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WOOD BURNING: IMPROVING POLLUTION AWARENESS

In France, general information on the air pollution caused by wood burning, coupled with personalized information on individual households' air quality, improved households' awareness of pollution and reduced indoor air pollution levels.

Featuring an evaluation by Rita Abdel Sater, Mathieu Perona, Elise Huillery, and Coralie Chevallier

OVERVIEW

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Outdoor and indoor air pollution are both meaningful causes of mortality worldwide.[1] However, indoor air pollution is a particularly significant issue in high-income countries, where residents spend more than 80 percent of their time indoors.[2]

In many settings, wood burning is an especially large contributor to pollution as measured though PM2.5 (a category of particulate matter with a diameter smaller than 2.5 µm). In Europe, residential wood burning constitutes over 45 percent of all PM2.5 contamination.[3] Despite this, the public is largely unaware of the negative impacts of wood burning. In France, for instance, the Indoor Air Quality Observatory estimates that 34 percent of dwellings are rendered unsafe by high concentrations of PM2.5,[4] but households tend to overestimate their own indoor air quality.[5]

Evidence is mixed on the effectiveness of information provision in changing behaviors, with different types of information having seemingly differential effects. In recent years, several interventions have found that personalized information on household energy usage through smart meters can alter citizens' consumption habits.[6] However, few interventions have compared the effects of generic and personalized information.

In France, Rita Abdel Sater (Paris Sciences et Lettres University), Mathieu Perona (CEPREMAP), Elise Huillery (Paris Dauphine University, J-PAL), and Coralie Chevallier (Paris Sciences et Lettres University) evaluated the impact of general and personalized information on the negative effects of wood burning and indoor pollution on households' awareness of pollution and pollution mitigation efforts.

KEY RESULTS

Air quality improved only in households that received personalized information. Households that received personalized information saw a 24 percent decrease of PM2.5 in their indoor pollution levels and were less likely to exceed the maximum threshold for safe air quality.

Households increased their awareness of the different sources of pollution but not of the associated health risks. Both types of information were effective in improving households' knowledge on a range of pollution-related topics, including identifying wood burning and cigarette smoking as primary sources of indoor pollution, but neither type of information altered perceptions of pollution's health risks.

The personalized information intervention was most cost-effective. Personalized information was 2.6 times more cost-effective than general information at reducing indoor PM2.5 concentrations.

The main channel of behavioral change seems to be the perception of individuals' own indoor air quality. Both interventions were successful at increasing the perceived detrimental impact of wood burning and smoking on indoor and outdoor air, but only the personalized emission intervention decreased the perceived quality of households' own indoor air.

EVALUATION

Researchers conducted a randomized evaluation to test the impact of general and personalized information on the negative effects of wood burning and indoor pollution on households' awareness of indoor pollutants and on indoor air quality. The intervention was developed in collaboration with the Interministerial Directorate for Public Transformation (DITP) and the Île-de-France Regional and Intergovernmental Department of Environment and Energy (DRIEE).

Households were invited to participate in the evaluation through a website, which offered to install an air quality monitor in homes. Participants received invitations to join the study through calls for volunteers by the DRIEE, emails to households that the Agency for the Environment and Energy Management had identified as wood burning, and an internet marketing service. Of the 4,200 people who volunteered, 370 reported using wood heating on occasion, and 281 of these were ultimately eligible. Researchers then randomly assigned these participants into three groups: a group that received only general pollution information (the general information group), a group that received general and personalized pollution information (the personalized information group), and a comparison group.

All individuals in the general information group and personalized information group received a series of eight informational leaflets between January and March 2020. The leaflets varied by week but generally contained information about the types of indoor activities that produce PM2.5 emissions and associated health risks, as well as potential mitigation techniques, with a specific focus on wood burning.

Individuals in the personalized information group, in addition to the aforementioned information in the leaflets, also received personalized information on their own PM2.5 emissions over the prior week. This information was collected from air quality monitors, which were installed in all households, including those in the general information and comparison groups. These households received a figure showing their own air quality over time, with times and dates of heightened pollution levels highlighted. Furthermore, these households received information on their own air quality compared to households in the comparison group.

All households completed two online surveys: one before the start of the intervention (between August and December 2019) and one after (at the end of March 2020). These surveys measured individuals' knowledge about air pollution broadly, knowledge about wood burning, and their own self-reported pollution practices, including wood burning.

RESULTS

Air quality improved only in households that received personalized information. PM2.5 decreased by 1.3 μg/m³, a 24 percent decrease, in the personalized information group relative to the comparison group, suggesting that these households changed their behavior during the intervention to lower their pollution levels. World Health Organization (WHO) guidelines state that individuals should not be exposed to PM2.5 concentrations greater than 25 μg/m³ more often than three times a year. Over the four months of the intervention, households in the personalized information group were over this threshold for 1.44 days fewer than the comparison group, a 50 percent decrease (see figure 2). No significant change was observed in the general information group.

Households with initially higher levels of indoor air pollution reduced their emissions the most. Households that were in the top quarter of households in PM2.5 pollution initially accounted for most of the impact of the personalized information. These households, which were less affluent and reported more wood burning before the intervention, reduced their indoor pollution by 4.9 μg/m³, a 36 percent decline relative to the comparison group. This corresponded to a drop in the number of days with PM2.5 concentrations over WHO guidelines from 12.4 days to 5.9 days, a 52 percent decrease.

Households increased their awareness of the different sources of pollution but not of the associated health risks. Households in the general and in the personalized information groups were more likely to cite both wood burning (by 50 percent in both groups) and cigarette smoking (by 100 percent and 136 percent, respectively) as primary sources of indoor

1 Burnett, Richard, Hong Chen, Mieczyslaw Szyszkowicz, Neal Fann, Bryan Hubbell, C. Arden Pope, Joshua Apte et al. 2018. "Global Estimates of Mortality Associated with Long-Term Exposure to Outdoor Fine Particulate Matter." *Proceedings of the National Academy of Sciences* 115, no. 38 (September): 9592–9597.

2 Klepeis, Neil E., William C. Nelson, Wayne R. Ott, John P. Robinson, Andy M. Tsang, Paul Switzer, Joseph V. Behar, Stephen C. Hern, and William H. Engelmann. 2001. "The National Human Activity Pattern Survey (NHAPS): A Resource for Assessing Exposure to Environmental Pollutants." *Journal of Exposure Science and Environmental Epidemiology* 11, no. 3 (July): 231–252.

3 Amann, Markus, Janusz Cofala, Zbigniew Klimot, Christian Nagl, and Wolfgang Schieder. 2018. "Measures to Address Air Pollution from Small Combustion Sources." Clean Air Outlook Combustion Sources Report, European Commission.

4 Boulanger, Guillaume, Thomas Bayeux, Corinne Mandin, Séverine Kirchner, Benoit Vergriette, Valérie Pernelet-Joly, and Pierre Kopp. 2017. "Socio-Economic Costs of Indoor Air Pollution: A Tentative Estimation for Some Pollutants of Health Interest in France." *Environment International* 104 (July): 14–24.

5 Langer, Sarka, Olivier Ramalho, Eline Le Ponner, Mickaël Derbez, Séverine Kirchner, and Corinne Mandin. 2017. "Perceived Indoor Air Quality and Its Relationship to Air Pollutants in French Dwellings." *Indoor Air* 27, no. 6 (November): 1168–1176.

6 See Tiefenbeck, Verena, Lorenz Goette, Kathrin Degen, Vojkan Tasic, Elgar Fleisch, Rafael Lalive, and Thorsten Staake. 2018. "Overcoming Salience Bias: How Real-Time Feedback Fosters Resource Conservation." *Management Science* 64, no. 3 (March): 1458–1476; Tiefenbeck, Verena, Anselma Wörner, Samuel Schöb, Elgar Fleisch, and Thorsten Staake. 2019. "Real-Time Feedback Promotes Energy Conservation in the Absence of Volunteer Selection Bias and Monetary Incentives." *Nature Energy* 4, no. 1 (January): 35–41.

PM2.5 pollution. However, neither the general information nor the personalized information group altered their perceptions of pollution's health risks.

Households' intentions to use word burning declined following the intervention. Individuals receiving both types of interventions were 12 percentage points less likely to say they would burn wood once a week or less this upcoming winter, a 25 percent increase relative to the comparison group (48 percent). However, they were no more likely to support antiwood burning regulations and no less likely to report enjoying lighting a fire.

The personalized information intervention was most cost-effective. In reducing PM2.5, the personalized information intervention was 2.6 times more cost-effective than the general information intervention.

FIGURE 1.

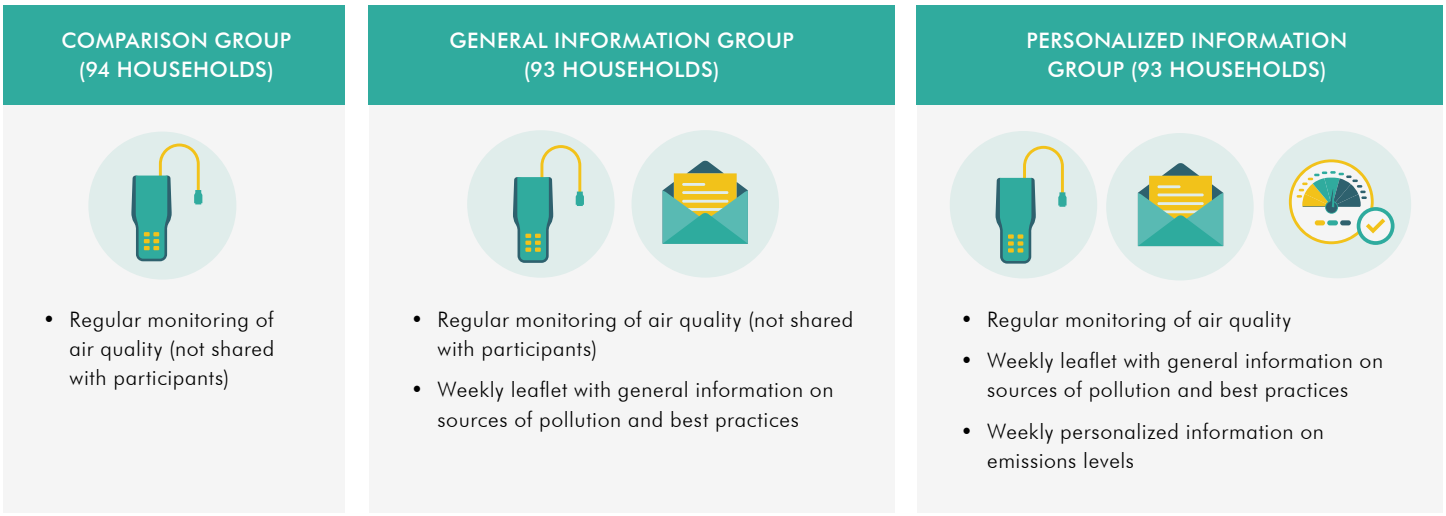
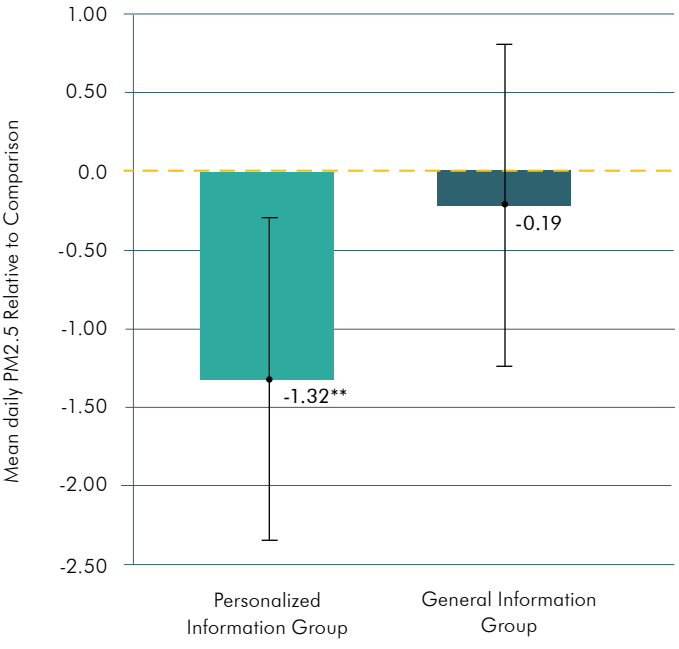


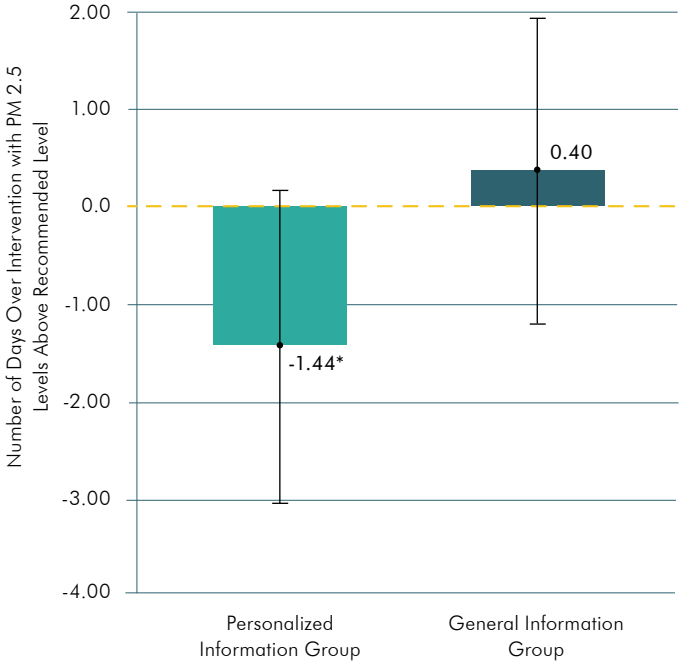
FIGURE 2. Mean daily PM2.5 concentration decreased in the personalized information group but not in the general information group



Note: Figure represents changes relative to the comparison group. Error bars represent 95% confidence intervals. Statistically significant difference relative to the comparison group is noted at the 1% (***), 5% (**), or 10% (*) level.

Source: Sater et al. April 2022, Table 2, p. 33

FIGURE 3. The total number of days over the course of the intervention in which PM2.5 levels exceeded recommended limits, decreased in the personalized information group but not in the general information group



Note: Figure represents changes relative to the comparison group. Error bars represent 95% confidence intervals. Statistically significant difference relative to the comparison group is noted at the 1% (***), 5% (**), or 10% (*) level.

Source: Sater et al. April 2022, Table 5, p. 35

POLICY LESSONS

Personalized information can have a large impact on pollution behavior and on health. Evidence has shown that similar interventions aiming to reduce household energy consumption have had an effectiveness ranging from 2 to 20 percent, suggesting that the personalized information intervention was particularly effective at reducing pollution.[7] The pollution reduction across all individuals receiving personalized information, which averages 1.3 μg/m³, may also be significant from a public health perspective. As little as a 1 μg/m³ increase in PM2.5, for instance, is associated with a deterioration in health outcomes.[8]

Information may be most effective when it is personalized and offers social comparisons. Researchers suggest that the personalized emission profile, in which individuals are shown their own pollution levels relative to other households, may help households update their beliefs and spur decreased pollution. It is also notable that both groups exhibited greater knowledge of activities that produce pollution, while only personalized information led them to change their behavior. This contributes to a broader literature that suggests that knowledge of environmental and health issues does not necessarily change behavior, perhaps due to people's irrational optimism about their own circumstances. In contrast, personalized information may help counter this optimism. These findings indicate that knowledge and awareness on their own are insufficient to change behavior, but real-time feedback combined with social comparison can be effective in counteracting inattention and biased beliefs about one's own emissions.

The generalizability of this intervention for broader contexts may be somewhat limited. Given the characteristics of study participants, the results of this intervention may not be applicable to the general population. All individuals in this intervention agreed to install an air quality monitor, likely making them more sensitive to air quality concerns than others. This may have plausibly led researchers to either over- or underestimate the effectiveness of the intervention on the general population.

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8 Wu, Xiao, Rachel C. Nethery, M. Benjamin Sabath, Danielle Braun, and Francesca Dominici. 2020. "Air Pollution and COVID-19 Mortality in the United States: Strengths and Limitations of an Ecological Regression Analysis." *Science Advances* 6, no. 45 (November): eabd4049.