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Time To Play: The Relationship Between Time Spent Playing and Educational Outcomes in Peru

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Abstract

Every day, children around the world are playing. There has been plenty of research on the importance of different kinds of play, but very little on the importance of the *quantity* of play. Understanding the relationship between educational outcomes and the amount of time spent playing would allow parents to better structure their children's time and would settle the debate between psychologists and economists on whether play has inherent value for a child's future outcomes. I focus on Peru because conducting this research in a developing country context broadens the current research mostly focused on high-income countries. Using child-level, longitudinal data from the Young Lives Survey in Peru, I perform several regressions to better understand how time spent playing at age five is related to test scores and grade level at age fifteen. Ultimately, I find little evidence for a strong relationship, either positive or negative. However, I do find that more play is related to better math scores for children in the lowest wealth quartile, and lower educational attainment for children in the second-lowest wealth quartile. This suggests that a relationship between the quantity of play and educational outcomes may exist, but only for particular populations. Further study is needed to carefully untangle these relationships and settle this debate.

Keywords: Play, education, Peru

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Introduction

Economics and developmental psychology are at odds when it comes to the impact of the quantity of play on life outcomes. On the one hand, economists view play time essentially as a good (Becker, 1965), with no positive effects on a child's life outcomes. On the other hand, it is widely accepted among psychologists and neurobiologists, and even economists, that early experiences have a strong influence on the development of cognitive and social skills and on brain architecture and neurochemistry (Knudsen et al., 2006; Shonkoff et al., 2000). Developmental psychologists go one step further, viewing play as critically important in child development (Piaget, 1962). Indeed, there is already some evidence that play is important for cognitive development (Bergen, 2018; Nicolopoulou, 2018; Tamis-LeMonda et al., 2004; Urke et al., 2018), and even for longer-term outcomes (Schweinhart & Weikart, 1997; Gertler et al., 2014). Yet so far, there has been minimal research on the relationship between time spent playing and educational outcomes, and not in a developing country context. Thus, my research will focus on the question: "How does time spent playing correspond to later test scores and educational persistence for children in Peru?"

On the international stage, Finland is often looked to as a "gold standard" in education, and play is an important part of their model. Finland's education system is unregimented – short school days, low amounts of homework, and no national exams apart from the final one at the very end of high school (Finnish National Agency for Education, 2018). Especially in pre-primary education and early elementary school, play is prioritized as a method of learning (Walker, 2015; Hancock, 2011). Ever since the first Programme for International Student Assessment (PISA) exam was administered in 2000, Finland has scored highly compared to other OECD countries, so many have attempted to replicate its system in order to replicate its success. However, its scores

have been steadily declining since it first made headlines in 2000, and the gap between rich and poor pupils has been steadily rising, so perhaps it has not been as successful as it might first appear (The Economist, 2019). Still, Finland does score quite highly, and perhaps its system allows students a better overall quality of life not reflected in PISA scores. In any case, Finland's relative wealth and homogenous culture make it difficult to directly compare it and its play-based education strategies to Peru, so we need to examine Peru specifically to draw any conclusions about the play-educational outcomes relationship there.

Education in Peru

Peru is a developing country in South America with an average yearly per-capita income of about 6,530 USD (Worlddata.info, 2019). As of 2018, 81.9% of all adults over the age of 25 have at least completed primary school, 58.0% of all adults over 25 have completed upper secondary school, and these numbers seem to be trending steadily upwards (World Bank, 2018). It is in this context that children go to school to learn and to improve their economic futures. There is one year of compulsory pre-school education (*educatión inicial)* that begins approximately at age five. There are then six years of primary school and five years of secondary school, with students completing school around age 17 (World Education News and Reviews, 2015).

Grade repetition has been decreasing in recent years; in 2007, about seven percent of students repeated a grade, while in 2017 only about three percent did so (UNESCO Institute for Statistics, 2019). Results are different for indigenous children, however; in 2007, schools with an indigenous student population over 50% had rates of grade repetition around 13% (Cueto et al., 2010). Drop-out rates also differ by indigeneity; in 2007, the out-of-school rate was about eight percent, compared to the national average of about five percent (Cueto et al., 2010; UNESCO Institute for Statistics, 2019).

Learning outcomes, as measured by the 2018 PISA exam scores, are different along gendered and socio-economic lines (OECD, 2019). Girls outperformed boys in reading, but boys outperformed girls in math and science. Socio-economically advantaged students outperformed disadvantaged students in reading. While these are the only factors that PISA measured, they are certainly not the only ones impacting educational outcomes – another set of important factors are related to the child's early childhood environment.

Early Childhood Environment and Outcomes

There is a substantial body of literature on how a child's early environment impacts their development and future life outcomes. Glewwe et al. (2001) found that Filipino children with better nourishment, as measured by height-for-age, performed better in school, both because they entered school earlier and because of greater learning productivity per year of schooling. Gould et al. (2011) examined the 1949 Magic Carpet Operation, a natural experiment where over 50,000 Yemenite families were airlifted to Israel and scattered across the country essentially randomly. When in an early childhood environment with better sanitary and infrastructure conditions, these immigrant children were more likely to obtain higher education, marry at an older age, have fewer children, and work at age 55. The Moving to Opportunity project, which randomly assigned housing vouchers to low-income families and examined how moving when young impacts life outcomes, presents contrasting evidence. Children who moved to lower-poverty neighborhoods did not have significantly different educational outcomes (Sanbonmatsu et al., 2006) or physical health outcomes (Ludwig et al., 2013); the only statistically significant effect was that females who moved were less likely to have mental health problems (Ludwig et al., 2013).

Preschool can also be an important part of a child's early environment. Head Start is a public preschool program in the United States for disadvantaged children. Garces et al. (2000)

found that participation in Head Start was associated with a significantly increased probability of completing high school and attending college for white children, and with a significantly lower likelihood of having been charged or convicted of a crime for black children. Similarly, the Perry Preschool Project was a two-year high-quality play-based preschool program with weekly home visits for black children living in poverty in Ypsilanti, Michigan. It led to greater educational and economic successes for the children and significantly reduced their crime rate (Schweinhart & Weikart, 1997), and the annual social rate of return on this preschool investment is estimated between seven and ten percent (Heckman et al., 2010). It is important to note that since both of these preschool programs were targeted towards specific demographics, their results may not be generalizable to *all* students.

In their cross-disciplinary examination of research in economics, developmental psychology, and neurobiology, Knudsen et al. (2006) corroborated the general findings above. They showed that early experiences are influential for the development of cognitive and social skills and on brain architecture and neurochemistry, and that it becomes more difficult for human skill development and neural circuitry to change over time. Thus, there is substantial evidence suggesting the importance of a child's early environment on their long-term outcomes. It is possible that an early environment conducive to lots of play may impact long-term outcomes, too. I will next examine how various disciplines have treated play, then discuss the current literature on the beneficial effects of play.

Economic Theory and Play

Economic theory has thus far rarely considered play and leisure to have any inherent value or potential to create better outcomes. Instead, leisure is generally considered in terms of its opportunity cost – like the cost of studying or working less (Becker, 1965; Gershuny, 2009; Sevilla

et al., 2012). Thus, the theory goes, more play would lead to worse educational outcomes, worse test scores, and worse labor market outcomes.

Crispin and Kofoed (2019) offer evidence of the opportunity cost of leisure. Using the American Time Use Survey, they found that if a high school student was working, they were significantly less likely to participate in extracurricular activities, and they spent significantly fewer hours in extracurricular activities if they did participate. They also found that the fathers' education level was an important factor, and that while low-income students were less likely to participate in extracurriculars, this effect was largely driven by selection of students into the labor market. Pike et al. (2008) examined the opportunity cost of working in relation to grades, using the 2004 National Survey of Student Engagement (NSSE) to find that first-year university students in the United States working over 20 hours per week achieved lower grades. Both Pike et al. and Crispin and Kofoed present strong evidence of the existence of important trade-offs – working more means enjoying less leisure and lower academic achievement.

There is also evidence that studying increases academic achievement. While Schuman et al. (1985) found that there is at best only a small relationship between studying and grades for U.S. university students, Michaels and Miethe (1989) claimed that specification errors (the functional form and the omission of important variables) render these results spurious. Rather, Michaels and Miethe used their own survey for university students and found significant main and interactive effects of academic effort and college grades. More recently, Andrietti and Velasco (2015) found that there was a statistically significant and positive relationship between hours studying and grades for university students in Spain. Both of these studies imply an important trade-off: more leisure time, if it means less time spent studying, likely leads to lower grades.

Psychological Theory and Play

Psychologists and many educators approach play differently – they see it possible (and even likely) that play in and of itself has the potential to improve child development, and thus childhood outcomes. Maria Montessori and her philosophy of education famously emphasized a blend of freedom and structure using interactive teacher lessons, freely chosen activities, and engagement with peers – all of which were intrinsically rather than extrinsically rewarded (Lillard, 2013). While Montessori herself did not see the value in some types of play, her approach has become somewhat synonymous with playful learning.

But what exactly is play? Defining play is notoriously difficult, but it can be conceived along a few important dimensions (Pellegrini, 2009). The first is the "structural" dimension of play, which relates to the directly observable actions while a child is at play, like exaggerated movements, running, jumping, alternating roles, and "play face". The second is the functional dimension of play, which relates to how the child's actions resemble a functional behavior but do not serve that purpose – for example, using a play kitchen and pretending to make eggs (but not actually cooking anything). The final dimension is the causal dimension of play, which examines the contexts in which play is observed – it is interrupted by more serious concerns, is voluntary, and is characteristic of juveniles.

There are two foundational theories of play: that of Piaget, and that of Vygotsky. Piaget, a central figure in western theories of child development, essentially viewed play as a way for children to subordinate the world they encounter to their own points of view (assimilation), which counterbalances the forces of accommodation (the domination of the internal by the external) (Pellegrini, 2009). Vygotsky, another prominent child development theorist based out of the former USSR, viewed play as a form of reconciliation between wishes that cannot be fulfilled in

reality (but can in fantasy) and societal norms limiting those choices, and this reconciliation happens by creating an imaginary world that also conforms to societal reality at some level (Pellegrini, 2009).

Empirical research on play has largely been based on these two theorists and can be categorized into four main types of play. Based on Piaget's (1962) theory of development, different types of play correspond to different stages in child development (Pellegrini, 2009). The earliest form of play is functional or practice play, and corresponds to the sensorimotor period of development, involving repetition of behaviors and routines. The next form of play is symbolic play, often known as pretend, fantasy, or make-believe play, and is "assimilative behavior where a behavior is taken out of its functional context", like using a banana to represent a telephone (Pellegrini, 2009, p.15). Another form of play is games-with-rules, where children play by rules that are defined *a priori*. A final category of play based more on Vygotsky's work is social play, either with adults or with peers.

Play and Child Development

Certain types of play may have a strong impact on child development. Bergen (2018) found in her review of neuroscience and psychology literature that sensorimotor play is an important precursor to other levels of child development. In a review of the literature, Nicolopoulou (2018) found that pretend play is beneficial to child development, although Lillard et al. (2012) did a similar review of the literature and found that existing evidence does not support causal claims of the unique importance of pretend play.

The relationship between social play and child development has been well-studied across cultures. Urke et al. (2018) used Demographic and Health Surveys (DHS) in Honduras and found

that maternal psychosocial stimulation was significantly associated with early childhood development. Abimpaye et al. (2019) performed a randomized controlled trial of a parenting intervention on playful learning in Rwanda and found that children whose parents received the intervention had significantly higher child development scores. Tamis-LeMonda et al. (2004) used observational data from the National Head Start Evaluation Study in the United States and found that supportive parenting during play improved children's cognitive and language outcomes. Finally, Gertler et al. (2014) used a randomized controlled trial and found that facilitating mother-child play for stunted Jamaican toddlers developed their cognitive and socioemotional skills.

Play and Long-Term Outcomes

Play, and the improved cognitive development that follows, influences lifetime outcomes. As mentioned earlier, the Perry Preschool Project was a play-based preschool program that led to improved educational and economic outcomes alongside a significantly reduced crime rate (Schweinhart & Weikart, 1997). However, play was not necessarily the reason for these improved outcomes – the program also included weekly home visits and fostered strong parent-child relationships that lasted long after the child began formal schooling.

Gertler et al. (2014) were able to isolate the effects of play through a randomized controlled trial. They found that facilitating mother-child play for stunted Jamaican toddlers improved their cognitive and socioemotional skills, and that the intervention increased the children's earnings 20 years later by 25%, allowing them to catch up to their non-stunted peers. This improvement was not due to long-term increased maternal activities with the child – by age 7, there was no difference in maternal stimulation between the treatment and control groups. The improved incomes may have been due to increased parental *investment* in the child, however; as children exited the intervention period with higher skills, the parents may have recognized that schooling had higher

returns than they previously realized, and by age 22, the treatment group had significantly more years of schooling attainment and a significantly higher proportion still enrolled in school. The improved incomes may also be due to the program improving children's skills enough so that families moved abroad to take advantage of better education and labor market opportunities; the migration rate of the treatment group was significantly higher than that of the control group. Still, both the Perry Preschool Project and the Gertler et al. study offer evidence that play may be important in determining future life outcomes.

Important Gaps

While there has been significant research on the importance of different types of play for child development and life outcomes, there has been very little work on the importance of *time* spent playing. Is simply allotting time for play sufficient to attain the beneficial outcomes related to play, or must the play be of a specific type? Pellegrini et al. (1995) lend support to the hypothesis that playing more positively impacts educational achievement – they found that inattention before recess was much higher than inattention after recess. But there have been no studies, to my knowledge, that directly examine the relationship between time spent playing and educational outcomes.

Much of the research on the importance of play for child development and life outcomes has been conducted in developed countries. With the exception of a number of studies on the importance of parent-child interaction (Gertler et al., 2014; Urke et al., 2018; Abimpaye et al., 2019), there has been minimal research on the importance of play in developing countries in general, and very little in Peru in particular. By leaving out developing countries, we risk believing a particular relationship to be universally true, when in fact the relationship may vary by country for cultural, socio-economic, or other reasons. It is not necessarily true that the play-education

relationship is different in Peru than it is in the United States and other high-income countries – but given the opportunity to investigate this relationship in Peru, it makes sense to do so.

Thus, this paper will contribute to the literature in two ways: 1) by examining the effect of *time* spent playing, and 2) by conducting the analysis in a developing country context, specifically Peru. Based on the work of Gertler et al. (2014) and others, I hypothesize that children who spend more time playing have better educational outcomes than children who play less.

This paper proceeds as follows. In the next section, I outline the theoretical framework for my analysis, drawing on principles of utility maximization and the production function for academic achievement. Next, I discuss my empirical model and potential bias in my estimates. I then describe the Young Lives Survey data and present my results, finding little evidence for a strong relationship between quantity of play and educational outcomes in general, but some evidence that it may be important for specific groups. I conclude with a call for more studies on this relationship, and a warning to policymakers to be aware of the strong effects of wealth on educational outcomes.

Theoretical Framework

Children are usually not in charge of how they allocate their time – this is dictated by their parents/caregivers. Parents want to maximize their utility with respect to their child by choosing the amount of leisure enjoyed and income earned by the child. We can imagine this takes a Cobb-Douglass form:

$$U = C^{\alpha} L^{\beta} \tag{1}$$

where *U* is the *parents'* utility with respect to the child, *C* is consumption, *L* is leisure, and the parent is choosing these values *for* their child. The parents' utility maximization regarding the child is subject to a budget constraint:

$$Y = pC + wL \tag{2}$$

where *Y* is income, *p* is the price of goods, and *w* is the wage rate. This wage rate is not necessarily money that the child is earning directly, but rather can represent the wage someone else in the household is able to earn because the child is performing household tasks.

The objective function is thus

$$(C, L, \lambda) = C^{\alpha} L^{\beta} - \lambda[Y - pC - wL] \tag{3}$$

with first order conditions of

$$\frac{\partial F}{\partial C} = \alpha C^{\alpha-1} L^{\beta} - \lambda p^{*} = 0 \tag{4}$$

$$\frac{\partial F}{\partial L} = \beta C^{\alpha} L^{\beta-1} - \lambda^{*} w = 0 \tag{5}$$

$$\frac{\partial F}{\partial \lambda} = -Y + pC + wL = 0 \tag{6}$$

Solving the system of equations, we can find the demand for the child's leisure time:

$$L^{*} = \frac{Y}{w(1 + {}^{\alpha}/_{\beta})} \tag{7}$$

Thus, parents choose the child's amount of leisure time according to the demand function above. This leisure time may be spent in a variety of ways. The child could be engaging in play, whether that be functional/practice play, symbolic play, games-with-rules, social play, or other types of play. They could also spend their leisure time studying for school or otherwise preparing for their future. Each of these different uses of leisure time could have different implications for educational outcomes.

Educational outcomes can be modeled as the output of a standard production function. Glewwe and Muralidharan (2016) model the production function for educational outcomes as

$$A = a(S, Q, C, H, I) \tag{8}$$

where A is skills learned (achievement), S is years of schooling, Q is a vector of school and teacher characteristics (quality), C is a vector of child characteristics (which includes "innate ability"), H is a vector of household characteristics (like credit constraints and parental taste for schooling), and I is a vector of school inputs that are under the control of households (like attendance, effort in school and homework, and school supplies). We can think of study time, which is one of the possible uses of a child's leisure time in the Cobb-Douglass function above, as part of vector I.

Leisure time in the form of play may also impact educational outcomes – as suggested by the psychological literature, play in and of itself may be beneficial to children's cognitive development and educational outcomes. Thus, we can add onto the model of Glewwe and Muralidharan:

$$A = a(S, Q, C, H, I, P) \tag{9}$$

where *P* is a vector of play characteristics including time spent playing, the type of play, who it was with, etc.

Glewwe and Muralidharan caution that variation in observed school and teacher characteristics (*Q*) and household characteristics (*H*) are likely to be correlated with omitted school, teacher, and household variables that determine learning outcomes, leading to biased estimates. In the next section, I discuss my empirical model and the steps I took to reduce this bias.

Empirical Model

Drawing on the theoretical model above, we can empirically model the relationship between educational attainment and time spent playing as

$$A_i = \alpha + \beta(T_i) + \delta(X_i) + \varepsilon_i$$

where A_i is educational outcomes, T_i is proportion of time spent playing for individual child i at age five, X_i is a vector of controls, and ε_i is the error term. I focused on time spent playing as my independent variable of interest because 1) it was a gap in the literature that I could fill, and 2) data availability.

I measured four different educational outcomes (*A*). Three of these outcomes were test scores: I used the child's test scores in 2016 (age 15) in math, reading, and vocabulary. The fourth outcome was grade attained by 2016.[1]

This model does not demonstrate a neat causal relationship. While it is unlikely that higher test scores from the future caused changes in time spent playing in the past (reverse causality), it is still entirely possible that time spent playing was correlated with the error term due to omitted

[1] Since I controlled for the year the child entered primary school, this outcome essentially measures whether the child progressed steadily through school since starting (whatever year they started), or whether they were held back a grade/dropped out.

variables, and thus the regressions produced biased estimates. Omitting variables only results in biased coefficients if the omitted variables are correlated with the included variables – thus, I chose to add control variables that would likely be correlated with time spent playing. Additionally, if the omitted variable is not an important determinant of the dependent variable, the bias from the omitted variable will be small – thus, I only added control variables that could have a theoretical influence on the child's educational outcomes. By carefully selecting control variables, I was able to mitigate, but not fully eliminate, the omitted variable bias.

One potential source of bias is that children in wealthier households may have been more enriched by play activities. Their play time might have included cognitively stimulating toys, or there may have been things about their home environment that enriched their play experience. Conversely, children in poorer households may not have experienced types of play that improved their cognitive development. In other words, there may have been a qualitative difference between the types of play experienced between wealthier and poorer households, causing an over-estimate of the effect of play time on educational outcomes. In order to address this, I both controlled for wealth in my main regression and performed secondary regressions for each wealth quartile.

Another potential source of bias is that parents with more education may have played with their children more. Since the literature suggests that parent-child play can be extremely beneficial for a child's cognitive development, children with highly-educated parents may have been able to play more with their parent, and thus attain better educational outcomes than children with less-educated parents. However, it is also possible that parents with more education played with their children *less* due to higher opportunity costs of their time – and thus the children with less-educated parents might actually have reaped more benefits from play. Overall, the actual effect of omitting parental education is ambiguous, but parental education still could easily have impacted the results.

In order to address this, I included an interaction term between the share of time spent playing and whether the primary caregiver completed secondary education. This way, we can see what the relationship between play and educational outcomes was specifically for children with highly-educated parents.

A third potential source of bias is that the quality of play may have been different in different environments – rural children's play may have been more (or less) enriching than urban children's play. While the direction of this effect is ambiguous, it could have easily impacted and biased my results. To address this, I included an interaction term between the share of time spent playing and whether the child was living in a rural or urban area at age 5. I also performed secondary regressions for each environment.

In order to align with the claim in psychological literature that different types of play have different types of effects, I included variables that might have influenced the type of play that the child had. I first included whether the child's household owned a television. If a child's household owned a television, the child may have spent some of their play time watching television, which may have been less enriching than other types of play available to the child. Omitting this variable would likely lead to an underestimate of the actual effect of time spent playing on educational outcomes; luckily, I was able to include this as a control variable. I also included whether the child had a sibling aged four through ten when the child was five years old. Omitting this variable would lead to an underestimate of the actual effect of time spent playing on educational outcomes – having a sibling around may have encouraged more social and pretend play, thus improving the quality of the play.

I included several school-related variables to minimize omitted variable bias. Children who started school earlier were likely to have higher test scores and be in a higher grade. Omitting the

year the child started school would likely lead to an overestimate of the effect of time spent playing, so this was an important control. The next control I used is whether or not the child was in any school (daycare, preschool, or primary school) when the time use data was taken. If they were in school during this time, one would expect that they played for a much lower share of their time. But for those children that were in school at that time, it is possible that playing more still had an impact on their later test scores or educational attainment – and excluding this variable would lead to an underestimate of the true effect of time spent playing on educational outcomes. Thus, I controlled for whether they were in school when the time use data were collected. I also controlled for the type of school the child attended. Not all schools offered the same quality of education, and educational outcomes were likely different for different types of schools. The schools all fell into one of four categories: public, private, parochial/NGO, and other. Since children often attended several different types of schools throughout their years of education, I measured this with the proportion of school years in each type of school. School type could signal parental investment and interest in the child, so omitting these variables could introduce bias, although the direction of this bias is somewhat ambiguous. I included school type in all my regressions to account for this potential bias.

I also included several demographic variables to minimize bias. Omitting whether the child had an indigenous ethnicity and whether the child's first language was indigenous may likely lead to an underestimate of the true effect of time spent playing, since indigenous children typically have worse educational outcomes in Peru. Omitting the child dependency ratio may lead to an underestimate of the true effect of time spent playing, as more children per adult was likely positively associated with amount of time spent playing, but negatively associated with educational outcomes. Finally, omitting the gender of the child could introduce bias if one gender played more

than the other, and also had different academic outcomes due to gender and not due to play. To minimize bias, I included all these demographic variables. I included interaction terms for these demographic variables as well, since they could all have impacted the *type* of play experienced by the child, and thus the relationship between time spent playing and educational outcomes.

Finally, I included regional dummy variables, and clustered my standard errors by region (more specifically, the sentinel site). This should help account for differences between regions not already captured by the other variables.

Unfortunately, there are a few variables that I was not able to include. One important one is the child's personality. It is quite possible that children with certain personalities played more than other children, and that these children had better (or worse) educational outcomes due to this personality, and not due to the time they spent playing. I would expect this to bias my estimates upwards, but due to the scant literature on play time, it is difficult to say.

I also was not able to include the parents' level of investment and interest in the child's education. Some parents value education more than others, and this value placed on education could easily have led to both less time playing and higher educational outcomes for reasons unrelated to play, and thus my estimate of the importance of time spent playing would be an underestimate. Of course, it is also possible that the parents that value education also gave their child *more* time to play, which would then lead to an overestimate of the importance of time spent playing; thus, parental value of education could have a somewhat ambiguous effect on the direction of the bias.

Finally, I also was not able to include information about *how* the child spent their play time. This is particularly frustrating because many studies have shown the importance of parents playing

with their children, but I did not have the information to identify whether this was occurring. While this is not strictly necessary to answer the question of how playing more in general was related to educational outcomes, omitting this information may bias my estimates downwards, since I included *all* types of play, not just those that were beneficial for educational outcomes.

The direction of the overall bias from omitted variables on my estimate of time spent playing is somewhat ambiguous. I would predict that omitting information about the child's personality would lead to an overestimate of the impact of time spent playing, but this relationship is not well-studied, as I noted earlier. I would also predict that omitting information about the parents' preferences for their child's education would lead to an underestimate of the impact of time spent playing, but it is also possible for this relationship to work in the other direction. Overall, there is not a clear direction of the bias of my estimates one way or another. Caution should be used when interpreting my results, due to these important omitted variables.

Data and Descriptive Statistics

The Young Lives Survey is a large-scale longitudinal study following children and youth around the world from 2002 to 2016 (Morrow, 2017).[2] In Peru, there have been five rounds of surveys following about 2000 children. The children were selected using sentinel sites, which is a form of purposive sampling from health surveillance studies where the site represents a certain type of population and is thus expected to show trends affecting those people or areas (Young Lives, 2018). To choose these twenty sites, researchers removed the top five percent in an aggregated measure of access to services, schooling, infant mortality, etc. of the 1,818 districts in Peru at the time, then selected districts semi-randomly to cover urban, peri-urban, rural, coastal,

[2] The Young Lives Survey has robust ethical practices, with informed consent and reciprocity. For more about Young Lives Survey's ethics, see Morrow (2013).

mountain and Amazon areas. Once a district was chosen, a random population center (like a village or hamlet) was chosen within a district, then a random census tract within the population center, then a random street block within the census tract. Fieldworkers visited all dwellings in each block or cluster of houses to find children of the right ages. Once one block was completed, the fieldworker visited a neighboring block, and continued this process until the required number of children (approximately 100 for the younger cohort) was reached. While this process does not necessarily yield a nationally representative sample, the demographic characteristics of their sample mirror those of the DHS, once one takes into account that the probability of a district being selected was proportional to its population size.

Basic summary statistics for my variables of interest and my control variables are shown in Tables 1 and 2. I will next delve into the specifics of my most important variables: time use and educational outcomes.

Time Use

When the child was around five years old, the Young Lives Survey asked the primary caregiver of the child how much time the child spent on a pre-specified set of activities. The exact question was, “In the last week on a typical work (or school) day how many hours did the child spend on the following activities?” The categories available were sleeping, looking after others (younger siblings, sick people, other household members), domestic tasks (fetching water, firewood, cleaning, cooking, washing, shopping, etc.), unpaid work on the family farm/cattle herding/shepherding/other family business, paid (remunerated) work or activities outside of the household or for someone not in the household, at school, studying outside of school time, and play time/leisure time. Unfortunately, respondents were not able to add their own categories or add nuance to their answers, so it is possible that the child spent time doing other (unreported)

Table 1: Summary Statistics

VARIABLES	Mean	Std. Dev.	Min	Max
Math z-scores	0.051	0.961	-2.271	3.196
Reading z-scores	0.017	0.990	-3.756	2.535
Vocabulary z-scores	0.025	0.977	-5.486	1.660
Grade in 2016	8.960	1.003	4	21
Share of time spent sleeping	0.512	0.071	0	0.909
Share of time spent playing	0.203	0.100	0	0.625
Share of time spent at school	0.182	0.089	0	0.421
Share of time spent studying	0.060	0.040	0	0.227
Share of time spent on household chores	0.024	0.032	0	0.381
Share of time spent caring for others	0.014	0.038	0	0.526
Share of time spent on unpaid work	0.004	0.027	0	0.375
Share of time spent on paid work	0	0	0	0
Wealth index	0.474	0.229	0.0002	0.922
Year started school	2007.511	0.736	2003	2009
Child dependency ratio	1.228	0.757	0.125	7
Proportion of school years in public schools	0.839	0.285	0	1
Proportion of school years in private schools	0.148	0.278	0	1
Proportion of school years in parochial or NGO schools	0.008	0.045	0	0.571
Proportion of school years in other schools	0.005	0.028	0	0.300

All statistics are for the most restricted sample (1753 observations, limited by data for Grade in 2016).

Table 2: Frequency table

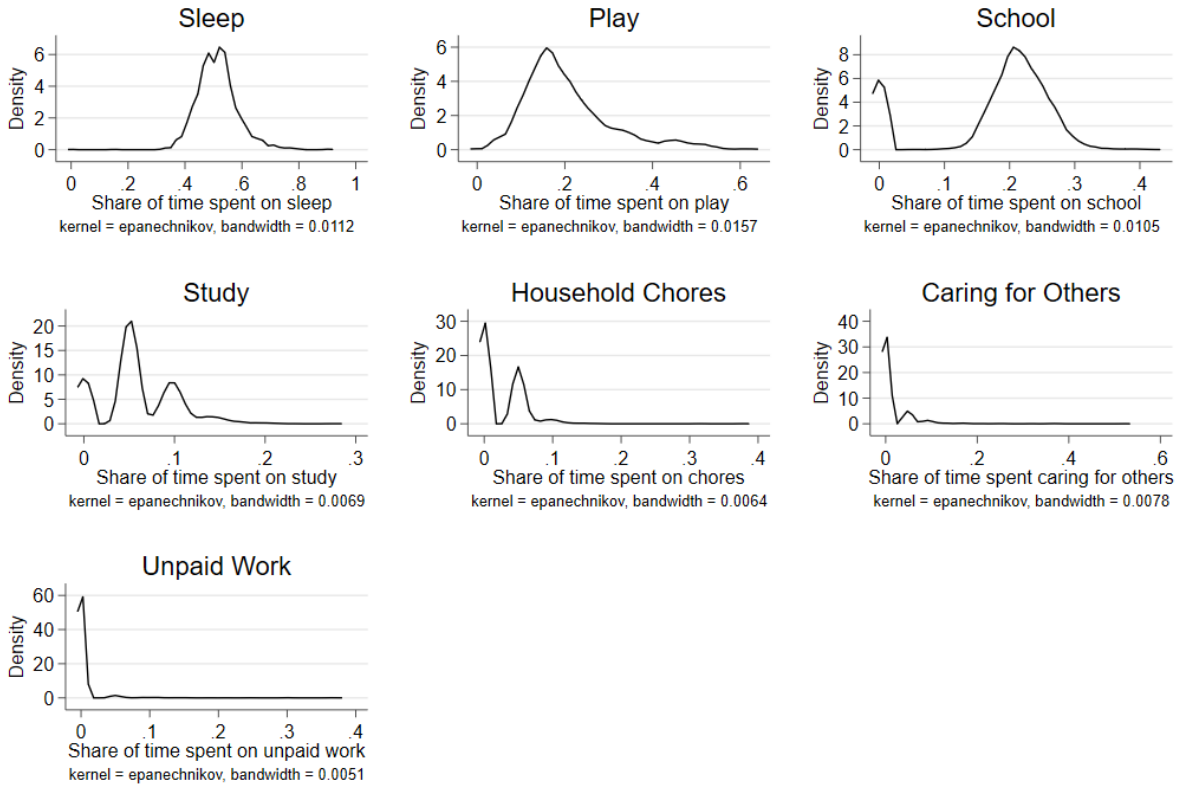
VARIABLES	Yes	No
Male	879	874
Child's first language is indigenous	249	1504
Indigenous ethnicity	272	1481
Rural	533	1220
Had a sibling ages 4-10	832	921
Caregiver completed secondary education	663	1090
Household owns working television	1235	518
In school during time use survey	1459	294

All statistics are for the most restricted sample (1753 observations, limited by data for Grade in 2016).

activities, or that the child was doing multiple activities at once (like studying and looking after others). For these reasons, along with possible data errors, not all of the time use categories added up to exactly 24 for each child. To adjust for the different total reported hours, I used the *share* of hours the child spent on each activity (of the total hours reported for that child, what percent of the time did they spend doing x activity?). Table 1 includes basic information about the share of time the child spent on each activity.

Because the survey put play and leisure in the same category, I will use the terms interchangeably from here on out, but it is important to note that they are not necessarily the same – while play is leisure, leisure is not necessarily play. For example, the child may have spent their leisure time watching television, reading for fun, or even simply watching other children play – and these activities are not typically described as play. I tried to account for this somewhat by including the presence of a television in the household as an interaction term in my regressions,

Figure 1: Time Share Density Plots



but I was not able to fully differentiate between the time a child spent on non-play leisure activities and the time spent on play.

Density plots of time use when the child is five years old (survey round two) are displayed in Figure 1. We can see that play was fairly normally distributed, even as other time use categories had more uneven distributions. In particular, school had two "humps" – one for children who *were* in school during the time use survey, and one for children who were not. 249 children (about 17%) in my sample were not in school during the time use survey (see Table 2) – this underscores the importance of using whether the child was in school during the time use survey as a control.

What was the true opportunity cost of play? The two time use categories most strongly correlated with play were school and studying (see Table 7 in the Appendix for details). This aligns

with the prior theory we laid out – that when a child is not playing, they are spending their time doing school-related activities. This tradeoff is visualized in Figure 8 (Appendix) as well – children who played the most spent less time on all other categories, but most notably on school and studying.

Educational Outcomes

In 2016 (age 15), the survey included tests for the youth in mathematics, reading, and vocabulary (with the Peabody Picture Vocabulary Test, or PPVT) [3], and these are three of the main outcomes I examine.[4] The fourth measure, the child's grade in 2016, is a measure of educational persistence – whether the child is progressing through school as expected, both by being in school at all and by being in the right grade. Summary statistics for these outcomes are shown in Table 1.

Figure 2 shows density plots of cognitive scores in math, reading and vocabulary, as well as the child's grade in 2016. If the child started primary school in 2008 (around age six or seven) and did not repeat or skip any grades, they would be expected to be in Secondary Grade 3 ("9" in the plots below) or above in 2016. The school year in Peru runs from around early March to late November, so the child was most likely in the same grade throughout the entire year. There was generally a normal distribution for all three test scores and for expected grade, although vocabulary seemed to have two "peaks", perhaps relating to how some children started school later and so had not learned as much vocabulary.

[3] The Spanish version of the Peabody Picture Vocabulary Test (PPVT) was used for the vocabulary test.
[4] All children were given the same tests. The z-score for these tests was calculated using the full sample of children who took the tests in round five; still, the summary statistics show means only slightly below zero and standard deviations of very slightly below 1, so it is reasonable to continue to interpret these as z-scores.

Figure 2: Educational Outcomes Density Plots

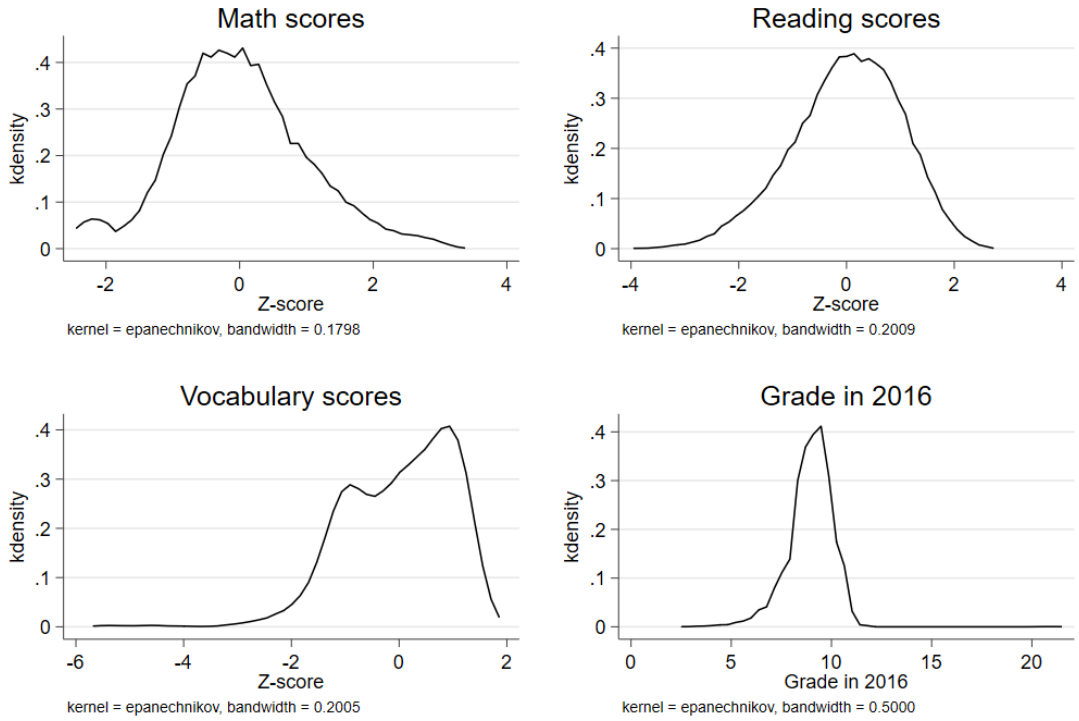


Figure 3 and Figure 4 show the same educational outcomes, but now examine the relationship with time spent playing. Figure 3 and Figure 4 differ in the sample used to create the density plots. Because not all children were in school yet when their time use data was taken (and the children in school spent less time spent playing since they now spent time at school), it did not make sense to analyze measures of play quantity for both of these groups together. I controlled for whether or not the child was in school by creating density plots for both groups.

I separated out the children who played the most (Upper 30%) and children who played the least (Lower 30%). In both figures we can see that children who played more generally had higher test scores, but the relation between time spent playing and the child's grade in 2016 is somewhat ambiguous, and possibly even negative for children who were in school when the time use data was taken.

Figure 3: Educational Outcomes for Children in School, by Play

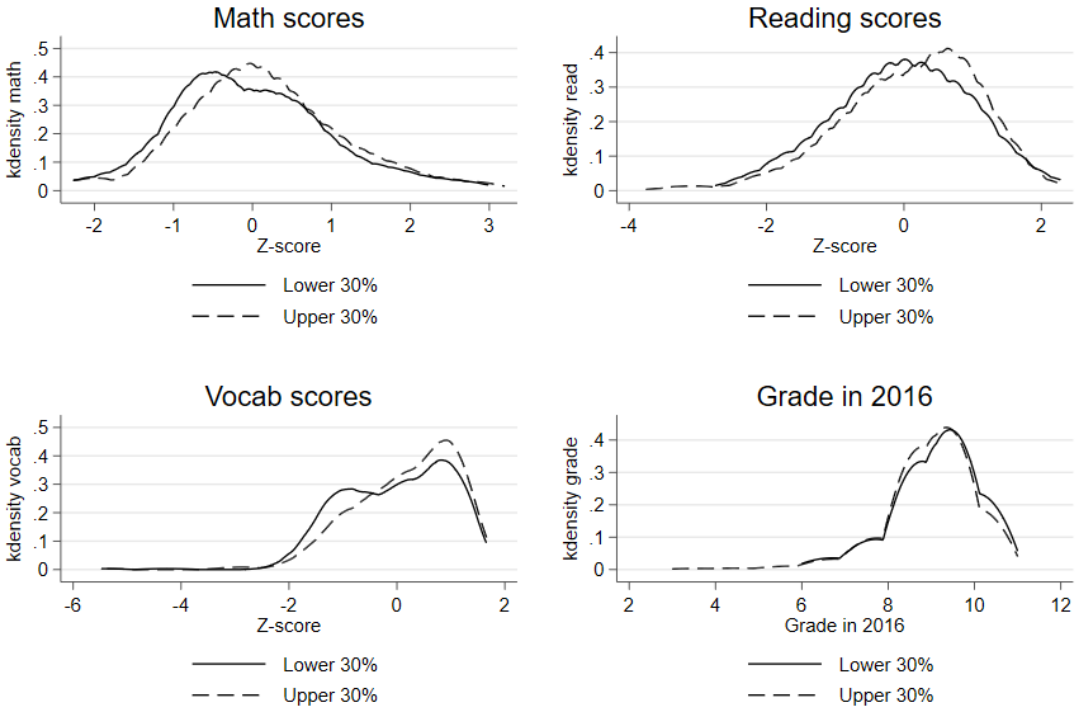


Figure 4: Educational Outcomes for Children Not in School, by Play

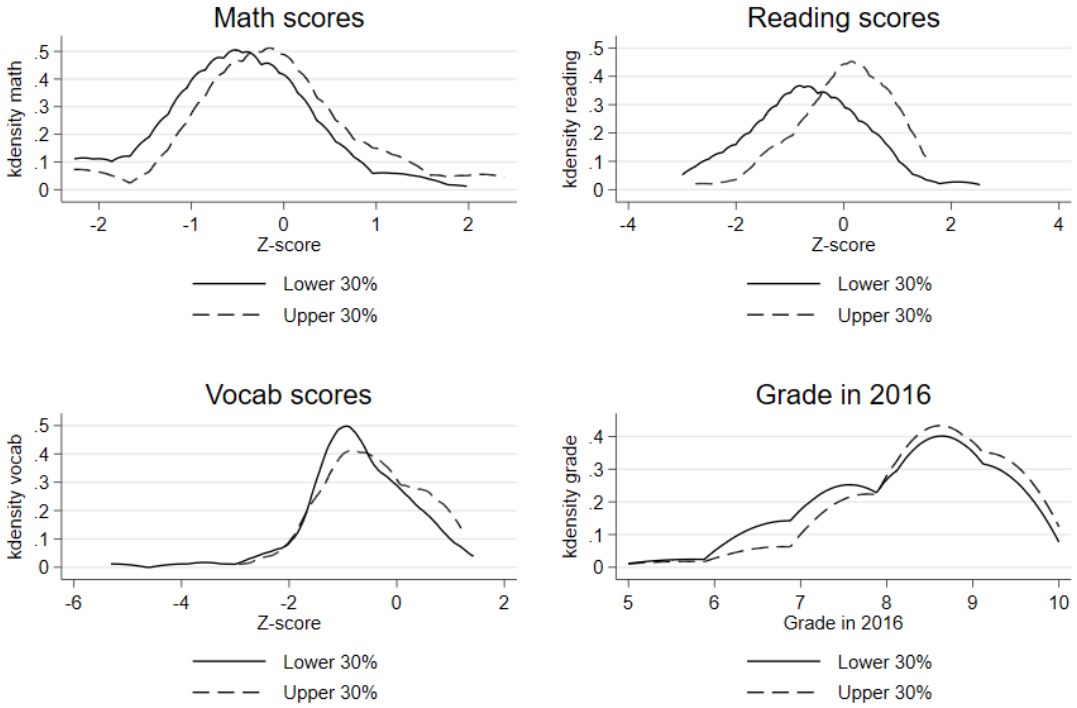


Figure 5 and Figure 6 show these same educational outcomes but examine the relationship with wealth. Wealth was measured by the wealth index created by the Young Lives Survey, which is a score between zero and one and is evenly weighted between three categories: housing quality, access to services, and consumer durables (Briones, 2017). The housing quality category itself was evenly weighted between four subcategories: main material of walls, main material of roof, main material of floor, and household density[5]. The access to services category was also evenly weighted between four subcategories: electricity, drinking water source, sanitation facility, and fuel for cooking[6]. The consumer durables category was the total number of certain important items the family possesses[7].

Figure 5 and Figure 6 separate out the children from the most and least wealthy 30% of households and examine how their educational outcomes differed. Again, I controlled for whether the child was in school by creating these density plots by wealth for both groups (children in school, and children not in school). It is clear from both figures that children in wealthier families tended to have higher test scores and be in a higher grade in 2016.

Figure 7 illustrates the relationship between time spent playing and wealth. I separated out the children from the most and least wealthy 30% of households, then examined how the amount

[5] The main material of walls received a score of 1 if it was made of brick/concrete or of concrete blocks, and a score of 0 for anything else. The main material of roof received a score of 1 if it was made of concrete/cement, galvanized/corrugated iron, or tiles/slates, and a score of 0 for anything else. The main material of the floor received a score of 1 if it was made of cement/tile, laminated material, stone (granite/marble), polished stone, or parquet, and a score of 0 for anything else. Household density was calculated as the ratio of the number of rooms (excluding kitchen, bathrooms, corridor, and garage) and the number of household members; this number was rescaled to be between 0 and 1, compared with the maximum and minimum household densities in the sample for that country.
[6] Electricity received a 1 if they had electricity (not counting car batteries). Drinking water received a 1 if it was piped water to the house/plot (public network) or a well/tube well with a hand pump. Sanitation received a 1 if they had a flush toilet/septic tank or a pit latrine. Fuel for cooking received a 1 if it was gas/electricity or kerosene/paraffin.
[7] There were 12 consumer durables items: radio, television, bicycle, motorbike, automobile, landline phone, mobile phone, refrigerator, stove, blender, iron, and record player.

Figure 5: Educational Outcomes for Children in School, by Wealth

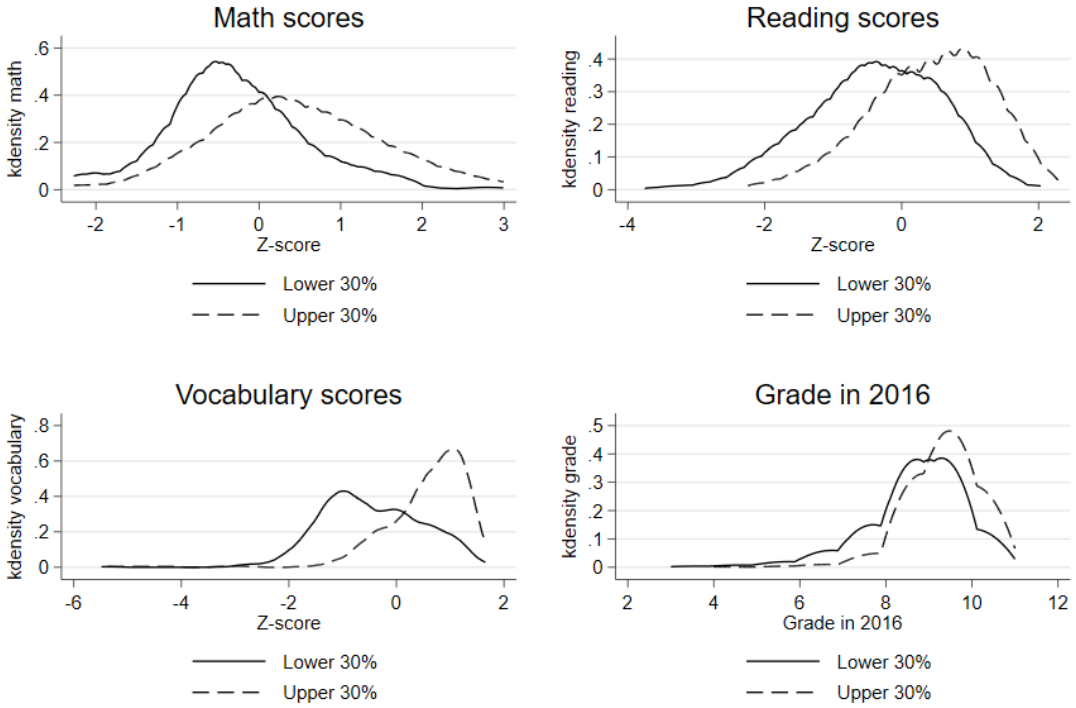
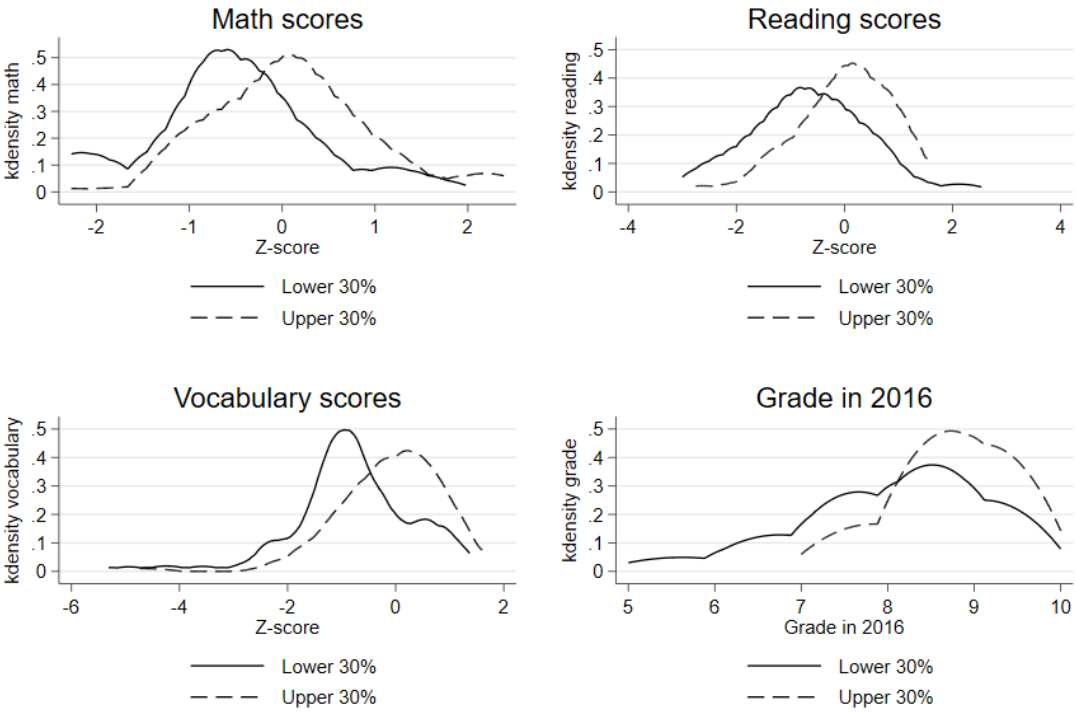
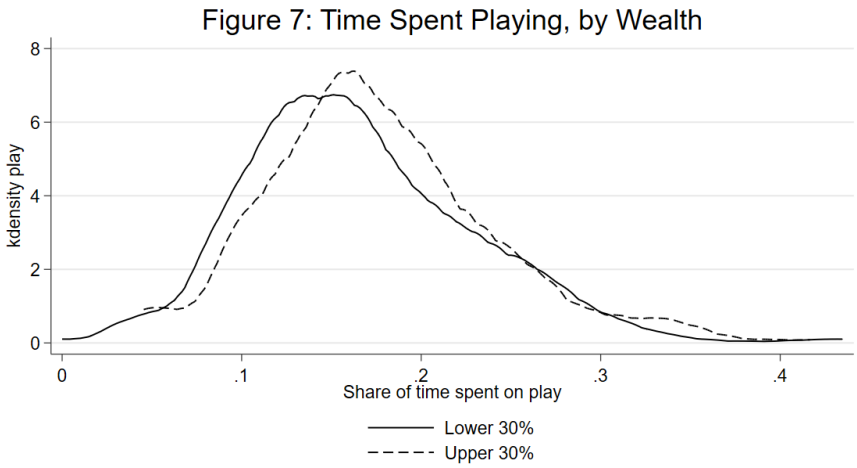


Figure 6: Educational Outcomes for Children Not in School, by Wealth





of time they spent playing differed. We can see that wealthier children spent more time playing than poorer children, but that the distributions are not extremely different. Caution should be used when interpreting the impact of time spent playing on educational outcomes, since there was no such thing as a wealthy child who spent none of their time playing.

Results

I performed several basic linear regressions to understand the relationship between play and educational outcomes. The independent variable of interest in all these regressions is the share of time spent on play. The dependent variables are math z-scores, reading z-scores, vocabulary z-scores, and the student's grade in 2016.

Share of time spent playing

Table 3 reports the results from the first four regressions, where the independent variable of interest is the share of time spent playing, and a separate ordinary least squares (OLS) regression was performed for each of the four of the educational outcome variables, using all the controls and interactions specified earlier. For detailed results, see Table 8 in the Appendix. I did not observe a statistically significant relationship between play at age five and educational outcomes in 2016

Table 3: Share of time spent on play and educational outcomes

VARIABLES	(1) Math z-score	(2) Reading z-score	(3) Vocab z-score	(4) Grade in 2016
Share of time spent on play	1.273	0.199	0.874	-1.039
	(0.888)	(0.970)	(0.557)	(0.635)
Share of time spent playing x Child dependency ratio	-0.598***	-0.235	0.112	-0.0129
	(0.191)	(0.401)	(0.241)	(0.240)
Share of time spent playing x Male	0.0855	0.999**	0.584	0.401
	(0.262)	(0.402)	(0.396)	(0.345)
Share of time spent playing x Indigenous first language	-0.00489	1.236	0.561	0.359
	(0.529)	(0.935)	(0.724)	(0.446)
Share of time spent playing x Indigenous ethnicity	0.140	0.214	0.321	-0.0191
	(0.644)	(0.672)	(0.769)	(0.482)
Share of time spent playing x Rural	-0.365	-0.780	-0.709	-0.0600
	(0.514)	(0.562)	(0.649)	(0.298)
Share of time spent playing x Had sibling age 4-10	0.442	0.0227	-0.834**	0.294
	(0.396)	(0.564)	(0.358)	(0.414)
Share of time spent playing x Caregiver completed secondary education	0.413	0.307	-0.241	0.0260
	(0.640)	(0.463)	(0.321)	(0.465)
Share of time spent playing x Household owns working television	-0.328	-0.323	-0.700***	0.371
	(0.459)	(0.490)	(0.190)	(0.328)
Constant	-0.723*	0.358	-0.363	12.61***
	(0.364)	(0.413)	(0.274)	(0.534)
Observations	1,805	1,768	1,780	1,753
R-squared	0.217	0.222	0.354	0.294
Demographic controls	YES	YES	YES	YES
Wealth controls	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note. All estimates were obtained using a linear probability model. Standard errors are clustered by sentinel site. Controls include household wealth, gender, indigenous first language, indigenous ethnicity, primary caregiver education level, owning a working television, whether the child was in school during the time use survey, the year the child started school, and the child dependency ratio of the household.

(age fifteen). However, some of the interaction terms were statistically significant, and I will briefly mention them here.

Being male had a strong positive relationship with math scores and a strong negative relationship with reading scores. The interaction between share of time spent on play and male was strongly positive for reading scores, however – playing more was associated with higher reading scores for males. However, for a male to have a higher score than a female who spent none of her time playing, he had to spend at least 22.5% of his time playing (slightly over the mean of 20.6%).

More children per adult in a household (higher child dependency ratio) had a strong positive relationship with math scores. This is counterintuitive; controlling for all other household characteristics, one would expect that households with more children would have fewer resources to dedicate to each child, thus lowering their expected outcomes. But the interaction between the share of time spent on play and the child dependency ratio was negative: playing more was related to lower test scores given a child dependency ratio, and having a higher child dependency ratio was related to lower test scores given a set share of time spent playing. The ultimate effect of the child dependency ratio is ambiguous and depends on the actual share of time spent on play (the more time spent on play, the more negative the effect of the higher child dependency ratio), and is tricky to interpret due to the continuous nature of both the child dependency ratio and the share of time spent on play.

The interaction with having a similarly-aged sibling, as well as with the household having a working television, was negative and statistically significant for vocabulary scores – I discuss this more at length later.

Wealth Quartiles

I performed the same analysis, using the same control variables and interaction terms, but separated the children into different groups based on their wealth quartiles. It is possible that play had very different effects depending on where the child's family was on the socio-economic ladder, or that children in different wealth quartiles played differently, with different effects on educational outcomes as a result.

The results of this analysis can be seen in Table 4. For detailed results, see Tables 9-12 in the Appendix. There was a strong positive relationship between the share of time spent playing and math scores for children in the lowest wealth quartile. Here, spending 10% more time on play (increasing the share of time spent on play by 0.1) at age five was associated with a 0.239 increase in the child's math z-score. The mean math z-score for children in the lowest wealth quartile was -.396, with a standard deviation of about .042. For this group of children, then, a 0.239 increase in the z-score was substantial, but not enough to bring them up to the average of all the other children sampled.

The reason for the play-math relationship for children in the lowest wealth quartile is unclear. Only 18% of households in the lowest wealth quartile had televisions (compared to 69%, 92%, and 99% of quartiles two, three, and four respectively), so it is possible that those children were spending play time not watching television, and instead engaging in more developmentally useful play than children in other wealth quartiles. But playing more did not seem to have a strong relationship with any other educational outcomes for children in the lowest wealth quartile, so while this is a strong, statistically significant result, caution must be used in drawing conclusions from it, barring other corroborating work.

TABLE 4: WEALTH QUARTILES

Math scores and share of time spent on play

VARIABLES	(1) Q1	(2) Q2	(3) Q3	(4) Q4
Share of time spent on play	2.389**	1.615	-0.440	-8.028
	(0.895)	(1.238)	(1.384)	(5.579)
Constant	-0.0828	-1.059	0.0591	2.004*
	(0.480)	(0.769)	(0.653)	(1.060)
Observations	446	455	459	445
R-squared	0.170	0.240	0.200	0.165
Demographic controls	YES	YES	YES	YES
Wealth controls	YES	YES	YES	YES
Interactions	YES	YES	YES	YES

Reading scores and share of time spent on play

VARIABLES	(1) Q1	(2) Q2	(3) Q3	(4) Q4
Share of time spent on play	1.054	-1.342	2.262	0.0622
	(1.099)	(1.381)	(1.339)	(3.200)
Constant	2.278**	0.867	-0.355	1.388**
	(0.971)	(1.025)	(0.456)	(0.567)
Observations	429	443	455	441
R-squared	0.228	0.211	0.180	0.164
Demographic controls	YES	YES	YES	YES
Wealth controls	YES	YES	YES	YES
Interactions	YES	YES	YES	YES

Vocabulary scores and share of time spent on play

VARIABLES	(1) Q1	(2) Q2	(3) Q3	(4) Q4
Share of time spent on play	1.405*	-1.322	1.266	-0.864
	(0.691)	(1.188)	(1.001)	(3.102)
Constant	0.381	0.505	-0.640	-0.0150
	(0.807)	(0.604)	(0.432)	(0.607)
Observations	436	447	454	443
R-squared	0.266	0.321	0.269	0.155
Demographic controls	YES	YES	YES	YES
Wealth controls	YES	YES	YES	YES
Interactions	YES	YES	YES	YES

Educational attainment and share of time spent on play

VARIABLES	(1) Q1	(2) Q2	(3) Q3	(4) Q4
Share of time spent on play	0.390	-3.113**	-1.657*	-2.868
	(0.880)	(1.450)	(0.817)	(1.832)
Constant	15.12***	14.13***	12.54***	12.41***
	(0.869)	(0.864)	(0.626)	(0.847)
Observations	419	443	453	438
R-squared	0.347	0.253	0.329	0.262
Demographic controls	YES	YES	YES	YES
Wealth controls	YES	YES	YES	YES
Interactions	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note. All estimates were obtained using a linear probability model. Standard errors are clustered by sentinel site. Controls include gender, indigenous first language, indigenous ethnicity, primary caregiver education level, owning a working television, whether the child was in school during the time use survey, the year the child started school, and the child dependency ratio of the household.

There was also a strong negative relationship between the share of time spent playing and educational attainment in 2016 for children in the second-lowest wealth quartile, independent of the year they began primary school. Spending 10% more time on play at age five was associated with a 0.3113 decrease in the child's educational attainment in 2016. The mean educational attainment for children in the second wealth quartile was 8.804 (so between eight and nine years of schooling completed), with a standard deviation of 0.056. While a 0.3 decrease is not practically meaningful, the negative relationship may still be something to consider.

The reason for the play-vocabulary relationship for children in the second wealth quartile is also unclear. It is possible that something in their play environment made them less likely to engage in the types of play that have strong effects on child development. However, I could not discern what aspects of their environment that might be.

Rural and Urban Environments

I again performed the same analysis, using the same control variables and interaction terms, but separated the children into different groups based on whether they were in an urban or rural setting at age 5. Again, it is possible that play had very different effects depending on the child's locational context, or that children in urban and rural areas played differently, with different effects on educational outcomes as a result.

Ultimately, I did not see any evidence of this - the results of the rural/urban analysis can be seen in Table 5. For detailed results, see Tables 13 and 14 in the Appendix. There was no statistically significant relationship between play at age five and any of the educational outcomes, for either the rural or urban children. This is not necessarily evidence that children's experiences of play were not different in urban and rural areas, but it is evidence that any differences in their types of play did not impact educational outcomes.

Types of Play

As discussed earlier, the psychological literature examines many different types of play. I did not have much information about the type of play the children were engaging in during their time spent playing, but I did know some things about the household that might have influenced what the child was doing with their leisure time. I knew if a child's household owned a television – and a child spending their time watching television may have been less enriching than the child spending their time engaging in pretend play, for example. In the main regression that included all the children (Table 3), owning a television had a strong positive relationship with vocabulary scores, but the interaction with the share of time spent on play was negative, which implies that the child actually watching TV had negative effects on their vocabulary scores. This would then

TABLE 5: RURAL AND URBAN OUTCOMES

Share of time spent on play and educational outcomes, Rural

VARIABLES	(1) Math z-score	(2) Reading z-score	(3) Vocab z-score	(4) Grade in 2016
Share of time spent on play	0.550	-1.344	0.179	-0.867
	(0.598)	(1.120)	(0.462)	(1.021)
Constant	-0.500	0.276	-0.0565	15.20***
	(0.638)	(1.037)	(1.063)	(0.865)
Observations	557	533	541	533
R-squared	0.138	0.207	0.286	0.293
Demographic controls	YES	YES	YES	YES
Wealth controls	YES	YES	YES	YES
Interactions	YES	YES	YES	YES

Share of time spent on play and educational outcomes, Urban

VARIABLES	(1) Math z-score	(2) Reading z-score	(3) Vocab z-score	(4) Grade in 2016
Share of time spent on play	2.107*	0.852	0.956	-1.343*
	(1.087)	(1.131)	(0.849)	(0.694)
Constant	-1.080**	-0.148	-0.483	12.15***
	(0.466)	(0.428)	(0.321)	(0.531)
Observations	1,248	1,235	1,239	1,220
R-squared	0.184	0.125	0.245	0.237
Demographic controls	YES	YES	YES	YES
Wealth controls	YES	YES	YES	YES
Interactions	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note. All estimates were obtained using a linear probability model. Standard errors are clustered by sentinel site. Controls include wealth, gender, indigenous first language, indigenous ethnicity, primary caregiver education level, owning a working television, whether the child was in school during the time use survey, the year the child started school, and the child dependency ratio of the household.

imply that some types of play are neutral towards test scores, while some are actually harmful for test scores.

I also had information about whether the child had siblings in a relatively similar age group (age four to age ten, when the main child was age five). It is possible that having a sibling around encouraged more social and pretend play. In my main regression (Table 3), having a sibling with a similar age had a negative relationship with math scores. Meanwhile, the interaction between share of time spent on play and having a sibling was negative for vocabulary scores. So siblings were negatively related to math test scores (independent of the child dependency ratio!), and spending more time playing and having a sibling had a negative relationship with vocabulary test scores. Both of these results imply that siblings, and spending time playing with siblings, may actually have a detrimental effect on educational outcomes. Perhaps social play is not as useful as previously hypothesized, but it could also be that social play is critical for child development in ways unrelated to educational outcomes. And it should also be noted that *having* a sibling does not necessarily result in social play – I still did not have information about what the child was doing during the time that their caregivers reported as play.

Important Covariates

Several of the variables I controlled for were extremely important determinants of educational outcomes. The most notable was household wealth, which had a positive and statistically significant relationship with all the outcomes I measured in my main regression. It also had a positive and statistically significant impact on all educational outcomes for rural children, and for the math and vocabulary scores of urban children. This reflects what we saw earlier in Figures 5 and 6 – wealthier children have better educational outcomes than poorer children. This result is intuitive, as wealthier households can invest more in their children than poorer households

can, and thus their children have better outcomes. This overwhelming result is evidence that education is not a "great equalizer" in Peru – students from wealthier families have better educational outcomes, and policymakers should pay special attention to income inequality in schools in order to provide as many opportunities as possible to students from poor families.

Several variables related to schools also had a strong relationship with educational outcomes. Starting school in a later year had a negative relationship with all test scores. This is unsurprising, since one learns more content in math, reading, and vocabulary as one continues in school, and thus would likely score higher in those subject areas the longer one was in school. Relatedly, spending more years in a private school had a strong positive relationship with all test scores. Perhaps this is because the quality of education at these schools was generally higher, but it could also be that there are qualities correlated with a child going to private school that are the main factor in test scores (like high-ability or wealthy children being sent to private school).

Several variables related to family characteristics also had a strong relationship with educational outcomes. The level of education of the primary caregiver had a strong positive relationship with math and vocabulary scores, and a positive but not statistically significant relationship with reading scores and grade in 2016. This positive relationship aligns with intuition and prior studies – children of educated parents go farther and do better in education, since educated parents often value education more than their less-educated counterparts. If the child spoke an indigenous language as a first language, they performed statistically significantly worse in the vocabulary tests than children with Spanish as a first language. This makes sense given that the vocabulary test was given in Spanish.

Attrition

Some children chosen for the first round of the survey moved away, refused to continue participation, or were otherwise not surveyed in subsequent rounds – the attrition rate between rounds one and five was 8.2%. In order to understand how random or non-random this attrition was, I examined the determinants of attrition. I performed three probit regressions with three dependent variables: whether the child was ever missing from a survey round, whether the child was missing in survey round two (when the time use data was taken), and whether the child was missing in survey round five (when the educational outcomes were measured).

The results from these regressions can be seen in Table 6. The only factor that ever statistically significantly predicted attrition was whether the primary caregiver felt "part of the community" in the first round. The direction of this relationship was intuitive – people who felt like they were a part of the community were less likely to attrit. But beyond that, I saw little evidence of a systematic trend through which children dropped out of the study, and so I do not consider attrition to be a major limitation in my analysis.

Limitations

While all the primary caregivers were asked the same question about how many hours the child spent on play, they may not have all interpreted the question in the same way. The definition of play is somewhat nebulous, so different caregivers might have categorized the same actions (e.g. watching tv) differently. This could definitely impact my results, especially if similar households categorized play similarly. Thus, because of the subjective nature of play, the time use survey data that I use may be unreliable and render unreliable results.

Social desirability bias may have also impacted responses to the time use questions. If a caregiver saw it socially desirable to say, for example, that their child was attending school even

Table 6: Determinants of attrition

VARIABLES	(1) Ever missed a round	(2) Not in round 2	(3) Not in round 5
Wealth index	-0.271	-0.501*	-0.286
	(0.183)	(0.262)	(0.199)
Male	-0.0576	-0.147	-0.0797
	(0.0725)	(0.103)	(0.0778)
Caregiver's first language is indigenous	-0.0641	-0.0907	0.00837
	(0.115)	(0.180)	(0.123)
Indigenous ethnicity	-0.104		-0.170
	(0.111)		(0.122)
Caregiver completed secondary education, round 1	-0.0511	-0.177	0.0501
	(0.0910)	(0.128)	(0.0975)
Household size	-0.00429	-0.0199	0.00509
	(0.0157)	(0.0229)	(0.0167)
Any events that decreased household welfare since pregnancy with child	-0.0169	0.0235	-0.00898
	(0.0746)	(0.104)	(0.0800)
Do you feel part of the community	-0.235**	-0.0539	-0.210**
	(0.0938)	(0.138)	(0.101)
Constant	-0.768***	-1.142***	-1.009***
	(0.153)	(0.217)	(0.164)
Observations	2,035	1,723	2,035
Pseudo R-squared	0.00745	0.0189	0.00705

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note. The dependent variable of interest is listed below the column number. All estimates were obtained using a probit model. A higher wealth index score indicates more wealth. All of the children with an indigenous ethnicity were observed in survey round two.

when they were not, the caregiver may have altered their responses to match what they perceived as socially desirable. This would also render the time use survey data unreliable and bring the accuracy of my results into question.

While I included numerous controls, omitted variable bias still may have been present. If

that was the case, then my estimates of the relationship between time spent playing and educational outcomes may be inaccurate. One important variable I did not control for is the child's personality – children with certain personalities related to higher (or lower) educational outcomes might have selected into (or out of) play when they were children. I think it reasonable to say that the child's play time is mostly determined by the primary caregiver, but this was likely still a factor. I also was not able to control for the parents' level of interest and investment in their child's education – parents who highly valued education may have allowed less time for their child to play, but also provided many other inputs important to the education production function. While I did control for the type of school the child attended and the primary caregiver's level of education (which may be proxies for how much the parent cared about the child's education), I was not able to fully address this problem.

Play is a complicated concept, and the time a child spent on "play time/leisure time" may not truly get at the positive aspects of play that researchers have previously identified. For example, pretending to be a shopkeeper, playing hopscotch, and watching television would all have been counted in the same category of play in this survey. But many would categorize these as different types of play, with different types of potential effects on educational outcomes. While I do include the presence of a television in the home and whether there were siblings in a similar age range in my regressions as controls and as interactions with play, there are other kinds of play experiences the children may have had that I did not address. In particular, many studies have shown the importance of parents playing with the child, but I did not have the information to identify whether or not this was occurring.

Conclusion

Understanding the effects of time spent playing on children's educational outcomes would allow us to make the best recommendations for how parents should allocate their children's time. It would also settle a theoretical debate between economists and psychologists that hinges on whether play has inherent value. I found little evidence that spending more time playing at age five was related to educational outcomes at age fifteen. However, I did find that playing more was related to an increased math z-score for children in the lowest wealth quartile, and lower educational attainment for children in the second-lowest wealth quartile. I also found that playing more had a strong positive relationship with reading scores for male children, and that playing more had a strong negative relationship with math scores as the child dependency ratio increased. Finally, I have some evidence that spending leisure time watching television or playing with siblings may have actually negatively impacted educational outcomes. In general, these findings suggest that there may be a relationship between play and educational outcomes, but perhaps only for particular populations. Further study is needed to carefully untangle these relationships and settle this debate.

Even as the relation between play quantity and educational outcomes remains hazy, this work solidifies the importance of household wealth in determining a child's educational outcomes. In nearly all of my regressions, wealth had a positive and statistically significant impact on educational outcomes. As we push for policies that improve children's educational outcomes and lives, we must be cognizant of the role wealth plays in determining these outcomes, and actively work to provide opportunities to children from poor families in order to narrow this educational divide.

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Appendix

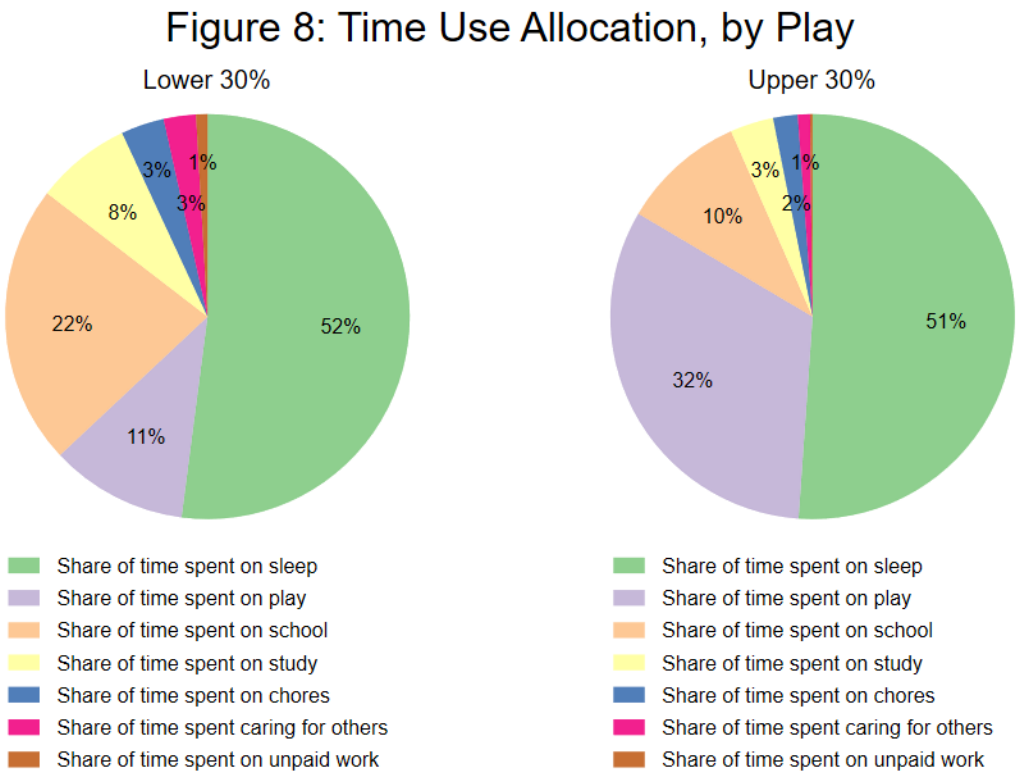
Figure 8: Time Use Allocation, by Play
Lower 30%
52%
11%
22%
8%
3%
3%
1%
Upper 30%
51%
32%
10%
3%
2%
1%
Share of time spent on sleep
Share of time spent on play
Share of time spent on school
Share of time spent on study
Share of time spent on chores
Share of time spent caring for others
Share of time spent on unpaid work

Table 7: Correlation between time use categories

	Play	Sleep	School	Study	Chores	Caring for others	Unpaid work
Play	1						
Sleep	-0.0933***	1					
School	-0.666***	-0.429***	1				
Study	-0.482***	-0.356***	0.513***	1			
Chores	-0.180***	0.00852	-0.182***	-0.168***	1		
Caring for others	-0.137***	-0.201***	-0.124***	-0.122***	0.144***	1	
Unpaid work	-0.0935***	-0.0137	-0.159***	-0.143***	0.123***	0.0281	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: Share of time spent on play and educational outcomes

VARIABLES	(1) Math z-score	(2) Reading z-score	(3) Vocab z-score	(4) Grade in 2016
Share of time spent on play	1.273	0.199	0.874	-1.039
	(0.888)	(0.970)	(0.557)	(0.635)
Wealth index	0.598**	0.488***	0.362**	0.337**
	(0.221)	(0.165)	(0.169)	(0.160)
Male	0.184**	-0.225**	0.0337	-0.166*
	(0.0768)	(0.104)	(0.0806)	(0.0934)
Child's first language is indigenous	-0.0370	-0.500	-0.560**	-0.257
	(0.200)	(0.295)	(0.223)	(0.274)
Indigenous ethnicity	-0.0461	-0.111	-0.0941	0.0872
	(0.170)	(0.180)	(0.193)	(0.119)
Rural	-0.0201	-0.0860	-0.0527	-0.115
	(0.187)	(0.169)	(0.164)	(0.0754)
Had a sibling ages 4-10	-0.206**	-0.111	-0.0202	-0.108
	(0.0949)	(0.115)	(0.0925)	(0.111)
Caregiver completed secondary education	0.300**	0.208*	0.377***	0.215*
	(0.138)	(0.101)	(0.0786)	(0.109)
Household owns working television	0.146	0.221*	0.295***	0.0105
	(0.106)	(0.110)	(0.0740)	(0.0921)
In school during time use survey	0.0723	0.0774	0.261***	0.159
	(0.0745)	(0.0983)	(0.0864)	(0.0926)
Year started school	-0.0728***	-0.148***	-0.0828**	-0.498***
	(0.0216)	(0.0366)	(0.0346)	(0.0714)
Child dependency ratio	0.141**	0.00826	-0.0236	-0.102
	(0.0590)	(0.0997)	(0.0863)	(0.0623)
Proportion of school years in private schools	0.315**	0.280**	0.323***	0.0840
	(0.117)	(0.123)	(0.0610)	(0.0699)
Proportion of school years in parochial or NGO schools	0.393	-0.0147	-0.0144	-1.923*
	(0.485)	(0.401)	(0.311)	(0.950)
Proportion of school years in other schools	0.485	-0.548	-0.0354	0.0937
	(0.453)	(0.534)	(0.546)	(0.987)
Share of time spent playing x Child dependency ratio	-0.598***	-0.235	0.112	-0.0129
	(0.191)	(0.401)	(0.241)	(0.240)

Table 8, continued

VARIABLES	(1) Math z-score	(2) Reading z-score	(3) Vocab z-score	(4) Grade in 2016
Share of time spent playing x Male	0.0855	0.999**	0.584	0.401
	(0.262)	(0.402)	(0.396)	(0.345)
Share of time spent playing x Indigenous first language	-0.00489	1.236	0.561	0.359
	(0.529)	(0.935)	(0.724)	(0.446)
Share of time spent playing x Indigenous ethnicity	0.140	0.214	0.321	-0.0191
	(0.644)	(0.672)	(0.769)	(0.482)
Share of time spent playing x Rural	-0.365	-0.780	-0.709	-0.0600
	(0.514)	(0.562)	(0.649)	(0.298)
Share of time spent playing x Had sibling age 4-10	0.442	0.0227	-0.834**	0.294
	(0.396)	(0.564)	(0.358)	(0.414)
Share of time spent playing x Caregiver completed secondary education	0.413	0.307	-0.241	0.0260
	(0.640)	(0.463)	(0.321)	(0.465)
Share of time spent playing x Household owns working television	-0.328	-0.323	-0.700***	0.371
	(0.459)	(0.490)	(0.190)	(0.328)
Constant	-0.723*	0.358	-0.363	12.61***
	(0.364)	(0.413)	(0.274)	(0.534)
Observations	1,805	1,768	1,780	1,753
R-squared	0.217	0.222	0.354	0.294

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note. All estimates were obtained using a linear probability model. Standard errors clustered by sentinel site. A higher wealth index score indicates more wealth.

Table 9: Share of time spent on play and math test scores, by wealth quartile

VARIABLES	(1) Q1	(2) Q2	(3) Q3	(4) Q4
Share of time spent on play	2.389**	1.615	-0.440	-8.028
	(0.895)	(1.238)	(1.384)	(5.579)
Male	0.125	0.331*	0.187	-0.00326
	(0.158)	(0.159)	(0.210)	(0.166)
Child's first language is indigenous	-0.119	0.134	-0.640	1.492***
	(0.257)	(0.386)	(0.664)	(0.0966)
Indigenous ethnicity	-0.00886	0.422	-0.437	-0.444
	(0.166)	(0.341)	(0.445)	(0.658)
Rural	-0.0457	-0.467	0.986**	0.0829
	(0.272)	(0.317)	(0.446)	(0.340)
Had a sibling ages 4-10	-0.136	0.0280	-0.485**	-0.133
	(0.198)	(0.237)	(0.199)	(0.294)
Caregiver completed secondary education	1.010*	0.663*	-0.0389	0.222
	(0.496)	(0.347)	(0.251)	(0.283)
Household owns working television	0.213	0.206	0.361	-1.869
	(0.256)	(0.187)	(0.281)	(1.312)
In school during time use survey	0.124*	0.106	-0.124	0.136
	(0.0663)	(0.149)	(0.220)	(0.264)
Year started school	-0.138**	-0.00695	-0.0449	-0.123
	(0.0522)	(0.0663)	(0.0522)	(0.0719)
Child dependency ratio	0.144	0.109	-0.0265	0.355
	(0.102)	(0.0951)	(0.124)	(0.247)
Proportion of school years in private schools	-0.0797	0.973**	0.433	0.221
	(0.542)	(0.425)	(0.267)	(0.167)
Proportion of school years in parochial or NGO schools	0.292	2.595**	1.832*	-1.088
	(2.332)	(0.979)	(0.933)	(0.718)
Proportion of school years in other schools	0.390	0.231	0.421	1.330
	(0.493)	(0.918)	(0.534)	(0.924)
Share of time spent playing x Child dependency ratio	-0.679	-0.395	0.358	-1.832
	(0.399)	(0.371)	(0.388)	(1.420)
Share of time spent playing x Male	0.169	-0.208	0.469	0.808
	(0.626)	(0.495)	(0.870)	(0.985)

Table 9, continued

VARIABLES	(1) Q1	(2) Q2	(3) Q3	(4) Q4
Share of time spent playing x Indigenous ethnicity	-0.605	-1.826	1.290	3.648*
	(0.659)	(1.425)	(1.430)	(2.080)
Share of time spent playing x Had sibling age 4-10	0.0300	-0.356	2.024***	-0.350
	(0.787)	(0.885)	(0.695)	(1.473)
Share of time spent playing x Caregiver completed secondary education	-2.364	-0.724	2.047*	1.231
	(1.640)	(1.325)	(0.995)	(1.209)
Share of time spent playing x Household owns working television	-0.612	0.160	-2.313**	9.048
	(0.904)	(0.693)	(0.958)	(5.470)
Share of time spent playing x Indigenous first language	-0.459	0.427	5.312***	
	(0.463)	(0.966)	(1.338)	
Share of time spent playing x Rural	-0.500	0.972	-3.617**	
	(0.739)	(0.953)	(1.584)	
Constant	-0.0828	-1.059	0.0591	2.004*
	(0.480)	(0.769)	(0.653)	(1.060)
Observations	446	455	459	445
R-squared	0.170	0.240	0.200	0.165

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note. All estimates were obtained using a linear probability model. Standard errors are clustered by sentinel site. In the fourth wealth quantile, there is only one rural child, so the interaction term is perfectly collinear with rural. Similarly, in the fourth wealth quantile, there are only four children with an indigenous first language, and the interaction term is perfectly collinear with indigenous first language. Finally, the fourth wealth quantile also only had one child from one of the sentinel sites (cluster 16), and this child had an indigenous first language, and thus there was perfect collinearity between the cluster and indigenous first language.

Table 10: Share of time spent on play and reading scores, by wealth quartile

VARIABLES	(1) Q1	(2) Q2	(3) Q3	(4) Q4
Share of time spent on play	1.054	-1.342	2.262	0.0622
	(1.099)	(1.381)	(1.339)	(3.200)
Male	-0.0709	-0.261	-0.158	-0.333
	(0.221)	(0.173)	(0.240)	(0.226)
Child's first language is indigenous	-0.231	-0.710***	-1.523**	0.193*
	(0.389)	(0.231)	(0.582)	(0.101)
Indigenous ethnicity	-0.264	0.452**	-0.340	-0.540
	(0.285)	(0.163)	(0.210)	(0.479)
Rural	-0.331*	-0.0890	0.206	-1.740***
	(0.182)	(0.206)	(0.589)	(0.358)
Had a sibling ages 4-10	-0.00436	-0.211	-0.470*	0.0526
	(0.219)	(0.211)	(0.253)	(0.290)
Caregiver completed secondary education	1.121**	0.0637	0.163	0.204
	(0.531)	(0.289)	(0.254)	(0.188)
Household owns working television	0.0270	0.302	0.822**	-0.911
	(0.300)	(0.222)	(0.329)	(0.814)
In school during time use survey	0.0583	0.0492	0.153	-0.297
	(0.0980)	(0.254)	(0.182)	(0.187)
Year started school	-0.333**	-0.202**	-0.124***	-0.0595
	(0.129)	(0.0955)	(0.0400)	(0.0546)
Child dependency ratio	-0.126	-0.0782	0.220**	0.548**
	(0.156)	(0.0979)	(0.104)	(0.244)
Proportion of school years in private schools	-0.897	-0.00643	0.379**	0.366*
	(1.209)	(0.346)	(0.179)	(0.183)
Proportion of school years in parochial or NGO schools	6.327*	1.060	0.711	-0.201
	(3.312)	(0.631)	(0.786)	(0.688)
Proportion of school years in other schools	-3.735***	0.749	0.931	-0.797
	(0.282)	(1.296)	(0.894)	(0.787)
Share of time spent playing x Child dependency ratio	-0.149	0.310	-0.587	-2.802*
	(0.447)	(0.328)	(0.621)	(1.373)
Share of time spent playing x Male	0.484	1.695**	0.730	1.039
	(0.840)	(0.703)	(1.052)	(1.284)

Table 10, continued

VARIABLES	(1) Q1	(2) Q2	(3) Q3	(4) Q4
Share of time spent playing x Indigenous ethnicity	0.880	-2.276***	0.854	3.023
	(0.887)	(0.644)	(0.780)	(1.761)
Share of time spent playing x Had sibling age 4-10	-0.859	0.667	1.454*	-0.349
	(0.931)	(0.955)	(0.840)	(1.546)
Share of time spent playing x Caregiver completed secondary education	-3.504*	1.161	1.013	0.653
	(1.776)	(1.399)	(1.023)	(0.957)
Share of time spent playing x Household owns working television	-0.0603	0.129	-3.021**	0.843
	(1.126)	(0.870)	(1.236)	(3.264)
Share of time spent playing x Indigenous first language	-0.391	2.964***	5.093**	
	(0.989)	(0.958)	(1.830)	
Share of time spent playing x Rural	-0.204	-0.852	0.164	
	(0.569)	(0.824)	(2.322)	
Constant	2.278**	0.867	-0.355	1.388**
	(0.971)	(1.025)	(0.456)	(0.567)
Observations	429	443	455	441
R-squared	0.228	0.211	0.180	0.164

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note. All estimates were obtained using a linear probability model. Standard errors clustered by sentinel site. In the fourth wealth quantile, there is only one rural child, so the interaction term is perfectly collinear with rural. Similarly, in the fourth wealth quantile, there are only four children with an indigenous first language, and the interaction term is perfectly collinear with indigenous first language. Finally, the fourth wealth quantile also only had one child from one of the sentinel sites (cluster 16), and this child had an indigenous first language, and thus there was perfect collinearity between the cluster and indigenous first language.

Table 11: Share of time spent on play and vocabulary scores, by wealth quartile

VARIABLES	(1) Q1	(2) Q2	(3) Q3	(4) Q4
Share of time spent on play	1.405*	-1.322	1.266	-0.864
	(0.691)	(1.188)	(1.001)	(3.102)
Male	0.198	-0.0742	0.0251	0.209
	(0.170)	(0.156)	(0.159)	(0.142)
Child's first language is indigenous	-0.260	-0.800**	-0.452	-0.0759
	(0.185)	(0.372)	(0.500)	(0.122)
Indigenous ethnicity	-0.316**	0.609*	-0.497**	-0.495
	(0.149)	(0.329)	(0.186)	(0.474)
Rural	-0.0574	-0.573**	0.964**	-1.011***
	(0.223)	(0.242)	(0.458)	(0.203)
Had a sibling ages 4-10	0.119	-0.173	-0.258	-0.236
	(0.220)	(0.182)	(0.170)	(0.176)
Caregiver completed secondary education	0.772***	0.255	0.354**	0.836***
	(0.245)	(0.275)	(0.147)	(0.271)
Household owns working television	0.626***	0.144	0.388	-0.406
	(0.150)	(0.183)	(0.233)	(0.545)
In school during time use survey	0.268**	0.219**	0.304*	0.112
	(0.127)	(0.104)	(0.156)	(0.315)
Year started school	-0.185	-0.0840	-0.0591	-0.0512
	(0.114)	(0.0692)	(0.0423)	(0.0779)
Child dependency ratio	-0.151	-0.0604	0.0864	0.255
	(0.141)	(0.141)	(0.122)	(0.231)
Proportion of school years in private schools	0.877	0.813***	0.374*	0.350***
	(0.541)	(0.253)	(0.186)	(0.0837)
Proportion of school years in parochial or NGO schools	2.168	0.593	-0.666	0.472
	(2.614)	(0.631)	(0.548)	(0.490)
Proportion of school years in other schools	-1.218*	1.812	0.593	0.252
	(0.592)	(1.499)	(1.064)	(0.946)
Share of time spent playing x Child dependency ratio	0.464	0.214	-0.0462	-1.072
	(0.419)	(0.432)	(0.475)	(0.964)
Share of time spent playing x Male	-0.212	1.628**	0.831	-0.961
	(0.659)	(0.634)	(0.725)	(0.637)

Table 11, continued

VARIABLES	(1) Q1	(2) Q2	(3) Q3	(4) Q4
Share of time spent playing x Indigenous ethnicity	1.003*	-2.931**	2.297**	2.452
	(0.566)	(1.138)	(0.922)	(1.566)
Share of time spent playing x Had sibling age 4-10	-1.311*	-0.130	0.143	0.347
	(0.752)	(0.718)	(0.811)	(0.818)
Share of time spent playing x Caregiver completed secondary education	-1.699*	0.330	0.0400	-2.471*
	(0.882)	(1.112)	(0.545)	(1.238)
Share of time spent playing x Household owns working television	-2.019***	0.0772	-1.632*	4.452*
	(0.610)	(0.763)	(0.902)	(2.278)
Share of time spent playing x Indigenous first language	-0.589	1.890*	2.100	
	(0.512)	(0.932)	(1.451)	
Share of time spent playing x Rural	-0.510	0.617	-3.581	
	(0.704)	(0.966)	(2.721)	
Constant	0.381	0.505	-0.640	-0.0150
	(0.807)	(0.604)	(0.432)	(0.607)
Observations	436	447	454	443
R-squared	0.266	0.321	0.269	0.155

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note. All estimates were obtained using a linear probability model. Standard errors clustered by sentinel site. In the fourth wealth quantile, there is only one rural child, so the interaction term is perfectly collinear with rural. Similarly, in the fourth wealth quantile, there are only four children with an indigenous first language, and the interaction term is perfectly collinear with indigenous first language. Finally, the fourth wealth quantile also only had one child from one of the sentinel sites (cluster 16), and this child had an indigenous first language, and thus there was perfect collinearity between the cluster and indigenous first language.

Table 12: Share of time spent on play and educational attainment, by wealth quartile

VARIABLES	(1) Q1	(2) Q2	(3) Q3	(4) Q4
Share of time spent on play	0.390	-3.113**	-1.657*	-2.868
	(0.880)	(1.450)	(0.817)	(1.832)
Male	-0.284	-0.0477	-0.205	-0.213
	(0.175)	(0.204)	(0.192)	(0.171)
Child's first language is indigenous	-0.354	0.331*	-0.719	0.220
	(0.421)	(0.177)	(0.470)	(0.136)
Indigenous ethnicity	-0.0445	0.378	0.164	-0.273
	(0.198)	(0.249)	(0.168)	(0.348)
Rural	-0.0683	-0.369*	0.170	0.131
	(0.151)	(0.208)	(0.338)	(0.328)
Had a sibling ages 4-10	-0.0702	-0.301	-0.295	0.222
	(0.204)	(0.274)	(0.238)	(0.189)
Caregiver completed secondary education	0.348	0.0279	-0.0634	0.579**
	(0.488)	(0.340)	(0.113)	(0.204)
Household owns working television	-0.0486	-0.0235	-0.0634	-0.544***
	(0.306)	(0.207)	(0.139)	(0.167)
In school during time use survey	0.327***	-0.105	0.0873	-0.00642
	(0.103)	(0.192)	(0.145)	(0.350)
Year started school	-0.852***	-0.620***	-0.411***	-0.341***
	(0.118)	(0.110)	(0.0856)	(0.0865)
Child dependency ratio	-0.0447	-0.176	-0.113	-0.124
	(0.0814)	(0.202)	(0.133)	(0.213)
Proportion of school years in private schools	0.165	0.577	0.275***	0.0485
	(0.285)	(0.355)	(0.0958)	(0.0606)
Proportion of school years in parochial or NGO schools	-4.922**	-1.339**	-0.0189	-2.216
	(2.187)	(0.540)	(0.435)	(1.382)
Proportion of school years in other schools	-1.174***	1.680*	2.330***	-1.555
	(0.405)	(0.939)	(0.748)	(1.343)
Share of time spent playing x Child dependency ratio	-0.314	0.0674	-0.113	0.537
	(0.514)	(0.708)	(0.388)	(1.263)
Share of time spent playing x Male	1.075	0.202	0.523	0.720
	(0.725)	(0.545)	(0.852)	(1.134)

Table 12, continued

VARIABLES	(1) Q1	(2) Q2	(3) Q3	(4) Q4
Share of time spent playing x Indigenous ethnicity	0.527	-1.124	0.570	1.082
	(0.830)	(1.333)	(0.789)	(1.304)
Share of time spent playing x Had sibling age 4-10	0.198	1.602*	1.116	-1.680
	(0.689)	(0.926)	(1.051)	(0.969)
Share of time spent playing x Caregiver completed secondary education	0.351	0.842	1.233**	-1.216
	(2.204)	(1.119)	(0.518)	(1.467)
Share of time spent playing x Household owns working television	-0.431	1.404	-0.326	2.038**
	(1.006)	(0.884)	(0.687)	(0.951)
Share of time spent playing x Indigenous first language	0.735	-1.661*	1.687	
	(0.870)	(0.835)	(1.408)	
Share of time spent playing x Rural	-0.794	1.490**	-0.730	
	(0.609)	(0.682)	(1.310)	
Constant	15.12***	14.13***	12.54***	12.41***
	(0.869)	(0.864)	(0.626)	(0.847)
Observations	419	443	453	438
R-squared	0.347	0.253	0.329	0.262

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note. All estimates were obtained using a linear probability model. Standard errors clustered by sentinel site. In the fourth wealth quantile, there is only one rural child, so the interaction term is perfectly collinear with rural. Similarly, in the fourth wealth quantile, there are only four children with an indigenous first language, and the interaction term is perfectly collinear with indigenous first language. Finally, the fourth wealth quantile also only had one child from one of the sentinel sites (cluster 16), and this child had an indigenous first language, and thus there was perfect collinearity between the cluster and indigenous first language.

Table 13: Share of time spent on play educational outcomes, Rural

VARIABLES	(1) Math z-score	(2) Reading z-score	(3) Vocab z-score	(4) Grade in 2016
Share of time spent on play	0.550	-1.344	0.179	-0.867
	(0.598)	(1.120)	(0.462)	(1.021)
Wealth index	0.826**	1.252***	0.674**	0.929**
	(0.371)	(0.347)	(0.305)	(0.389)
Male	0.0942	-0.155	0.144	-0.205
	(0.143)	(0.215)	(0.102)	(0.146)
Child's first language is indigenous	-0.0674	-0.440	-0.531***	-0.201
	(0.215)	(0.286)	(0.173)	(0.315)
Indigenous ethnicity	-0.000314	-0.116	0.00544	0.207
	(0.176)	(0.236)	(0.271)	(0.135)
Had a sibling ages 4-10	-0.0311	-0.121	0.0963	-0.226
	(0.169)	(0.182)	(0.190)	(0.148)
Caregiver completed secondary education	0.744	0.687	0.379	-0.381
	(0.465)	(0.487)	(0.219)	(0.489)
Household owns working television	-0.220	0.0636	0.276**	-0.179
	(0.146)	(0.208)	(0.107)	(0.155)
In school during time use survey	0.0239	-0.0926	0.272	0.132
	(0.108)	(0.135)	(0.165)	(0.153)
Year started school	-0.0950	-0.261**	-0.178	-0.790***
	(0.0668)	(0.100)	(0.115)	(0.108)
Child dependency ratio	0.0170	-0.173	-0.183	-0.0744
	(0.0994)	(0.141)	(0.106)	(0.0611)
Proportion of school years in private schools	0.891***	0.179	1.191***	0.269
	(0.282)	(0.583)	(0.289)	(0.433)
Proportion of school years in parochial or NGO schools	1.336	-1.278	5.496***	1.819
	(1.601)	(2.105)	(0.949)	(1.974)
Proportion of school years in other schools	0.107	-2.519***	-1.302***	-0.994***
	(0.263)	(0.197)	(0.211)	(0.295)
Share of time spent playing x Child dependency ratio	-0.261	0.193	0.712**	-0.313
	(0.429)	(0.481)	(0.300)	(0.406)
Share of time spent playing x Male	0.250	1.158	0.235	0.846
	(0.630)	(0.802)	(0.403)	(0.566)

Table 13, continued

VARIABLES	(1) Math z-score	(2) Reading z-score	(3) Vocab z-score	(4) Grade in 2016
Share of time spent playing x Indigenous first language	-0.165	1.045	0.286	0.325
	(0.303)	(0.807)	(0.621)	(0.697)
Share of time spent playing x Indigenous ethnicity	-0.697	-0.0776	-0.195	-0.452
	(0.643)	(0.813)	(0.926)	(0.417)
Share of time spent playing x Had sibling age 4-10	0.120	-0.257	-1.441**	0.548
	(0.713)	(0.552)	(0.671)	(0.716)
Share of time spent playing x Caregiver completed secondary education	-1.464	-0.963	-0.402	3.315*
	(1.569)	(1.491)	(1.055)	(1.633)
Share of time spent playing x Household owns working television	1.328	0.111	-0.362	0.764
	(0.840)	(1.004)	(0.569)	(0.595)
Constant	-0.500	0.276	-0.0565	15.20***
	(0.638)	(1.037)	(1.063)	(0.865)
Observations	557	533	541	533
R-squared	0.138	0.207	0.286	0.293

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note. All estimates were obtained using a linear probability model. Standard errors clustered by sentinel site. A higher wealth index score indicates more wealth.

Table 14: Share of time spent on play and educational outcomes, Urban

VARIABLES	(1) Math z-score	(2) Reading z-score	(3) Vocab z-score	(4) Grade in 2016
Share of time spent on play	2.107*	0.852	0.956	-1.343*
	(1.087)	(1.131)	(0.849)	(0.694)
Wealth index	0.546**	0.326	0.338**	0.235
	(0.214)	(0.197)	(0.159)	(0.165)
Male	0.212**	-0.266***	0.0281	-0.189
	(0.0955)	(0.0910)	(0.0920)	(0.118)
Child's first language is indigenous	0.554	-0.382	-0.345	-0.437*
	(0.387)	(0.355)	(0.268)	(0.213)
Indigenous ethnicity	-0.0563	-0.154	-0.158	-0.151
	(0.335)	(0.308)	(0.240)	(0.141)
Had a sibling ages 4-10	-0.312***	-0.197	-0.157*	-0.0898
	(0.0902)	(0.137)	(0.0833)	(0.142)
Caregiver completed secondary education	0.245	0.195*	0.374***	0.235**
	(0.147)	(0.0952)	(0.0782)	(0.0982)
Household owns working television	0.384*	0.259*	0.143	0.0526
	(0.184)	(0.147)	(0.123)	(0.148)
In school during time use survey	0.119	0.193*	0.196*	0.130
	(0.0944)	(0.111)	(0.0938)	(0.107)
Year started school	-0.0606*	-0.108***	-0.0534	-0.423***
	(0.0300)	(0.0335)	(0.0326)	(0.0655)
Child dependency ratio	0.264**	0.219**	0.178*	-0.0907
	(0.0968)	(0.0956)	(0.102)	(0.109)
Proportion of school years in private schools	0.325**	0.346**	0.354***	0.148**
	(0.125)	(0.127)	(0.0633)	(0.0644)
Proportion of school years in parochial or NGO schools	0.467	0.129	0.0605	-1.628*
	(0.483)	(0.424)	(0.343)	(0.916)
Proportion of school years in other schools	0.683	-0.0273	0.656	0.394
	(0.559)	(0.521)	(0.492)	(1.183)
Share of time spent playing x Child dependency ratio	-0.907**	-0.723	-0.579	0.0629
	(0.398)	(0.478)	(0.369)	(0.351)
Share of time spent playing x Male	0.133	1.011**	0.572	0.424
	(0.352)	(0.423)	(0.460)	(0.526)

Table 14, continued

VARIABLES	(1) Math z-score	(2) Reading z-score	(3) Vocab z-score	(4) Grade in 2016
Share of time spent playing x Indigenous first language	-0.956	1.016	1.293	1.121
	(1.701)	(1.612)	(1.521)	(1.091)
Share of time spent playing x Indigenous ethnicity	1.121	0.761	0.952	1.089**
	(1.079)	(1.231)	(1.136)	(0.514)
Share of time spent playing x Had sibling age 4-10	0.696	0.491	-0.219	0.372
	(0.451)	(0.767)	(0.377)	(0.584)
Share of time spent playing x Caregiver completed secondary education	0.654	0.335	-0.208	-0.0959
	(0.703)	(0.475)	(0.343)	(0.443)
Share of time spent playing x Household owns working television	-1.397**	-0.666	-0.512	0.196
	(0.583)	(0.623)	(0.392)	(0.536)
Constant	-1.080**	-0.148	-0.483	12.15***
	(0.466)	(0.428)	(0.321)	(0.531)
Observations	1,248	1,235	1,239	1,220
R-squared	0.184	0.125	0.245	0.237

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note. All estimates were obtained using a linear probability model. Standard errors clustered by sentinel site. A higher wealth index score indicates more wealth.