Heat and air pollution degrade learning and human capital development: global evidence from OECD PISA exams 2000-2018

Natalia Borzino[a]; Matthias Otto[b]; Tord Kjellstrom[b] and Jason Kai Wei Lee[c]

[a] Singapore ETH Centre (SEC), Singapore
[b] Health and Environment International Trust (HEIT), Mapua, Nelson, New Zealand.
[c] Yong Loo Lin School of Medicine, National University of Singapore (NUS)

We provide estimates of the causal effect of heat stress and air pollution on long-term learning ability and human capital accumulation using global data from the 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 (PM2.5) as a measure for air pollution. Our results suggest that heat stress and low air quality significantly degrade short-term cognitive performance, driven by a long-term accumulative impact of both heat and air pollution. Indeed, we found that a 1°C increase in the annual max WBGT and 1 ug/m3 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 arriving to a negative impact on the scores by 6.3% of a standard deviation. Furthermore, the effect of a 1°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 7.9% of a standard deviation. These findings provide evidence of the magnitude to which chronic exposures to both heat and air pollutants, evaluated separated and combined, can degrade learning, human capital development and ultimately, economic growth. Globally, climate change can unfairly penalize hotter regions and poorer countries and further exacerbate inequalities and compromise their human capital stock. We believe that policy interventions aimed to mitigate the effect of heat and air pollution in cities, and particularly in school classrooms, could help protect children and adolescents against the harmful effects. Investments made in this sense may confer important economic benefits for those countries in the short and long term.