

Heat and air pollution degrade learning and human capital development

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Human capital is associated with the knowledge and skills acquired by individuals and it is a critical component of economic development. We provide estimates of the impact of heat stress and air pollution on long-term learning ability, and therefore human capital accumulation, using global data from high-stake OECD PISA exams from 2000 to 2018. We created a database with the standardized scores for 59 countries with the maximum Wet Bulb Globe Temperature (WBGT) index as a measure of heat stress, and the mean annual concentrations of fine particulate matter less than 2.5 μm^3 (PM2.5) as a measure for air pollution. Our results showed heat stress and low air quality significantly degrade learning driven by a long-term cumulative and persistent impact of both heat and air pollution during the year prior to the tests. Indeed, a 1 degree C increase in the annual max WBGT and 1 $\mu\text{g}/\text{m}^3$ increase in the annual PM2.5 decreases the scores by 4.7% and 2.8% of a standard deviation, respectively. These long-term effects were concentrated solely in the school months reducing the scores by 6.3% of a standard deviation. Students in poorer countries are afflicted three times more by heat than those in rich countries. Low quality of sleep was also identified as a potential channel by which heat could affect learning. Furthermore, the effect of 1 degree C increase in the annual max WBGT on the standardized PISA scores exacerbates when it is combined with high unhealthy levels of PM2.5, decreasing the scores by up to 64% more than when combined with acceptable pollution levels.

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Increasing temperatures and air pollution have negative impacts on human health and short-term cognitive performance, however it is not clear the independent and synergistic effects that heat and poor air quality have on long-term learning of students at the global level. Our findings provide evidence of the magnitude by which chronic exposures to heat and air pollutants, evaluated separated and combined, can degrade learning and ultimately, economic growth, particularly in hotter and poorer countries, exacerbating inequalities. This has a strong impact on human capital development and ultimately, on economic growth, particularly in hotter and lower-income countries, exacerbating inequalities. Policy interventions aimed to mitigate the effect of heat and air pollution, and particularly in school classrooms and homes, could help protect children and adolescents against the harmful effects, providing important economic benefits for those countries in the short and long term.

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