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The Role of Children's Health in the Intergenerational Transmission of Economic Status

Anna Aizer*

Brown University and NBER

The Income Gradient in Child Health

On average, the children of poor parents are significantly less healthy than their richer counterparts. In the US, children living in poverty are 70% more likely to be born in worse health as measured by low birth weight and infant mortality; they are twice as likely to require hospitalization and miss 40% more days of school because of sickness, are three and a half times more likely to have high blood lead levels, and are 80% more likely to have their activity limited due to a chronic disease and be rated as being in fair or poor health by their parents (1–3).

However, the strong relationship between family income and child health need not be causal. It could be confounded by other parental characteristics or abilities correlated with both income and child health. In this review, I highlight empirical evidence, mostly from the economics literature, that credibly attempts to estimate a causal relationship between family income, its various mediators, and child health. This work typically exploits “natural experiments” that manipulate one factor (e.g., access to health insurance) while keeping constant all other underlying, and potentially confounding, family characteristics.

Two recent examples of this kind of empirical approach to estimating the causal impact of family income on child health exploit two antipoverty programs – food stamps and welfare. After the Food Stamp Program (which is largely a cash transfer) was implemented at a staggered rate across the US during the 1960s, birth weight increased among children born to the poorest families in areas that received food stamps first (4). And compared with mothers who applied for welfare but were rejected because they were seen as not sufficiently needy, the children of mothers who applied for welfare and were accepted were less likely to be undernourished and lived one year longer (5). The establishment of casinos on reservations increased the family income of Native American children living on reservations, but had no other impact on family characteristics, and these increases in family income were accompanied by declines in childhood obesity (6).

* aizer@brown.edu.

Why Parental Income Matters for Child Health: The Health Production Function

While the above evidence supports a causal impact of family income on child health, it does not specify how or why income matters. Economists consider a child's health to be a function of the child's initial stock of health (i.e., the health he or she was born with) and various investments which include parental time, medical care, nutrition, safe housing, etc., as well as random shocks to health. Families make investments in their children's health based on their budget constraint as well as their beliefs about the productivity or effectiveness of various investments.

Poor families may make fewer investments in their children's health for multiple reasons. First, the budget constraint is more likely to bind for families living in poverty so they may not purchase certain "investment" goods (e.g., healthy housing, medical care). Second, they may underestimate the return to such investments (7) and under-invest for that reason. Finally, families living in poverty may be what economists refer to as "less efficient producers" of health. That is, it may be more costly or difficult for a low income family to make the same investment. For example, even among those with the same health insurance coverage, lower income/less educated people were less likely to adhere to prescribed drug regimens (8).

Two other points regarding income and the production of child health are worth noting. The first is that the relationship between family income and child health is non-linear. That is, an additional dollar is more productive at low levels of income than at high levels of income (9). The second is that the magnitude of the relationship between family income and child health increases as children age (10–11). This is due in part to the fact that as children age, they accumulate or develop chronic health conditions. Moreover, not only are children living in poverty more likely to develop chronic conditions, but when they develop a chronic condition, the negative impact of that condition on one's health is greater for them.

Closing the Loop of Intergenerational Transmission: Child Health and Future Income

Child health affects future earnings in adulthood through two channels. The first, a direct channel, refers to the fact that poor health in childhood often leads to poor health in adulthood and the latter has been shown to lower earnings by reducing a person's productivity and labor supply (12–14). The second, indirect, channel refers to the fact that child health can affect the accumulation of other forms of human capital or skills such as cognitive achievement and schooling more generally. This channel is difficult to establish in part because the children of poor parents are more likely to have lower levels of cognitive achievement and schooling for reasons related to poverty more generally and not operating through child health.

Recent work has successfully exploited natural experiments that manipulate child health without affecting other characteristics of the child or family to establish a causal relationship between child health and cognitive achievement or schooling. For example, within twin

differences in birth weight (a measure of newborn health), should only reflect difference in newborn health and not differences in family background, and have been found to affect later IQ, schooling attainment, and adult employment and earnings (15–16). A de-worming campaign in the American south in the early twentieth century increased the literacy and schooling of affected children (17).

Empirical Evidence Regarding Mechanisms by Which Family Income Affects Child Health

Disparities in family income can result in disparities in child health because of differences in individual family circumstances and factors related to living in lower income neighborhoods. The former affects access to health insurance and medical care, parental behaviors such as smoking, parental stress and mental health, within family violence and nutrition. Neighborhoods determine exposure to environmental toxins, community violence, crowding, noise and other stressors, which also affect child health and well-being. In the context of an economic model of health production, the residential placement decision is considered an investment decision just as the decision to purchase health insurance and medical care. The empirical work described below is drawn from the former category (individual family mediators), with the exception of work on environmental toxins. This is largely due to the fact that there is more evidence of a causal relationship between these individual mediators and child health and well-being than the community mediators which often change together, making it difficult to isolate the causal impact of any single neighborhood factor.

Access to Health Insurance and Medical Care

Poor adults are much less likely to have health insurance than their non-poor counterparts (29 percent vs. 12 percent). But the difference in health insurance coverage for children is much smaller (9 vs. 6 percent), due to the Medicaid/SCHIP public health insurance programs for low income children (18). There is ample evidence that expansions of public health insurance to families living in poverty have improved child health (19–20), and more recent work has shown that past expansions in the Medicaid program during childhood are related to higher earnings later in life (21). However, the potential for further expansions to improve child health is limited as they would target increasingly higher income children who often already have access to private health insurance.

Moreover, even though Medicaid has been shown to improve health among poor children without health insurance, Medicaid coverage is typically inferior to private health insurance coverage for two reasons. First, because of the way the Medicaid program is structured, many children who are eligible for Medicaid do not enroll in the program until they need inpatient care and, as a result, they often fail to receive timely ambulatory care that can improve health and reduce the need for hospitalization (22). Second, Medicaid fees are significantly lower and the administrative burden generally greater than commercial insurance or Medicare. As a result, fewer physicians participate in the Medicaid program, reducing childrens' access to care, especially specialty care.

But differences in access to health insurance and medical care likely do not explain all or even most of the disparities in child health. For example, among children being treated at the same high quality cancer center for the same type of cancer, poorer children were more likely to relapse early and less likely to survive past 5 years, suggesting the need to look beyond access to medical care to explain disparities in child health (23).

Pollution and Environmental Toxins

There are significant income and racial disparities in families' exposure to pollution and environmental toxins. A large literature in environmental justice documents such disparities in exposure. Researchers attribute the disparities to two factors. The first, favored by political scientists, is the intentional siting of hazards in low income and minority neighborhoods where residents typically have low levels of political capital. The second, favored by economists, is the fact that housing prices reflect environmental quality (24) and as a result, lower income families, because they are more constrained, reside in lower quality homes.

Recent work has sought to estimate the causal impact of exposure to pollution on infant and child health by exploiting changes in pollution that are uncorrelated with changes in underlying family circumstance. For example, after passage of the Clean Air Act, which resulted in sudden and significant improvements in air quality in some areas but not others, families in affected areas experienced large reductions in pollution levels that resulted in reductions in infant mortality (25). More recent work has sought to estimate the impact of more common traffic pollution on infant health. After the introduction of EZ-pass which drastically reduced traffic near toll plazas, children born to mothers living near roads were less likely to suffer from prematurity and low birth weight after EZ-pass reduced congestion (26).

Research on the impact of exposure to pollution and environmental toxins is hampered in part because we do not routinely screen children for many environmental toxins. One exception is lead which has been linked, in both epidemiological studies and animal lab experiments, to worse cognitive and behavioral outcomes later in life (27). The US screens roughly one third of children under the age of two annually for elevated blood lead levels. This is an area where disparities in exposure have declined substantially over time, most likely due to strong regulatory prohibition on the use of lead in gas and household paint which has disproportionately affected exposure to lead in old urban centers (because of its high traffic and old homes) where poor and African American children are most likely to live (28).

Though the epidemiological literature linking elevated lead and child outcomes is substantial, it generally falls short of establishing a causal relationship. More recent work has exploited policy changes to estimate a causal impact of exposure to lead in early childhood on future outcomes. After the staggered de-leading of gasoline across US states in the 1980s and 1990s which drastically reduced child blood lead levels, test scores increased and behavioral problems decreased (29). The ubiquity of lead piping in urban water systems has been another major source of lead poisoning. In areas with acidic water, which is generally unrelated to the characteristics of the families or neighborhoods, lead pipes are

more likely to corrode enabling lead to enter the water supply. Children raised in neighborhoods with both lead pipes and highly acidic water have lower IQ later in life than children exposed to lead pipes but not acidic water (30). Housing policy changes that required lead mitigation resulted in declines in child preschool blood lead levels and improvements in child reading test scores in grade three (28).

Violence

Children living in poverty are more likely to be abused and to witness domestic violence (31). The generosity of a state's anti-poverty programs affects rates of child abuse and neglect: States that reduce their welfare benefits see immediate increases in the rate of children maltreated or neglected (32), suggesting a causal relationship between cash transfers for families living in poverty and child maltreatment. Children living in poverty are also much more likely to be exposed to intimate partner violence given the strong income gradient in domestic violence and the direct link between women's wages and domestic violence (33). Exposure to domestic violence is negatively related to various measures of child health, though the usual issues of confounding complicate causal inference (34). Research has attempted to establish a causal relationship by exploiting changes in legal sanctions against domestic violence that reduce violence but do not otherwise change family circumstances. When legal sanctions increased, domestic violence against women declined, resulting in improved newborn health among pregnant women who suffer higher rates of domestic violence in the absence of strict legal sanctions (35).

Stress

Stress is a factor that has received increasing attention as a mechanism by which poverty negatively affects health, and child health specifically. Lower income families are exposed to a greater number of stressful events in their lives (36). Repeated exposure to stress can result in what is referred to as "allostatic load," the physiological consequence of the body's heightened neural and neuroendocrine response to stress. A large body of work has established that allostatic load can result in multiple pathologies including hypertension, cardiovascular disease, diabetes, etc. (37–38).

There is growing evidence that maternal (or parental) stress negatively affect child health and well-being. This can occur when stress results in changes in maternal behavior towards their children. A second channel operates through prenatal programming. Work based largely on animal studies has established a strong link between exogenous in utero exposure to elevated levels of the stress hormone cortisol and worse offspring outcomes as measured by poor motor and mental functioning (39).

Despite strong evidence based on animal studies, establishing a causal relationship between maternal stress and child outcomes in humans is difficult because of the many confounders that lead one to question whether it is the stress or the underlying stressor that resulted in the worse outcomes. The answer has important policy implications. Recent work has tried to estimate whether maternal stress itself (and not the underlying stressors that may have affected it) resulted in diminished offspring outcomes. Two strategies have been to exploit differences across siblings within a family (thereby controlling for observed and unobserved

differences across families), or the quasi-random timing of stressful events (ie, the death of a relative). The rationale behind the latter is that such events should not adversely affect the living circumstances of the offspring, but should affect maternal stress. The evidence is somewhat mixed, with some but not all studies showing significant negative effects of maternal stress on offspring mental health, IQ and educational attainments (40–41).

Can Public Investments in Child Health Increase Mobility and Lower Inequality in the Next Generation?

Given the significant influence of parental income on child health, a reasonable question for policy makers is whether public investments in children can substitute for the disparities in private investments, increasing mobility and reducing inequality in the next generation. To shed light on this, I used international PISA test scores for 15 year-old children residing in 18 OECD countries in 2000 to generate a measure of inequality (the ratio of test scores at the 90th percentile to test scores at the 10th percentile) and a measure of mobility (the elasticity, similar to a correlation, between parental income and a child's test score, the greater the elasticity, the more immobile). With these two measures I examined changes over time within each country in mobility and inequality and, more specifically, whether increases in social spending predicted increased mobility and decreased inequality (43).

Of all the different types of social spending considered (health, education, family support, housing, labor support), increases in public spending (as a percent of GDP) on health early in a child's life was the most strongly related to increases in mobility and reductions in inequality: a 10% increase in health spending was correlated with an 11% increase in mobility and a slightly smaller decline in inequality. The category of spending with the next strongest relationship was family support and that relationship was only one third as strong.

Why would spending on health be so productive relative to other kinds of social spending? In addition to the large body of evidence showing that child health has a causal impact on future outcomes, it is also the case that investments in health are usually productive, in contrast to many investments in, for example, education, which have often yielded disappointing results (44). This may be because we know much more about how to improve health than how to improve educational outcomes. Moreover, health interventions can include significant effects on both health and educational outcomes. Regardless of reason, policy makers should take note that there is substantial evidence supporting the potential for public investments in child health to increase mobility and reduce inequality of the next generation.

Does the evidence reviewed here, based on the US and other developed countries have implications for children in developing countries? I would argue for two reasons that investments in child health in developing countries are likely to be even more important and effective. The first reason or rationale relates to the worse (on average) underlying health of children in developing countries. Because the health production function is such that investments at lower levels of health are more productive than similar investments at higher levels, this would suggest that investments in child health in developing countries are likely to yield even larger improvements in child health than similar investments made in

developed countries. Second, the economic returns to health in developing countries are likely higher. Better health increases labor supply and improves productivity among the employed in developing countries. Indeed, comparisons across countries suggest that improvements in population health are among the most important predictors of a country's future economic growth (45.) Because the mediators through which family income affects child health discussed here are largely universal in nature, there is every reason to think that improving child health in developing countries by increasing access to medical care and nutrition and reducing exposure to environmental toxins and stress would lead to increased growth and mobility in these nations as well.

Conclusion

A review of the existing research shows that investments in child health are productive. Not only do they improve child health, but evidence suggests they also likely affect other aspects of child development, including cognitive achievement and schooling, and leading to overall increases in adult employment and earnings. However, significant disparities in child health exist as a result of differences in the capacity of poor families to invest in their children's health. For this reason, government efforts to invest via public health insurance expansions, environmental regulations, etc. not only improve the average health of children, but also reduce disparities in child health, improve mobility and reduce future disparities in economic status. Efforts to roll back public investments in child health have the potential to reduce mobility and increase inequality of future generations.

References

1. Braveman PA, Cubbin C, Egerter S, Williams DR. & Pamuk E (2010). Socioeconomic Disparities in Health in the United States: What the Patterns Tell Us. *American Journal of Public Health*, 100, S186–S196. doi:10.2105/AJPH.2009.166082 [PubMed: 20147693]
2. Larson K & Halfon N (2010). Family Income Gradients in the Health and Health Care Access of US Children. *Journal of Maternal and Child Health*, 14, 332–342. doi:10.1007/s10995-009-0477-y.
3. Wood D (2003). The effect of child and family poverty on child health in the US. *Pediatrics*, 112,707–711. [PubMed: 12949326]
4. Almond D, Hoynes H, Schanzenbach DW (2011). Inside the war on poverty: the impact of food stamps on birth outcomes. *Review of Economics and Statistics*, 93, 387–403. doi:10.1162/REST_a_00089
5. Aizer A, Eli S Ferri J & Lleras-Muney A (2016). The long run impact of cash transfers to poor families. *American Economic Review*, 106, 935–971. doi: 10.1257/aer.20140529 [PubMed: 28713169]
6. Jones-Smith JC, Dow WH, & Chichlowska K (2014). Association between casino opening or expansion and risk of childhood overweight and obesity. *JAMA*, 311, 929–36. doi: 10.1001/jama.2014.604. [PubMed: 24595777]
7. Cutler D & Lleras-Muney A (2010). Understanding health differences by education. *Journal of Health Economics*, 29, 1–28. 10.1016/j.jhealeco.2009.10.003 [PubMed: 19963292]
8. Benner JS, Glynn RJ, Mogun H, Neumann PJ, Weinstein MC, & Avorn J (2002). Long-term persistence in use of statin therapy in elderly patients. *JAMA*, 288, 455–61. [PubMed: 12132975]
9. Doyle O., Harmon C., & Walker I. (2007). The impact of parental income and education on the health of their children. working paper. Coventry: University of Warwick, Department of Economics. Warwick economic research papers (No.788). http://www2.warwick.ac.uk/fac/soc/economics/research/workingpapers/2008/twerp_788.pdf

10. Case A, Lubotsky D & Paxson C (2002). Economic status and health in childhood: the origins of the gradient. *American Economic Review*, 92, 1308–1334. doi: 10.1257/000282802762024520 [PubMed: 29058397]
11. Currie J & Stabile M (2003). Socioeconomic status and child health: why is the relationship stronger for older children? *American Economic Review*, 93, 1813–1823. doi=10.1257/000282803322655563 [PubMed: 29058847]
12. Case A, Fertig A & Paxson C (2005). The lasting impact of childhood health and circumstance. *Journal of Health Economics*, 24, 365–389. 10.1016/j.jhealeco.2004.09.008 [PubMed: 15721050]
13. Smith JP (2007). The impact of social economic status on health over the life course. *Journal of Human Resources*, 42, 739–764. doi: 10.3368/jhr.XLII.4.739
14. Smith JP (2009). The impact of childhood health on adult labor market outcomes. *Review of Economics and Statistics*, 91, 478–489. doi: 10.1162/rest.91.3.478 [PubMed: 23585697]
15. Black SE, Devereux PJ, & Salvanes KG. (2007). From the cradle to the labor market? The effect of birth weight on adult outcomes. *Quarterly Journal of Economics*, 122, 409–439. doi: 10.1162/qjec.122.1.409.
16. Figlio D, Guryan J, Karbownik K & Roth J (2014). The effects of poor neonatal health on children's cognitive development. *American Economic Review*, 104, 3921–55. doi: 10.1257/aer.104.12.3921 [PubMed: 29533575]
17. Bleakley H (2007). Disease and development: evidence from hookworm eradication in the american south. *Quarterly Journal of Economics*, 122, 73–117. doi: 10.1162/qjec.121.1.73 [PubMed: 24146438]
18. Smith J.C. & Me C. (2015). Health Insurance Coverage in the United States: 2014 Current Population Reports Issued September 2015. P60–253(<http://www.cdc.gov/mmwr/preview/mmwrhtml/su6302a6.htm#Tab1>).
19. Currie J & Gruber J (1996). Health insurance eligibility, utilization of medical care, and child health. *The Quarterly Journal of Economics*, 111, 431–466. doi: 10.2307/2946684
20. Meyer BD, & Wherry LF (2012). Saving teens: using a policy discontinuity to estimate the effects of medicaid eligibility. NBER Working Paper No. 18309. doi: 10.3386/w15794
21. Brown SW, Kowalski AE, & Lurie IZ (2015). Medicaid as an investment in children: what is the long term impact on tax receipts? NBER Working Paper 20835. doi: 10.3386/w20835
22. Aizer A (2007). Public health insurance, program take-up and child health. *Review of Economics and Statistics* 89, 400–15. <http://www.mitpressjournals.org/doi/pdf/10.1162/rest.89.3.400>
23. Bona K, Blonquist TM, Neuberg DS, Silverman LB and Wolfe J (2016). Impact of Socioeconomic Status on Timing of Relapse and Overall Survival for Children Treated on Dana-Farber Cancer Institute ALL Consortium Protocols (2000–2010). *Pediatr Blood Cancer*, 63, 1012–1018. doi: 10.1002/pbc.25928 [PubMed: 26913850]
24. Currie J, Davis L, Greenstone M & Walker R. (2015). Environmental Health Risks and Housing Values: Evidence from 1,600 Toxic Plant Openings and Closings. *American Economic Review*, 105, 678–709. 10.1257/aer.20121656 [PubMed: 27134284]
25. Chay K & Greenstone M (2003). The Impact of Air Pollution on Infant Mortality: Evidence from Geographic Variation in Pollution Shocks Induced by a Recession. *The Quarterly Journal of Economics*, 118, 1121–1167. doi: 10.1162/00335530360698513
26. Currie J & Walker R (2011). Traffic congestion and infant health: evidence from e-zpass. *American Economic Journal: Applied Economics*, 3, 65–90. doi: 10.1257/app.3.1.65
27. Lanphear BL, Hornung R, Khoury J, Yolton K, Baghurst P, Bellinger DC., Canfield RL, Dietrich KN., Bornschein R, Greene T, Rothenberg SJ, Needleman HL, Schnaas L, Wasserman G, Graziano J & Roberts R (2005). Low-Level Environmental Lead Exposure and Children's Intellectual Function: An International Pooled Analysis. *Environ Health Perspect*, 113, 894–899. doi: 10.1289/ehp.7688 [PubMed: 16002379]
28. Aizer A Currie J Simon P & Vivier P (2016). Do low levels of blood lead reduce children's test scores? NBER WP #22558. doi: 10.3386/w22558
29. Reyes JW (2015). Lead Policy and Academic Performance: Insights from Massachusetts. *Harvard Educational Review*, 85, 75–107. 10.17763/haer.85.1.bj34u74714022730

30. Ferrie J, Rolf K & Troesken W (2012). Cognitive disparities, lead plumping, and water chemistry: prior exposure to water borne lead and intelligence test scores among world war two army enlistees. *Economics and Human Biology*, 10, 98–112. doi: 10.1016/j.ehb.2011.09.003 [PubMed: 22014834]
31. Sedlak AJ, Mettenburg J, Basena M, Petta I, McPherson K, Greene A, & Li S (2010). Fourth National Incidence Study of Child Abuse and Neglect (NIS-4): Report to Congress. Washington, DC: U.S. Department of Health and Human Services, Administration for Children and Families https://www.acf.hhs.gov/sites/default/files/opre/nis4_report_congress_full_pdf_jan2010.pdf
32. Paxson CH & Waldfogel J (2002). Work, welfare, and child maltreatment. *Journal of Labor Economics*, 20, 435–474. 10.1086/339609
33. Aizer A (2010). The gender wage gap and domestic violence. *American Economic Review*, 100, 1847–1859. doi: 10.1257/aer.100.4.1847 [PubMed: 25110354]
34. Osofsky JD, (1999). The impact of violence on children. *The Future of Children –Domestic Violence and Children*, 9, 33–49. https://www.princeton.edu/futureofchildren/publications/docs/09_03_2.pdf
35. Aizer A (2011). Poverty, violence and health: the impact of domestic violence during pregnancy on newborn health. *Journal of Human Resources*, 46, 518–538. doi: 10.1353/jhr.2011.0024 [PubMed: 24839303]
36. Taylor SE & Seeman TE (1999). Psychosocial Resources and the SES-Health Relationship. *Annals of the New York Academy of Sciences*, 896, 210–225. doi: 10.1111/j.1749-6632.1999.tb08117.x [PubMed: 10681899]
37. McEwen BS, & Gianaros PJ (2010). Central role of the brain in stress and adaptation: Links to socioeconomic status, health, and disease. *Annals of the New York Academy of Sciences*, 1186, 190–222. doi: 10.1111/j.1749-6632.2009.05331.x. [PubMed: 20201874]
38. Seeman T, Epel E, Gruenewald T, Karlamangla A, & McEwen BS (2010). Socio-economic differentials in peripheral biology: Cumulative allostatic load. *Annals of the New York Academy of Sciences*, 1186, 223–239. doi: 10.1111/j.1749-6632.2009.05341.x. [PubMed: 20201875]
39. Harris A, Seckl J (2011). Glucocorticoids, prenatal stress and the programming of disease. *Hormones and Behavior*, 59, 279–289. doi: 10.1016/j.yhbeh.2010.06.007. [PubMed: 20591431]
40. Black SE, Devereux PJ, & Salvanes KG. (2016). Does grief transfer across generations? bereavements during pregnancy and child outcomes. *American Economic Journal: Applied Economics*, 8, 193–223. doi: 10.1257/app.20140262
41. Class QA, Lichtenstein P, Långström N, & D’Onofrio BM (2011). Timing of prenatal maternal exposure to severe life events and adverse pregnancy outcomes: a population study of 2.6 million pregnancies. *Psychosom Med*, 73, 234–41. [PubMed: 21321257]
42. Aizer A, Stroud L & Buka S (2016) Maternal stress and child outcomes: evidence from siblings, *Journal of Human Resources*, 51, 523–555. doi:10.3368/jhr.51.3.0914-6664R [PubMed: 29118458]
43. Aizer A (2014). Rising inequality and intergenerational mobility: the role of public investments in human capital. *CESifo Economic Studies*, 60, 280–311. doi: 10.1093/cesifo/ifu010 [PubMed: 25419203]
44. Aizer A & Doyle J (2013). The economics of child well-being: measuring the effects of child welfare interventions on child outcomes chapter in *Handbook in Child Well-Being Theories, Methods and Policies in Global Perspective Volume 1*, eds. Ben-Arieh A, Casas F, Frønes I, Korbin JE. (Dordrecht Heidelberg New York London: Springer).
45. International Monetary Fund (2004) Health and development: Why investing in health is critical for achieving economic development goals. Accessed on October 10, 2016: <https://www.imf.org/external/pubs/ft/health/eng/hdwi/hdwi.pdf>