# Disaster Exposure in Childhood and Adult Noncognitive Skill: Evidence from the Philippines

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# Disaster Exposure in Childhood and Adult Noncognitive Skill: Evidence from the Philippines*

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Abstract

The relevance of non-cognitive skill to individuals' socio-economic outcomes has become a crucial point of interest. The literature suggests that those who possess growth mindsets—the belief that intelligence and ability can be developed—are more likely to succeed academically and respond better to adversity and social exclusion. However, how these beliefs or mindsets are formed are scarcely explored. Exploiting exogenous variations in the timing and path of tropical cyclones in the Philippines, this study examines the persistent effects of experiencing natural disasters in childhood on adult growth mindset. Results reveal that exposure to more tropical cyclones during in utero and infancy leads adults to believe that intelligence and ability are fixed and cannot be developed. We also provide evidence that this effect is mediated by poor childhood nutrition and health. Such findings point to the significance of prioritizing infant and maternal care in disaster and climate policy.

Keywords: implicit theories of intelligence; growth mindset; fetal origins hypothesis; tropical cyclones; climate change

JEL Codes: I25; J24; O15

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## 1. **Introduction**

Non-cognitive skill and personality traits have been recognized to play pivotal roles in lifetime success (Heckman et al. 2006). Previous studies show that individuals who believe that one's intelligence or ability is malleable and can be developed (possession of growth mindset) are more likely to perform well in school and respond better to social exclusion and adversity (Claro et al., 2016; Romero et al., 2014; Yeager & Dweck, 2012). These findings resulted to experiments and interventions in the classroom which seek to cultivate and *teach* growth mindsets (Blackwell et al., 2007; Damgaard and Nielsen, 2018; Kim et al., 2022; Outes-Leon et al., 2020; Yeager et al., 2019).[1]

However, three crucial issues remain. First, the determinants of growth mindset outside the school, such as household and community conditions, have scarcely been explored, except for the studies which demonstrate the poorer mindsets among females, ethnic minorities, and individuals from low-income households (Aronson et al., 2002; Bayer et al., 2020; Claro et al., 2016). This knowledge gap is critical as such conditions may diminish or even counteract the effectiveness of growth mindset interventions (Damgaard and Nielsen, 2018; Dweck and Yeager, 2019). Second, the focus on the school setting also prevents the measurement of and inquiry into *adult* mindsets. If certain experiences negatively affect the mindset of children, their effects may plausibly persist into adulthood. Longer-term impact of early life conditions suggests more relevance of corresponding policies and interventions. Third, majority of existing studies on mindsets are based in developed countries, while evidence from developing countries is scarce.

This study bridges these gaps in the literature by estimating the impact of socio-economic conditions in childhood on the mindsets later in life. Specifically, it examines the impact of exposure to tropical cyclones in the Philippines. Tropical cyclones are the most prevalent hazards with respect to economic losses, accounting for 38% of disaster related losses from 1970 to 2019 worldwide, and the Philippines experienced the greatest number of tropical-cyclone related disasters (15% of total) (World Meteorological Organization, 2021). Because these may cause damage to household property, shifts to consumption, and the reallocation of

[1] For example, in the experimental study by Kim et al. (2022), students in the treatment group were given a brief scientific article to read about growth mindset and provided an exercise that emphasized the idea that intelligence and ability are not fixed, and that extra effort and effective strategy use on their part can translate to a growth in these over time.

investments away from health and education (Björkman-Nyqvist 2013; Dercon and Porter 2014; Deuchert & Felfe, 2015; Herrera-Almanza & Cas, 2021), there is reason to believe that experiencing tropical cyclones during childhood has a long-lasting effect on mindset formation. Nonetheless, these impacts have not been explored in the literature.

The present study employs data from the Skills Toward Employment and Productivity (STEP) Skills Measurement Household Survey and a unique tropical cyclone frequency index. The STEP is a uniquely designed household survey which has been used to measure non-cognitive or socio-emotional skills in low and middle-income countries. Meanwhile, the index tracks the respondents' early life tropical cyclone experience by matching them with their respective provinces' exposure to tropical cyclones during several periods of their childhood. The identification strategy exploits the natural experiment arising from the exogenous variation in the trajectory and timing of tropical cyclones conditional on the province fixed effects.

The results show that increased exposure to tropical cyclones during in utero and infancy leads adults to believe that their intelligence and ability cannot be developed. We also provide evidence that these effects may be mediated by poor childhood nutrition and health.

These findings make three contributions to the literature. The first contribution is to the broad literature on the fetal origins hypothesis. Barker's (1990) seminal study argues that individuals who had been exposed to adverse conditions in utero are more prone to suffering chronic illnesses later into adulthood. Economic studies have since expanded on this by exploring a wide array of circumstances—e.g., pandemics, economic depressions, and civil conflicts—to analyze their impact on the adult outcomes, such as educational attainment and asset holding.[2] To the best of our knowledge, this is the first study to uncover the fetal origins of growth mindset and their mechanisms. Second, this paper also contributes to the growing literature regarding the belief formation. Earlier studies associate prior exposure to adverse conditions with beliefs about returns to financial market participation, prosociality, and efforts (Giuliano & Spilimbergo, 2014; Krutikova & Lilleør, 2015; Malmendier & Nagel, 2011; Shoji, 2018; 2021). This study points to the connection between early life circumstances and individuals' beliefs about their abilities and the value of skills development. Third, earlier studies on the mindset formation have demonstrated the significant association between gender, ethnicity, and economic conditions and the growth mindset (Aronson et al., 2002; Bayer et al.,

[2] See, for example, Akresh et al. (2012), Adhvaryu et al. (2019), Almond & Mazumder (2014), Bundervoet et al. (2009), Cutler et al. (2010), Maccini & Yang (2009), and Majid (2015).

2020; Claro et al., 2016). This study contributes to this literature by demonstrating the relevance of health conditions in childhood.

Parallels can be drawn between this paper and the earlier work of Krutikova & Lilleør (2015) and Shoji (2021). Both studies look at the effects of experiencing low rainfall in childhood on adult non-cognitive skills, such as core self-evaluation and locus of control, respectively. However, the present study differs from their studies, in that, we analyze the growth mindset, whose formation process is less understood in the literature. Furthermore, we observe the impact of tropical cyclones, which cause destructive effects on housing, assets, and infrastructure. These studies are complementary in the sense that they provide an abundance of evidence highlighting the association between early life circumstances and adult outcomes.

This study is outlined as follows: Section 2 proposes the linkages between early life tropical cyclone exposure and adult mindset based on the existing threads. Section 3 and Section 4 describe the dataset and identification strategy, respectively. Section 5 presents the empirical results, while Section 6 addresses potential threats to identification and conducts tests for robustness. Section 7 discusses underlying mechanisms and finally, Section 8 concludes.

## 2. **Conceptual Framework**

### 2.1. **Growth Mindset: Significance and Mechanism of Formation**

Leggett (1985) proposes that individuals' mindsets—defined as their beliefs on the nature of their own intelligence or ability—could be categorized as either incremental or entity; individuals with incremental or *growth* mindsets believe that intelligence and ability are a malleable and fluid quality that can be developed while people with entity or *fixed* mindsets hold that they are uncontrollable and crystallized. Dweck and Leggett (1988) later find that children with growth mindsets are more likely to be interested in improving their skills and competence, while those with fixed mindsets are more inclined to accomplish tasks in order to receive praise or avoid punishment. Later studies also show that compared to individuals who possess fixed mindsets, those who hold growth mindsets are more likely to welcome challenges if they lead to higher levels of skill mastery (Blackwell et al., 2007), exert initiative toward self-regulated learning (Dweck & Master, 2008), and see failure as a setback which can be corrected with increased effort (Dweck et al., 1995).

In line with these arguments, previous research shows preferable consequences of the growth mindset. Specifically, it reliably leads to an upward trajectory in grades among school-aged individuals (Blackwell et al., 2007; Romero et al., 2014; Yeager et al., 2019). Furthermore, growth mindsets among disadvantaged persons—such as students from low-income families, those subjected to racial bias, and teenagers transitioning from middle school to high school—are also associated with higher resilience, allowing them to overcome academic setbacks associated with adversity, social exclusion, and victimization (Aronson et al., 2002; Claro et al., 2016; Yeager & Dweck, 2012).

Given these strands in the literature, recent studies emphasize honing growth mindsets in children to achieve the predicted desirable outcomes. The academic intervention which directly *teaches* growth mindsets is one example (Blackwell et al., 2007; Damgaard and Nielsen, 2018; Kim et al., 2022; Outes-Leon et al., 2020; Yeager et al., 2019). Students are explicitly taught about the concept of "malleable intelligence" that learning changes the brain by forming new neural pathways, and that they have agency in and control of this process, through the sessions of reading, group activities, and discussion. They find positive effects of such an intervention on students' learning motivation and performance.

Furthermore, such interventions are beneficial particularly for students from disadvantaged backgrounds, as these could temper the effects of their handicap, whether perceived or material, on achievement. An online intervention to a nationally representative sample of middle to high school students in the United States was determined to have improved the grades among low-achieving students and increased participation in advanced mathematics courses (Yeager et al., 2019). Aronson et al. (2002) and Claro et al. (2016) along with a meta-analytic review by Sisk et al. (2018) also demonstrate supporting evidence.

On the other hand, the literature on mindset formation outside the classroom setting is still relatively scarce compared to the literature on growth mindset interventions. However, there are a few studies suggesting that past experiences inform individuals' estimation of their abilities. Studies of high school students from low-income backgrounds in Chile (Claro et al., 2016) and African-American college students (Aronson et al., 2002) show that both groups are more likely to hold fixed mindsets. These studies suggest that the lack of access to educational resources and "stereotype threat" could play a hand in making people believe that their intelligence and ability cannot be developed. Haimovitz and Dweck (2017) argue that parents who view and communicate failure as opportunities for learning tend to foster growth mindsets in their children regardless of the parents' mindset.

### 2.2. **The Fetal Origins Hypothesis and Belief Formation**

The broad literature on the fetal origins hypothesis may provide some leads to this quandary. The seminal study by Barker (1990) argues that individuals who had experienced adverse living conditions from in utero to childhood, such as poor maternal environment, housing, and diet, are more likely to become overweight as adults. Sufferers are also found to be more prone to diagnosis of diseases associated with obesity, including cardiovascular problems and diabetes. These suggest that the effects of poor "critical period" conditions are persistent and that they may remain latent until late into adulthood.

Since Barker (1990), focus has been directed to the effects of a wide array of early life circumstances—such as civil conflicts (Akresh et al., 2012; Singhal, 2019), outbreaks of diseases and famines (Banerjee et al., 2007; Cutler et al., 2010), and weather shocks (Maccini and Yang, 2009)—on various adult outcomes far beyond physiological health such as educational attainment and wages (Almond and Currie, 2011; Almond et al., 2018).[3]

The literature also suggests that conditions in early and later childhood determines individuals' beliefs and attitudes. Krutikova and Lilleør (2015) reveals that increased rainfall during in utero leads to higher adult core self-evaluation, a latent personality trait that indicates "the degree to which one has a generally positive and proactive view of oneself and one's relationship with the world" (p. 3). Shoji (2021) finds ample complementary evidence that experiencing rainfall *shortages* during early childhood leads people to believe that they cannot control life outcomes. It was also revealed that individuals who had experienced times of recession reported less financial risk-taking behavior and stock market participation, increased preference toward government redistribution and left-wing politics, and belief that success depends more on luck than effort (Giuliano & Spilimbergo, 2014; Malmendier & Nagel, 2011). These studies illustrate how exposure to negative conditions in different periods of life forms individuals' personality and belief which could potentially be extended to mindsets.

[3] For example, Majid (2015) uncovers that adult Muslims who had been exposed to maternal fasting during Ramadan in utero perform more child labor, score lower in cognitive and math tests, work fewer hours, and are more likely to be self-employed. Maccini and Yang (2009) find that Indonesian women who had experienced higher rainfall during infancy were taller, completed more schooling years, and held more assets. The most plausible explanation for such results is the increase in agricultural output, leading to higher investment in healthcare and education.

## 2.3. **The Climatology and Impact of Tropical Cyclones in the Philippines**

The Philippines is one of the most disaster-prone countries due to its geography and geology (Dilley et al., 2005). In particular, tropical cyclones, which are often accompanied by flooding, landslides, and storm surges, are the most frequently occurring hazards. According to Cinco et al. (2016), an average of 19.4 tropical cyclones enters the Philippine Area of Responsibility each year, around nine of which cross the country and make landfall.

Because the Philippines, like the other developing countries, is dependent on favorable weather for livelihood and productivity, geographical regions which are most prone to weather shocks and meteorological or hydrological disasters are also most susceptible to their potential long-term negative impact. Anttila-Hughes and Hsiang (2013) estimate that an average Filipino household's income is reduced by 6.57% due to tropical cyclone exposure in the previous year. Significant reductions to human capital investments are also found, such as those toward education (13.3%) and medicine (14.3%). Deuchert and Felfe (2015) and Herrera-Almanza and Cas (2021) later find that individuals who had experienced in childhood one or two super typhoons are more likely to have lower educational attainment, suggesting the perverseness of tropical cyclones' effects on capital accumulation.

Given the frequency with which tropical cyclones impact the Philippines, households must already consider and include risks associated with disasters in their decisions (Mendelsohn, 2000; Sawada, 2017; Viganò & Castellani, 2020); thus, the continued observance of large negative effects to households suggests that adaptation mechanisms are lacking, expensive, or both. At the same time, the unanticipated increased frequency of tropical cyclones may also subvert household expectation and budget allocation potentially leading to even more debilitating effects, whether direct or possibly long-term.

## 2.4. **Pathways to Mindset Formation**

The arguments in the previous sections suggest that early life tropical cyclone frequency shocks might affect mindset formation through two underlying mechanisms, namely education and health. First, the literature deems the classroom as the most crucial channel for mindset formation, and the exclusion from educational resources due to poverty (Claro et al., 2016) and racial bias (Aronson et al., 2002) leads individuals to hold fixed mindsets. However, frequent exposure to tropical cyclones aggravates children's access to educational resources for three reasons. First, they may damage infrastructure such as schools and roads, affecting the access physically. Second, tropical cyclones cause income and asset loss, leading the affected households to binding the credit constraint (Björkman-Nyqvist, 2013). Third, the negative shocks of tropical cyclones aggravate children's cognitive skills and health conditions, and these subsequently affect their schooling (Alderman et al., 2006; Bharadwaj et al., 2013; Maccini and Yang, 2009). The first two reasons indicate the significance of tropical cyclone exposure in the schooling period, while the third suggests that even the exposure in the preschool period could affect schooling as well.

Second, earlier studies have demonstrated that natural disasters negatively affect children's health conditions, such as nutrition intake and disability (Dercon and Porter 2014). Furthermore, children with disabilities and development delays e.g., those who weigh less, or are of shorter stature than their peers, associate their perceptions of their health with their ability to play and participate in school (Almqvist et al., 2006; Benjamin et al., 2017). This suggests the effects of experiencing natural disasters in childhood on individuals' beliefs and perceptions about their ability. Therefore, it is plausible that the effects on the perceptions may spillover to mindsets, causing individuals to believe that their ability or intelligence is deficient and cannot be developed.

## 3. Data

### 3.1. STEP Survey

#### 3.1.1. Sample

The present study makes use of two datasets. The first is the Skills Toward Employment and Productivity (STEP) Skills Measurement Household Survey, which has been designed by the World Bank and conducted in low and middle-income countries from 2012 to 2017. The survey in the Philippines was conducted with 3000 respondents between 2015 and 2016.

The survey households were selected through the following processes; First, the survey team defined urban barangays as barangays (1) with a population over 5,000, (2) those with at least one establishment over 100 employees, or (3) those with five or more establishments of 10 to 99 employees and with five or more defined public facilities within 2 km of the barangay administrative center.[4] The urban barangays are further divided into approximately equally

[4] The Philippines is divided into four primary geographic and administrative segments. The first are the 17 regions which span the three main island groups of Luzon, Visayas, and Mindanao in the Northern, Central, and Southern Philippines, respectively. These 17 regions are further subdivided into 81 provinces which then comprise 146 cities and 1,488

sized segments, each containing around 100 households. The primary sampling unit (PSU) of the survey is these urban barangay segments. Second, 200 PSUs and 25 replacement PSUs are randomly selected from the 5,028 urban barangay segments identified. Third, 15 dwellings and 15 replacement dwellings e.g., neighborhood compounds, apartment complexes, or condominiums are chosen in each PSU using a systematic random method.[5] Fourth, one household is selected from each dwelling with equal probability. Finally, one non-institutionalized individual aged 15 to 64 is randomly selected from each household.[6] An overall response rate of 94.8% was achieved with a total of 3,000 individuals interviewed, of which 165 are replacements.

Given the unavailability of data on the birthplace of respondents in the STEP survey, incorrectly assuming that all respondents were born in their current province of residence may result to a bias. This study addresses this by exploiting that the respondents who have had some degree of formal education were asked whether the province of their most recent educational institution attended was the same as that of their current residence. Among 2,424 respondents who answered this question, 502 reported that they previously studied outside their provinces. Hence, they are confirmed to have migrated at some point and are therefore excluded from the sample.

The remaining 2,498 respondents are then more likely to have resided in the same province since birth, and therefore used for our main analyses. One may be concerned that included in this sample are 576 respondents who did not have any formal schooling and thus

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municipalities. These are finally partitioned into the 42,046 barangays, the country's smallest administrative unit.

[5] 25 replacement PSUs and 15 replacement dwellings/households within each of the 225 PSUs are selected as reserves. The latter are activated when pre-selected households cannot respond due to refusal or inability to be interviewed, language problems, interviewers' difficulty in identifying dwellings, etc. In the case of the 2015-2016 Philippine cohort, the 25 replacement PSUs were not utilized, and 165 dwellings were activated due to the non-response of 165 pre-selected households.

[6] Non-institutionalized individuals are defined as those who do not reside in institutions e.g., prisons and hospitals, senior homes and hospices, and other group dwellings such as college dormitories and halfway homes.

cannot be verified whether they have resided in the same province since birth. Furthermore, migration before schooling cannot be fully ruled out even for the respondents who have studied in the same province. However, these concerns are unlikely to be serious for five reasons. First, Bohra-Mishra et al. (2017) argue that although higher typhoon incidence results in more internal outmigration, these are often short-distanced, with families using social networks to move to the nearest safe location, and are driven by reduced agricultural output (Dun, 2011; Gray & Mueller, 2012; Hassani-Mahmooei & Parris, 2012; Lu et al., 2012). Second, they also find that men and those with higher levels of education are more likely to migrate farther due to climate variability as financial, social, and human capital are strong determinants of migration (Bohra & Massey, 2009; Massey & Espinosa, 1997). These arguments support the use of the location of the last school attended as a proxy for birthplace, as uneducated individuals are unlikely to be migrants given their lack of capacity to migrate especially to urban barangays. In addition, none of the respondents are in the agricultural sector. Third, the frequency of tropical cyclones should not differ significantly between the respondents' current province and home province if these are located close to each other. Fourth, if the measurement errors in the tropical cyclone exposure among those with no educational background did result to bias, it would merely be an attenuation bias, because of the randomness of the trajectory of tropical cyclones. Therefore, this issue cannot explain away the significant impact of tropical cyclone exposure. Finally, robustness checks will be conducted later using the sample comprising only those who studied in the same province.

Table 1 presents the descriptive statistics of the 2,498 respondents available for analysis. The average respondent is observed to be around 37 years old, born in 1977 with 8.349 years of completed schooling. Figure 1 maps the geographic distribution of the survey respondents. The survey covers 39 out of 81 provinces in all 17 administrative regions including the four districts of the National Capital Region.

[Table 1]

[Figure 1]

### 3.1.2. Measures

A distinct feature of the STEP survey is the availability of questions for Dweck et al.'s (1995) "Growth Mindset Scale", particularly:

*Now we would like to ask you some different questions. For these questions, we want to know how much you agree or disagree with them[. From a scale of 1 or "strongly disagree" to 6 or "strongly agree",] How much do you agree or disagree with this statement…*

1. *You have a certain amount of intelligence, and you really can't do much to change it.*
2. *Your intelligence is something about you that you can't change very much.*
3. *You can learn new things, but you cannot really change your basic intelligence.*

The scale has been used in previous research to reliably elicit the mindsets of African American college students (Aronson et al., 2002), financially disadvantaged high school students (Claro et al., 2016), and adults (Thompson et al., 2013). In our sample, Cronbach's alpha is 0.92, demonstrating the high internal consistency and validity of the items. Responses are then averaged to obtain the growth mindset scores. Mean score in the sample is 2.893 with a standard deviation of 1.417. Figure 2 illustrates the histogram of results from the survey. The two humps in the distribution highlight the bimodal divide of mindsets between growth and fixed mindsets.[7]

[Figure 2]

Various measures for adult health outcomes are also readily available in the survey. Height was measured in centimeters while weight was self-reported in kilograms. Variables for body mass index (BMI) classifications such as "underweight" ($BMI < 18.5$), "healthy weight" ($18.5 < BMI < 30$), and "obese" ($BMI > 30$) are derived from these measures. Respondents were also asked if they were suffering from chronic diseases such as diabetes, asthma, cancer, hypertension, etc., and also the number of days they were not able to conduct their usual activities due to such chronic diseases, other health problems, and/or accidents. We construct three health outcomes using these variables: (1) the adult height standardized by gender, (2) the binary indicator of healthy weight in BMI, and (3) the indicator of "active in the past four weeks" which takes unity if the respondents had no inactive days due to the chronic diseases. Table 1 presents the summary statistics.

### 3.2. Tropical Cyclone Frequency Index

[7] The survey also includes questions for the other noncognitive skills and preferences, such as Big 5, grit, time preference, and risk preference. However, they only make use of single-item questions to elicit them, which may have validity and reliability issues (Schmidt, 2018).

The second dataset is a unique tropical cyclone frequency index constructed using the Western Pacific tropical cyclone best track dataset (BTD) from the National Oceanic and Atmospheric Administration's (NOAA) International Best Track Archive for Climate Stewardship (IBTrACS) and the "Philippines – Subnational Administrative Boundaries" geographic dataset from the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) in the Philippines.

IBTrACS contains aggregated BTDs from various operational meteorology agencies such as the United States' Joint Typhoon Warning Center (JTWC) and the Japanese Meteorological Agency's (JMA) Regional Specialized Meteorological Centre (RSMC) in Tokyo (Knapp et al., 2010). These BTDs comprise data such as the location of tropical cyclones, wind speeds and radii which are recorded in three-hour intervals. The JMA-RSMC is responsible for recording tropical cyclone activity and issuing relevant advisories within the Western Pacific basin where the Philippine archipelago is located. From the dataset spanning from 1884 to the present, the tracks of 984 tropical cyclones which entered the Philippine Area of Responsibility from 1949 to 2014 were identified. Tropical depressions, or tropical cyclones with a maximum wind speed of 61 km/h, recognized by the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAG-ASA) were excluded because they are not recorded by the JMA-RSMC.

Meanwhile, the OCHA's dataset comprises the geographic boundaries of three of the four administrative levels of the Philippines, namely, the regional, provincial, and municipal and city levels. It is derived from survey data from the Philippine Statistics Authority (2017) and the National Mapping and Resource Information Authority (NAMRIA) (The United Nations Office for the Coordination of Humanitarian Affairs, 2020).

To construct the index, the tropical cyclone tracks and provincial administrative boundaries are first rendered using geographic information system (GIS) software. Then, a spatial join algorithm is used to tally how many times a provincial boundary is directly traversed by tropical cyclones each year beginning in 1949. Figure 3 depicts a summary of the climatology of tropical cyclones. Finally, the weather shock is thus defined as the tropical cyclone exposure shock given by the formula $Weather_{jt} = W_{jt} - \overline{W_j}$ where $W_{jt}$ denotes the number of tropical cyclone exposures in province $j$ in year $t$ and $\overline{W_j}$ is the provincial mean over the years available.

After combining the two datasets according to the respondents' birth province and year, the shock is identified for three periods: from in utero to infancy (the previous year and the yea of birth), pre-school period (1 to 6 years since birth), and elementary school period (7 to 12 years since birth). The histograms for each measure are depicted in Figure 4. Around 8.69% of the sample had been exposed to at least one more tropical cyclone during in utero and infancy compared to the mean exposure frequency of their respective provinces.

[Figure 3]

[Figure 4]

4. **Identification Strategy**

This study identifies the effect of tropical cyclone exposure in early life on adult mindset following the ordinary least squares (OLS) model:

$$Mindset_{ijt} = \beta Weather_{jt} + \mu X_{ij} + \theta_j + \delta_t + \epsilon_{ijt} \quad (1)$$

where $Mindset_{ijt}$ denotes the mindset score of respondent $i$, born in province $j$ in year $t$. $Weather_{jt}$ includes the slate of previously defined tropical cyclone exposure shocks for each period of early life. $X_{ij}$ comprises controls for gender, language, and the respondents' parents' educational attainment. Province and birthyear fixed effects are also controlled for by $\theta_j$ and $\delta_t$, respectively. $\theta_j$ absorbs observed and unobserved provincial-level characteristics, such as agro-climatic, geographic, and socio-economic conditions at the time of survey. [8] The coefficient of interest is $\beta$ in this model. Controls for other characteristics such as the respondents' educational attainment, employment, or socio-economic status, either in childhood or at the time of the survey, are not included as these could potentially be determined by early life circumstances and may dampen the magnitude of $\beta$. Standard errors are clustered at the provincial level (39 clusters). The identification strategy exploits the natural experiment arising from the exogenous variation in timing and trajectory of such cyclone shocks conditional on the provincial and birthyear fixed effects. Potential threats to identification, such as sample selection and measurement errors, are carefully discussed in Section 6.

[8] For example, provinces in Northern and Central Philippines are more likely to experience weather shocks compared to those in the South as illustrated by Figure 2. Such characteristics must be absorbed by provincial fixed effects.

## 5. **Results**

Table 2 presents the estimation results. Based on Column (1), people who had been exposed to more tropical cyclones during in utero and infancy are more likely to believe that their intelligence and ability is fixed and cannot be changed. An increase in the frequency of tropical cyclones beyond the provincial average leads to 0.05 standard deviation decreases in the growth mindset score. The coefficients of tropical cyclones in the preschool and schooling periods are smaller in magnitude and statistically insignificant. Column (2) estimates the model using the sample in rural provinces, suggesting the robustness of findings.[9]

It is difficult to compare the effect size of our results with that of previous studies, given the lack of studies analyzing the formation process of adult mindset in developing countries. Therefore, we compare the coefficient of tropical cyclone exposure with that of male dummy in Table 2. The literature confirms significant gender differences in noncognitive skills, such as mindset, grit, and locus of control (Dweck, 2013; Dyal, 1984; Lloyd et al., 2005; Sigmundsson, et al., 2020), and these are a critical issue in the literature. As predicted by the literature, Column (1) shows that males' growth mindset score is 0.45 standard deviation higher than women. This suggests that the impact of experiencing one additional tropical cyclone in childhood on adult mindsets is equivalent to 12% of the impact of gender. Therefore, the impact of tropical cyclone exposure is not only statistically significant but also substantial.

Columns (3) and (4) test the heterogeneity of impact across genders by additionally controlling for the interaction terms between the tropical cyclone exposure and male dummy. Unlike previous studies that have demonstrated larger impacts of economic shocks in early life for females than for males (Datar et al., 2013; Maccini & Yang, 2009; Rose, 1999; Shoji, 2021), we do not find significant heterogeneity. The interaction terms are positive, as expected, but statistically insignificant.

[Table 2]

## 6. **Threats to Identification and Robustness Checks**

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[9] The rural subsample excludes respondents who were born or reside in the four districts of the National Capital Region and the provinces of Davao del Norte and Davao del Sur, identified by the National Economic and Development Authority as areas belonging in the metropolitan centers Metro Manila and Metro Davao, respectively.

6.1. **Sample Selection**

Our sample may be subject to the sample selection problem through three stages. First, it has been established that extreme weather events like tropical cyclones are associated with increased risk of mortality, including stillbirths and child mortality, and out-migration (Deschênes & Moretti, 2009). Second, even if the shocks do not affect the population distribution through the mortality and out-migration, the affected people may be more likely to refuse to participate in the STEP survey if they negatively affect the literacy level. Third, the sample selection could occur because of the exclusion of those who studied in the other provinces from the sample. If the excluded respondents' migration to the current province was driven by tropical cyclones, our sample may exclude those who had been particularly vulnerable to the shocks. These possibilities suggest that appropriately addressing the sample selection problem should make the estimated impact even larger. Therefore, this issue cannot explain away our findings in Section 5.

Nonetheless, we conduct the following analyses to assess each of these possibilities; First, if increased exposure to tropical cyclones in childhood leads to mortality and out-migration, then the provincial population sizes of the cyclone-affected cohort should be smaller than that of non-affected cohort at the time of the survey. Using province-level panel data, we regress the following OLS model;

$$\log\left(N_{jt}\right) = \gamma Weather_{jt} + \theta_j + \delta_t + \epsilon_{jt} \quad (2)$$

where, $N_{jt}$ denotes the population size of those who were born in year *t* and reside in province *j* at the time of the survey. The other variables are defined in Section 4. We expect $\gamma = 0$. The data on provincial population comes from the Philippine Population Census in 2015. Table A1 shows the results. Columns (1) through (3) use the data on all provinces, while Columns (4) through (6) restrict the sample to the study site of the STEP Survey. The coefficients of tropical cyclone exposure are small and statistically insignificant, supporting our identification strategy.

Second, regarding the potential issue of low response rate among the cyclone-affected people, we consider that it is unlikely to be severe given the high response rate in the survey, as mentioned in Section 3.1.1 (94.8%).

Third, to assess whether the exclusion of those who studied in the other provinces can explain the negative coefficient, we compare the respondent characteristics between those who studied in the same province and those from the other provinces. Table A2 shows that the former group exhibits higher growth mindset score and taller height than the latter group, while parents' education levels, a predictor of vulnerability to natural disasters in childhood, is comparable between the groups.[10] These results imply that the exclusion of the latter group cannot explain our findings.

Finally, to examine the overall severity of sample selection issue through all the three stages, we estimate Equation (2) using the final sample size from each birthyear and province as the dependent variable, instead of the population size. Similar to the previous hypothesis, if there is sample selection, then tropical cyclone exposure during in utero and infancy should have a significantly negative impact on the number of observations from each cohort. Table A4 demonstrates that tropical cyclones during in-utero and infancy are uncorrelated with the sample size. By contrast, the tropical cyclone exposure in the preschool period is negatively associated with the number of male respondents (Column (2)). However, the coefficient becomes smaller and marginally significant in the rural sample (Column (5)). This is counter to the pattern predicted by the sample selection, because the impact of tropical cyclones on the mortality and migration should be even larger in such areas.

The results in this subsection suggest that potential sample selection in the datasets is unlikely to be crucial, if any. We should also mention that these results do not necessarily dispute previous studies which show that natural disasters are associated with increased child mortality and migration. Whereas previous studies emphasize the effects of devastating natural disasters, such as super typhoons, the present study also comprises the effects of "weak" tropical cyclones such as tropical storms.

### 6.2. **Measurement Error in the Frequency of Tropical Cyclones**

Our measure of the frequency of tropical cyclones is subject to the measurement errors, mainly due to two issues. First, our sample includes the 576 respondents without formal education whose information about the home province is unavailable. Second, poor and old villagers may not remember their age accurately and report an approximate age (age heaping). These cause a measurement error in the shock variables if the survey data are matched with the tropical cyclone data in the wrong province and year, thereby resulting to attenuation bias toward zero. To address these possibilities, first, we estimate the models after dropping the 576

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[10] In Table A3, using the subsample of those who had ever attended school, we regress the indicator of attending the school in the same province on the predetermined respondent characteristics, birthyear fixed effects, and province fixed effects. The results also confirm that there is no systematic difference between the groups.

respondents. Second, since the recall error is likely to become larger with the respondent's age, we estimate the model after dropping those aged 50 or over. The results in Table A5 are robust to the changes in the sample. A distinction in this table is that tropical cyclone exposure in the schooling period is positively associated with the growth mindsets in Column (1), although this is not robust in the other specifications.

## 7. **Mechanisms**

In Section 2, two hypotheses were presented regarding the channels through which early life tropical cyclone exposure could lead to fixed mindsets in adults: education and health. First, cyclone shocks even before the schooling period could affect the educational attainment if they harm children's cognitive skills. To test the plausibility of this channel, we regress the respondents' educational attainment on the same independent variables as the benchmark estimation, given the unavailability of data on the cognitive skills. Table 3 shows that respondents' educational attainment is uncorrelated with the frequency of tropical cyclone exposure in their childhood. This provides evidence counter to the education hypothesis. It is important to note that these results do not necessarily dispute previous findings which associate experiencing super typhoons with lower educational attainment, such as Deuchert and Felfe (2015) and Herrera-Almanza and Cas (2021), since our data include moderate and severe cyclones.

The second hypothesis may likewise be tested by estimating the effect of the exposure to early life tropical cyclones on adult health outcomes, such as standardized height, indicator of healthy weight in BMI, and indicator of being active during the past four weeks. The results on the adult height are particularly relevant because adult height is a strong predictor of nutrition and resource availability before age five (Fogel, 1994; Maccini & Yang, 2009; Schultz, 2002, 2005; Steckel, 1995; Strauss & Thomas, 1998).

Table 4 demonstrates the patterns in line with the health hypothesis. Column (1) presents that an increase in the frequency of tropical cyclone exposure during in utero to infancy leads to 0.065 standard deviation decrease in adult height. Furthermore, the tropical cyclones in the preschool and schooling periods do not affect the height, in line with the results in Table 2. Column (5) shows that it is also associated with the decrease in the propensity of being physically active by 1.9 percentage points, while the coefficient of tropical cyclones in the preschool period is counter-intuitively positive. These results are robust to the use of rural subsample (Columns (2) and (6)).

To explore the plausibility of health hypothesis more carefully, we regress the mindsets on the health outcomes in addition to the independent variables in Equation (1). If the health conditions are a major channel, we should observe that the coefficients of health outcomes are significantly positive and the coefficient of tropical cyclones in childhood becomes smaller than the results in Table 2 (Maccini and Yang, 2009).[11]

Table 5 provides supporting evidence. Column (1) presents that the coefficient of adult height is positively associated with the growth mindset. The results are robust to the inclusion of other health outcomes in Column (7), although the results do not hold in the rural subsamples (Columns (2) and (8)). Regarding the coefficient of tropical cyclone exposure, the result in Column (1) is 6% smaller than the result of Column (1) in Table 2 (-0.052), and it becomes only marginally significant. Additional controls for the other health outcomes do not affect the magnitude of coefficient (Column (7)).

Given these results, a plausible interpretation for the underlying mechanisms is that tropical cyclones adversely impact individuals' nutritional intake, health development, and programming during their mothers' pregnancy and their infancy. Subsequently, cyclone-affected individuals have poorer beliefs about their own health, which in turn, negatively affects their beliefs about their ability and intelligence.

[Table 3]

[Table 4]

[Table 5]

## 8. **Conclusion**

This study reveals that frequent exposure to tropical cyclones during in utero and infancy leads individuals to believe that their intelligence or ability is fixed and cannot be developed even in adulthood. We also provide evidence that the effects of tropical cyclones on maternal, fetal, and infant health appear to be the most plausible pathway of influence.

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[11] This approach is, however, subject to potential concerns about omitted variables, measurement errors in the mediating variables, and reverse causality. The results should therefore be taken only as suggestive.

Three policy implications can be taken from these results. First, due to their frequency, tropical cyclones should already be a primary consideration in household budgets (Anttila-Hughes & Hsiang, 2013). However, the continued observance of both short-term and long-term impact suggests that adaptation and recovery mechanisms remain to be costly or inaccessible. Given the overwhelming evidence that more favorable critical period conditions are vital to long-term human development, policymakers are called to improve access to and prioritize childcare and maternal health in disaster risk reduction and recovery programs. Second, this study highlights how anthropogenic climate change is a globalized systemic risk with far-reaching temporal and spatial consequences (Goldin & Mariathasan, 2014). As tropical cyclones and other climatic disasters continue to intensify due to global warming, the importance of concerted climate action from the global community is expressed not only to deter climate change, but also to eradicate poverty and inequality. Finally, at the local level, the adage "the Filipino spirit is waterproof" has been ingrained into national consciousness since it was first coined in 2012 after Typhoon Gener (internationally known as Typhoon Saola) devastated Northern Philippines. The mantra was coined to echo the myth of "Filipino resilience": that no matter how many deluges, floods, and landslides affected the disaster-prone country, its population would always survive and recover. This study shows that survival comes with latent and debilitating costs that could otherwise be avoided if structural improvements were set in place.

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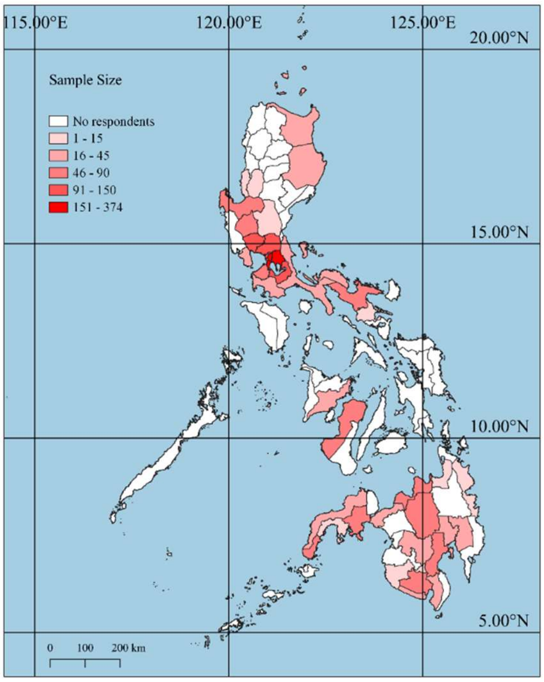


**Figure 1.** Geographical Distribution of the Final Sample

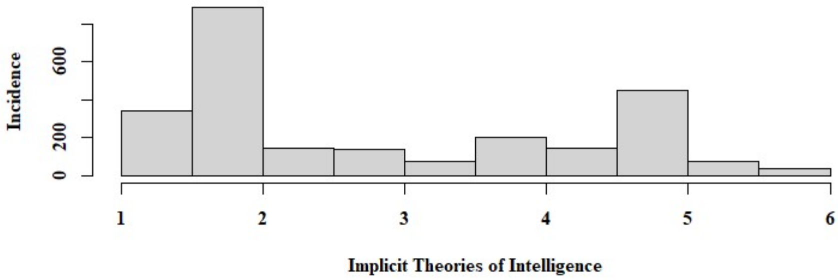


**Figure 2.** Histogram of Growth Mindset Scores

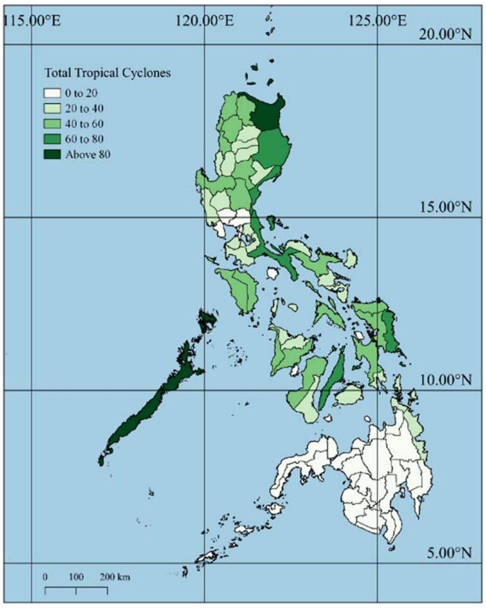


**Figure 3.** Philippine Tropical Cyclone Frequency Heatmap from 1949 to 2014.

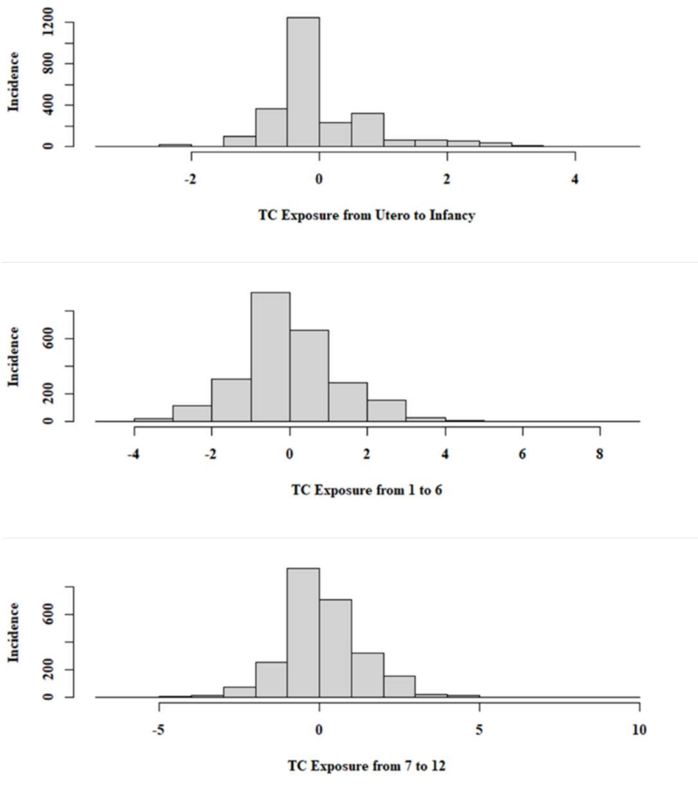


**Figure 4.** Histograms of Tropical Cyclone Exposure Deviation in Utero and Infancy (Top), in Preschool Period (Middle), and in Elementary School Period (Bottom)

**Table 1: Summary Statistics**

| Sample: | Full | | Rural | |
|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. |
| TC exposure in utero to infancy | 0.019 | 0.799 | 0.015 | 0.904 |
| TC exposure in preschool period | -0.015 | 1.243 | -0.057 | 1.420 |
| TC exposure in elementary school period | 0.098 | 1.258 | 0.087 | 1.460 |
| Growth mindset scale (standardized) | 0.000 | 1.000 | 0.059 | 0.997 |
| Male | 0.514 | | 0.502 | |
| Age | 37.130 | 12.839 | 36.882 | 12.787 |
| Year of birth | 1977.2 | 12.8 | 1977.4 | 12.8 |
| Ever attended elementary school | 0.786 | | 0.778 | |
| Completed elementary school | 0.581 | | 0.553 | |
| Mother's education level: | | | | |
| Less than primary | 0.542 | | 0.552 | |
| Primary | 0.127 | | 0.117 | |
| Lower secondary | 0.042 | | 0.033 | |
| Upper secondary | 0.035 | | 0.022 | |
| Higher than upper secondary | 0.254 | | 0.275 | |
| Father's education level: | | | | |
| Less than primary | 0.455 | | 0.464 | |
| Primary | 0.127 | | 0.111 | |
| Lower secondary | 0.078 | | 0.071 | |
| Upper secondary | 0.043 | | 0.031 | |
| Higher than upper secondary | 0.298 | | 0.323 | |
| Mother language: | | | | |
| Tagalog | 0.549 | | 0.434 | |
| Kapampangan | 0.084 | | 0.128 | |
| Visayan / Cebuano / Sinugbuanong Binisaya | 0.148 | | 0.176 | |
| Others | 0.219 | | 0.262 | |
| Height (standardized by gender) | 0.000 | 1.000 | 0.092 | 0.971 |
| Healthy weight (1 if 18.5<BMI<25) | 0.440 | | 0.442 | |
| Active in the past 4 weeks | 0.835 | | 0.815 | |
| N | 2498 | | 1588 | |

Notes: The rural subsample excludes respondents who were born or reside in the four districts of the National Capital Region and the provinces of Davao del Norte and Davao del Sur, identified by the National Economic and Development Authority as areas belonging in the metropolitan centers Metro Manila and Metro Davao, respectively.

**Table 2: The Impact of Tropical Cyclone Exposure on Adult Mindset**

| Dependent variable: | Growth mindset scale (standardized) | | | |
|---|---|---|---|---|
| Sample: | Full | Rural | Full | Rural |
| | (1) | (2) | (3) | (4) |
| TC exposure in utero to infancy | -0.052** | -0.058** | -0.054* | -0.078** |
| | (0.024) | (0.026) | (0.029) | (0.029) |
| TC exposure in utero to infancy | | | 0.004 | 0.040 |
| x Male | | | (0.049) | (0.047) |
| TC exposure in preschool period | -0.013 | -0.014 | -0.013 | -0.023 |
| | (0.021) | (0.022) | (0.030) | (0.033) |
| TC exposure in preschool period | | | 0.001 | 0.017 |
| x Male | | | (0.037) | (0.043) |
| TC exposure in elementary school period | 0.023 | 0.030* | 0.020 | 0.025 |
| | (0.016) | (0.016) | (0.026) | (0.029) |
| TC exposure in elementary school period | | | 0.006 | 0.010 |
| x Male | | | (0.035) | (0.034) |
| Male | 0.452*** | 0.478*** | 0.452*** | 0.477*** |
| | (0.045) | (0.049) | (0.046) | (0.049) |
| Controls | Yes | Yes | Yes | Yes |
| Year of birth fixed effects | Yes | Yes | Yes | Yes |
| Province fixed effects | Yes | Yes | Yes | Yes |
| Observations | 2,498 | 1,588 | 2,498 | 1,588 |

Notes: The OLS coefficients are reported. The standard errors clustered at the provincial level are presented in parentheses. Control variables include father's and mother's education level and mother language. *** p<0.01, ** p<0.05, * p <0.1.

**Table 3: The Impact of Tropical Cyclone Exposure on Educational Attainment**

| Dependent variable: | Ever attended elementary school | | Completed elementary school | |
|---|---|---|---|---|
| Sample: | Full | Rural | Full | Rural |
| | (1) | (2) | (3) | (4) |
| TC exposure in utero to infancy | 0.001 | -0.009 | 0.011 | 0.008 |
| | (0.013) | (0.012) | (0.014) | (0.014) |
| TC exposure in preschool period | -0.008 | -0.007 | 0.005 | -0.002 |
| | (0.008) | (0.007) | (0.008) | (0.008) |
| TC exposure in elementary school period | 0.004 | 0.001 | 0.004 | 0.003 |
| | (0.006) | (0.006) | (0.007) | (0.009) |
| Male | 0.030** | 0.037* | 0.022 | 0.027 |
| | (0.015) | (0.021) | (0.025) | (0.020) |
| Controls | Yes | Yes | Yes | Yes |
| Year of birth fixed effects | Yes | Yes | Yes | Yes |
| Province fixed effects | Yes | Yes | Yes | Yes |
| Observations | 2,498 | 1,588 | 2,498 | 1,588 |

Notes: The OLS coefficients are reported. The standard errors clustered at the provincial level are presented in parentheses. Control variables include father's and mother's education level and mother language. *** p<0.01, ** p<0.05, * p <0.1.

**Table 4: The Impact of Tropical Cyclone Exposure on Health Outcomes**

| Dependent variable: | Height (standardized) | | Healthy weight (18.5<BMI<25) | | Active in the past 4 weeks | |
|---|---|---|---|---|---|---|
| Sample: | Full | Rural | Full | Rural | Full | Rural |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| TC exposure in utero to infancy | -0.065** | -0.063** | -0.025 | -0.022 | -0.019* | -0.021* |
| | (0.024) | (0.025) | (0.015) | (0.016) | (0.010) | (0.011) |
| TC exposure | -0.005 | -0.009 | -0.015** | -0.020** | 0.011** | 0.012** |
| in preschool period | (0.019) | (0.018) | (0.007) | (0.008) | (0.004) | (0.005) |
| TC exposure | -0.017 | -0.013 | -0.014* | -0.018** | -0.010 | -0.014* |
| in elementary school period | (0.014) | (0.013) | (0.008) | (0.007) | (0.007) | (0.008) |
| Male | -0.006 | 0.026 | -0.036* | 0.004 | 0.005 | -0.010 |
| | (0.046) | (0.053) | (0.019) | (0.021) | (0.018) | (0.022) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Year of birth fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Province fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 2,498 | 1,588 | 2,498 | 1,588 | 2,498 | 1,588 |

Notes: The OLS coefficients are reported. The standard errors clustered at the provincial level are presented in parentheses. Control variables include father's and mother's education level and mother language. *** p<0.01, ** p<0.05, * p <0.1.

**Table 5: The Association between Health Outcomes and Mindset**

| Dependent variable: | Growth mindset scale (standardized) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sample: | Full | Rural | Full | Rural | Full | Rural | Full | Rural |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Height (standardized) | 0.047** | 0.011 | | | | | 0.047** | 0.013 |
| | (0.023) | (0.030) | | | | | (0.022) | (0.030) |
| Healthy weight (18.5<BMI<25) | | | 0.013 | -0.048 | | | 0.007 | -0.067 |
| | | | (0.043) | (0.056) | | | (0.048) | (0.060) |
| Active in the past 4 weeks | | | | | -0.001 | 0.068 | 0.002 | 0.092 |
| | | | | | (0.052) | (0.059) | (0.060) | (0.066) |
| TC exposure in utero to infancy | -0.049* | -0.057** | -0.052** | -0.059** | -0.052** | -0.056** | -0.049* | -0.057** |
| | (0.025) | (0.027) | (0.024) | (0.026) | (0.024) | (0.026) | (0.025) | (0.027) |
| TC exposure in preschool period | -0.013 | -0.014 | -0.013 | -0.015 | -0.013 | -0.015 | -0.013 | -0.016 |
| | (0.020) | (0.022) | (0.021) | (0.023) | (0.021) | (0.022) | (0.021) | (0.023) |
| TC exposure in elementary school period | 0.024 | 0.030* | 0.023 | 0.029* | 0.023 | 0.031* | 0.024 | 0.030* |
| | (0.016) | (0.017) | (0.016) | (0.017) | (0.016) | (0.016) | (0.016) | (0.017) |
| Male | 0.452*** | 0.478*** | 0.453*** | 0.478*** | 0.452*** | 0.479*** | 0.453*** | 0.479*** |
| | (0.044) | (0.049) | (0.045) | (0.049) | (0.045) | (0.049) | (0.044) | (0.049) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year of birth fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Province fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 2,498 | 1,588 | 2,498 | 1,588 | 2,498 | 1,588 | 2,498 | 1,588 |

Notes: The OLS coefficients are reported. The standard errors clustered at the provincial level are presented in parentheses. Control variables include father’s and mother’s education level and mother language. *** p<0.01, ** p<0.05, * p <0.1.

**Online Appendix**

**Table A1: Test for Sample Selection**

**Dependent Variable: Log(provincial population size by birthyear)**

| | All Provinces | | | Surveyed Provinces | | |
|---|---|---|---|---|---|---|
| | Male & Female | Male | Female | Male & Female | Male | Female |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| TC exposure in utero to infancy | -0.001 | -0.000 | -0.001 | 0.001 | 0.001 | 0.001 |
| | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) | (0.004) |
| TC exposure | 0.001 | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 |
| in preschool period | (0.003) | (0.003) | (0.004) | (0.004) | (0.003) | (0.004) |
| TC exposure | 0.002 | 0.001 | 0.002 | 0.005 | 0.004 | 0.006* |
| in elementary school period | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) | (0.004) |
| Year of birth fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Province fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 4,437 | 4,437 | 4,437 | 1,989 | 1,989 | 1,989 |

Notes: The OLS coefficients are reported. The standard errors clustered at the provincial level are presented in parentheses. *** p<0.01, ** p<0.05, * p <0.1.

**Table A2: Summary Statistics by the School Location**

| Location of latest school? | In the other province | | In the same province | | No schooling | |
|---|---|---|---|---|---|---|
| Included in the final sample? | No | | Yes | | Yes | |
| | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| TC exposure in utero to infancy | - | - | 0.03 | 0.80 | -0.02 | 0.80 |
| TC exposure in preschool period | - | - | -0.04 | 1.23 | 0.06 | 1.29 |
| TC exposure in elementary school period | - | - | 0.11 | 1.26 | 0.06 | 1.24 |
| Growth mindset scale (score) | 3.37 | 1.29 | 3.94 | 1.42 | 4.65 | 1.25 |
| Growth mindset scale (standardized) | | | -0.11 | 1.01 | 0.38 | 0.88 |
| Male | 0.44 | | 0.51 | | 0.53 | |
| Age | 39.40 | 12.34 | 37.11 | 13.17 | 37.19 | 11.68 |
| Year of birth | 1975.10 | 12.34 | 1977.27 | 13.15 | 1977.07 | 11.69 |
| Ever attended elementary school | 1.00 | | 1.00 | | 0.07 | 0.26 |
| Completed elementary school | 0.85 | | 0.74 | | 0.05 | 0.21 |
| Mother's education level: | | | | | | |
| Less than primary | 0.54 | | 0.57 | | 0.44 | |
| Primary | 0.18 | | 0.16 | | 0.02 | |
| Lower secondary | 0.06 | | 0.05 | | 0.01 | |
| Upper secondary | 0.09 | | 0.04 | | 0.00 | |
| Higher than upper secondary | 0.13 | | 0.17 | | 0.53 | |
| Father's education level: | | | | | | |
| Less than primary | 0.47 | | 0.45 | | 0.47 | |
| Primary | 0.19 | | 0.15 | | 0.04 | |
| Lower secondary | 0.09 | | 0.10 | | 0.01 | |
| Upper secondary | 0.08 | | 0.05 | | 0.01 | |
| Higher than upper secondary | 0.17 | | 0.25 | | 0.47 | |
| Mother language: | | | | | | |
| Tagalog | 0.54 | | 0.54 | | 0.57 | |
| Kapampangan | 0.05 | | 0.09 | | 0.07 | |
| Visayan / Cebuano / Sinugbuanong Binisaya | 0.21 | | 0.15 | | 0.13 | |
| Others | 0.20 | | 0.22 | | 0.22 | |
| Height (cm) | 153.06 | 11.92 | 157.50 | 11.86 | 160.96 | 11.82 |
| Height (standardized by gender) | | | -0.07 | 1.01 | 0.22 | 0.94 |
| Healthy weight (1 if 18.5<BMI<25) | 0.44 | | 0.45 | | 0.42 | |
| Active in the past 4 weeks | 0.82 | | 0.84 | | 0.81 | |
| N | 502 | | 1,922 | | 576 | |

**Table A3: Difference in Respondent Characteristics by the School Location**

| | Dep Var: 1 if Attended the School in the Same Province | |
|---|---|---|
| | Full | Rural |
| | (1) | (2) |
| Male | 0.040*** | 0.017 |
| | (0.013) | (0.017) |
| Mother's education level: Primary | -0.021 | -0.006 |
| | (0.022) | (0.033) |
| Mother's education level: Lower secondary | -0.032 | -0.009 |
| | (0.044) | (0.065) |
| Mother's education level: Upper secondary | -0.129** | -0.120 |
| | (0.053) | (0.091) |
| Mother's education level: Higher than upper secondary | -0.006 | -0.007 |
| | (0.026) | (0.028) |
| Father's education level: Primary | 0.001 | -0.046 |
| | (0.028) | (0.034) |
| Father's education level: Lower secondary | 0.043 | -0.042 |
| | (0.042) | (0.049) |
| Father's education level: Upper secondary | 0.012 | -0.060 |
| | (0.044) | (0.067) |
| Father's education level: Higher than upper secondary | 0.031 | 0.020 |
| | (0.020) | (0.027) |
| Mother language: Tagalog | -0.010 | -0.046 |
| | (0.051) | (0.049) |
| Mother language: Kapampangan | 0.077 | 0.047 |
| | (0.070) | (0.074) |
| Mother language: Visayan / Cebuano / Sinugbuanong Binisaya | -0.084* | -0.012 |
| | (0.048) | (0.063) |
| Joint significance of mother's education level (p-value) | 0.1473 | 0.5881 |
| Joint significance of father's education level (p-value) | 0.3240 | 0.1491 |
| Joint significance of mother language (p-value) | 0.1333 | 0.4340 |
| Year of birth fixed effects | Yes | Yes |
| Province fixed effects | Yes | Yes |
| Observations | 2,424 | 1,500 |

Notes: The sample of those who have ever attended school is used. The OLS coefficients are reported. The standard errors clustered at the provincial level are presented in parentheses. *** p<0.01, ** p<0.05, * p <0.1.

**Table A4: Test for Sample Selection**

**Dependent Variable: Log (the number of respondents by province and birthyear +1)**

| Sample: | | Full | | | Rural | |
|---|---|---|---|---|---|---|
| | Male & Female | Male | Female | Male & Female | Male | Female |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| TC exposure in utero to infancy | -0.019 | -0.002 | -0.019 | -0.019 | -0.006 | -0.014 |
| | (0.013) | (0.013) | (0.012) | (0.013) | (0.012) | (0.011) |
| TC exposure | -0.013 | -0.016** | -0.006 | -0.007 | -0.011* | -0.001 |
| in preschool period | (0.008) | (0.006) | (0.008) | (0.008) | (0.006) | (0.008) |
| TC exposure | -0.001 | 0.003 | -0.007 | 0.002 | 0.007 | -0.005 |
| in elementary school period | (0.009) | (0.006) | (0.009) | (0.009) | (0.006) | (0.008) |
| Year of birth fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Province fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,989 | 1,989 | 1,989 | 1,989 | 1,989 | 1,989 |

Notes: The OLS coefficients are reported. The standard errors clustered at the provincial level are presented in parentheses. *** p<0.01, ** p<0.05, * p <0.1.

**Table A5: Robustness to Measurement Errors**

| Dependent variable: | Growth mindset scale (standardized) | |
|---|---|---|
| Excluded sample: | Data on the home province is unavailable | Age over 50 |
| | (1) | (2) |
| TC exposure from in utero to infancy | -0.074** | -0.057** |
| | (0.029) | (0.025) |
| TC exposure in preschool period | -0.025 | -0.010 |
| | (0.023) | (0.022) |
| TC exposure in elementary school period | 0.044*** | 0.019 |
| | (0.015) | (0.019) |
| Male | 0.396*** | 0.422*** |
| | (0.055) | (0.055) |
| Controls | Yes | Yes |
| Year of birth fixed effects | Yes | Yes |
| Province fixed effects | Yes | Yes |
| Observations | 1,922 | 2,045 |

Notes: The OLS coefficients are reported. The standard errors clustered at the provincial level are presented in parentheses. Control variables include father's and mother's education level and mother language. *** p<0.01, ** p<0.05, * p <0.1.