Examining the Transgenerational Effects of Maternal Stress on Offspring Telomere Length in a Biracial Sample

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Introduction

- Maternal stressors occurring during pregnancy have been associated with shorter telomere length (TL) in offspring [1-6].
- A striking feature of this literature is the scarcity of non-White, particularly Black samples
    For example, the 3 largest studies to date included White/European participants [5, 7, 8].
- Furthermore, timing of maternal stress exposure (maternal pregnancy vs lifespan vs childhood stress) and type of pregnancy stress (social vs. financial) have rarely been examined.

➔ This study examined the effects of maternal stress during the critical periods of childhood, pregnancy, and across the lifespan on offspring TL in a sample of 222 mother-child dyads.

Methods

- Maternal participants (112 Black; 110 White; age 37-42) and their youngest offspring ($M_{age} = 8$; age 2-17) were re-recruited as part of a larger prospective cohort study (National Heart, Lung and Blood Growth & Health Study-NGHS; Richmond site).
- Maternal participants completed sociodemographic and self-report questionnaires of maternal stress exposure:
    - Prospective reports of stressors in later childhood/adolescents (16-19 or 17-20 years) [9]
    - Retrospective reports of stressful life events during the most recent pregnancy [10]
    - Retrospective reports of lifespan stressors (Stress and Adversity Inventory-STRAIN) [11]
- Mother and child provided saliva samples for quantitative polymerase chain reaction (qPCR) telomere length measurement.
- Multiple linear regression models were used to examine the impact of the maternal stress, race, and the stress-by-race interaction on offspring TL, controlling for maternal TL as well as offspring gender and age.

Results

- Descriptive information is provided in Table 1. Regression models and statistics are presented in Table 2.
- Results showed that greater count of maternal pregnancy stressors predicted shorter offspring TL but only in children of White mothers. When examining type of pregnancy stressor (social vs. financial), only greater count of maternal financial stressors was significantly associated with shorter TL in offspring of White mothers.
- Maternal childhood and lifespan stressors were not significantly associated with offspring TL.

Table 1. Descriptive statistics for sociodemographic information, childhood, pregnancy, and lifespan stressors, as well as telomere length of mother-child dyads.

	Category	Variable	Entire Sample ($n = 222$) Mean (SD) or No. (%)	Black Mothers ($n = 112$) Mean (SD) or No. (%)	White Mothers ($n = 110$) Mean (SD) or No. (%)
Maternal descriptives	Sociodemographics	Age, years	39.31 (1.14)	39.37 (1.09)	39.25 (1.20)
		Education, No. (%) less than college degree	138 (62%)*	87 (78%)	51 (46%)
		Annual household income, No. (%) < $60,000	90 (43%)*	63 (60%)	27 (25%)
	Childhood stressors	Total count of stressors during later childhood (LES)	14.81 (8.29)	15.64 (8.83)	13.98 (7.65)
	Pregnancy stressors	Total count of stressors during pregnancy	1.87 (2.07)*	2.43 (2.25)	1.31 (1.72)
		Total count of social stressors during pregnancy	1.28 (1.52)*	1.72 (1.68)	0.85 (1.22)
		Total count of financial stressors during pregnancy	0.59 (0.86)*	0.72 (0.92)	0.46 (0.78)
	Lifespan stressors	Total count of stressors across the lifespan (STRAIN)	26.89 (15.68)	27.90 (16.40)	25.80 (14.89)
	Cellular aging marker	Telomere length (T/S ratio)	1.19 (0.24)*	1.24 (0.24)	1.13 (0.22)
Child descriptives	Sociodemographics	Age, years	8.12 (3.98)	8.41 (4.05)	7.83 (3.91)
		Gender, No. (%) female	119 (54%)	58 (52%)	61 (56%)
	Cellular aging marker	Telomere length (T/S ratio)	1.57 (0.44)	1.60 (0.47)	1.53 (0.39)

* indicates significant race differences ($p < .05$). Notes: LES = Life Events Scale; STRAIN = Stress and Adversity Inventory
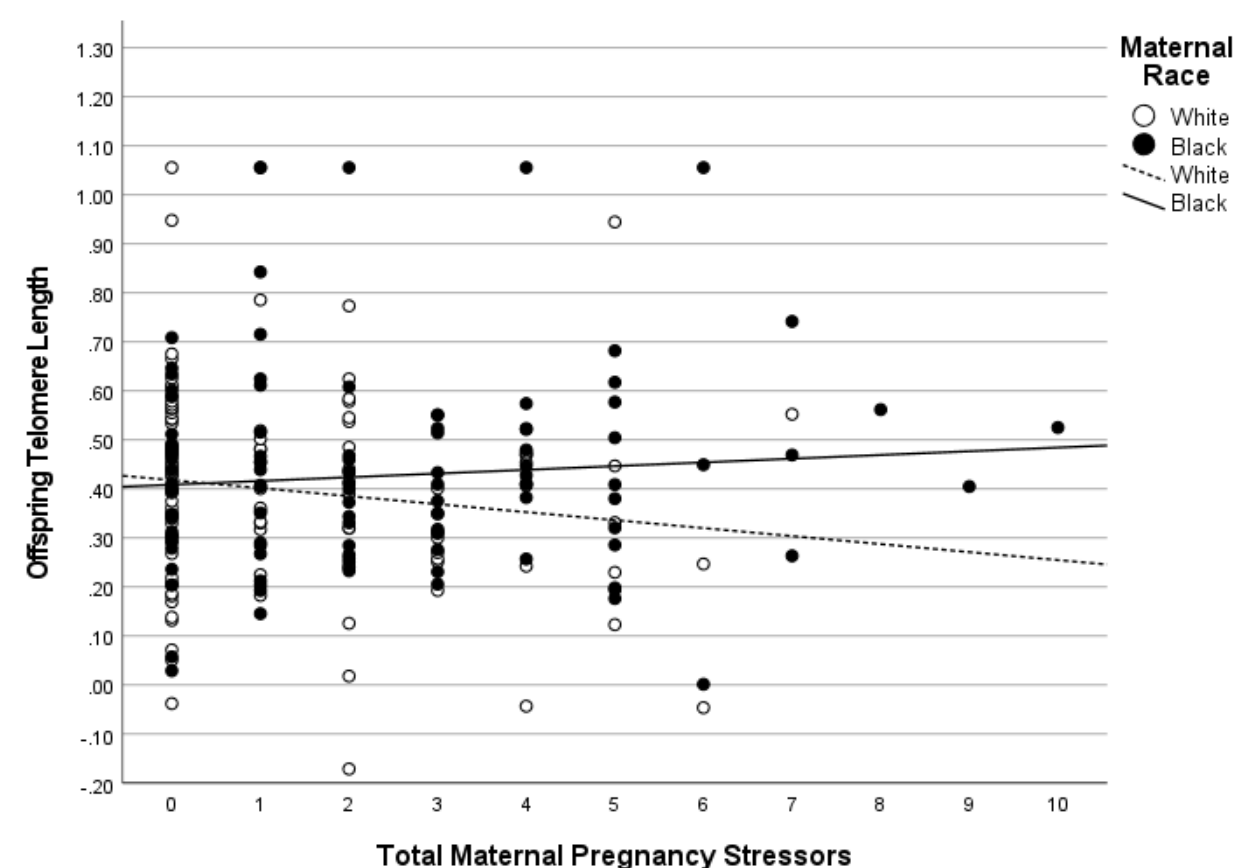

Figure 1

Association between maternal stressors occurring during pregnancy and offspring telomere length in children of Black and White mothers. Mothers who experienced more stressors during pregnancy had offspring with shorter telomere length. This relation was significant for children of White, but not Black mothers.

Note: Offspring telomere length was winsorized and natural log transformed.

Table 2. Maternal childhood, pregnancy, and lifespan stressors predicting offspring telomere length (TL).

Model	Variable	Beta	t	p
Model 1: Childhood stressors[a]	Constant		15.23	<.001
	Maternal TL	0.26	3.78	<.001
	Child age	-0.01	-0.07	.947
	Child gender (0 = boy; 1 = girl)	0.11	1.67	.096
	Childhood stressors	-0.07	-0.62	.538
	Maternal race (0 = White; 1 = Black)	0.03	0.48	.634
	Interaction of childhood stressors-by-race	0.04	0.36	.720
Model 2: Total pregnancy stressors[b]	Constant		14.08	<.001
	Maternal TL	0.26	3.67	.000
	Child age	0.01	0.12	.907
	Child gender (0 = boy; 1 = girl)	0.11	1.64	.104
	Total pregnancy stressors	-0.22	-1.80	.074
	Maternal race (0 = White; 1 = Black)	0.04	0.61	.544
	Interaction of total pregnancy stressors-by-race	0.24	2.02	.044
Model 3: Social pregnancy stressors[c]	Constant		13.91	<.001
	Maternal TL	0.26	3.62	<.001
	Child age	-0.01	-0.13	.898
	Child gender (0 = boy; 1 = girl)	0.12	1.73	.085
	Social pregnancy stressors	-0.13	-1.03	.307
	Maternal race (0 = White; 1 = Black)	0.03	0.47	.641
	Interaction of social pregnancy stressors-by-race	0.16	1.36	.176
Model 4: Financial pregnancy stressors[d]	Constant		14.81	<.001
	Maternal TL	0.25	3.64	<.001
	Child age	0.02	0.32	.751
	Child gender (0 = boy; 1 = girl)	0.10	1.42	.158
	Financial pregnancy stressors	-0.26	-2.33	.021
	Maternal race (0 = White; 1 = Black)	0.04	0.57	.573
	Interaction of financial pregnancy stressors-by-race	0.25	2.27	.024
Model 5: Lifespan stressors[e]	Constant		13.32	<.001
	Maternal TL	0.28	3.47	.001
	Child age	-0.03	-0.34	.731
	Child gender (0 = boy; 1 = girl)	0.13	1.63	.105
	Lifespan stressors	-0.04	-0.32	.748
	Maternal race (0 = White; 1 = Black)	0.05	0.61	.545
	Interaction of lifespan stressors-by-race	0.05	0.40	.693

Outcome: Offspring telomere length (TL; winsorized and natural log transformed)
[a] Model fit $R = 0.300$; $R2 = 0.090$; $F(6, 202) = 3.33$; $p = .004$
[b] Model fit $R = 0.320$; $R^2 = 0.103$; $F(6, 195) = 3.72$; $p = .002$
[c] Model fit $R = 0.304$; $R^2 = 0.092$; $F(6, 195) = 3.30$; $p = .004$
[d] Model fit $R = 0.333$; $R^2 = 0.111$; $F(6, 195) = 4.04$; $p = .001$
[e] Model fit $R = 0.330$; $R^2 = 0.109$; $F(6, 152) = 3.09$; $p = .007$

Discussion

- These data show, for the first time, race differences and type and timing effects in the transmission of maternal stressor exposure on offspring TL.
- Findings point to pregnancy stressors, in particular, as influential social-environmental exposures that may shape offspring TL.
- Results further highlight the need for a deeper understanding of the transgenerational transmission of stressor effects in Black mothers.

Funding

References

1. Entringer, S., et al., Stress exposure in intrauterine life is associated with shorter telomere length in young adulthood. Proceedings of the National Academy of Sciences, 2011. 108(33): p. E513-E518.
2. Entringer, S., et al., The fetal programming of telomere biology hypothesis: an update. Philosophical Transactions of the Royal Society B: Biological Sciences, 2018. 373(1741): p. 20170151.
3. Marchetto, N.M., et al., Prenatal stress and newborn telomere length. American Journal of Obstetrics and Gynecology, 2016. 215(1): p. 94. e1-94. e8.
4. Send, T.S., et al., Telomere length in newborns is related to maternal stress during pregnancy. Neuropsychopharmacology, 2017. 42(12): p. 2407-2413.
5. Verner, G., et al., Maternal psychological resilience during pregnancy and newborn telomere length: a prospective study. American Journal of Psychiatry, 2020: p. appi. ajp. 2020.19101003.
6. Carroll, J.E., et al., Prenatal maternal stress prospectively relates to shorter child buccal cell telomere length. Psychoneuroendocrinology, 2020. 121: p. 104841.
7. Ämmälä, A.-J., et al., Maternal stress or sleep during pregnancy are not reflected on telomere length of newborns. Scientific Reports, 2020. 10(1): p. 1-10.
8. Slykerman, R.F., et al., Maternal stress during pregnancy and small for gestational age birthweight are not associated with telomere length at 11 years of age. Gene, 2019. 694: p. 97-101.
9. Franko, D.L., et al., Expanding our understanding of the relationship between negative life events and depressive symptoms in black and white adolescent girls. Psychological Medicine, 2004. 34(7): p. 1319.
10. Prevention, C.f.D.C.a., Phase 5 Core Questionnaire–Pregnancy stressful life events. Pregnancy Risk Assessment Monitoring System (PRAMS)(CDC, Washington, DC, 2005), 2005.
11. Slavich, G.M. and G.S. Shields, Assessing lifetime stress exposure using the Stress and Adversity Inventory for Adults (Adult STRAIN): an overview and initial validation. Psychosomatic Medicine, 2018. 80(1): p. 17-27.