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Socioeconomic Status and Telomere Length in a Sample of African American Men

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An abstract of

A thesis submitted to the Faculty of the

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Abstract

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A substantial body of literature has documented socioeconomic and racial disparities in health. African American men experience particularly adverse aging-related health outcomes. A growing area of research examines the impact of socioeconomic status (SES) on biological functioning. Leukocyte telomere length (LTL) is a biomarker of cell aging. Previous studies of the association between SES and LTL have used varied measures of SES and have produced mixed results. The present study examines the association between multiple measures of SES and LTL in a sample of 92 African American men between 30 and 50 years of age. Measures of SES used were income, financial strain, education, and work status. LTL was measured with a polymerase chain reaction assay from dried blood spot samples collected using a micro-lancet. Multinomial logistic regression models were used to predict short, medium, and long tertiles of LTL. Income ($p = .043$) and financial strain ($p = .029$) were significantly associated with LTL. A significant interaction was found between employment status and education. Educational attainment was significantly associated with LTL only among those not employed ($p = .034$). These results suggest that SES is related to biological aging among midlife African American men. The biological aging associated with SES represents a possible mechanism leading to adverse aging-related outcomes for this population.

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Chapter I – Introduction

Socioeconomic status (SES) has been associated with multiple health outcomes including reduced life expectancy (Clarke et al., 2010; Marmot et al., 1984), increased risk of heart disease (Fiscella and Tancredi, 2008), lower self-rated health (Franks et al. 2003), and depression (Lorant et al., 2003). In general, higher SES is associated with improved health outcomes across the life course, disparities being most pronounced in midlife (Adler and Stewart, 2010). This relationship is not only present for the most disadvantaged members of society but persists across the socioeconomic gradient (Adler et al., 1994; Chen et al., 2006), suggesting that there is no 'poverty threshold' beyond which individuals attain parity in health. Numerous measures of SES have been associated with health status including income (Marmot, 2002), educational attainment (Adams, 2002), and employment status (Brown et al., 2012).

It has been argued that that SES may impact health differently for Blacks than Whites because of the synergistic effects of discrimination and SES (Williams, 2006). Blacks have disadvantageous health outcomes compared to Whites for a number of measures, including higher prevalence of risk factors for cardiovascular disease (McGruder et al., 2004) higher risk of low birth weight (Collins and David, 2009), and lower life expectancy (Mensah et al., 2009). Like socioeconomic inequities, racial disparities in health are most pronounced at middle age, and slightly decline thereafter (Shuey and Willson, 2008). Black men, in particular, suffer some of the most adverse aging-related outcomes. They have a life expectancy shorter than Black women and Whites and Hispanics of either gender (Olshansky et al., 2012) as well as greater risk of death from coronary heart disease (Safford et al., 2012), stroke (Gillum, 1999), and prostate cancer (Evans et al., 2008). Differential healthcare quality, behavioral risk factors, and SES do not fully account for racial disparities (Antwi et al., 2013; Franks et al., 2006).

The non-equivalence of SES metrics for different groups is a problem inherent in population-based research on SES and health. For example, Blacks have less wealth than whites at the same level of income (Williams and Collins, 1995). Furthermore, Blacks may not experience the same health benefits from some forms of higher SES, such as educational attainment (Farmer and Ferraro, 2005). Gender may also moderate the relationship between SES and health, due to differing social roles and life histories. Unemployment may be more harmful to health for men than for women, and educational attainment may be more predictive of health for men (Matthews et al., 2009).

Socioeconomic measures such as financial strain may be instrumental in overcoming the problem of non-equivalence. Financial strain can be conceptualized as the difficulty arising from the perceived inability of a person's financial resources to meet their needs (Szanton et al., 2008). There is some evidence that financial strain is predictive of health, independent of traditional SES metrics such as income and education (Shippee et al., 2012; Szanton et al., 2010). The independent predictive ability of financial strain suggests that it may be a more accurate assessment of true SES than traditional metrics. Alternatively, it may reflect intra-individual variation in cognitive responses to similar circumstances.

Though various associations between socioeconomic factors and health have been established, the pathways linking them are not as apparent. Access to healthcare and behavioral risk factors have been unable fully explain these relationships. An emerging area of research examines associations between SES and the functioning of various biological systems (McEwen and Gianaros, 2010). The biological dysregulation associated with socioeconomic disadvantage may be an important factor linking SES and health.

Likewise, racial disparities in health have been firmly established, but the mechanisms linking race and health are less clear. This is especially true for African American men, who experience exceptionally high rates of mortality from various age-related diseases. Some have argued that differences in SES explain a substantial portion of racial inequity in health (Do et al., 2012). Biologic aging associated with SES may be one factor leading to adverse health outcomes for African American men.

Chapter II – Literature Review

LTL has been conceptualized as a marker of biologic aging. Telomeres are protein complexes that cap and protect chromosome ends and are essential in maintaining chromosomal stability (Blasco, 2005). They shorten with each successive round of cell division, thus increasing chronological age is associated with decreasing LTL (Aubert and Lansdorp, 2008). However, physiological processes, such as oxidative stress, may accelerate the shortening of telomeres (Kurz et al., 2004). LTL has been shown to predict a number of age-related health outcomes (Demissie et al., 2006; Zee et al., 2010) and risk of mortality (Bayaska et al., 2007) independently of chronological age. Furthermore, there is evidence that socioeconomic disparities in LTL appear before the onset of aging-related disease (Needham et al., 2012). Because LTL is predictive of future morbidity and mortality, it is a useful indicator for examining biologic aging in midlife individuals. LTL has been linked to a variety of psychosocial stressors which suggests that an individual's social environment may impact biologic aging. This lends plausibility to the notion that SES may be related to LTL.

Past studies of relationships between SES and LTL have reported mixed results. While some have reported positive associations between measures of SES and LTL (Shiels et al., 2011; Steptoe et al., 2011; Surtees et al., 2012; Needham et al., 2012; Adler et al., 2013; Robertson et al., 2012a; Caroll et al., 2013; Needham et al., 2013), others have not (Adams et al., 2007; Batty et al., 2009; Woo et al., 2009). Furthermore, the measures of SES significantly related to LTL have been inconsistent across studies. Educational attainment has been the dimension of SES most consistently linked with LTL (see Robertson et al., 2012b) with several studies reporting a significant association (Steptoe et al., 2011; Surtees et al. 2012; Adler et al. 2013; Robertson et al., 2012a). Relationships with parental education level (Needham et al., 2012; Carroll et al., 2013), individual income (Shiels et al., 2011), home ownership (Shiels et al., 2011; Robertson et al., 2012a; Carroll et al. 2013), parental social class (Robertson et al., 2012a), occupational class (Cherkas et al., 2006), and employment status (Batty et al. 2009) have also been reported.

There some evidence that race/ethnicity may moderate the association between SES and LTL. Given the documented racial/ethnic disparities in health it seems plausible that African Americans (or Blacks) would have shorter telomeres than Whites. However, findings on race/ethnicity and LTL have been equivocal. While some studies have found longer LTL in Whites (Diez-Roux et al., 2009; Geronimus et al., 2010), others have found the reverse (Aviv et al., 2009; Hunt et al., 2008; Needham et al., 2013). One study examining the association between SES and LTL found that having more than a high school education was a stronger predictor of longer telomeres for Blacks than it was for Whites (Adler et al., 2013). Another study found that home ownership was associated with longer telomeres for Whites and Hispanics but not for Blacks (Carroll et al., 2013). A third study found that having less than a high school education significantly predicted shorter telomeres, but when examined in each group individually, the association was significant for Whites but not for African Americans or Mexican Americans (Needham et al., 2013). These results may suggest the non-equivalence of some measures of SES for different racial/ethnic groups (McDade, 2008).

Few studies have examined the association between SES and LTL at multiple stages in the life course, however, Robertson et al., examined the relationships between SES variables and LTL in three cohorts of Scottish adults approximately 35, 55, and 75 years of age (2012a). For those aged 35, education, home tenure, area-level deprivation, and home ownership were associated with LTL. However, these associations did not hold true for the two older cohorts. This suggests that some measures of SES may be more relevant for predicting LTL for those of middle age.

The present study built on the existing literature by examining the association between SES and LTL in a sample of midlife African American men. Many of the previous studies examined this relationship in older samples. However, midlife represents an ideal stage in the life course to examine the variation in biologic aging. Disparities in health are most pronounced in midlife, and SES may be particularly salient for predicting health outcomes in populations of middle age. Furthermore, exploring the relationship between SES and LTL in this sample may offer insight into processes taking place before the onset of clinical disease that may lead to adverse aging-related health outcomes for African American men.

The inconsistent results of previous studies may be due, in part, to the non-equivalent importance of some metrics of SES for the various groups studied. The current study examined a measure of financial strain in relation to LTL. Financial strain measures the appraised difficulty in meeting one's financial needs, given the available resources. This may help take into account differences in SES not captured by traditional measures. It may also offer insight into variation in responses to similar socioeconomic circumstances.

To address these issues, the present study examined the association between several measures of SES and LTL, controlling for age and other health-related factors in a sample of 92 midlife African American men. Measures of SES used were educational attainment, income, work status, and financial strain. A multivariate model was used to examine whether these measures were independently predictive of LTL. In addition, interactions among SES variables in predicting LTL were explored.

Chapter III – Methods

Study Design and Procedures

The Bay Area Heart Health Study recruited 95 African American men between the ages of 30 and 50 from the San Francisco Bay Area between February of 2010 and May of 2010. In order to be eligible, participants had to report being between 30 and 50 years of age, self identify as African American, report US nativity and parental US nativity, be free of any serious illness, and be able to read, write, and understand English.

Participants were recruited from socioeconomically diverse neighborhoods through self-referral, posted advertisements, and word-of-mouth. A trained lay research staff performed data collection in a university or church room. Interviewers administered a questionnaire to assess basic demographic characteristics. Participants then completed a self-administered computer-assisted questionnaire that included psychological, socioeconomic, and behavioral measures. A minimally invasive physical was performed during which anthropometric and biological data were collected. Study participants were compensated with a $70 gift card. The University of California, San Francisco Committee on Human Research approved all study protocols.

Outcome Variable: Leukocyte Telomere Length

Telomere length was measured in dried blood spot (DBS) samples collected from study participants. To collect these samples, each participant's finger was pricked with a micro-lancet, and the first drop of blood was wiped away. The four subsequent drops of about 50 μL were applied to filter paper, allowed to dry, and stored at -80 C (McDade et al., 2007). Genomic DNA was purified from the DBS samples, and telomere length was measured twice on each DBS sample with an average CV of 6.3% between the two runs for the entire sample of 95 specimens. The original published telomere length assay was adapted for this study (Cawthon R.M., 2002; Lin et al., 2010). Because preliminary analyses suggested an absence of a linear relationship between predictor variables and LTL, Telomere lengths were divided into tertiles and categorized as 'short,' 'medium,' or 'long.' Several recent studies have analyzed quantiles of telomere length (e.g., Yaffe et al., 2011; Weischer et al., 2013)

Main Predictors: Socioeconomic Variables

Income, education, financial strain, and work status were examined as predictors of LTL category. To assess income, participants were asked to select the option that reflected their individual monthly wages after taxes. The available choices were in increments of $500, from “$0-500” up to “$9,501” or more. Individuals were then assigned the middle value of their chosen category as their monthly wages. To estimate yearly income, monthly wages were multiplied by twelve. To aid interpretability, income was scaled to increments of $10,000. Financial Strain assessed self-reported difficulty in making monthly bill payments (0 = not difficult at all, 1 = slightly difficult, 2 = somewhat difficult, 3 = very difficult, and 4 = extremely difficult). Education was grouped into five levels (1 = no formal education, elementary or grade school, or junior high school; 2 = high school or GED/high school equivalent; 3 = some college but did not graduate or associate degree/community college; 4 = college degree; and 5 = graduate degree). Income, education, and financial strain were treated as continuous variables. Respondents were dichotomized into categories of “working” or “not working.”

Covariates

Covariates selected were a combination of those drawn from the literature and conceptually important factors. Chronologic age and marital status are common demographic covariates and potential confounders. Furthermore, chronologic age is closely linked with LTL. This study sought to examine the associationbetween SES and LTL in a healthy sample. Though participants were screened for serious illness, some variation in overall health was inevitable. To help account for this, self-rated health and a chronic conditions index were included. Smoking status, blood pressure, and obesity are important lifestyle-related risk factors. Due to the possibility of confounding by these factors, this study controlled for smoking status, diastolic blood pressure, and waist-hip ratio. Age was assessed as self-reported chronological age in years. Relationship status was categorized as married or unmarried. Participants were presented a checklist of chronic conditions and assigned a value of “1” for each condition they reported having and a value of “0” for each condition they did not report having. The values were then summed to create a chronic conditions index. Self-rated health was evaluated by asking whether a participants appraised their own health to be 1 = poor, 2 = fair, 3 = good, 4 = very good, or 5 = excellent. To measure blood pressure, a research assistant took four consecutive measurements. The mean of the last three measurements was used, disregarding the first. Both diastolic and systolic blood pressure data were available, but only diastolic was used, due to the likelihood of collinearity. Waist and hip circumference were measured in inches, and the waist measurement was divided by the hip measurement to create the waist-hip ratio. Smoking status was classified based on CDC criteria (CDC, 1994).

Data Analysis

Two observations with values for telomere length more than three standard deviations away from the mean were excluded from analyses. These values may represent measurement error or may have resulted from contamination with external genetic material. Another participant with a missing value for income was excluded, leaving a final sample size of 92 used for analysis. Bivariate analyses were performed, using ANOVA tests for continuous variables and Chi-Square tests for categorical variables. A series of multinomial logistic regression models predicting tertiles of LTL were specified. The final set of covariates consisted of income, financial strain, education level, work status, age, relationship status, and index of chronic conditions, self-rated health, diastolic blood pressure, waist-hip ratio, and smoking status. Analyses were performed using SAS 9.3.

Chapter IV – Results

Descriptive statistics are presented in Table 1. In bivariate analyses, age ($p = .002$) and diastolic blood pressure ($p = .041$) were significantly different across categories of telomere length. Income ($p = .053$) and smoking status ($p = .058$) approached significance.

In the final model income, financial strain, age, chronic conditions index, self-rated health, diastolic blood pressure, waist-hip ratio, and smoking status differentiated between two or more categories of telomere length ($p < .05$). Odds ratios and 95% confidence intervals for the model are presented in Table 2. Increasing income significantly increased the odds of being in the ‘medium’ category as opposed to the ‘short’ category ($p = .043$), and increasing financial strain significantly increased the odds of being in the ‘short’ category as opposed to the ‘medium’ category ($p = .029$).

Due to the difficulty in interpreting odds ratios in multinomial logistic regression, predicted probabilities were calculated for various values of the statistically significant variables, holding covariates at the mean. These are presented for income in Figure 1 and for financial strain, age, chronic conditions index, self-rated health, diastolic blood pressure, waist-hip ratio, and smoking status in Table 3. For financial strain, chronic conditions, and self-rated health the values selected were the highest, lowest, and middle values for each scale or index. For age, diastolic blood pressure, and waist-hip ratio, the values used were the mean, one standard deviation above the mean, and one standard deviation below the mean. For income, the values chosen were increments of $10,000, up to $100,000. For smoking, each category was examined (current, former, never) rather than continuous values.

Interactions were explored between SES variables, and the interaction between work status and education level was significant ($p = .040$). Education level was not a significant predictor of telomere length category among those in the work force. Among those not in the workforce, higher educational attainment was associated with greater odds of having long telomeres rather than short telomeres ($p = .034$). Predicted probabilities of telomere length category by education level were calculated for those not in the work force. These predicted probabilities are presented in Figure 2. As education level increased, predicted probability of being in the 'long' category increased, and predicted probability of being in the 'short' category decreased. Predicted probability of being in the 'medium' category remained relatively stable.

Chapter V – Discussion

The present analyses found associations between socioeconomic factors and LTL in a sample of midlife African American men, controlling for demographic and health-related covariates. In the final model, income and financial strain had statistically significant relationships with LTL, but employment status and educational attainment did not. However, a significant interaction between work status and educational attainment was reported. These results suggest that SES may contribute to disparities in aging-related outcomes.

This study is the first to test the association between financial strain and LTL. Financial strain was significantly related to LTL, independent of income, education, and employment status. This finding is consistent with recent studies suggesting that financial strain is predictive of health status, even when controlling for traditional measures of SES (Shippee et al., 2012; Szanton et al., 2010). High levels of financial strain have been associated with increased psychological distress (Angel et al., 2003; Ferraro and Su, 1999). Various forms of psychological distress, in turn, have been linked to LTL (Drury et al., 2012; Epel et al., 2004; Tyrka et al., 2010). This suggests that the stress associated with the appraised insufficiency of one's resources to meet financial needs may be particularly relevant to biologic aging. Equal levels of education and income may not confer the same advantages to all individuals. Survey-based measures of SES are not sensitive to differences such as quality of education or variable wealth at the same level of income. Financial may help account for this inherent non-equivalence in objective measures of SES. Future studies should test the association between financial strain and LTL in samples representing other populations.

Income was also significantly associated with LTL. Most previous studies, largely examining older populations, have not found significant relationships between SES and LTL. One previous study reporting a significant association between income and LTL examined the association in a sample of adults aged 35-64 (Shiels et al., 2011). This inconsistency may reflect the greater importance of income as a marker of SES for midlife individuals. In addition, some measures of income may not account for some sources of income important to older individuals, such as social security or financial support from family members.

Though no significant main effects were discovered for employment status and educational attainment, a significant interaction between them was found. When stratifying by employment status, education was significantly linked to LTL only among those not employed. For those not employed, increasing education was associated with greater odds of having long telomeres rather than short telomeres. One explanation for this result is that education may be a more relevant marker of SES for those who are not employed and less relevant for those who are employed. Higher educational attainment may confer stronger cognitive skills for coping with stressful life circumstances, such as being out of work (Ross and Wu, 1995). Conversely, lower educational attainment may increase vulnerability to adverse circumstances.

These findings, along with evidence that SES accounts for some of the racial inequity in health (Do et al., 2012), suggest that the biological aging associated with SES may be one process leading to adverse aging-related health outcomes for African American midlife men. Given the equivocal nature of the evidence on race/ethnicity and LTL, longitudinal research is needed to explore whether the socioeconomic patterning of LTL contributes to racial disparities in aging.

These results have several implications for public health and policy. First, interventions aimed at promoting healthy aging in African American men should address socioeconomic factors. Intervening on behavioral risk factors alone is not likely to be effective. Second, programs that address the financial strain associated with socioeconomic disadvantage may reduce some of the impact of low SES on health. Finally, social and economic policies that promote structural equality are essential. This study is consistent with the vast and growing literature on socioeconomic and racial/ethnic disparities suggesting that social equality is necessary to achieve equity in health.

Despite its advantages, the present study had several limitations. It used a small convenience sample, limiting the statistical power and generalizability of these findings. These associations should be replicated in a larger, representative sample. In addition, the cross-sectional nature of the data makes causal inference problematic. The question of causal direction in the relationship between SES and health is a difficult one in general. It seems clear that SES impacts health, but health can also impact SES by impeding social and economic activities, such as work and schooling (Kawachi et al., 2010). However, the fact that absence of serious illness was one of the inclusion criteria for the study suggests that socioeconomic factors impacting LTL is more plausible than the reverse. This insight is supported by a study showing socioeconomic disparities in LTL among adolescents, who are not yet in the work force (Needham et al., 2012).

In summary, the present study constitutes evidence that socioeconomic factors are associated with biological aging among African American men. This suggests a possible mechanism leading to adverse aging-related health outcomes for African American men. The novel finding of an association between financial strain and LTL indicates that the appraised sufficiency of available resources to meet financial needs may be predictive of LTL, independent of conventional measures of SES. The interaction between employment status and educational attainment highlights the need to further explore the interplay of socioeconomic variables in predicting LTL. Future studies should examine these associations longitudinally in representative samples in order to test whether the biological aging associated with SES contributes to racial disparities in aging-related outcomes.

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Appendix A: Tables

Table 1. Descriptive characteristics of Bay Area Heart Health Study participants (n = 92) by telomere length category

	Short (n = 31) Mean (SD) or n (%)	Medium (n = 30) Mean (SD) or n (%)	Long (n = 31) Mean (SD) or n (%)	Total (n = 92) Mean (SD) or n (%)
Income in $10,000	1.6 (14.0)	2.6 (30.0)	1.4 (10.4)	1.9 (20.3)
Financial Strain	1.8 (1.0)	1.2 (1.1)	1.4 (1.1)	1.4 (1.1)
Education Level	2.6 (0.9)	2.8 (1.0)	2.5 (0.7)	2.7 (0.84)
Work Status				
Working	16 (32.0%)	18 (36.0%)	16 (32.0%)	50 (54.4%)
Not Working	15 (35.7%)	12 (28.6%)	15 (28.6%)	42 (45.7%)
Age	46.4 (4.1)	43.7 (5.5)	41.5 (6.4)	43.8 (5.7)
Relationship Status				
Unmarried	24 (34.3%)	24 (34.3%)	22 (31.4%)	70 (76.1%)
Married	7 (31.8%)	6 (27.3%)	9 (40.9%)	22 (23.9%)
Chronic Conditions	2.0 (1.5)	2.5 (2.1)	1.6 (1.6)	2.0 (1.8)
Self-rated Health	3.4 (1.1)	3.1 (1.0)	3.6 (0.8)	3.4 (0.95)
Diastolic BP	84.9(11.6)	77.1 (15.9)	77.5(10.0)	79.9(13.1)
Waist-hip Ratio * 10	9.3 (0.7)	9.1 (0.7)	9.3 (0.8)	9.2 (0.7)

Smoking Status				
Non-smoker	9 (32.1%)	13 (46.4%)	6 (21.4%)	28 (30.4%)
Current Smoker	19 (38.0%)	15 (30.0%)	16 (32.0%)	50 (54.4%)
Former Smoker	3 (21.4%)	2 (14.3%)	9 (64.3%)	14 (15.2%)

Table 2. Multinomial logistic model performed on a sample of Bay Area Heart Health Study participants (n = 92) regressing telomere length categories on variables of socioeconomic status and covariates

	Short vs. Long OR (95% CI)	Medium vs. Long OR (95% CI)	Short vs. Medium OR (95% CI)
Income in $10,000	1.12 (0.69, 1.81)	1.58 (1.00, 2.51)	**0.71 (0.51, 0.99)***
Financial Strain	1.37 (0.71, 2.66)	0.62 (0.30, 1.30)	**2.21 (1.09, 4.51)***
Education Level	0.92 (0.39, 2.18)	0.85 (0.36, 2.03)	1.08 (0.51, 2.30)
Working vs. Not	1.32 (0.30, 5.90)	1.08 (0.23, 5.12)	1.22 (0.28, 5.44)
Age	**1.23 (1.08, 1.41)***	**1.16 (1.02, 1.31)***	1.07 (0.93, 1.22)
Unmarried vs. Married	2.15 (0.52, 8.88)	4.68 (0.94, 23.23)	0.46 (0.10, 2.04)
Chronic Conditions	1.23 (0.81, 1.88)	**1.77 (1.10, 2.86)***	0.70 (0.46, 1.05)
Self-rated Health	0.52 (0.22, 1.27)	**0.35 (0.14, 0.86)***	1.51 (0.73, 3.12)
Diastolic BP	**1.09 (1.02, 1.16)***	1.03 (0.97, 1.08)	**1.07 (1.00, 1.13)***
Waist-hip ratio * 10	0.34 (0.11, 1.10)	**0.15 (0.04, 0.54)***	2.23 (0.81, 6.10)
Smoking Status (Ref: Current)			
Never	1.33 (0.23, 7.66)	2.14 (0.37, 12.31)	0.62 (0.13, 3.00)
Former	**0.08 (0.01, 0.56)***	**0.07 (0.01, 0.67)***	1.07 (0.12, 9.61)

*** Results statistically significant at P <= .05)**

Table 3. Predicted probabilities of telomere length category calculated from a multinomial logistic model regressing telomere length category on variables of socioeconomic status and covariates for a sample of Bay Area Heart Health Study participants

	Short	Medium	Long
Financial Strain			
Not Difficult (0)	0.18	0.53	0.29
Somewhat Difficult (2)	0.41	0.25	0.34
Extremely Difficult (4)	0.64	0.08	0.28
Age			
Low (38.13)	0.18	0.24	0.59
Moderate (43.85)	0.34	0.32	0.34
High (49.57)	0.51	0.33	0.16
Chronic Conditions			
None	0.34	0.15	0.51
Moderate (3)	0.32	0.42	0.26
High (6 or more)	0.19	0.73	0.08
Self-rated Health			
Poor (1)	0.27	0.67	0.06
Good (3)	0.35	0.38	0.27
Excellent (5)	0.23	0.11	0.66
Diastolic BP			

Low (66.77)	0.16	0.34	0.5
Moderate (79.87)	0.34	0.32	0.34
High (92.97)	0.58	0.24	0.18
*Waist-hip Ratio * 10*			
Low (8.52)	0.32	0.53	0.15
Moderate (9.23)	0.34	0.32	0.34
High (9.94)	0.27	0.14	0.58
Smoking Status			
Never	0.35	0.46	0.19
Former	0.09	0.07	0.85
Current	0.39	0.32	0.29

Appendix B: Figures

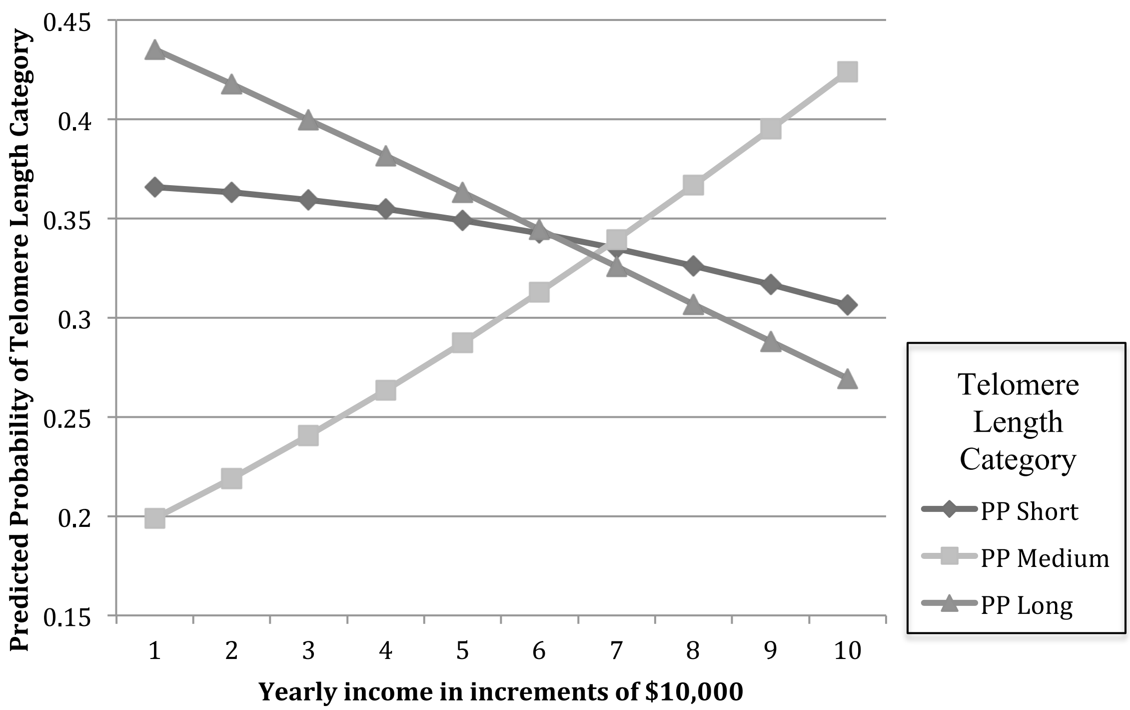

Figure 1. Predicted probabilites of telomere length category by income in the Bay Area Heart Health Study

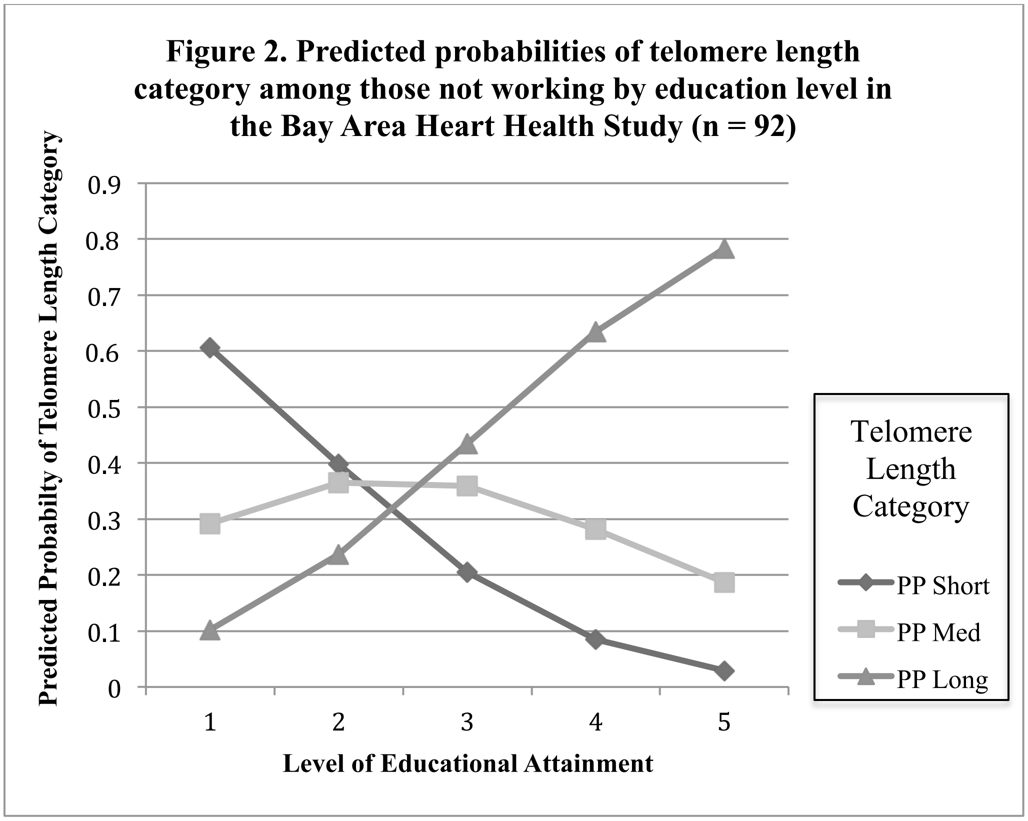
Figure 2. Predicted probabilities of telomere length category among those not working by education level in the Bay Area Heart Health Study (n = 92)
Predicted Probabilty of Telomere Length Category
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
5
Level of Educational Attainment
Telomere Length Category
PP Short
PP Med
PP Long

n