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Sheepskin effects of education in the 10-year Framingham risk of coronary heart disease

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Abstract

While the association between education and adult health is well documented, it is unclear whether quantity (i.e. years of schooling) or credentials (i.e. degrees) drive this association. Individuals with degrees may have better health than their non-credentialed counterparts given similar years of schooling, the so-called “sheepskin” effect. This paper contributes to this line of inquiry by examining associations of educational degree and years of schooling with the Framingham Risk Score, a measure of 10-year risk of coronary heart disease (CHD), using data from a unique birth cohort (the New England Family Study; participants mean age 42 years) with prospective information on childhood health and intelligence quotient (IQ). According to our results, years of schooling were inversely associated with 10-year CHD risk in the unadjusted model but not in the fully adjusted models that included degree attainment. By contrast, associations between degree attainment and 10-year CHD risk remained significant in the fully adjusted models that included years of schooling. College degree holders had 10-year CHD risk 19% (95% CI: –33%, –2%) lower than individuals with HS degrees or less in the fully adjusted models. Subanalyses evaluating sheepskin effects on the individual components of the 10-year CHD risk algorithm showed the expected education gradient was generally noted for each of the individual components, with decreasing prevalence of “high risk” values associated with higher degree credentials. Our results suggest educational credentials provide an additional benefit to risk of coronary heart disease beyond schooling.

Keywords

CHD risk; Education; Sheepskin effect

Introduction

Research has consistently reported inverse relationships between educational attainment and risk of coronary heart disease (CHD) (Becker, 1964; Gonzalez, Rodriguez Artalejo, & Calero, 1998; Harper, Lynch, & Smith, 2011; Kaplan & Keil, 1993; Loucks et al., 2009). While highly educated individuals have lower rates of CHD than less educated individuals, it is unclear what specific aspects of education contribute most to this decrease in CHD risk. Two of the most commonly studied aspects of education are years of schooling and degree credential.

Although used interchangeably, years of schooling and degree credential differ conceptually. Years of schooling implies skills learned in school directly lead to increases in human capital that, in turn, affect health (Spence, 1973). The additional benefit associated with degree attainment that is above and beyond the benefit conferred by years of schooling alone imply other pathways beyond skill accumulation may play a significant role in the association between education and health. This difference in a given outcome associated with a degree, after adjusting for years of schooling, is called a credential or “sheepskin effect”. The economics literature has widely reported sheepskin effects for wages (Ferrer, 2002; Silles, 2008). However, research on whether there is a sheepskin effect on health is mixed. One study reported a linear relationship between years of schooling and blood pressure using data from the National Health Interview Survey. The authors interpreted this finding as evidence of no sheepskin effects for blood pressure because the association for years usually associated with a degree obtainment did not differ from years not usually associated with a degree (e.g. 12 years of schooling vs. 11 years of schooling; (Cutler & Lleras-Muney, 2008). In an earlier study using the New England Family Study of middle-aged participants from the United States and information on both years of schooling and educational degree we found significant sheepskin effects on systolic and diastolic blood pressure (Liu et al., 2011).

The objectives of this study were to evaluate whether there is a sheepskin effect in the 10-year risk for CHD using the validated Framingham algorithm among middle-aged (mean age 42 years) study participants. Secondary analyses were used to evaluate whether there are sheepskin effects on previously unexplored individual modifiable CHD risk factor components of the Framingham CHD risk algorithm, including smoking, total cholesterol, HDL cholesterol and diabetes. A growing body of work suggests education has causal effects on several individual factors associated with cardiovascular risk such as smoking and obesity (Chandola, Clarke, Morris, & Blane, 2006; Cutler & Lleras-Muney, 2008; Etile & Jones, 2011; Kenkel, Lillard, & Mathios, 2006; MacInnis, 2006), but it is unclear whether degree credentials drive such associations.

Methods

Sample

Data from this study were collected from one of the sub-samples that comprise the New England Family Study (NEFS). NEFS was established in 2001 to follow-up the 17,921 adult children of pregnant women who had participated in the National Collaborative Perinatal

Project (NCP) at the Providence, Rhode Island and Boston, Massachusetts sites between 1959 and 1966 (Broman, 1984; Niswander & Gordon, 1972). Each of the several research projects within NEFS typically follows different subsets of individuals. Data for the current analyses were sourced from EdHealth, a NEFS study specifically designed to assess pathways linking education and health. The EdHealth participants were selected with preference for racial/ethnic minorities, low or high educational attainment, and assessed during 2005–2007. There were 914 participants selected, of which 898 were eligible (e.g. living, not incarcerated), 618 participated (69% response rate) and 576 completed in person clinical assessments. We excluded 13 participants who reported a doctor-diagnosed myocardial infarction/angina/coronary heart disease at the time of the blood draw, and 155 participants missing information for estimation of the Framingham Risk Score (reasons for missing information include blood draw refusal, equipment error or difficulty with blood draw). The sample size for current analyses was 393 participants in 264 families, reflecting the presence of several sibling pairs. Approximately 65% of our respondents had no siblings in the study, 25% had one sibling in the study, and 2% had two or more siblings in the study.

Included study participants did not differ significantly from excluded participants for most variables, including years of education, degree attainment, race/ethnicity, childhood SES, childhood IQ, proportion with a childhood chronic disease, current smoking status or diabetes status ($p < 0.05$). However, excluded participants were older compared to included participants ($M = 43$ vs. 42 years old, $p < 0.01$) and a higher proportion of included participants were non-Hispanic white (80% vs. 72%, $p = 0.03$). The study protocol was approved by the institutional review board of the Harvard School of Public Health and Brown Medical School.

Primary exposure variable

Educational attainment was categorized as high school (HS) degree/General Educational Development (GED), some post-secondary training, or college degree (i.e. bachelor's or higher degree). The category of "some post-secondary training" included participants who reported additional schooling after high school but no college degree (e.g. individuals who completed some college course work for credit, technical/trade/vocational school, or a certificate program). Given the small number of participants with less than a high school diploma ($n = 24$), we included those participants with participants having a high school degree/GED. Years of schooling were calculated by summing respondent's self-reported last completed grade in secondary school with self-reported years of schooling since high school (range = 6–39).

Primary outcome variable

The 10-year risk of coronary heart disease (i.e. CHD death and myocardial infarction) was calculated as a gender-specific percentage using the validated Framingham Risk Algorithm (Wilson et al., 1998). The Framingham Risk Score (FRS), a standard tool clinically used for measuring future coronary heart disease risk, incorporates common characteristics that contribute to cardiovascular disease (i.e. total and HDL cholesterol, systolic and diastolic blood pressure, diabetes, smoking status, age, and gender). Previous studies found the Framingham risk score to have good predictive validity with a c-statistic for prediction of

CHD events of 0.74 in men and 0.77 in women (Wilson et al., 1998). Additionally, external validity tests suggest the Framingham risk score performs reasonably well in white and black participants and both genders (D'Agostino, Grundy, Sullivan, & Wilson, 2001).

Components of the 10-year CHD risk variables were assessed in the EdHealth study. Current smoking status was based on self-report to the question, "Do you smoke cigarettes now?" (yes or no). Diabetes status was assessed by self-report to the question, "Have you ever been told by a doctor or health professional that you have diabetes?" (yes or no). Lipids were measured in non-fasting plasma samples at CERLab (Harvard Medical School, Boston, MA) using a Hitachi 911 analyzer, and participating in the Centers for Disease Control and Prevention/National Heart, Lung, and Blood Institute Lipid Standardization Program. Total cholesterol was measured enzymatically (CV = 1.7%; Allain, Poon, Chan, Richmond, & Fu, 1974). HDL cholesterol was measured using a direct enzymatic colorimetric assay shown to meet the rigid requirements established by the Lipid Standardization Program (CV = 3.3%; Rifai et al., 1998). Systolic and diastolic blood pressure were measured for seated participants, after a 5 min rest, in their right arm resting at heart level, using automated blood pressure monitors (VSMedTech BpTru, Coquitlam, BC, Canada) that have demonstrated good validity and reliability, compared with the auscultation method (Mattu, Heran, & Wright, 2004). Five blood pressure readings were obtained in 1 min intervals. Systolic and diastolic blood pressure values were calculated as the mean of the lowest three systolic or diastolic blood pressure readings, excluding the first recorded blood pressure. For approximately 1% ($n = 4$) of the participants, the mean of the two lowest systolic or diastolic blood pressure readings were used due to missing data.

Potential confounders

To address confounding, we included variables that could be associated with the outcome and the exposure but are unlikely to be in the pathway linking education and older adult CHD risk (A; Case, Fertig, & Paxson, 2005; Case, Lobotsky, & Paxson, 2002) including race/ethnicity (Non-White vs. White), mother's educational attainment (More than HS degree vs. HS degree or less), cognitive aptitude (verbal IQ at age 7), childhood chronic health condition at age seven (yes or no) and family socioeconomic status (SES) at age seven. Childhood socioeconomic index is a composite index based on the occupation and education of the head of the household and combined income of all family members (range = 0–9.3) (Myrianthopoulos & French, 1968). Childhood chronic disease was based on mother's reports, presence of chronic health conditions noted in medical records, or a diagnosis made by study physicians during study physical examination (Kubzansky, Martin, & Buka, 2009). Verbal IQ was measured using the Wechsler Intelligence Scale for Children (WISC), a standard measure with excellent reliability and validity (Wechsler, 1949), when the individual was 7 years old and age-standardized with a mean IQ score of 100 and an SD of 15 in the general population. Childhood socioeconomic and other characteristics were obtained from the NCPP data collected during childhood. All of the continuous variables were sample mean centered so the intercept represents the outcome when all independent variables are at their mean values.

Analytic method

Multivariable-adjusted linear regression evaluated associations of education with the Framingham Risk Score. Linear regression analyses were first performed to evaluate associations between years of schooling and degree credential and the calculated 10-year CHD risk separately. We then included both measures of education in the fully adjusted model to quantify any changes in the effect estimates. We compared the effect estimate of an educational degree between the partially adjusted model that included sociodemographics and the fully adjusted with the addition of years of schooling. A significant effect of degree, independent of years of schooling, would suggest sheepskin effect exists. Moreover, we conducted sensitivity analyses to see whether estimates would differ if we used more detailed educational degree credentials categories. Secondary analyses evaluated associations of years of schooling and degree credentials with individual components of FRS algorithm using multivariable-adjusted linear regression for continuous dependent variables (systolic blood pressure, diastolic blood pressure, total cholesterol level, and HDL cholesterol level) and logistic regression for the categorical dependent variable (smoking and diabetes status). The distributions of the 10-year CHD risk score, systolic blood pressure, diastolic blood pressure, total cholesterol and HDL were skewed, and consequently log (natural) transformed for regression analyses. All regression coefficients with the log-transformed outcomes were exponentiated and can be interpreted as percentage change for the comparison group vs. the reference group. Adjusted models included potential confounders such as age, sex, race, and early life factors (e.g. family socioeconomic index at the age of 7, etc.). Although age and gender are incorporated in the CHD risk score, we still included both of these variables in our adjusted models to account for residual confounding by age and gender. Additionally, we tested for interactions with age, sex and, childhood SES. We did not find any statistical evidence that the effect differed by gender or by age (p -value for the interaction term was 0.35 for gender and degree credentials and 0.64 for age). However, the interaction term for childhood SES and degree credential was statistically significant (p -value = 0.02). For that reason, we also present the results stratified by childhood SES (mean split of childhood SES measure). Assumptions of conditional normality and constant variance were tested and met for the linear regression models. We accounted for multiple siblings per family by correcting the standard errors using the Eicker-Huber-White modified sandwich estimator, which assumes no correlation between families but allows for within-family correlations to occur (Rogers, 1993). To assess whether missing data biased the results we reran analyses using a multivariate normal model to impute missing data from all the family clusters simultaneously and analyzed the imputed data as a multilevel model with a random intercept. While there is no definitive recommendation in the literature on how to analyze multiply imputed clustered data, estimates from these multilevel models were similar to the results in the regression models presented in our paper (results not shown). All analyses were conducted using Stata version 11.2 (Stata Corp, Texas).

Results

Descriptive statistics for the study participants ($n = 393$) are shown in Table 1. Of the study participants, 80% were White race/ ethnicity, 58% were female, and had an average of 15

years of schooling. In general, higher degree attainment was associated with lower mean 10-year CHD risk and with most behavioral and biological CHD risk factors (Table 1). College degree holders consistently had the lowest risk values for overall 10-year CHD and its components with the exception of total cholesterol. For example, only 13% (95% CI = 7, 19) of college degree holders reported currently smoking compared to 29% (95% CI = 22, 37) for those with some post-secondary training and 35% (95% CI = 27, 43) among those with a HS degree or less.

Table 2 summarizes the results from five different regression models with CHD risk as the outcome: unadjusted model with years of schooling, unadjusted model with degrees, partially adjusted model with years of schooling and sociodemographic characteristics, partially adjusted model with degrees and socio-demographic characteristics, and a fully adjusted model with years of schooling, educational degree and sociodemographic characteristics. Years of schooling were inversely associated with 10-year CHD risk in the unadjusted and partially adjusted models (Table 2). Each year of schooling was associated with an average decrease of 2% in 10-year CHD risk in the unadjusted and the model adjusted for race and childhood characteristics. However, the association between years of schooling and 10-year CHD risk was no longer statistically significant when degree attainment was included in the model (Table 2).

While participants with some post-secondary training had lower CHD risk compared to participants with high school degree in the unadjusted models, the estimate was no longer significant after adjustment for sociodemographic characteristics. Participants with a college degree had a 10-year CHD risk that was on average 28% lower than those with high school degree (95% CI: -41%, -13%) and a 22% lower 10-year calculated risk for CHD compared with high school degree (95% CI: -34%, -9%) after adjusting for race and childhood characteristics. In the model that further adjusted for years of schooling, college degree holders had a 10-year CHD risk of 19% lower than individuals with HS degrees or less (95% CI: -33%, -2%). In the stratified analyses, there were significant decreases in CHD-risk associated with college degree-holders only among respondents with low childhood SES. Among those with a low childhood SES, college degree-holders have an FRS that was 32% lower (95% CI = -48%, -11%) than the average FRS for respondents with HS degrees or less. No significant association between years of schooling or degree attainment was noted in the fully adjusted model among those with high childhood SES. When degree credentials were grouped into six categories (less than high school, GED/high school diploma, post-secondary training certificate, associate's degree, bachelor's degree, graduate degree), the direction of effects were consistent with our main results; higher degree credentials were associated with lower 10-year CHD risk and years of schooling was not statistically significant (Appendix 1).

In subanalyses evaluating sheepskin effects on the individual components of the 10-year CHD risk algorithm, a degree gradient was noted for systolic blood pressure, diastolic blood pressure, smoking and diabetes with respondents with a college degree having lowest risk or odds. However, only the association between college degree and diastolic blood pressure was statistically significant (Table 4). No difference between degree credential groups was noted for cholesterol levels (Table 3).

Discussion

While the association between educational level and CHD risk is well-established (Becker, 1964; Gonzalez et al., 1998; Harper et al., 2011; Kaplan & Keil, 1993; Loucks et al., 2009), it is unclear what aspects of education drive this association. This study investigated whether a credential effect was present in the association between education and 10-year CHD risk. We found that college degree credentials were significantly associated with lower 10-year CHD risk even after adjusting for years of schooling and important childhood characteristics. Overall, our findings suggest that credential effects may be important for CHD risk, while years of schooling were not associated with CHD independently of degree attainment.

Earlier research has suggested no sheepskin effect in health. One study using National Health Interview Survey data found a linear association between years of schooling and blood pressure with no significant decreases in risk noted for the years of schooling usually associated with degree attainment (Cutler & Lleras-Muney, 2008). Another study found years of schooling to be associated with better overall perceived health and physical functioning even after accounting for degree attainment (Ross & Mirowsky, 1999). However, such studies were limited in that they were either able to assess for sheepskin effect by examining for nonlinearities using years of schooling data alone, or they were not able to adjust for important confounders such as IQ and childhood socioeconomic status. Our findings may differ from results published in previous literature because of those reasons.

Furthermore, this study extends previous work by examining credential effect for composite risk for CHD. Results from a separate analysis of the New England Family Study participants in the United States suggested an educational gradient where higher degrees were associated with larger decreases systolic and diastolic blood pressure, independent of years of schooling (Liu et al., 2011). A previous study using this dataset found adult literacy skills such as listening skills were independently associated with 10-year CHD risk among women after adjusting for years of schooling (Martin et al., 2011). It is unclear whether literacy skills are a confounder or a mediator in the association between degree and health. Literacy skills measured in adulthood are likely to be closely inter-related to degree attainment. Conceptually, adult literacy skills suggest primary pathways to better health to be individual knowledge and understanding while credential effects suggest additional socioeconomic mechanisms.

Generally, a significant effect noted for years of schooling suggests skill accumulation where each year is associated with incremental increases in knowledge and skill. In our study, years of schooling remained statistically significant when adjusted for sociodemographic variables although the effect estimate was greatly reduced. The effect estimate associated with years of schooling was further reduced and became nonsignificant once degree credential was included in the model. A sheepskin effect suggests multiple advantages associated with a degree credential may lead to better health. It is possible that increased income or occupational prestige associated with degree attainment is responsible for the sheepskin effect (Kawachi, Adler, & Dow, 2010). An earlier study by Erikson and

Torssander (2009) found that Swedish men and women with professional education had significantly lower mortality risk compared to those with just compulsory schooling. Moreover, even among those with professional education there was a marked hierarchy with the lowest mortality risk among medical doctors and professors (Erikson & Torssander, 2009). Alternatively, degree-holders may also have certain attributes and characteristics (e.g. perseverance, positivity, etc.) leading to healthier behaviors and lower CVD risk.

Results from our stratified analysis also provide some support for resource substitution theory. According to the resource substitution theory, the effects of education are greater for socially disadvantaged groups because the absence of other resources make them more dependent on education for well-being. We found that the sheepskin effect for FRS was only noted among those with low childhood SES. Among those with low childhood socioeconomic status, a college degree was associated with large and significant percentage decreases in FRS score compared to respondents with HS degrees. However, no significant association was noted for years of schooling or degree attainment among individuals with high childhood socioeconomic status. Degree attainment may help alleviate higher health risk associated with early-life social disadvantage. Our result supports other studies that have suggested education can partially compensate adverse environments in early life (Heckman, Moon, Pinto, Savelyev, & Yavitz, 2010).

The current study also advances knowledge by demonstrating significant educational credential effects with estimated 10-year CHD risk, as well as evaluating associations of education credentials with individual CHD risk factors including smoking, diabetes, total and HDL cholesterol, and systolic and diastolic blood pressure. We find that a college degree was related in the expected direction with higher HDL cholesterol, as well as lower systolic and diastolic blood pressure, smoking and risk for diabetes, compared to participants having high school are consistent with other studies documenting associations between socioeconomic position with CHD risk factors (Chandola et al., 2006; Colhoun, Hemingway, & Poulter, 1998; Cutler & Lleras-Muney, 2008; Etilé & Jones, 2011; Gilman et al., 2008; Kenkel et al., 2006; MacInnis, 2006; Maty, Everson-Rose, Haan, Raghunathan, & Kaplan, 2005). Although the models for each of the CHD risk factors that comprise the Framingham Risk Score were generally not statistically significant, the regression coefficient associated with college degree were generally as in the expected direction (i.e. associated with lower risk) with the exception of total cholesterol. This findings is similar to results previously reported in the literature (Goldman Turra, Rosero-Bixby, Weir, & Crimmins, 2011). Although only the association between degree and diastolic blood pressure was statistically significant, all other CHD risk factors were in the direction expected, which likely combined to contribute to statistically significant associations between degree credentials and the 10-year calculated CHD risk utilizing the Framingham Risk Score.

Strengths and limitations

With regard to strengths, this study used a longitudinal dataset with prospectively assessed childhood measures of IQ, socioeconomic status and health. This allowed the adjustment for potential childhood confounding factors (i.e. cognitive ability, childhood health, family

socioeconomic status), characteristics often not available in previous studies. Furthermore, adult biological measures (i.e. blood pressure and cholesterol) were objectively assessed, eliminating potential bias associated with self-reports. With regard to limitations, study participants were largely white race/ethnicity, reflecting the general population of Massachusetts and Rhode Island at the study onset. Consequently, the generalizability of our findings of other racial/ethnic groups may be limited. An additional study weakness is the CHD risk algorithm is not as accurate a measure of CHD as the measurement of CHD events themselves. However, given the relatively young age of the participants (mean age 42 years), it is too early in the life course to evaluate associations with CHD events in this study. Education may have an effect on a wide range of CHD risk factors. Consequently by utilizing a validated CHD prediction algorithm that encompasses a variety of CHD risk factors, it allows the evaluation a variety of systems that may be simultaneously influenced by educational attainment. The relations between education and the individual components of the CHD risk algorithm provide additional, more specific information as to the potential effects of education on each individual CHD risk factor. Finally, there may be residual confounding due to imperfect measurement of childhood health as well as other measures of family socioeconomic status.

In summary, despite advances in medicine, cardiovascular diseases remain the leading cause of death in the world today. Our finding of a credential effect in the association between education and 10-year CHD risk suggests a college degree offers a socioeconomic advantage beyond the benefits associated with years of schooling. This finding emphasizes the importance of education and degree attainment as an important upstream social determinant of health. Clarifying which education measure (schooling vs. degree credential) independently contributes to health can help us construct better CHD risk scores for clinical use as well as promote more targeted educational interventions.

Appendix 1

Table A

Associations of educational attainment with log-transformed Framingham CHD risk algorithm (95% CI)

	Unadjusted ^{a,b}	Adjusted for sociodemographics ^{c,a}	Adjusted for sociodemographics and years of schooling ^a
Years of schooling	–	–	–1 (–3, 1)
Less than high school (n = 24)	21 (–12, 67)	27 (–14, 86)	26 (–14, 84)
GED/High school degree (n = 117)	Reference	Reference	Reference
Certificate (n = 78)	4 (–19, 33)	12 (–8, 37)	13 (–8, 39)
Associate's (n = 66)	–22 (–38, –1)	1 (–16, 21)	2 (–16, 38)

	Unadjusted ^{a,b}	Adjusted for sociodemographics ^{c,a}	Adjusted for sociodemographics and years of schooling ^a
Bachelor's (n = 81)	−26 (−41, −6)	−21 (−33, −6)	−19 (−33, −1)
Graduate degree (n = 27)	−25 (−46, 4)	−17 (−35, 7)	−13 (−36, 18)

^a Natural log-transformed point estimates can be interpreted as % change in risk for CHD within next 10 years for comparison vs. reference group. High school is the referent group for educational credential analyses. There is no referent group for years of schooling analyses.

^b Partially adjusted model includes age, gender, race, mother's education, childhood verbal IQ, childhood health and childhood SES.

^c Fully adjusted model includes age, gender, race, mother's education childhood verbal IQ, childhood health, childhood SES, years of schooling and degree attainment.

References

- Allain CC, Poon LS, Chan CS, Richmond W, Fu PC. Enzymatic determination of total serum cholesterol. *Clinical Chemistry*. 1974; 20:470–475. [PubMed: 4818200]
- Becker, GS. Human capital. Columbia University Press; New York: 1964.
- Broman, S. The collaborative perinatal project: an overview. In: Mednick, S.; Harway, M.; Finello, K., editors. *Handbook of longitudinal research*. Praeger; New York: 1984. p. 185-215.
- Case A, Fertig A, Paxson C. The lasting impact of childhood health and circumstances. *Journal of Health Economics*. 2005; 24:365–389. [PubMed: 15721050]
- Case A, Lobotsky D, Paxson C. Economic status and health in childhood: the origins of the gradient. *American Economic Review*. 2002; 92:1308–1344.
- Chandola T, Clarke P, Morris JN, Blane D. Pathways between education and health: a causal modelling approach. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*. 2006; 169:337–359.
- Colhoun HM, Hemingway H, Poulter NR. Socio-economic status and blood pressure: an overview analysis. *Journal of Human Hypertension*. 1998; 12:91–110. [PubMed: 9504351]
- Cutler, D.; Lleras-Muney, AMNY., editors. *Education and health: Evaluating theories and evidence*. Russell Sage Foundation; New York: 2008.
- D'Agostino RB, Grundy S, Sullivan LM, Wilson P. Validation of the Framingham coronary heart disease prediction scores – results of a multiple ethnic groups investigation. *JAMA – Journal of the American Medical Association*. 2001; 286:180–187.
- Erikson R, Torssander J. Clerics die, doctors survive: a note on death risks among highly educated professionals. *Scandinavian Journal of Public Health*. 2009; 37:227. [PubMed: 19286749]
- Etilé F, Jones AM. Schooling and smoking among the baby boomers – an evaluation of the impact of educational expansion in France. *Journal of Health Economics*. 2011; 30:811–831. [PubMed: 21703710]
- Ferrer AR, CW. The role of credentials in the Canadian labour market. *Canadian Journal of Economics*. 2002; 35
- Gilman SE, Martin LT, Abrams DB, Kawachi I, Kubzansky L, Loucks EB, et al. Educational attainment and cigarette smoking: a causal association? *International Journal of Epidemiology*. 2008
- Goldman N, Turra C, Rosero-Bixby L, Weir D, Crimmins E. Do biological measures mediate the relationship between education and health: a comparative study. *Social Sciences & Medicine*. 2011; 72:307–315.

- Gonzalez MA, Rodriguez Artalejo F, Calero JR. Relationship between socioeconomic status and ischaemic heart disease in cohort and case-control studies: 1960–1993. *International Journal of Epidemiology*. 1998; 27:350–358. [PubMed: 9698119]
- Harper S, Lynch J, Smith GD. Social determinants and the decline of cardiovascular diseases: understanding the links. *Annual Review of Public Health*. 2011; 32:39–69.
- Heckman JJ, Moon SH, Pinto R, Savelyev PA, Yavitz AQ. Analyzing social experiments as implemented: a reexamination of the evidence from the high-scope Perry preschool program. *Quantitative Economics*. 2010; 1:1–46. [PubMed: 23255883]
- Kaplan GA, Keil JE. Socioeconomic factors and cardiovascular disease: a review of the literature. *Circulation*. 1993; 88:1973–1998. [PubMed: 8403348]
- Kawachi I, Adler NE, Dow WH. Money, schooling, and health: mechanisms and causal evidence. *Annals of the New York Academy of Sciences*. 2010; 1186:56–68. [PubMed: 20201868]
- Kenkel D, Lillard D, Mathios A. The roles of high school completion and GED receipt in smoking and obesity. *Journal of Labor Economics*. 2006; 24:635–660.
- Kubzansky L, Martin L, Buka S. Early manifestations of personality and adult health: a life course perspective. *Health Psychology*. 2009; 28:364–372. [PubMed: 19450043]
- Liu SY, Buka SL, Linkletter CD, Kawachi I, Kubzansky L, Loucks EB. The association between blood pressure and years of schooling versus educational credentials: test of the sheepskin effect. *Annals of Epidemiology*. 2011; 21:128–138. [PubMed: 21184953]
- Loucks EB, Lynch JW, Pilote L, Fuhrer R, Almeida ND, Richard H, et al. Life course socioeconomic position and incidence of coronary heart disease: the Framingham offspring study. *American Journal of Epidemiology*. 2009
- MacInnis, B. Evidence from the pre-lottery Vietnam draft. University of California; Berkeley: 2006. Does education impact health?.
- Martin LT, Schonlau M, Haas A, Derose KP, Rudd R, Loucks EB, et al. Literacy skills and calculated 10-year risk of coronary heart disease. *Journal of General Internal Medicine*. 2011; 26:45–50. [PubMed: 20809155]
- Mattu GS, Heran BS, Wright JM. Overall accuracy of the BpTRU – an automated electronic blood pressure device. *Blood Press Monitoring*. 2004; 9:47–52.
- Maty SC, Everson-Rose SA, Haan MN, Raghunathan TE, Kaplan GA. Education, income, occupation, and the 34-year incidence (1965–99) of type 2 diabetes in the Alameda County study. *International Journal of Epidemiology*. 2005a; 34:1274–1281. [PubMed: 16120636]
- Myrionthopoulos NC, French KS. An application of the U.S. Bureau of the census socioeconomic index to a large, diversified patient population. *Social Science & Medicine*. 1968; 2:283–299. [PubMed: 5760819]
- Niswander, KR.; Gordon, M. The women and their pregnancies: The collaborative perinatal study of the national institute of neurological diseases and stroke. National Institutes of Health; Washington, D.C.: 1972.
- Rifai N, Cole TG, Iannotti E, Law T, Macke M, Miller R, et al. Assessment of interlaboratory performance in external proficiency testing programs with a direct HDL cholesterol assay. *Clinical Chemistry*. 1998; 44:1452–1458. [PubMed: 9665423]
- Rogers WH. Regression standard errors in clustered samples. *Stata Technical Bulletin*. 1993; 13(19–23):13.
- Ross CE, Mirowsky J. Refining the association between education and health: the effects of quantity, credential and selectivity. *Demography*. 1999; 36:445–460. [PubMed: 10604074]
- Silles M. Sheepskin effects in the returns to education. *Applied Economic Letters*. 2008; 15:217–219.
- Spence AM. Job market signalling. *Quarterly Journal of Economics*. 1973; 88:355–379.
- Wechsler, D. Wechsler intelligence scale for children; manual. Psychological Corp; New York: 1949.
- Wilson PW, D'Agostino RB, Levy D, Belanger AM, Silbershatz H, Kannel WB. Prediction of coronary heart disease using risk factor categories. *Circulation*. 1998; 97:1837–1847. [PubMed: 9603539]

Table 1

Descriptive statistics (means with range or proportions with 95% CI) of outcomes and covariates by educational attainment.

	All participants (<i>n</i> = 393)	HS degree (<i>n</i> = 141)	Some post- secondary training (<i>n</i> = 144)	College degree (<i>n</i> = 108)	<i>p</i> -Value for trend
Mean years of schooling (range)	15 (6–39)	12 (7–18)	15 (8–34)	19.1 (15–37)	<0.01
Mean age (range)	42 (39–47)	42 (39–46)	42 (39–47)	42 (39–46)	0.73
Male (%)	42	48	35	43	0.35
Non-Hispanic white (%)	80	79	81	82	0.58
Mother's education: more than HS degree (%)	30	17	31	44	<0.01
Childhood SES	6 (0–9)	5 (0–5)	6 (1–9)	6 (1–9)	<0.01
Verbal IQ at age 7	99 (61–160)	96 (69–160)	98 (61–130)	106 (63–139)	<0.01
Childhood chronic disease (%)	16	13	17	17	0.31
Average 10-year CHD risk (range)	4 (1–23)	5 (1–23)	5 (1–21)	4 (1–18)	<0.01
High CHD risk (%)	8	10	10	4	0.06
Average total cholesterol in mg/dL (range)	197 (99–332)	196 (101–332)	197 (119–327)	199 (99–316)	0.67
Average HDL cholesterol in mg/dL (range)	50 (15–133)	47 (19–93)	51 (23–133)	51 (15–111)	0.06
Average systolic blood pressure in mmHg (range)	115 (67–183)	117 (74–183)	116 (67–168)	112 (87–154)	0.01
Average diastolic blood pressure in mmHg (range)	76 (47–110)	77 (47–109)	77 (51–110)	74 (51–102)	0.03
Diabetes (%)	6	6	8	3	0.38
Current smoker (%)	27	35	29	13	<0.01

Table 2

Association between education with calculated 10-year risk (%) for coronary heart disease (95% CI)^a.

	Unadjusted ^{a,b}	Adjusted for sociodemographic characteristics ^{a,c}	Adjusted for sociodemographic characteristics and degree ^{a,d}
Years of schooling	-2 (-4, -1)	-2 (-3, 0)	-1 (-2, 1)
	Unadjusted ^{a,b}	Adjusted for sociodemographic characteristics ^{a,c}	Adjusted for sociodemographic characteristics and years of schooling ^{a,d}
High school	Reference	Reference	Reference
Some post-secondary training	-12 (-27, 6)	-4 (-11, 20)	5 (-10, 23)
College degree	-28 (-40, -13)	-22 (-34, -8)	-19 (-33, -2)

^a Natural log-transformed point estimates in the table above were exponentiated and can be interpreted as % change in risk for CHD within next 10 years for comparison vs. reference group. High school is the referent group for educational credential analyses. There is no referent group for years of schooling analyses.

^b Unadjusted.

^c Partially adjusted model includes age, gender, race, mother's education, childhood verbal IQ, childhood health and childhood SES.

^d Fully adjusted model includes age, gender, race, mother's education childhood verbal IQ, childhood health, childhood SES, years of schooling and degree attainment.

Table 3

Association between education with calculated 10-year risk (%) for coronary heart disease (95% CI) stratified by childhood SES^a.

	Low childhood SES			High childhood SES		
	Unadjusted^{a,b}	Adjusted for sociodemographic characteristics^{a,c}	Adjusted for sociodemographic characteristics and degree^{a,d}	Unadjusted^{a,b}	Adjusted for sociodemographic characteristics^{a,c}	Adjusted for sociodemographic characteristics and degree^{a,d}
Years of schooling	-3 (-5, 0)	-3 (-5, -1)	-1 (-3, 1)	-2 (-4, 1)	0 (-2, 2)	0 (-2, 3)
High school	Reference	Reference	Reference	Reference	Reference	Reference
Some post-secondary training	-15 (-34, 11)	-11 (-28, 9)	-9 (-27, 14)	-6 (-28, 22)	26 (1, 56)	25 (-1, 57)
College degree	-30 (-48, -6)	-37 (-50, -20)	-32 (-48, -11)	-23 (-41, 0)	-2 (-23, 24)	-5 (-29, 28)

^a Natural log-transformed point estimates in the table above were exponentiated and can be interpreted as % change in risk for CHD within next 10 years for comparison vs. reference group. High school is the referent group for educational credential analyses. There is no referent group for years of schooling analyses.

^b Unadjusted.

Table 4

Associations of educational attainment with individual components to Framingham CHD risk algorithm (95% CI).

Educational attainment	HDL (%)^{a,b}	Total cholesterol (%)^{a,b}	Systolic BP (%)^{a,b}	Diastolic BP (%)^{a,b}	Smoking (OR)^{a,c}	Diabetes (OR)^{a,c}
Years of schooling	0 (−1, 1)	0 (−1, 1)	0 (−1, 0)	0 (0, 0)	1 (1, 1)	1 (1, 1)
High school	Reference	Reference	Reference	Reference	Reference	Reference
Some post-secondary training	−2 (−10, 6)	0 (−5, 6)	0 (−3, 4)	−1 (−5, 3)	1 (1, 2)	1 (0, 6)
College degree	3 (−7, 14)	0 (−7, 7)	−3 (−7, 1)	−5 (−9, −1)	1 (0, 1)	1 (0, 8)

^aFully adjusted models include age, gender, race, mother's education, childhood verbal IQ, childhood health, childhood SES, years of schooling and degree attainment.

^bNatural log-transformed point estimates in the table above were exponentiated and can be interpreted as % change in specified CHD component within next 10 years for comparison vs. reference group. High school is the referent group for educational credential analyses. There is no referent group for years of schooling analyses.

^cOdds ratio.