

# Extreme Temperature May Increase Health Investment: Persistent Improved Sanitation Behaviors as Adaptation in India

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## 1. Introduction

Policymakers and researchers increasingly recognize the significant negative impact the changing climate can have on human welfare. Climate change increases the frequency of extreme weather events, which in turn reduce human welfare either directly, by increasing mortality (e.g., Deschenes and Greenstone, 2011), or indirectly by causing damages to agriculture (e.g., Schlenker and Roberts, 2009) and labor productivity (e.g., Somanathan et al., 2021). These short-run negative welfare consequences have been well known.

But little is known about the persistent positive effects of weather shocks on human welfare over time. I document that temperature shocks can have a persistent positive effect on human health by inducing adaptive investment in health-improving durable goods to avoid behaviors that involve walking outside. If these outside behaviors are harmful to health, weather-induced investment in these goods can persistently improve health over time. My focus on the persistent positive effect on health differs from several past studies that show the persistent negative effects of temperature on economic growth (Dell et al., 2012) and educational outcomes (Park, 2020).

Therefore, this paper examines the effect of extreme temperatures on health investment by looking at the case of sanitation behaviors, i.e., the construction and usage of latrines, in rural India during the period of nationwide sanitation policy, the Swachh Bharat Mission.

## 2. Conceptual Framework and Empirical Strategy

Extreme temperatures can affect a household's decision of whether to construct latrines or maintain open defecation practices in two ways. First, extreme temperatures can have a positive effect on latrine investment as an adaptation behavior by increasing the discomfort of walking outside for open defecation (discomfort channel). Second, as an opposite effect, extreme temperatures can have a negative effect on latrine investment by reducing agricultural output and consequently reducing income (income channel). This paper empirically examines which of these two channels dominates.

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To examine the causal effect of temperature on latrine investment in India, I exploit presumably random year-to-year variation in temperature at the district level after controlling for district fixed effects, year fixed effects, and rainfall. I group the daily temperature measures into eight bins to capture the nonlinear relationship between temperature and latrine investment. I employ a distributed-lag model that includes lagged temperature for up to 10 years to test the persistence of the effect.

### **3. Results**

I find that extremely cold and hot temperatures increase latrine investment, and this effect persists over multiple years. An additional hot day with an average temperature exceeding 35°C leads to an increase in latrine investment by 3 per 1,000 households relative to a day in the 15-20°C range, which amounts to a 1.1% increase from the pre-SBM periods. An additional cold day with an average temperature below 5°C leads to an increase in latrine investment by 27 (10%) per 1,000 households. These estimates are cumulative effects, which are the sum of contemporaneous effects and lagged effects (up to three years). The overall positive cumulative effects suggest that the discomfort channel dominates the income channel, and the effects persist over three years. Heterogeneous effects by the baseline temperature level further illustrate the dominance of the discomfort channel. I find that the positive effects of hot temperatures on latrine investment are concentrated in districts with lower baseline temperatures because people in these districts are less adapted to hot temperatures and therefore feel more discomfort.

I also find that extreme temperatures similarly increase latrine usage at the intensive margin conditional on latrine ownership, which is consistent with the discomfort channel. I find an additional hot day with an average temperature of 30-35°C leads to a 14.3% increase in latrine usage from the baseline usage rate relative to a day in the 15-20°C range when using daily temperature from a 1-week reference period before the survey. I also find a positive effect of an additional cold day with a temperature of 5-10°C on latrine usage (12.0% increase from baseline usage rate) when using a 12-month reference period for temperature.

### **4. Conclusion**

Taken together, my analysis highlights the surprising fact that extreme temperatures can improve health by incentivizing adaptive investment in health technologies as people want to avoid the discomfort of walking outside. Extreme temperatures have a persistent positive effect on latrine investment, which can have long-lasting health benefits in terms of reduced diarrheal diseases and mortality. A back-of-the-envelope calculation shows that in rural India, an additional cold and hot day with an average temperature of below 5°C or above 35°C decreases diarrheal post-neonatal mortality by 2.72% and 0.31%, respectively.