exposure, harm (benefit) health, lower (improve) academic performance. We find that the responses are more prominent for the loss-framed score impact than the gain-framed version, revealing loss aversion and attention in a high-stakes setting.

Fifth, the information treatments have no direct impact on students' mental health. This is reassuring, as one may be concerned that the information on air pollution and its impacts may be depressing to students directly, especially those who are not aware of the pollution risks *ex-ante* or who are not able to adopt avoidance measures to reduce pollution exposure and impacts.

Lastly and remarkably, air purifier adoption improves the mental health of compliers by 0.1

SD, as consistently measured by mental well-being, life satisfaction, depression and anxiety. It further increases math scores by around 0.1 SD, but there is no impact on English or Chinese scores. This result echoes recent studies on the physiological impact of pollution on logic reasoning and suggests that the effect may be driven more by pollution reduction at home due to air purifier adoption compared with the psychological and other channels.

This paper makes several contributions to the literature. First, as far as we know, it is the first to causally evaluate the information provision program on air pollution using a large-scale experimental design. Some studies exploit the discontinuity caused by air pollution alerts to show behavioral changes due to the alerts at the local level (e.g. Graff Zivin and Neidell. 2009; Liu et al. 2018; Anderson et al. 2022). Recent studies focus on the overall provision of air quality information, highlighting the potential welfare gains due to better access to information or better data quality (e.g. Ito and Zhang 2020; Greenstone et al. 2022; Barwick et al. 2024). However, it is challenging to separate these channels, which often occur together and overlap with other bundling policies. Relatedly, some recent working papers employ RCTs on air quality forecasts, alerts, or defensive equipment including air masks outdoors and air purifiers in the households (e.g. Rema et al. 2021; Ahmad et al. 2024; Baylis et al. 2024; Chowdhury et al. 2024; Imtiaz et al. 2025), while there is little attention to information design. Our paper fills this gap by examining the composition of information programs and their effectiveness using an RCT. Importantly, our findings highlight the role of tailored advisory and its impacts to ensure the effectiveness of information programs on air pollution.

Second, we are among the first to track and link behavioral changes to human capital outcomes in an important setting. The paper speaks to the broad literature on health, education, and households. The mental health of children and adolescents is critical for human capital development, but there is a lack of evidence on its determinants (e.g. Currie et al. forthcoming). We show that targeted information can increase air purifier adoption, which can further improve mental health and test scores of adolescents, while the information itself does not directly affect mental health. Our findings also underscore the environmental determinants of mental health, which are understudied (e.g. Bishop et al. 2023). Importantly, information spillover within the family from the children to their parents plays a key role due to the salience of information. Unfortunately, we find that gender bias exists in human capital investment against pollution risks.

Third, this paper is closely related to a large body of literature on information design and

nudges (e.g. Stiglitz 2002; Loewenstein and Chater 2017; Thaler 2018; Bergemann and Morris 2019; Haaland et al. 2023). We provide novel and useful insights into belief, risk perception and behaviors. The finding that the willingness to pay (WTP) for clean air only manifests in test scores for students highlights the importance of tailored information design. We further reveal loss aversion of adolescent students and parents in a high-stakes situation.

Finally, our findings have important policy implications for the environment and behaviors. While more research and practice focus on the mitigation of pollution risks, we show that adaptation is crucial and can be nudged. Not only the information provision in a timely and accurate manner, but also the specific design, matters for welfare. The findings can assist the design of existing information programs and promote their adoption worldwide. In addition, it is encouraging that the dissemination of research findings indeed matters for behaviors and policies.

The reminder of the paper is organized as follows. Section II introduces the background. Section III describes the experimental design and implementation. Section IV reports the results, followed by a discussion in Section V. Section VI concludes.

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