Food Insecurity, Telomere Length and the Potential Modifying Effects of Social Support in NHANES

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Abstract

Objective: Telomere length (TL) is a posited pathway through which chronic stress results in biological dysregulation and subsequent adverse health outcomes. Food insecurity is associated with shorter TL. Social support, which is defined by the size and function of an individual's social network, is associated with better health outcomes. The present study assesses whether social support modifies the relationship between food security and TL.

Design: Cross-sectional study design. Linear regression was used to assess the association between social support and TL, stratified by social support level. A multiplicative interacted model was used to formally test modification.

Setting: Data come from the National Health and Nutrition Examination Survey (NHANES) 1999-2000 and 2001-2002 waves.

Participants: Adults aged 60 years and older who have measurements for TL.

Results: Our sample comprised 2,674 participants, and 63.5% of the total sample had low social support, with 13.3% being food insecure. In fully adjusted models, food insecurity was negatively though modestly associated (P=0.13) with TL. Associations between food insecurity and TL were significantly modified by social support (interaction P=0.026), whereby food insecurity had a stronger effect among individuals with high social support (coefficient = -0.099 (95% CI: -0.161, -0.038)) compared to low social support (coefficient = -0.001, (95% CI: -0.033, 0.032)).

Conclusion: Food insecurity is modestly associated with shorter TL. Contrary to our hypothesis, food insecurity had more deleterious effects on TL among participants with high social support than low social support. Results may indicate that the food insecure population is a higher needs population, and increased social support reflects these needs rather than providing protective effects.

Key words: telomere length; food insecurity; social support; NHANES;

Introduction

Telomeres are caps of nucleotide repeats at the ends of chromosomes that ensure genetic integrity during mitosis.[1, 2] Telomeres naturally shorten through the lifespan as a result of cellular division and incomplete replication, thus telomere length is a marker of biological age and ultimately long-term health.[3] Prior research has identified shorter telomere length to be associated with a range of health outcomes, including mortality, cardiovascular disease, cancer progression, diabetes, and obesity.[4-7] Along with aging, exposure to external stress (physical and psychosocial stressors) can further accelerate telomere shortening through senescence-signaling pathways.[8] As such, telomere length is hypothesized to be a biomarker of chronic stress that causes downstream biological dysregulation and illness, and thus may be a mediator of health outcomes.[2, 8, 9]

Socioeconomic status (SES) is associated with telomere length. Low SES has been linked to shorter telomere length in adults, children, and at the neighborhood-level.[10-12] Notably, in a recent prospective cohort study, parental SES was positively associated with telomere length in newborns.[13] A systematic review on chronic social stress and telomere length found evidence that poverty-related stressors may induce telomere shortening.[14] It has been hypothesized chronic social stress leads to inflammation and oxidative stress, and in turn causes DNA damage and telomere shortening.[9, 15] Food insecurity, which is defined as an individual or household having an insufficient supply or access to safe and nutritious food needed for normal growth and to maintain a healthy life,[16] is linked to higher stress and is considered a chronic stressor.[17-19] In line with findings from other socioeconomic factors, food insecurity was recently found to be negatively associated with telomere length in a US representative sample.[20]

While chronic stress has adverse health consequences, evidence suggests social support is protective against chronic stress.[21] Social support is defined by two dimensions: (1) social structure, including network size and frequency of interactions, and (2) functional support, including emotional, financial, and assistive support.[22] As social support mitigates effects of chronic stress,[23-25] it follows that increasing levels of social support may be protective of telomere length. In fact, loneliness and low social support was found to predict shorter telomere lengths.[26] Similar results were found at the neighborhood level; individuals living in

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neighborhoods with high social cohesion had longer telomere lengths than individuals in low social cohesion neighborhoods.[27] Finally, another NHANES study found that spousal support is related to telomere length, where unmarried participants had shorter telomere lengths after adjusting for other sources of social support, sociodemographic factors, and comorbidities.[28]

Despite a growing body of literature indicating adverse effects of poverty on telomere length and protective effects from social support, there are no studies to our knowledge investigating whether social support mitigates effects of poverty or food insecurity on telomere length. In this paper, we assess social support as an effect modifier of food insecurity on telomere length (T/S ratio) using National Health and Nutrition Examination Survey (NHANES) data. We hypothesize that high social support is positively associated with telomere length among food insecure individuals.

Methods

Data source

Data come from the National Health and Nutrition Examination Survey (NHANES), which is conducted by the US National Center for Health Statistics (NCHS).[29, 30] The NHANES is designed to assess the health and nutritional status of the US population, combining interviews and physical examinations. NHANES is a cross-sectional survey that uses multistage probability sampling design for a nationally representative sample. Data are collected over two-year periods through survey interviews and examinations by medical personnel. We merged 1999-2002 NHANES data on telomere length (available among a sub-sample of respondents aged 20 years and older between 1999-2002), food security (available for full sample), social support (available for respondents aged 60 years and older), and participant demographics (available for all respondents). Our sub-sample for analysis corresponds to the years and age range with available data on all of these modules of interest (e.g., adults aged 60 and older in the 1999-2002 surveys). **Figure 1** depicts the sample selection flow chart. Given data are de-identified and publicly available, this study was exempt from IRB review.

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Measures

Telomere assays have been described in detail previously.[31] Leukocyte telomere length measurements were obtained for two NHANES cycles using polymerase chain reaction (PCR) method to measure telomere length relative to standard reference DNA (T/S ratio). We log-transformed the T/S ratio for a normally distributed telomere length variable.

One adult member per household was asked about food security over the past 12 months. Food security is categorized by NHANES as "food secure", "marginally food secure", "food insecure without hunger", "food insecure with hunger". For this study, we combined "food secure" with "marginally food secure", and "food insecure without hunger" with "food insecure with hunger" for a binary food security variable (secure vs insecure). We conducted sensitivity analyses to assess different combinations of food security.

NHANES social support questions were pulled from the Yale Health and Aging Study and Social Network Index – Alameda County Study.[29, 30] Consistent with prior research on social support in NHANES,[28, 32, 33] we created a social support index comprised of four questions that were each assigned 1 point if answered in the affirmative: marital status (married, not married); can count on someone to provide emotional support (yes, no); has someone they can count on if they need some extra help financially (yes, no); and having more than 5 friends (yes, no). The social support index ranged from 0 to 4 and was dichotomized, with a score ≥3 defined as high social support.

Statistical analysis

We assessed means of demographic characteristics among the full sample and then stratified by food insecurity (food secure vs food insecure). To test whether demographic characteristics differed by food security status, we conducted bivariate analyses using t-test and chi-square tests. A kernel density plot was used to assess the distribution of mean telomere length by social support. We used linear regression models to assess associations between food security, social support, and log transformed telomere length. In our base model, we regressed logged TL onto food insecurity, social support, and covariates. Our covariates included: age (continuous), female sex, self-reported race/ethnicity (non-Hispanic White (reference), non-Hispanic Black, Hispanic,

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other), educational attainment (range: <9th grade to ≥college graduate) and body mass index (BMI; as calculated by NHANES using height and weight measurements). Race-ethnicity was intentionally included in statistical analyses as a potential confounder of the relationship between food insecurity and telomere length based on the following criteria: (1) the prevalence of food insecurity is 2-3 times greater in Hispanic and non-Hispanic Black households compared to non-Hispanic White households,[34] (2) average telomere length differs according race-ethnicity and is hypothesized to be a potential mechanism by which racial discrimination results in adverse health outcomes,[35] and (3) we do not have reason to believe race-ethnicity would be an intermediary of the causal pathway between food insecurity and telomere length.

To assess whether social support modifies the association between food insecurity and telomere length, we ran an interacted model using a cross-product term between food insecurity and social support. We then stratified our models by food insecurity to evaluate the direction and strength of modification by social support.

For sensitivity analyses, we ran our base model and interaction model stratified by median age (70 years) and ran a model adjusted for smoking status (categorized as never (reference), former, current). While NHANES is nationally representative, our sub-sample for analysis is not; it is limited by data availability, including observations with information on telomere length and social support (both are sub-samples of the overall dataset). Our goal in this analysis is not to describe nationally representative estimates, but rather to examine a relationship between characteristics. Thus, we do not use sampling weights in this analysis.[36] All analyses were performed using STATA SE 17.0.

Results

Our sample for analysis included 2,674 participants (**Table 1**). The average age was 71.5 years, 49.1% of the total sample was female, the majority was non-Hispanic White (58.3%), and 63.5% of the total sample was categorized as having low social support. Of the 2,674 total participants, 356 (13.3%) were food insecure. Food insecurity status differed with respect to age, race/ethnicity, educational attainment, BMI, income, marital status, and social support (P<0.05). Telomere length did not significantly differ by food insecurity status; however, telomere length

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significantly differed according to social support level (P=0.07), such that the high social support group had longer telomere length (**Figure 2**).

In our base model among the full sample, food insecurity was not significantly associated with telomere length, adjusting for social support and covariates (**Table 2**). However, in our stratified model (**Table 3**), we found significant negative associations between food insecurity and telomere length among the high social support group (β = -0.099; 95% confidence interval (CI) = -0.16, -0.04), but a non-significant relationship among the low support group (β = -0.001; 95% CI = -0.03, 0.03). Results from our interacted model showed significant modification by social support on the multiplicative scale (β= -0.076, P=0.026; **Table 3**).

Results from our sensitivity analysis, where we first stratified our base and interacted models by median age (70 years), were consistent with our main results in terms of direction of the coefficients, but the coefficients on the interactions was significant at the 5% level only among those under 70 years of age (**Appendices 1 & 2**). Findings were robust to the inclusion of smoking status as a covariate (results not shown).

Discussion

This is the first study to evaluate whether social support modifies the food insecurity—telomere length relationship. We used nationally representative data from US to investigate whether social support mitigates the negative association between food insecurity and telomere length. Food insecurity was significantly associated with shorter telomeres. However, contrary to our hypothesis, we found that food insecurity had a more deleterious association with telomere length among participants with high social support. Further, food insecurity was not associated with telomere length among participants with low social support.

In alignment with prior literature, we found an inverse relationship between food security and telomere length, though results were only significant among the sub-sample reporting high social support, and not among the full sample.[20, 37] Our results are also consistent with prior literature indicating age and sex are associated with telomere length.[35, 38] Chronic stress, which can result from discrimination, food insecurity, and poverty-related factors, has commonly been shown to

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have adverse effects on telomere length, with some evidence that stress from poverty may induce attrition.[13-15, 31] A recent study, also using NHANES, demonstrated food insecure individuals had significantly lower telomere lengths compared to food secure individuals.[20] However, in that study, this relationship was only significant among younger participants (ages 25-44 years), whereas our study found a significant relationship among those aged 60 to 85 years. Another mixed finding study conducted among Mesoamerican parents and children found increasing levels of food insecurity was significantly associated with shorter telomere lengths among fathers, but was not among mothers or children.[37] Further, maternal food insecurity was not found to be associated with newborn telomere length in a cohort of California mothers.[39] Together, these results indicate food insecurity may be differentially deleterious to telomere length across the lifespan.

Findings from the effect modification analyses are in contrast to our hypothesis. Similar to prior literature,[10, 26, 28] we found participants with high social support have longer telomere length compare to those with low social support. However, while we found evidence of a modifying effect from social support, the adverse effect of food insecurity was found only among the high social support group. This was an unexpected result given the large body of research indicating the protective effects of social support on health.[25, 40-42] Studies on telomere length, in particular, have found such protection from social support.[28, 43, 44] Notably, the *Adults in the Making* trial, a family-based prevention program focused on improving family social support and resilience, showed a significant difference in telomere length attrition over 5 years between trial arm, such that intervention participants did not experience a reduction in telomere length in contrast to controls.[45]

Given the evidence of protective effects from social support, along with the cross-sectional design of this study, our finding of more deleterious effects from food insecurity among individuals with high social support suggests social support could reflect endogeneity in the observed relationship. The food insecure population is generally a higher needs population, and increased social support may be reflective of increased needs rather than protective effects. Thus, longitudinal data, where changes in food security, telomere length, and social support could be observed, would better identify the causal direction of this relationship.

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Limitations

Limitations of this study should be considered in interpreting the results. First, the study sample is comprised of older individuals (60 – 85 years old) due to NHANES asking the social support module to only this age group, which presents multiple limitations. Telomeres shorten with age,[3] thus the older aged sample further obscures potential causal inferences on the relationship between food insecurity, telomere length, and social support. Further, the older age may distort the level of social support compared to the participants' average lifetime social support, particularly given widowing, which was scored as 0 in the creation of the social support index. Finally, the older age range results in lower generalizability and prevents any investigation across the life course. Given this array of limitations from the older sample, future research should include a more diverse age range to investigate the relationship between food insecurity and TL. Second, the social support measure used an index developed from four NHANES questions, which may not be as comprehensive as validated social support scales, such as the Multidimensional Scale of Perceived Social Support. However, a prior study similarly created a social support index using NHANES data and dichotomized the scale for analysis.[28, 46] Third, data collection took place 20 years ago, as telomere length was only measured in those two NHANES cycles. Ideally, there would be more cycles with telomere length measures to improve sample size and power, particularly given the reduced sample size from NHANES' age-restriction of social support questions. Further, the prevalence of food insecurity and social support have changed over time.[47, 48] However, we do not believe this would alter relationship observed between food insecurity and social support. Relatedly, the US Department of Agriculture (USDA) definition of food security changed from a binary to 4-level categorical variable in 2006, but NHANES used this 4-level variable in the 1999-2002 cycles and continues to do so.[49] Thus, the operationalization of food security in the present study does not differ from current USDA standards.

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Conclusion

We found food insecurity was associated with shorter telomere length in a nationally representative sample from 1999-2001. There is evidence that social support modifies this relationship, such that food insecurity demonstrated a more adverse relationship with telomere length among the high social support group as compared to low. While this finding is in contrast to our hypothesis, this finding suggests higher social support may be an indicator of higher needs and thus higher vulnerability rather than providing protection in this population. These results emphasize the consequences of food insecurity on health. Future research is needed to further examine the relationship between food insecurity and social support on telomere length, particularly in a younger, working-age sample, and with longitudinal data to better identify the causal relationship. Telomere length offers a direct biological connection between food insecurity and long-term health outcomes. As such, initiatives that increase food security, such as the social safety net, should be improved to prevent and abate adverse health outcomes and chronic diseases.

Authorship:

Sarah M Lima: data analysis, statistical interpretation, manuscript preparation and editing;

Xuefeng Ren: study conception, statistical interpretation, manuscript editing;

Lina Mu: study conception, statistical interpretation, manuscript editing;

Heather M Ochs-Balcom: statistical interpretation and manuscript editing;

Tia Palermo: study conception, data analysis, statistical interpretation, manuscript preparation and editing

Ethical standards disclosure: Exempt - not human subjects research. This study uses secondary, de-identified data.

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References

1. Aly HA, Domènech Ò. Aroclor 1254 induced cytotoxicity and mitochondrial dysfunction in isolated rat hepatocytes. Toxicology. 2009;262(3):175-83.

2. Meier HCS, Hussein M, Needham B, *et al.* Cellular response to chronic psychosocial stress: Ten-year longitudinal changes in telomere length in the Multi-Ethnic Study of Atherosclerosis. Psychoneuroendocrinology. 2019;107:70-81.

3. Starkweather AR, Alhaeeri AA, Montpetit A, *et al.* An integrative review of factors associated with telomere length and implications for biobehavioral research. Nurs Res. 2014;63(1):36-50.

4. Haycock PC, Heydon EE, Kaptoge S, *et al.* Leucocyte telomere length and risk of cardiovascular disease: systematic review and meta-analysis. BMJ. 2014;349:g4227.

5. Maciejowski J, de Lange T. Telomeres in cancer: tumour suppression and genome instability. Nat Rev Mol Cell Biol. 2017;18(3):175-86.

6. Mundstock E, Sarria EE, Zatti H, *et al.* Effect of obesity on telomere length: Systematic review and meta-analysis. Obesity (Silver Spring). 2015;23(11):2165-74.

7. Zhao J, Miao K, Wang H, *et al.* Association between telomere length and type 2 diabetes mellitus: a meta-analysis. PLoS One. 2013;8(11):e79993.

8. Aviv A. Telomeres and human aging: facts and fibs. Science of Aging Knowledge Environment. 2004;2004(51):pe43-pe.

9. Tyrka AR, Price LH, Kao HT, *et al.* Childhood maltreatment and telomere shortening: preliminary support for an effect of early stress on cellular aging. Biol Psychiatry. 2010;67(6):531-4.

10. Mitchell AM, Kowalsky JM, Epel ES, *et al.* Childhood adversity, social support, and telomere length among perinatal women. Psychoneuroendocrinology. 2018;87:43-52.

11. Theall KP, McKasson S, Mabile E, *et al.* Early hits and long-term consequences: tracking the lasting impact of prenatal smoke exposure on telomere length in children. Am J Public Health. 2013;103 Suppl 1:S133-5.

12. Alexeeff SE, Schaefer CA, Kvale MN, *et al.* Telomere length and socioeconomic status at neighborhood and individual levels among 80,000 adults in the Genetic Epidemiology Research on Adult Health and Aging cohort. Environ Epidemiol. 2019;3(3):e049.

13. Martens DS, Janssen BG, Bijnens EM, *et al.* Association of Parental Socioeconomic Status and Newborn Telomere Length. JAMA Netw Open. 2020;3(5):e204057.

14. Oliveira BS, Zunzunegui MV, Quinlan J, *et al.* Systematic review of the association between chronic social stress and telomere length: A life course perspective. Ageing Res Rev. 2016;26:37-52.

15. Geronimus AT, Hicken MT, Pearson JA, *et al.* Do US Black Women Experience Stress-Related Accelerated Biological Aging?: A Novel Theory and First Population-Based Test of Black-White Differences in Telomere Length. Hum Nat. 2010;21(1):19-38.

16. Moncayo JR, Cafiero C. Hunger and food insecurity: FAO; 2021 [Available from: http://www.fao.org/hunger/en/.

17. Coleman-Jensen A, Rabbitt MP, Gregory CA, *et al.* Household Food Security in the United States in 2020, ERR-298, U.S. Department of Agriculture, Economic Research Service.; 2021.

18. Bruening M, Dinour LM, Chavez JBR. Food insecurity and emotional health in the USA: a systematic narrative review of longitudinal research. Public Health Nutr. 2017;20(17):3200-8.

19. Yang TC, Matthews SA. The role of social and built environments in predicting self-rated stress: A multilevel analysis in Philadelphia. Health Place. 2010;16(5):803-10.

20. Mazidi M, Kengne AP, Vatanparast H. Food Security and Leukocyte Telomere Length in Adult Americans. Oxid Med Cell Longev. 2017;2017:5427657.

21. Ozbay F, Johnson DC, Dimoulas E, *et al.* Social support and resilience to stress: from neurobiology to clinical practice. Psychiatry (Edgmont). 2007;4(5):35-40.

22. Charney DS. Psychobiological mechanisms of resilience and vulnerability: implications for successful adaptation to extreme stress. Am J Psychiatry. 2004;161(2):195-216.

23. Cohen S, Wills TA. Stress, social support, and the buffering hypothesis. Psychol Bull. 1985;98(2):310-57.

24. Cohen S. Social relationships and health. Am Psychol. 2004;59(8):676-84.

25. Taylor SE. Social support: A review. In: HS F, editor. The Oxford Handbook of Health Psychology2011.

26. Stein JY, Levin Y, Lahav Y, *et al.* Perceived social support, loneliness, and later life telomere length following wartime captivity. Health Psychol. 2018;37(11):1067-76.

27. Needham BL, Carroll JE, Diez Roux AV, *et al.* Neighborhood characteristics and leukocyte telomere length: the Multi-Ethnic Study of Atherosclerosis. Health Place. 2014;28:167-72.

28. Barger SD, Cribbet MR. Social support sources matter: Increased cellular aging among adults with unsupportive spouses. Biol Psychol. 2016;115:43-9.

29. Centers for Disease Control and Prevention (CDC). National Center for Health Statistics (NCHS). National Health and Nutrition Examination Survey Data. Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 1999-2000. Available at: https://wwwn.cdc.gov/nchs/nhanes/search/DataPage.aspx?Component=Questionnaire&CycleBeginYear=1999.

30. Centers for Disease Control and Prevention (CDC). National Center for Health Statistics (NCHS). National Health and Nutrition Examination Survey Data. Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2001-2002. Available at:

https://wwwn.cdc.gov/nchs/nhanes/search/DataPage.aspx?Component=Questionnaire&CycleBeginYear=2001.

31. Needham BL, Adler N, Gregorich S, *et al.* Socioeconomic status, health behavior, and leukocyte telomere length in the National Health and Nutrition Examination Survey, 1999–2002. Social science & medicine. 2013;85:1-8.

32. Rees CA, Karter AJ, Young BA. Race/ethnicity, social support, and associations with diabetes self-care and clinical outcomes in NHANES. Diabetes Educ. 2010;36(3):435-45.

33. Ashe KM, Lapane KL. Food Insecurity and Obesity: Exploring the Role of Social Support. J Womens Health (Larchmt). 2018;27(5):651-8.

34. Coleman-Jensen A, Rabbitt MP, Gregory CA, *et al.* Statistical supplement to household food security in the United States in 2021. 2022.

35. Diez Roux AV, Ranjit N, Jenny NS, *et al.* Race/ethnicity and telomere length in the Multi-Ethnic Study of Atherosclerosis. Aging Cell. 2009;8(3):251-7.

36. Solon G, Haider SJ, Wooldridge JM. What Are We Weighting For? Journal of Human Resources. 2015;50(2):301-16.

37. Flannagan KS, Jansen EC, Rozek LS, *et al.* Sociodemographic correlates and family aggregation of leukocyte telomere length in adults and children from Mesoamerica. Am J Hum Biol. 2017;29(3).

38. Ly K, Walker C, Berry S, *et al.* Telomere length in early childhood is associated with sex and ethnicity. Scientific Reports. 2019;9(1):10359.

39. Izano MA, Cushing LJ, Lin J, *et al.* The association of maternal psychosocial stress with newborn telomere length. PLoS One. 2020;15(12):e0242064.

40. Reblin M, Uchino BN. Social and emotional support and its implication for health. Curr Opin Psychiatry. 2008;21(2):201-5.

41. Kelly ME, Duff H, Kelly S, *et al.* The impact of social activities, social networks, social support and social relationships on the cognitive functioning of healthy older adults: a systematic review. Syst Rev. 2017;6(1):259.

42. Thoits PA. Mechanisms linking social ties and support to physical and mental health. J Health Soc Behav. 2011;52(2):145-61.

43. Hailu EM, Needham BL, Lewis TT, *et al.* Discrimination, social support, and telomere length: the Multi-Ethnic Study of Atherosclerosis (MESA). Ann Epidemiol. 2020;42:58-63.e2.

44. Carroll JE, Roux AVD, Fitzpatrick AL, *et al.* Low Social Support Is Associated With Shorter Leukocyte Telomere Length in Late Life: Multi-Ethnic Study of Atherosclerosis. Psychosomatic Medicine. 2013;75(2):171-7.

45. Brody GH, Yu T, Beach SRH, *et al.* Prevention Effects Ameliorate the Prospective Association Between Nonsupportive Parenting and Diminished Telomere Length. Prevention Science. 2015;16(2):171-80.

46. Laniado N, Cloidt M, Shah P. Social support and oral health among working-age and older adults in the United States. Journal of Public Health Dentistry.n/a(n/a).

47. US Department of Agriculture. Food Security and Nutrition Assistance. Available at: https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/food-security-and-nutrition-assistance/. [

48. Capurro DA, Harper S. Socioeconomic inequalities in health care utilization in Paraguay: Description of trends from 1999 to 2018. J Health Serv Res Policy. 2022;27(3):180-9.

49. USDA Definitions of Food Security. Available at: https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/definitions-of-food-security/.

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Table 1. Demographic descriptive statistics

	Overall, N = 2,674		Food secure, N = 2,236		Food insecure, N = 356		
	Mean(SD) or n(%)	95% CI	Mean(SD) or n(%)	95% CI	Mean(SD) or n(%)	95% CI	P-val
Telomere length	0.9 (0.22)	[0.89, 0.91]	0.90 (0.22)	[0.89, 0.91]	0.89 (0.21)	[0.87, 0.91]	0.368
Age	71.5 (7.89)	[71.2, 71.8]	71.7 (7.94)	[71.4, 72.1]	69.7 (7.29)	[69.0, 70.5]	<0.001
<70 years	1209 (45.2%)		992 (44.4%)		185 (52.0%)		0.007
≥70 years	1465 (54.8%)		1244 (55.6%)		171 (48.0%)		
Female	1312 (49.1%)		1082 (48.4%)		188 (52.8%)		0.121
Race-ethnicity							
Non-Hispanic White	1559 (58.3%)		1440 (64.4%)		84 (23.6%)		<0.001
Non-Hispanic Black	397 (14.9%)		324 (14.5%)		59 (16.6%)		
Hispanic	664 (24.8%)		426 (19.1%)		208 (58.4%)		
Other	54 (2.0%)		46 (2.1%)		5 (1.4%)		
Education							
<9th grade	690 (25.9%)		459 (20.6%)		205 (57.6%)		<0.001
9-12th grade (no diploma)	466 (17.5%)		386 (17.3%)		64 (18.0%)		
High school/GED	619 (23.2%)		556 (24.9%)		50 (14.0%)		
Some college/assoc. degree	492 (18.4%)		450 (20.2%)		26 (7.3%)		
College graduate &	401 (15.0%)		381 (17.1%)		11 (3.1%)		

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higher BMI	28.2 (5.37)	[28.0, 28.5]	28.2 (5.40)	[27.9, 28.4]	28.8 (5.27)	[28.2, 29.4]	0.044
Income (in thousand dollars)	34.66 (23.57)	[33.7, 35.6]	36.87 (23.84)	[35.8, 37.9]	18.73 (13.99)	[17.2, 20.3]	<0.001
Married	1597 (62.4%)		1362 (63.8%)		189 (54.8%)		0.001
Social support							
High support	808 (30.2%)		720 (34.4%)		61 (18.2%)		<0.001
Low support	1699 (63.5%)		1373 (65.6%)		274 (81.8%)		

Abbreviations: CI = confidence interval, BMI = body mass index

Note: Quantitative variables by social support: independent t-test. Qualitative variables by social support: chi-square.

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Table 2. Food insecurity, high social support, telomere length.

Food insecurity and telomere length, adjusted for social support (N = 2,280)	
	β (95% CI)
Food insecure	-0.022 (-0.051, 0.007)
High social support	0.014 (-0.006, 0.034)
Age	-0.007 (-0.008, -0.006)
Female	0.053 (0.034, 0.072)
Non-Hispanic Black	0.024 (-0.004, 0.052)
Hispanic	-0.021 (-0.047, 0.005)
Other race	-0.017 (-0.082, 0.049)
BMI	0.000 (-0.002, 0.001)
Education	0.003 (-0.004, 0.011)

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Table 3. Effect modification by social support of food insecurity on telomere length

	High social support **N = 313** *β (95% CI)*	**Low social support** **N = 1,976** *β (95% CI)*
Food insecure	-0.099 (-0.161, -0.038)	-0.001 (-0.033, 0.032)
Age	-0.007 (-0.01, -0.005)	-0.007 (-0.009, -0.006)
Female	0.044 (0.012, 0.076)	0.056 (0.033, 0.079)
Non-Hispanic Black	0.058 (-0.001, 0.118)	0.012 (-0.02, 0.045)
Hispanic	0.026 (-0.018, 0.071)	-0.043 (-0.075, -0.011)
Other	-0.080 (-0.179, 0.02)	0.027 (-0.059, 0.114)
BMI	-0.003 (-0.006, 0.00)	0.00 (-0.002, 0.003)
Education	0.004 (-0.008, 0.017)	0.001 (-0.008, 0.011)
Cross product *food insecure x high social support*: coefficient = -0.076, P=0.026		

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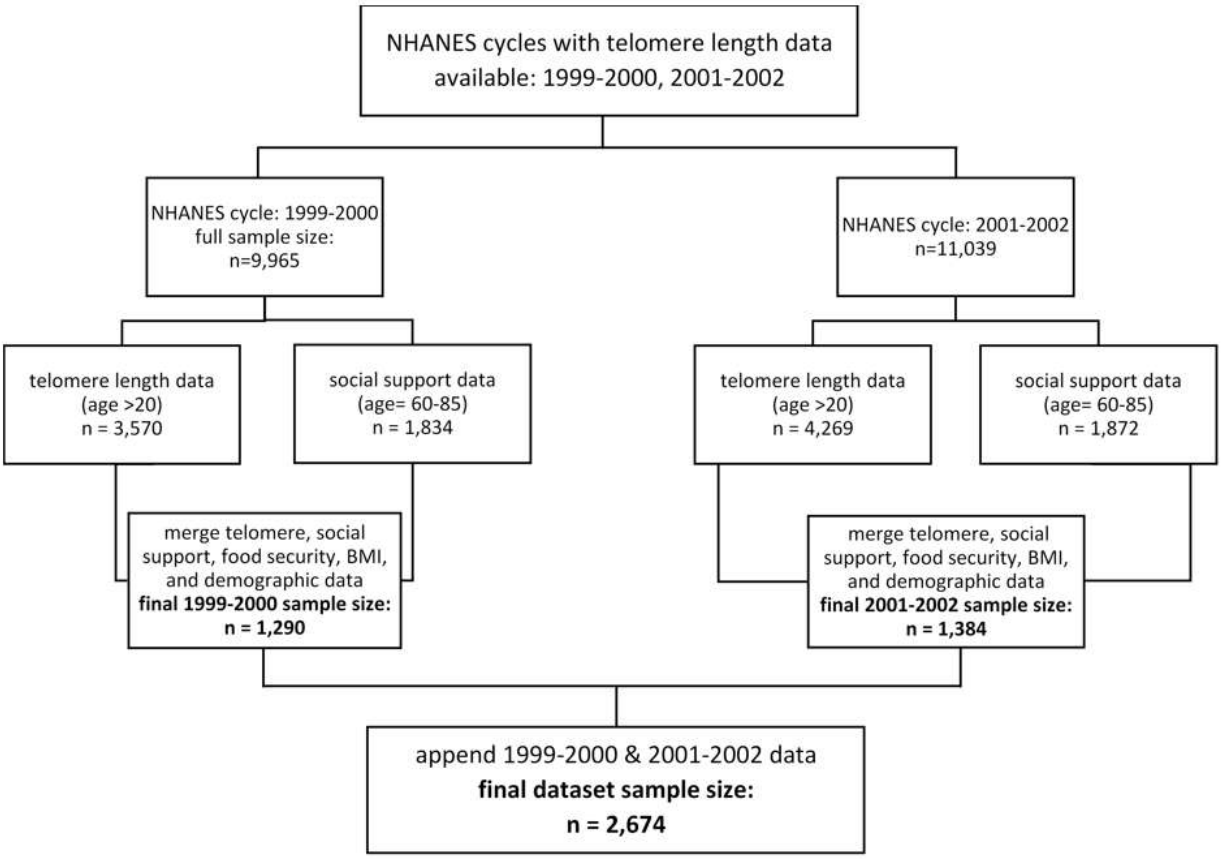

Figure 1. NHANES sample selection flow chart.

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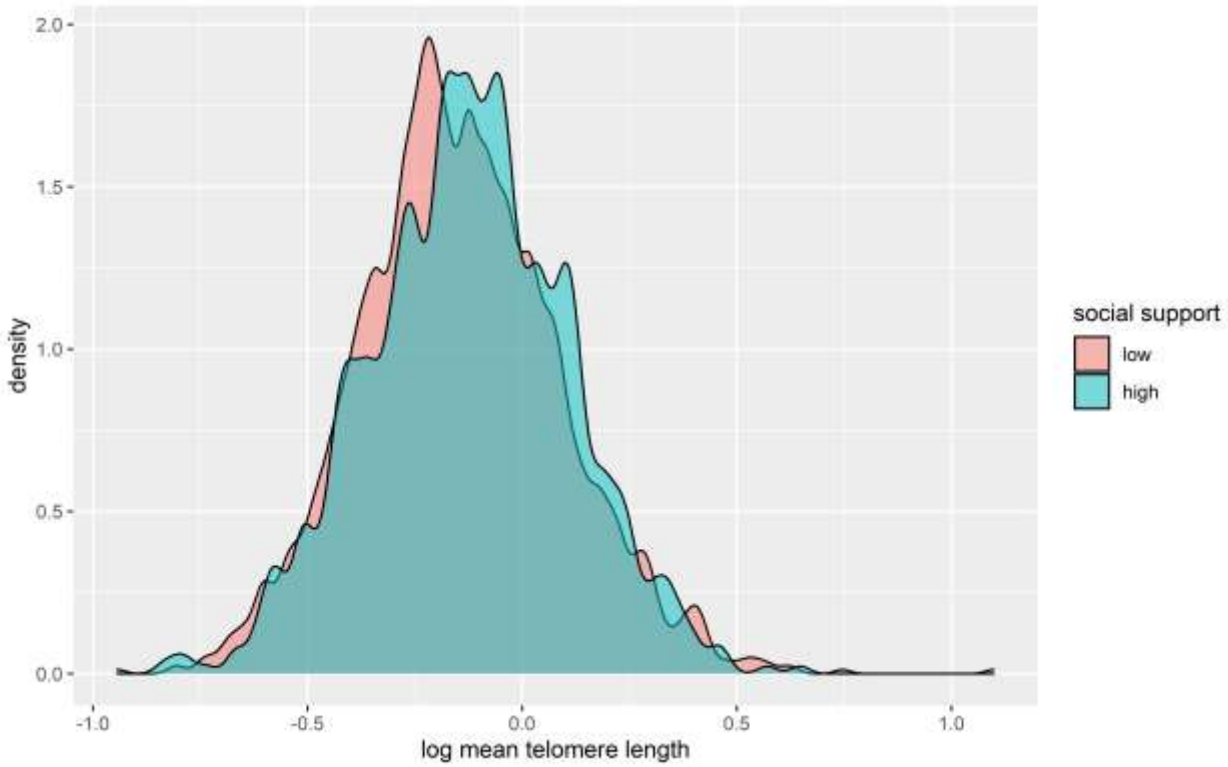

Figure 2. Distribution of telomere length by social support level (P = 0.07).

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Supplementary Table 1. Base model results stratified by median age (70 years)

	Under 70 years **N = 1,086** *β (95% CI)*	**70 years and above** **N = 1,194** *β (95% CI)*
Food insecure	-0.025 (-0.064, 0.015)	-0.013 (-0.056, 0.030)
High social support	0.015 (-0.013, 0.043)	0.018 (-0.011, 0.048)
Female	0.053 (0.027, 0.079)	0.047 (0.020, 0.073)
Non-Hispanic Black	0.014 (-0.023, 0.052)	0.043 (-0.001, 0.087)
Hispanic	-0.035 (-0.070, 0.000)	0.014 (-0.025, 0.053)
Other	-0.031 (-0.115, 0.053)	0.038 (-0.067, 0.143)
BMI	0.000 (-0.002, 0.002)	0.000 (-0.002, 0.003)
Education	0.001 (-0.010, 0.012)	0.008 (-0.003, 0.019)

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Supplementary Table 2. Interaction model stratified by median age (70 years)

	Under 70 years **N = 1,086** *β (95% CI)*	**70 years and above** **N = 1,194** *β (95% CI)*
Food insecure	-0.003 (-0.047, 0.041)	-0.003 (-0.050, 0.043)
High social support	0.026 (-0.004, 0.056)	0.023 (-0.008, 0.054)
Food insecure x high social support	-0.095 (-0.184, -0.007)	-0.051 (-0.153, 0.051)
Female	0.052 (0.025, 0.078)	0.047 (0.020, 0.073)
Non-Hispanic Black	0.019 (-0.019, 0.056)	0.042 (-0.002, 0.086)
Hispanic	-0.035 (-0.069, 0.000)	0.013 (-0.025, 0.052)
Other	-0.032 (-0.116, 0.053)	0.039 (-0.066, 0.144)
BMI	0.000 (-0.002, 0.002)	0.000 (-0.002, 0.003)

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