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FRAGILE FAMILIES RESEARCH BRIEF

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The Fragile Families and Child Wellbeing Study changed its name to The Future of Families and Child Wellbeing Study (FFCWS). Due to the issue date of this document, FFCWS will be referenced by its former name. Any further reference to FFCWS should kindly observe this name change.

Effects of Social Disadvantage and Genetic Sensitivity on Children's Telomere Length

Background

Disadvantaged social environments are believed to increase chronic stress and undermine positive child development and wellbeing. Recent research suggests that specific biomarkers such as telomere length (TL) reveal how much stress individuals experience over time. The telomere is a sequence repeat at the end of each chromosome which is sometimes referred to as a "mitotic clock". Over the normal passage of time the telomere shortens due to cell division, making the individual more susceptible to poor health outcomes. The chromosomes of persons from disadvantaged socio-economic backgrounds and other stressful environments are more likely to show shortened telomere length at earlier ages. The extent to which the social environment affects stress is also believed to vary according to a person's genetic makeup; specifically, some people are more sensitive to their environments than others.

This research brief examines whether the association between exposure to disadvantaged environments and shortened TL is evident in childhood and whether it is more pronounced among children carrying specific genetic markers. The research that informs this brief is the first to examine TL among African American children and the first to document a gene-social environment interaction for TL.

Data and Methods

The data come from the Fragile Families and Child Wellbeing Study (FFCWS), which is following a cohort of nearly 5,000 children born between 1998 and 2000. Interviews with both mothers and fathers took place in the hospital soon after the child's birth, with follow up interviews being conducted at ages one, three, five, and nine years old. Saliva samples used to analyze DNA were collected during the age 9 follow-up interview.

The analysis is based on 40 nine-year-old, African American boys who participated in the 9 year interview and provided saliva samples. Researchers chose this population because African Americans are understudied in research on TL and genetic sensitivity, and because prior research indicates that boys may be more sensitive than girls to negative family environments.

To measure the family environment, researchers used data from all four waves of FFCWS including data on the family income/needs ratio, maternal education, harsh parenting index, family structure and stability and maternal depression. The income/needs ratio is a continuous variable based on total family income by household size. To measure maternal education, three categories were used: (i) less than high school, (ii) high school graduate, and (iii) at least some college. Harsh parenting items were taken from the Conflict Tactics Scale and included a count of how often mothers engaged in harsh psychological behaviors (e.g., yelling, threatening) and harsh physical behaviors (hitting, slapping). To measure family structure/stability, four categories were used: (i) stable two-parent families, (ii) stable single-mother families, (iii) families with one partnership change, and (iv) families with multiple partnership changes. Maternal depression scores were based on the composite international diagnostic interview (CIDI) short form. Once all the indicators of the family environment were constructed, the researchers used them to identify 20 boys raised in the most disadvantaged environments and 20 boys raised in the most advantaged environments.

Most prior reports of telomere length (TL) have used DNA derived from blood cells. In order to validate the use of saliva to measure TL, researchers conducted a separate study that compared TL taken from blood and TL taken from saliva. Average TL was significantly greater in saliva than in blood samples but the two measures were highly and significantly correlated.

In order to determine genetic sensitivity levels, a combination of genes from both the serotonergic and dopaminergic pathways were measured. Serotonin and dopamine are neurotransmitters, chemicals that transmit signals in between the nerve cells of the brain. These systems are believed to regulate thought, mood, attention, and motivation. Two serotonin pathway genetic sensitivity scores were created by (i) summing the number of homozygous genotypes composed of sensitizing alleles (5-HTTLPR-S, STin2-12, TPH2a-G [*rs4570625*], TPH2b-T [*rs1386494*]) and (ii) summing the number of sensitizing alleles. This process resulted in possible scores of 0-4 for the first measure and 0-8 for the second measure, with higher scores indicating greater sensitivity. Similar to the serotonergic scores, two dopamine pathway genetic sensitivity scores were created by (i) summing the number of homozygous genotypes composed of sensitizing alleles (the C allele for DAT1 [*rs40184*], 7R for DRD4, T allele for DRD2 [*rs1800497*], and Met allele for COMT [*rs4680*]) and (ii) summing the number of sensitizing alleles. This results in a possible score of 0-4 for the first measure and 0-8 for the second measure, again with higher scores indicating greater sensitivity. Collectively, these scores were used to determine the extent to which children were sensitive to stressful social environments.

Results

Table 1 reports results for the association between boys' social environment and TL. Model 1 shows that living in a disadvantaged family environment is associated with a 19% shorter TL than living in an advantaged environment. Models 2 through 5 show the associations between boys' TL and each of the separate environmental measures. Model 2 shows that a doubling of the family income/needs ratio is associated with a 5% increase in the boys' TL (measured as log TL). Model 3 shows that a low score on the parenting quality index is associated with a 3% decrease in a boys' TL. Finally, model 4 shows that being exposed to multiple changes in family structure by age nine is associated with a 40% decline in boys' TL. Model 5 uses mother's education as a robustness check for economic hardship and shows that having a mother with a high school degree is associated with a 32% increase in a child's TL (as compared with having a mother with less than a high school degree), and having a mother with at least some postsecondary education is associated with a 35% increase in TL.

Table 1: Robust Regression Estimates of Social Predictors of Log Telomere Length

	ln (TL)				
Measure	Model 1	Model 2	Model 3	Model 4	Model 5
Disadvantaged environment	-0.19*				
Average income/needs ratio		0.05*			
Harsh parenting index			-0.03		
Family structure changes					
Two-parent					
Single mother				-0.21	
One transition				-0.12	
Multiple transitions				-0.40*	
Mother's education					
Less than high school					
High school					0.32**
At least some college					0.35**

**P < 0.05, **P < 0.001, one-tailed.*

Next the researchers examined whether the negative association between being raised in a disadvantaged family and boy's TL differed for boys with different genetic sensitivity. Figure 1, shows that, among children with 0 sensitizing serotonin genotypes, there is little difference in TL. However, for children with higher levels of genetic sensitivity (i.e., those with 2+ sensitizing genotypes), we see a large difference. Figure 2, shows a similar (but not as strong) relationship with the family environment and the dopamine pathway genotypes. Namely, for boys with 0 sensitizing dopamine genotypes, there is only a small, insignificant difference in TL by environment, whereas for boys with 1 and 2+ sensitizing dopamine genotypes, there is a large and significant difference, with boys with sensitizing genotypes having longer TL in advantaged environments and shorter TL in disadvantaged environments. The serotonin results also show that the most sensitive group of boys has the longer TL in the advantaged environment and shorter TL in the disadvantaged environment. While the dopamine results are slightly different for the advantaged environment, they show that the most sensitive group has the shorter TL in the disadvantaged environment. These findings imply a genetically encoded differential sensitivity to the environment using TL as the biomarker.

Figure 1: Ln (Telomere Length) by Environment Type and Serotonin Genotype Counts

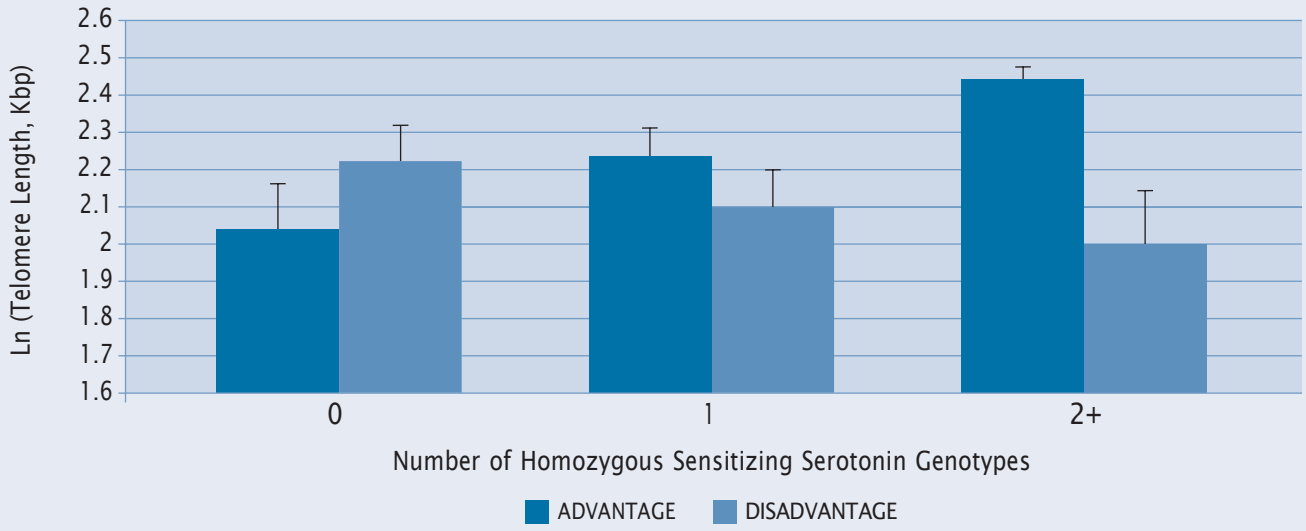
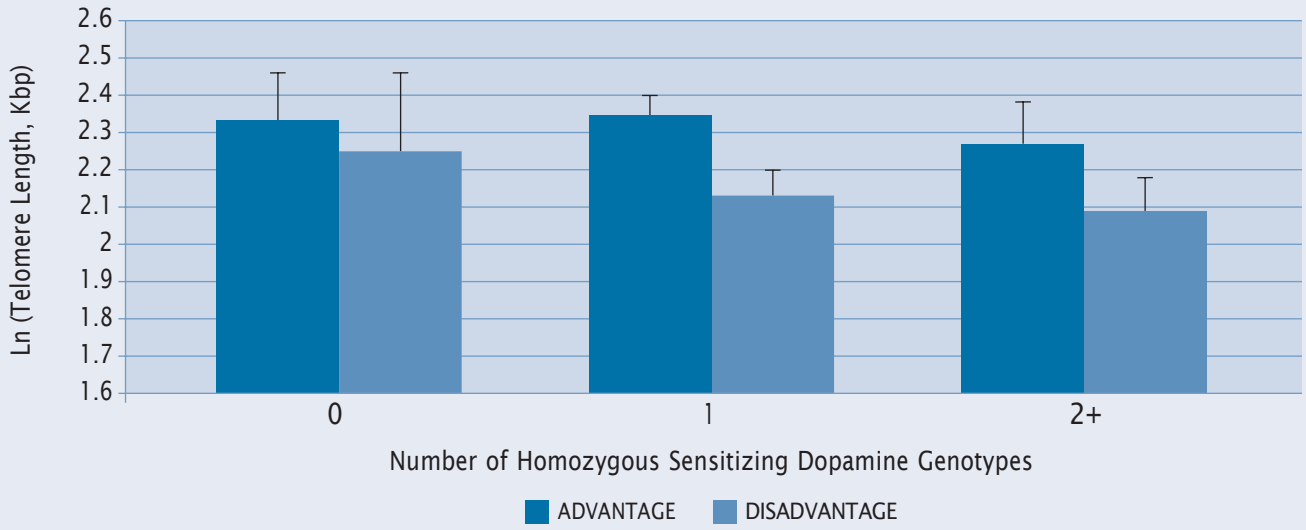


Figure 2: Ln (Telomere Length) by Environment Type and Dopamine Genotype Counts



Conclusions

The analyses reported in this brief make a number of methodological and substantive contributions. Firstly, they demonstrate the utility of using saliva DNA to measure children's telomere length which is both easier and less costly to collect than the blood samples typically used in TL research. This finding also highlights the feasibility for researchers to examine how changes in the social environment over time are associated with changes in TL by reducing costs and simplifying data collection. The analyses are also the first to examine TL in a sample of African American children, thereby including a previously underrepresented population in research on genetic sensitivity.

The analyses provide evidence that exposure to disadvantaged environments in childhood is associated with shorter TL and that the shortening of the telomere can be measured in childhood. Breaking the environmental factor into its different components also provides insight. Family socioeconomic status, family structure/stability, and harsh parenting all exhibit influence on TL.

Most importantly, the analyses reported in this brief are the first to identify a gene-social environment interaction for TL. Using two genetic sensitivity scores, the researchers found that African American boys with the highest scores on the serotonin and dopamine pathway genetic sensitivity have shorter TL than their peers when exposed to disadvantaged social environments and longer TL when exposed to advantaged environments. This finding indicates that an individual's genetic architecture moderates the magnitude and direction of the physiological response to environmental stressors.

RECENT WORKING PAPERS

The following comprises a list of the most recent Working Papers authored by the Center for Research on Child Wellbeing (CRCW) faculty and research associates. A complete list of Working Papers is also available for viewing and downloading on the CRCW web site: http://crcw.princeton.edu/publications/publications.asp.

WP14-08-FF: Wade Jacobsen "Punished for their Fathers: School Discipline Among Children of the Prison Boom"

WP14-09-FF: Sara McLanahan, Thema Bryant-Davis, Caroline Holcombe, Sarah James, Anthea Gray "An Epidemiological Study of Children's Exposure to Violence in the Fragile Families Study"

WP14-07-FF: Calvina Ellerbe, Jerrett Jones, Marcia Carlson "Nonresident Fathers' Involvement after a Nonmarital Birth: Exploring Differences by Race/Ethnicity"

WP14-06-FF: Julia Goldberg, Marcia Carlson "Patterns and Predictors of Coparenting after Unmarried Parents Part"

WP14-05-FF: Marcia Carlson, Alicia VanOrman, Kimberly Turner "Fathers' Investments of Money and Time across Residential Contexts"

WP14-04-FF: Daniel Schneider, Kristen Harknett, Sara McLanahan "Intimate Partner Violence in the Great Recession"

WP14-01-FF: Ronald Mincy, Elia De la Cruz Toledo "Unemployment and Child Support Compliance Through the Great Recession"

WP13-14-FF: Marcia Carlson, Alicia VanOrman "Trajectories of Couple Relationship Quality after Childbirth: Does Marriage Matter?"

WP13-12-FF: Kristin Turney "Liminal Men: Incarceration and Family Instability"

WP11-19-FF: Naomi Sugie "Chilling Effects: Diminished Political Participation among Romantic Partners of Formerly Incarcerated Men"

For more information about the Fragile Families and Child Wellbeing Study, go to www.fragilefamilies.princeton.edu. To review public and working papers from the Fragile Families Study, go to http://crcw.princeton.edu/publications/publications.asp.

This research brief was adapted from "Social Disadvantage, Genetic Sensitivity, and Children's Telomere Length" by Colter Mitchell, John Hobcraft, Sara S. McLanahan, Susan Rutherford Siegel, Arthur Berg, Jeanne Brooks-Gunn, Irwin Garfinkel, and Daniel Notterman (published in PNAS, 2014, Vol. 111, Issue 16, pgs. 5944-5949).

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