

Abstract

Residential solar photovoltaic (PV) systems are widely recognized for their environmental benefits—reducing greenhouse gas emissions and air pollution. This study uncovers a previously undocumented role: solar PV adoption serves as a buffer against heat-related mortality. Rising extreme temperatures pose growing public health risks, yet households' ability to maintain safe indoor temperatures through cooling depends critically on energy affordability. As electricity prices increase due to supply disruptions and geopolitical shocks, vulnerable populations face heightened exposure to temperature-related mortality. We examine whether distributed renewable energy—specifically residential solar PV installations—can mitigate these risks by reducing households' reliance on grid electricity during extreme heat events. We exploit a natural experiment created by the 2011 Great East Japan Earthquake, which triggered electricity price increases of up to 38 percent following nuclear plant shutdowns. Using prefecture-by-month mortality data from Japan (2009–2014), we employ an instrumental variable strategy leveraging exogenous spatial and temporal variations in solar radiation and electricity prices to identify the causal effect of solar PV adoption on temperature-related mortality. Solar PV adoption significantly reduces heat-related mortality, with effects concentrated among individuals aged 65 and older. Effects are more pronounced in warmer regions and in areas with more energy usage constraints. No comparable effects are observed at cold temperatures, consistent with solar PV's strong summer generation profile. These findings show that distributed renewable energy provides direct health protection during climate extremes. However, because adoption remains concentrated among higher-income households, associated health benefits may accrue unevenly, highlighting the need for targeted policies.

Keywords: Climate adaptation; Extreme heat; Solar photovoltaic; Renewable energy; Mortality; Health inequality