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Degrees of health disparities: Health status disparities between young adults with high school diplomas, sub-baccalaureate degrees, and baccalaureate degrees

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Abstract

Community colleges have increased post-secondary educational access for disadvantaged youth, but it is unknown how community college degrees fit into the educational gradient of health status disparities. Using data from high school graduates in the National Longitudinal Study of Adolescent Health, we compared young adults ages 26–31 whose highest degrees were high school diplomas (n=5584), sub-baccalaureate credentials (sub-BAs include community college certificates and associate's degrees) (n=2415), and baccalaureate degrees (BAs) (n=3303) on measures of hypertension, obesity, smoking, sleep problems, dyslipidemia, and depression. Comparisons used multivariate Poisson regression with robust standard errors after exact and nearest-neighbor Mahalanobis matching within propensity score calipers on 23 baseline factors measured in 1995. High school graduates and sub-BAs differed significantly on 3 of 23 baseline factors. After matching, sub-BAs were 16% less likely to smoke daily than if they had only a high school diploma but did not differ in other health status measures. Sub-BAs and BAs differed significantly on 14 of 23 baseline factors. After matching, BAs were 60% less likely to smoke daily, 14% less likely to be obese, and 38% less likely to have been diagnosed with depression. Sub-BA degrees are accessible to high school graduates irrespective of academic backgrounds and predict lower smoking prevalence. BAs are less accessible to high school graduates and predict lower chances of smoking, depression, and obesity.

Keywords

Health status disparities; Educational status; propensity scores; Cohort studies; Young adults

Introduction

Community colleges have allowed disadvantaged youth to access post-secondary education more than in past generations. Community college degrees are relatively new, so it is still unknown how they fit into the educational gradient of health status disparities. This research compares young adults whose highest degrees are high school diplomas, sub-baccalaureate credentials (associate's degrees and community college certificates), and baccalaureate degrees on measures of hypertension, obesity, daily smoking, sleep problems, depression, and dyslipidemia.

The gradient between health status and educational status is well-known among researchers, but past health disparities research has focused on the bachelor's degree. A recent survey of the economic returns to community college cited health returns to sub-BA credentials as a gap in the literature (Belfield and Bailey 2011).

Formerly a negligible portion of the post-secondary educational system, community college students are a large and growing population, comprising 47% of undergraduates and 29% of traditionally-aged undergraduates (under age 25) (Snyder and Dillow 2011, Table 212). The rate of growth of sub-BA degrees has surpassed that of BAs: between 1973 and 2009, 149% more AAs and 73% more BAs were issued (Snyder and Dillow 2011, Table 279). Community college has been the primary institution for expanding college access to disadvantaged youth who can attend despite poor grades or resource restrictions that may have barred them in earlier generations (Settersten and Ray 2010). The economic and other gains from sub-BA credentials are controversial: Kane and Rouse found in 1995 that community college degrees have payoffs only for women (12% increase in wages) but not men (Kane and Rouse 1995), but the mid-skill job market has expanded enormously since then (Carnevale, Rose, and Cheah 2011; Sommers 2009).

Educational attainment has been widely recognized as a root of health disparities (Woolf and Braveman 2011). People with higher levels of education have better health status by almost every health measure: obesity and waist circumference (Hermann et al 2011; Cutler and Lleras-Muney 2010), smoking (Cutler and Lleras-Muney 2010), heavy drinking (Cutler and Lleras-Muney 2010), oral health (Bernabé 2011), cardiovascular disease and its risk factors (Kavanagh et al 2010; Fiscella and Franks 2004; Ernstsen, Bjerkeset, and Krokstad 2010), cancer mortality (Sprague et al 2011), diet quality (Azagba and Sharaf 2011; Aggarwal et al 2011), and greater success quitting smoking in response to health problems (King et al 2007). The health status of the US population has improved across most educational levels between 1971 and 2002, but educational disparities widened for premature adult mortality (Reither et al 2006), smoking, and diabetes (Kanjilal et al 2006). Education-linked health and longevity disparities between US adults with and without BAs have been estimated to have an economic value of $1 trillion (Schoeni et al 2011) and to be responsible for about 40% of premature adult cancer deaths (Siegel et al 2011).

Recent comprehensive surveys of health status disparities have not accounted for the increasing role of sub-BA degrees as a separate educational category. Frequently studies use “some college” as an intermediate educational level between high school diplomas and BAs. The “some college” designation groups people with useful vocational credentials such as an associate’s degree in nursing with people who left college without a credential after liberal arts courses. Using several nationally representative surveys, Braveman and colleagues (2010) compared the health of high school graduates, “some college,” and college graduates using unadjusted measures for both children (infant mortality, child health status, child healthy eating, child sedentary behavior) and adults (life expectancy at age 25, health status, activity limitations due to chronic disease, and diabetes). In the 2000 National Health Interview Survey, Barbeau and colleagues compared smoking among high school graduates, “some college” or associate’s degree (grouped together), and college graduates (Barbeau, Krieger, and Soobader 2004).

Grouping sub-BAs with “some college” may give inaccurate estimates of health status disparities depending on whether credentials or years of schooling drive health status disparities. The evidence on this point is mixed. Some researchers have linked each year of schooling with improved health status (Cutler and Lleras-Muney 2010), but others have found health returns only from earned degrees rather than from the number of years of education (Backlund, Sorlie, Johnson 1999; Liu et al 2011).

Educational attainment may confer value by signaling productivity to employers (the credential or sheepskin effect) (Jaeger and Page 1996; Grubb 1997), by improving human capital linearly through years of education (the human capital effect) (Ehrenberg 2004), or both (Ferrer and Riddell 2002). These hypotheses have been tested using the BA as the

primary college degree, but the existing evidence suggests that sub-BAs confer value through credential rather than human capital. In the context of the BA degree, Gullason found a human capital effect (earnings were linearly related to years of education) for employees whose professions were relevant to their college major and a credential effect for employees whose bachelor's degrees were in subjects unrelated to their professions (1999). In the context of sub-BA degrees, Grubb found the opposite: credentials were better predictors of earnings than years of education (1997). This difference between BAs and sub-BAs could be explained by the nature of sub-BA degrees, which are often highly tailored to specific jobs in the mid-skill labor market (Carnevale, Rose, and Cheah 2011; Sommers 2009).

Following studies of the economic returns to sub-BA credentials, this paper estimates the health returns to sub-BA credentials by comparing the health status of young adults whose highest attained degrees are high school diplomas, sub-BA credentials (associate's degree or community college certificate), and bachelor's degrees. The analysis is unique due to its use of survey-weighted nationally representative data and matched sampling methods.

Methods

Data

We tested these hypotheses in the National Longitudinal Study of Adolescent Health (Add Health) data, a nationally representative sample of students who were grades 7–12 in 1995, with an over-sample of selected populations (Udry 2003). Respondents and parents were interviewed in their homes in 1995 (baseline) and 1996, and respondents were followed in 2001 and 2008. Sensitive questions were asked by audio computer-assisted self-interview. This study used the baseline and 2008 waves. Pre-college variables were measured in the baseline in-home interview in 1995, when the sample was ages 12–18. Educational status and health outcomes were measured in 2008, when the sample was ages 26–32.

The sample of interest included respondents who had graduated high school and had known survey weights. We compared respondents whose highest degrees were high school diplomas (n=5584), sub-BAs (community college certificates and associate's degrees) (n=2415), and bachelor's degrees (BAs) (n=3303). Sample weights were missing for 5.3% of respondents who attended replacement schools --- schools chosen to replace non-participating schools according to their match on 8 characteristics such as size and grade levels --- with no logical value to substitute (Tourangeau and Shin 1999). Analyses were repeated with and without the sample weights, and the results did not differ. High school equivalence exams (GEDs) were not counted as high school diplomas because of observed differences in their employment and health outcomes in other studies (Barbeau et al 2004).

Measures

Pre-college factors—Pre-college factors measured at baseline were included if they were either important predictors of post-secondary educational attainment (Willis and Rosen 1979; Wilson 2001; Haveman and Wolfe 1995) — such as socioeconomic status, demographics, test scores, grades, and positive expectancies — or baseline values of each of the health status measures, if available. Socioeconomic status was measured as parent-reported education level (10 categories), parent-reported household income (log), and parent response to a question about whether the household has enough money to pay bills.

Demographic measures included gender, race/ethnicity (black, Latino, Asian), age, respondent and parent nativity (whether the respondent/parent was born in the US), and whether English was the primary language spoken at home. Educational factors included

intention to attend college (Likert scale), Peabody Vocabulary Test percentile, grade average (mean of all available grades in English, math, science, and history), an indicator for grade missingness in all 4 courses, and binary indicator of having problems completing homework at least once per week.

Positive expectancies was a composite variable based on items including whether the respondent expected to be killed by age 21, live until age 35, contract HIV, and get married (Cronbach's alpha = 0.61).

Baseline health status included measured body mass index (BMI), overweight status (BMI greater than 25), a depression index based on the Center for Epidemiologic Studies Depression Scale (CES-D), depression status based on gender and CES-D score, having smoked in the past month, and sleeping enough.

Health status—We used 7 measures of health status in 2008, all binary and constructed by the Add Health survey. Obesity was defined as 1 for respondents with a measured body mass index greater than 30, and otherwise 0. Stage 1 hypertension was coded as 1 for respondents who responded that they had ever been diagnosed with high blood pressure, or who had measured blood pressure at least 140/90 mm Hg, and otherwise 0. Stage 2 hypertension was coded as 1 for respondents who reported having ever been diagnosed with high blood pressure, or who had measured blood pressure at least 160/100 mm Hg, and otherwise 0. High cholesterol was coded as 1 for respondents who reported having ever been diagnosed with high cholesterol or triglycerides or lipids. Self-reported sleep problems were defined as 1 for respondents who reported snoring/stopping breathing during sleep and reported weekly problems falling asleep or staying asleep. Self-reported depression was coded as 1 for respondents who reported having ever been diagnosed with depression or feeling depressed "a lot" or "all" of the past 7 days, and otherwise 0. Self-reported daily smoking was coded as 1 for respondents who reported smoking 30 of the past 30 days, and otherwise 0.

Educational attainment—Educational attainment was measured as the highest degree listed in a detailed history of every degree attained, reported in 2008. Respondents attained their highest degree 3–13 years after baseline (1995). We used two educational markers of interest: a binary indicator for having a sub-BA credential versus a high school diploma (missing for respondents with a BA degree or above) and a binary indicator for having a sub-BA credential versus a BA (missing for respondents with above a BA and only a high school diploma.)

Data analysis

Bivariate analysis of educational gradients for each measure of health status used Cuzick's non-parametric test for trend, a generalization of the Mann-Whitney test (Cuzick 1985). Multivariate analyses estimated the relative risks of each health status for respondents with a sub-BA credential versus a high school diploma (or BA versus sub-BA) using multivariate regression, controlling for all baseline measures described above. These health statuses are not rare (Figure 1), so the multivariate regression used a Poisson working model with robust standard errors instead of logistic regression to yield consistent and unbiased estimators that are also easily interpretable (Cummings 2009; Lumley, Kronmal, and Ma 2006; McNutt et al 2003; Zou 2004). Robust standard errors were estimated with the R sandwich library (Zeileis 2004; Zeileis 2006).

The relative risks of each health status were estimated from survey-weighted multivariate regressions, both before matching and after matching. The post-matching regression analysis weighted observations by the product of the survey and matching weights.

Motivation for matched sampling

Matched sampling identifies BAs (or high school graduates) with pre-college characteristics similar to sub-BAs to minimize confounding by important baseline characteristics (Rosenbaum 2004; Morgan and Winship 2007; Gelman and Hill 2007; Rubin 2006). Ideally, exact duplicates of every sub-BA could be found among the BAs (Stuart 2008). Because exact matching is generally infeasible, we use other methods of matching to create a comparison group with similar distributions of pre-college factors (Morgan and Winship 2007; Gelman and Hill 2007; Imai, King, Stuart 2008). Past research has found that background factors impact adult outcomes primarily through the level of educational attainment (Wilson 2001), making matching on background factors particularly crucial for studies on the role of educational attainment in adult outcomes.

Different matching methods yield similar results in simulation, but some sociologists and statisticians recommend nearest-neighbor matching within propensity score calipers because it balances on both means and higher-order moments (Morgan and Winship 2007; Austin 2009). Exact matching can be combined with other matching methods to make respondents identical on factors that might otherwise cause large differences, similar to blocking in randomized experiments (Morgan and Winship 2007; Ho et al 2008). A matching method's appropriateness is gauged post-facto by the balance achieved, so any method and choice of matching factors that result in balanced groups is considered appropriate (Morgan and Winship 2007; Gelman and Hill 2007).

Matching on pre-college factors

This study used exact matching and 1:1 nearest-neighbor matching within propensity score calipers in the R statistical library MatchIt (Ho et al 2008; Ho et al 2007). The exact matching factor was expectation of college attendance, measured on a Likert scale, the factor with the largest mean pre-matching difference between sub-BAs and BAs. Propensity scores are the estimated probability of getting a sub-BA degree versus a BA. Nearest-neighbor matching identifies the BA "closest" to each sub-BA, preferably within calipers of 0.25 standard deviations in estimated propensity score. The Mahalanobis metric measures the correlation-adjusted distance between respondents based on respondents' values of two continuous variables: test score percentile and grade average. The propensity model included all other pre-college factors listed above.

Match adequacy is determined by "balance," the similarity of covariate distributions of BAs and sub-BAs as determined by standardized differences in means (Morgan and Winship 2007). Standardized differences in means were measured by Cohen's effect size (d), a measure of difference between groups that is not sensitive to sample size. Matching reduces sample size, but Cohen's effect size allows us to compare different-sized groups without concern that differences became insignificant due to sample size reduction rather than improved balance. Cohen's effect size is defined as the absolute value of the difference between means divided by the average of standard deviations before matching. Cohen's effect size can be greater than 1.0 and is classified as follows: inconsequential (0.0–0.2), small (0.2–0.5), medium (0.5–0.8), and large (larger than 0.8) (Cohen 1988). For good balance between groups, we require the difference between the groups to have Cohen's effect size less than 0.1 to be certain that it is an inconsequential difference. Standardized differences in means are displayed in a Love plot (Love 2002), before and after matched sampling. Continuous or multiple categorical variables were examined using quantile-quantile plots in the MatchIt library.

Results

Health status by educational level (raw data)

Among high school graduates, each increased level of educational attainment predicted higher chances of dyslipidemia and lower chances of obesity, daily smoking, hypertension stages 1 and 2, sleep problems, and depression, according to Cuzick's test for trend (Figure 1).

Comparing sub-BAs versus high school diplomas

Young adults whose highest degree was a community college credential were 16% less likely to smoke daily than young adults with only a high school diploma, after controlling for baseline socioeconomic status, smoking, health status, and demographics. They did not differ in the other 6 measures of health status. Young adults whose highest degree was a sub-BA credential (associate's degree or certificate) differed significantly in only three baseline factors, compared with young adults with only a high school diploma (Figure 2). The three factors that did differ had marginally significant Cohen's effect size, all 0.25 or less where less than 0.20 is classified as inconsequential. Males were less likely than females to have a community college credential: 42.7% of young adults whose highest degree was a sub-BA credential were males versus 54.9% of those with only a high school diploma (d=0.24). Young adults whose highest degree is a sub-BA credential had an average GPA of 2.79 versus 2.65 among those with only a high school diploma (d=0.21). Young adults whose highest degree is a sub-BA credential had higher college expectations than those with only a high school diploma: 4.24 versus 3.96 on a 5 point Likert scale (d=0.25).

The matching model identified young adults whose highest degree is a high school diploma who were most similar to the young adults whose highest degree is a community college degree. Out of the 5584 high school graduates, we identified 2415 similar to the sub-BAs. Nearest neighbor matching without replacement achieved balance on average across all factors (Figure 2). After matching on baseline factors, young adults whose highest degree is sub-BA were 16% less likely to smoke daily than those with only a high school diploma (Table 1).

Highest degree sub-BA versus BA

Young adults whose highest degree was a BA were 57% less likely to smoke daily, 37% less likely to have sleep problems, 31% less likely to have depression, 16% less likely to be obese, and 22% less likely to have stage 2 hypertension, compared with young adults whose highest degree was a community college credential, after controlling for baseline socioeconomic status, smoking, health status, and demographics.

Young adults whose highest degree is a BA differed significantly in 12 baseline characteristics from youth whose highest degree is a sub-BA credential (Figure 3). They have medium effect size for expectations of college attendance (4.71 vs. 4.24 on a 5 point Likert scale), GPA (3.22 vs. 2.79), positive expectancies (4.61 vs. 4.38 on a 5 point Likert scale), standardized test score percentile (81 vs. 76), and parent's educational level. They have small effect size differences in household income ($45,000 vs. $35,000), percentage who smoked in the past 30 days (16.9% vs. 27.1%), depression score on the modified CES-D (10.4 vs. 11.8, where 22 is classified as depressed for males and 24 for females), percentage Latino (11.4% vs. 19.0%), percentage overweight (19.0% vs. 28.3%), percent with a positive depression screen (3.0% vs. 5.8%), item non-response to grades questions (4.5% missing versus 8.3% missing), and age in 2008 (28.8 vs. 29.1).

Nearest neighbor matching with replacement achieved balance on average across all factors (Figure 3). The matching model identified young adults whose highest degree is a BA who were most similar to the young adults whose highest degree is a community college degree. Out of the 3303 BAs, 1260 were similar to the sub-BAs. After matching on background characteristics that may predict having highest degree be BA vs. sub-BA, respondents with a BA were 60% less likely to smoke daily, 14% less likely to be obese, and 38% less likely to have been diagnosed with depression (Table 1).

Discussion

Young adults whose highest degree was a sub-BA credential did not differ substantially from young adults with only a high school diploma in pre-college attributes, including grades, test scores, parent education, and parents' household income. This similarity may suggest that high school background is not prohibitive to attaining a sub-BA credential, and it is consistent with the wide range of non-academic community college programs.

Despite similar high school backgrounds, young adults with sub-BA credentials were less likely to smoke daily than similar young adults with only a high school diploma, even though the two groups did not differ in baseline smoking. Community college may teach norms of non-smoking, which could translate into life-long health improvements relative to no post-secondary degree.

By contrast, young adults whose highest degree is a BA differ substantially in many pre-college factors from young adults whose highest degree is sub-BA, including grades and test scores. These differences concurs with previous research that suggests that completing a BA is difficult for many high school graduates, and it concurs with recommendations that high school graduates with lower high school grades can complete a community college credential before attempting a BA, in case of BA non-completion, as some community colleges have begun to do (Seppanen 2001).

After matching on pre-college factors, BA-educated young adults were substantially less likely to be depressed, obese, and to smoke daily than sub-BAs. This finding is consistent with that of Barbeau (2004) but in contrast with that of Braveman, which found no educational trend in obesity among an older population of adults using NHANES from 1999–2004 for adults over age 20 (2010). The two studies are different populations in different times — this study looks at young adults ages 26–31 in 2008, a time when obesity was more prevalent than at the time of Braveman's study. The research matched on parents' education and household income to remove potential confounding by socioeconomic background.

Other research has found that sub-BA degrees gives access to jobs with better job conditions, but sub-BAs may still be at the bottom of the status hierarchy, which could create work stress and worsened health compared with BAs. Conversely, professional training poses high standards, so community college graduates may feel more stress than nonprofessional workers with only a high school diploma. This research found that in spite of that potential disadvantage, sub-BAs still have better health status than high school graduates in one measure — smoking — and do not differ in other measures. Four-year colleges may promote norms of better eating, exercise, and not smoking, which could explain the differences observed in obesity and smoking.

This study identified emerging health disparities within a cohort of nationally representative high school students with high school diplomas. The study compared those whose highest degree is a community college credential with their counterparts with higher educational attainment (highest degree is BA) and slightly lower educational attainment (highest degree

is high school diploma.) The community college graduates from the nationally representative cohort are likely nationally representative of high school graduates who earned community college credentials in young adulthood. Their counterparts from the high school diploma-only and BA groups may not be nationally representative because they were chosen to be similar to those whose highest degree is a community college credential. The study does not generalize to those who earn community college credentials after a high school equivalency degree, or who earn community college credentials after young adulthood. This study nonetheless suggests that American high school graduates who earn a community college credential in young adulthood are less likely to smoke daily than if they did not earn a post-secondary degree, but they are more likely to smoke daily and more likely to be obese than if they earned a BA.

Matching balanced groups on background factors determined in the economics and education literature to differ substantially between people with different educational levels. The three groups — those whose highest degree was a high school diploma, sub-BA, and BA — did not differ in these factors after matching. The groups may have differed on unobserved factors that were not correlated with the factors that were matched on.

Young adults are usually healthy, so it is noteworthy to see health disparities in a sample of 26–31 year olds. As in earlier findings, smoking and obesity interventions need to be focused at high school and community college graduates and employees in mid-skill jobs (Barbeau et al 2004), and may be most effective if combined with workplace safety activities geared towards creating healthier workplaces (Barbeau et al 2006; Sorensen and Barbeau 2006).

Sub-baccalaureate degrees are accessible to high school graduates irrespective of backgrounds and may lower smoking prevalence. Baccalaureate attainment is not accessible to all high school graduates, but it may reduce smoking, depression, and obesity.

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References

Aggarwal A, Monsivais P, Cook AJ, Drewnowski A. Does diet cost mediate the relation between socioeconomic position and diet quality? Eur J Clin Nutr. 2011; 65(9):1059–1066. [PubMed: 21559042]

Austin PC. The relative ability of different propensity score methods to balance measured covariates between treated and untreated subjects in observational studies. Medical Decision Making. 2009; 29(6):661–677. [PubMed: 19684288]

Azagba, Sunday; Sharaf, Mesbah F. Disparities in the frequency of fruit and vegetable consumption by socio-demographic and lifestyle characteristics in Canada. Nutrition Journal. 2011; 10:118. [PubMed: 22027238]

Backlund E, Sorlie PD, Johnson NJ. A comparison of the relationships of education and income with mortality: the national longitudinal mortality study. Social Science & Medicine. 1999; 49(10):1373–1384. [PubMed: 10509827]

Barbeau, Elizabeth M.; Krieger, Nancy; Soobader, Mah-Jabeen. Working class matters: socioeconomic disadvantage, race/ethnicity, gender, and smoking in NHIS 2000. American Journal of Public Health. 2004; 94(2):269–278. [PubMed: 14759942]

Barbeau, Elizabeth M.; Li, Yi; Calderon, Patricia; Hartman, Cathy; Quinn, Margaret; Markkanen, Pia; Roelofs, Cora; Frazier, Lindsay; Levenstein, Charles. Results of a union-based smoking cessation intervention for apprentice iron workers (United states). Cancer Causes & Control: CCC. 2006; 17(1):53–61.

Belfield, Clive R.; Bailey, Thomas. The benefits of attending community college: A review of the evidence. Community College Review. 2011; 39(1):46–68.

Bernabé, Eduardo; Suominen, Anna L.; Nordblad, Anne, et al. Education level and oral health in Finnish adults: evidence from different life course models. Journal of Clinical Periodontology. 2011; 38(1):25–32. [PubMed: 21058971]

Braveman, Paula A.; Cubbin, Catherine; Egerter, Susan; Williams, David R.; Pamuk, Elsie. Socioeconomic disparities in health in the united states: what the patterns tell us. American Journal of Public Health. 2010; 100(Suppl 1):S186–S196. [PubMed: 20147693]

Carnevale, A.; Rose, SJ.; Cheah, B. The college payoff: education, occupations, lifetime earnings. Technical report, Georgetown University, Center on Education and the Workforce. 2011.

Cohen, J. Statistical power analysis for the behavioral sciences. 2 edition. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.

Cummings, Peter. The relative merits of risk ratios and odds ratios. Arch Pediatr Adolesc Med. 2009; 163(5):438–445. [PubMed: 19414690]

Cutler, David M.; Lleras-Muney, Adriana. Understanding differences in health behaviors by education. Journal of Health Economics. 2010; 29(1):1–28. [PubMed: 19963292]

Cuzick, Jack. A Wilcoxon-type test for trend. Statistics in Medicine. 1985; 4(4):543–547. [PubMed: 4089356]

Ehrenberg, Ronald G. Econometric studies of higher education. Journal of Econometrics. 2004; 121(1–2):19–37.

Ernstsen, Linda; Bjerkeset, Ottar; Krokstad, Steinar. Educational inequalities in ischaemic heart disease mortality in 44,000 Norwegian women and men: the influence of psychosocial and behavioural factors. the HUNT study. Scandinavian Journal of Public Health. 2010; 38(7):678–685. [PubMed: 20699350]

Ferrer, Ana M.; Riddell, W. Craig The role of credentials in the canadian labour market. Canadian Journal of Economics. 2002; 35(4):879–905.

Fiscella, Kevin; Franks, Peter. Should years of schooling be used to guide treatment of coronary risk factors? Annals of Family Medicine. 2004; 2(5):469–473. [PubMed: 15506583]

Gelman, Andrew; Hill, Jennifer. Data Analysis using regression and multilevel/hierarchical models. New York: Cambridge University Press; 2007.

Grubb, W. Norton The returns to education in the Sub-Baccalaureate labor market, 1984–1990. Economics of Education Review. 1997; 16(3):231–245.

Gullason, Edward T. The stability pattern of sheepskin effects and its implications for the human capital Theory-Screening hypothesis debate. Eastern Economic Journal. 1999; 25(2):141.

Haveman, Robert; Wolfe, Barbara. The determinants of children's attainments: A review of methods and findings. Journal of Economic Literature. 1995; 33(4):1829–1878.

Hermann, Silke; Rohrmann, Sabine; Linseisen, Jakob, et al. The association of education with body mass index and waist circumference in the EPIC-PANACEA study. BMC Public Health. 2011; 11:169. [PubMed: 21414225]

Ho D, Imai K, King G, Stuart E. Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference. Political Analysis. 2007; 15(3):199–226.

Ho, D.; Imai, K.; King, G.; Stuart, EA. Matchit: Nonparametric preprocessing for parametric causal inference, software version 2.3-1. Technical report, Harvard Institute for Quantitative Social Sciences. 2008.

Imai K, King G, Stuart E. Misunderstandings among experimentalists and observationalists about causal inference. Journal of the Royal Statistical Society, Series A. 2008; 171(2):481–502.

Jaeger, David A.; Page, Marianne E. Degrees matter: New evidence on sheepskin effects in the returns to education. The Review of Economics and Statistics. 1996; 78(4):733–740.

Kane, Thomas J.; Rouse, Cecilia Elena. Labor-Market returns to two and Four-Year college. The American Economic Review. 1995; 85(3):600–614.

Kanjilal, Sanjat; Gregg, Edward W.; Cheng, Yiling J.; Zhang, Ping; Nelson, David E.; Mensah, George; Beckles, Gloria LA. Socioeconomic status and trends in disparities in 4 major risk factors for cardiovascular disease among US adults, 1971–2002. Archives of Internal Medicine. 2006; 166(21):2348–2355. [PubMed: 17130388]

Kavanagh, Anne; Bentley, Rebecca J.; Turrell, Gavin; Shaw, Jonathan; Dunstan, David; Subramanian, SV. Socioeconomic position, gender, health behaviours and biomarkers of cardiovascular disease and diabetes. Social Science & Medicine. 2010; 71(6):1150–1160. [PubMed: 20667641]

King, Gary; Polednak, Anthony P.; Gilreath, Tamika; Bendel, Robert B. Disparities in smoking cessation among U.S. adults with a history of asthma. Annals of Behavioral Medicine: A Publication of the Society of Behavioral Medicine. 2007; 33(3):312–317. [PubMed: 17600458]

Liu, Sze Yan; Buka, Stephen L.; Linkletter, Crystal D.; Kawachi, Ichiro; Kubzansky, Laura; Loucks, Eric B. The association between blood pressure and years of schooling versus educational credentials: test of the sheepskin effect. Annals of Epidemiology. 2011; 21(2):128–138. [PubMed: 21184953]

Love, Thomas E. Displaying covariate balance after adjustment for selection bias. In Section on Health Policy Statistics, New York, August 11 2002. Joint Statistical Meetings. 2002

Lumley, Thomas; Kronmal, Richard; Ma, Shuangge. Relative risk regression in medical research: Models, contrasts, estimators, and algorithms. Biostatistics Working Paper Series 293. University of Washington; 2006.

McNutt, Louise-Anne; Wu, Chuntao; Xue, Xiaonan; Hafner, Jean Paul. Estimating the relative risk in cohort studies and clinical trials of common outcomes. American Journal of Epidemiology. 2003; 157(10):940–943. [PubMed: 12746247]

Morgan, SL.; Winship, C. Counterfactuals and causal inference: Methods and principles for social research. New York: Cambridge University Press; 2007.

Reither, Eric N.; Peppard, Paul E.; Remington, Patrick L.; Kindig, David A. Increasing educational disparities in premature adult mortality, wisconsin, 1990–2000. WMJ: Official Publication of the State Medical Society of Wisconsin. 2006; 105(7):38–41. [PubMed: 17163085]

Rosenbaum, PR. Applied Bayesian Modeling and Causal Inference from Incomplete-Data Perspectives. In: Gelman, Andrew; Meng, Xiao-Li, editors. chapter Matching in observational studies. Chicester West Sussex, England: John Wiley and Sons; 2004. p. 15-24.

Rubin, Donald B. Matched Sampling for Causal Effects. New York: Cambridge University Press; 2006.

Schoeni, Robert F.; Dow, William H.; Miller, Wilhelmine D.; Pamuk, Elsie R. The economic value of improving the health of disadvantaged americans. American Journal of Preventive Medicine. 2011; 40(Suppl 1)(1):S67–S72. [PubMed: 21146781]

Seppanen, Loretta. The new transfer Student-Students completing job preparatory programs with a transfer goal. Paper presented at “Transfer: The Forgotten Function” Conference; July 30–31, 2001; Overland Park, KS. 2001.

Settersten, Richard; Ray, Barbara E. Not Quite Adults: Why 20-Somethings Are Choosing a Slower Path to Adulthood, and Why It’s Good for Everyone. Bantam. 2010

Siegel, Rebecca; Ward, Elizabeth; Brawley, Otis; Jemal, Ahmedin. Cancer statistics, 2011: the impact of eliminating socioeconomic and racial disparities on premature cancer deaths. CA: A Cancer Journal for Clinicians. 2011; 61(4):212–236. [PubMed: 21685461]

Snyder, TD.; Dillow, SA. Technical Report NCES 2011-015, National Center for Education Statistics, Institute of Education Sciences. Washington, DC: U.S. Department of Education; 2011. Digest of education statistics, 2010.

Sommers D. The national labor market projections for community college students. New directions for community colleges. 2009; 146:33–52.

Sorensen G, Barbeau Elizabeth M. Integrating occupational health, safety and worksite health promotion: opportunities for research and practice. La Medicina Del Lavoro. 2006; 97(2):240–257. [PubMed: 17017356]

Sprague, Brian L.; Trentham-Dietz, Amy; Gangnon, Ronald E.; Ramchandani, Ritesh; Hampton, John M.; Robert, Stephanie A.; Remington, Patrick L.; Newcomb, Polly A. Socioeconomic status and survival after an invasive breast cancer diagnosis. Cancer. 2011; 117(7):1542–1551. [PubMed: 21425155]

Stuart EA. Developing practical recommendations for the use of propensity scores. discussion of a critical appraisal of propensity-score matching in the medical literature between 1996 and 2003. Statistics in Medicine. 2008; 27(12):2062–2065. [PubMed: 18286673]

Tourangeau, R.; Shin, HC. Technical report, Carolina Population Center. Chapel Hill, NC: University of North Carolina at Chapel Hill; 1999. National longitudinal study of adolescent health: grand sample weight.

Udry, J Richard. Carolina Population Center. Chapel Hill, NC: University of North Carolina at Chapel Hill; 2003. The National Longitudinal Study of Adolescent Health (Add Health), Waves I & II, 1994–1996; Wave III, 2001–2002 [machine-readable data file and documentation].

Willis, Robert J.; Rosen, Sherwin. Education and Self-Selection. Journal of Political Economy. 1979; 87(5):S7–S36.

Wilson, Kathryn. The determinants of educational attainment: Modeling and estimating the human capital model and education production functions. Southern Economic Journal. 2001; 67(3):518–551.

Woolf, Steven H.; Braveman, Paula. Where health disparities begin: The role of social and economic determinants—And why current policies may make matters worse. Health Affairs. 2011; 30(10): 1852–1859. [PubMed: 21976326]

Zeileis, Achim. Econometric computing with hc and hac covariance matrix estimators. Journal of Statistical Software. 2004; 11(10):1–17.

Zeileis, Achim. Object-oriented computation of sandwich estimators. Journal of Statistical Software. 2006; 16(9):1–16.

Zou, Guangyong. A modified Poisson regression approach to prospective studies with binary data. American Journal of Epidemiology. 2004; 159(7):702–706. [PubMed: 15033648]

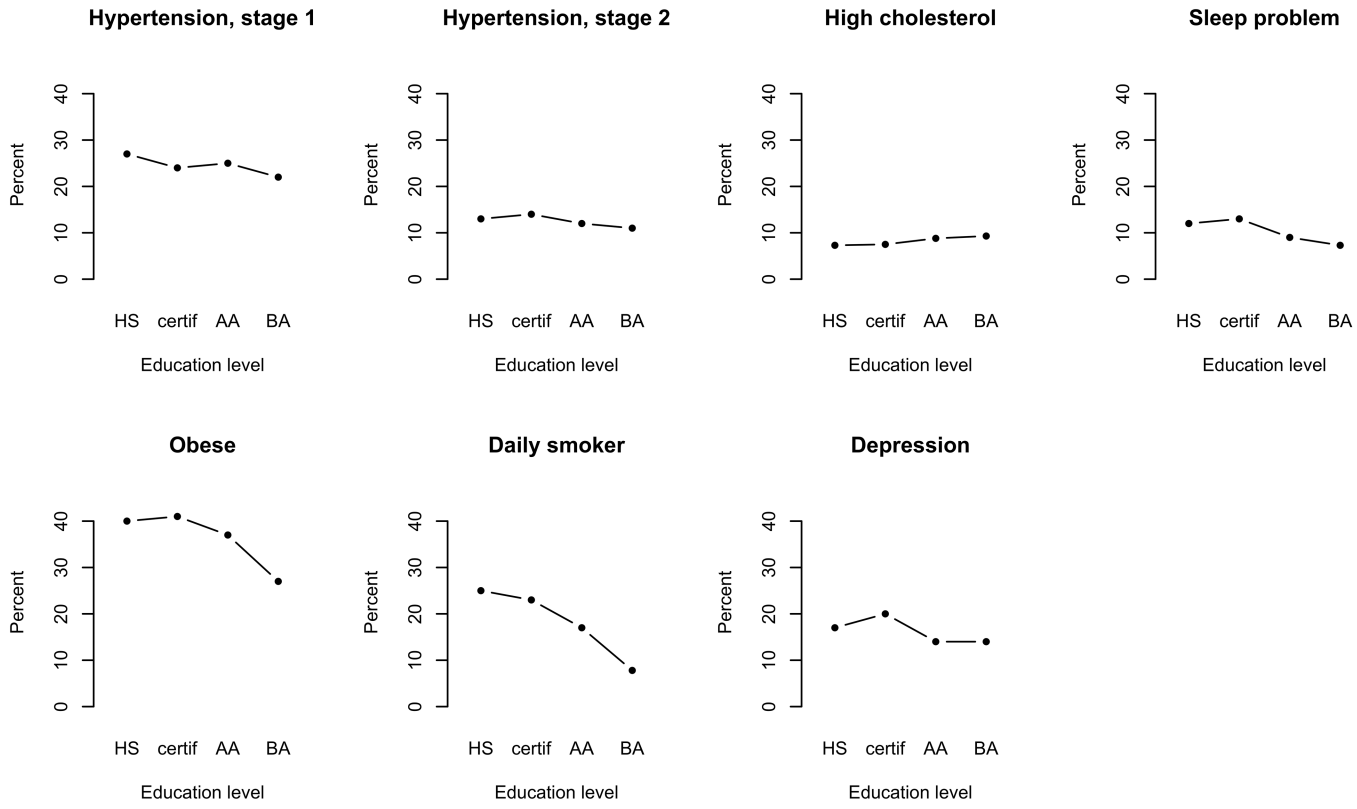

Figure 1.

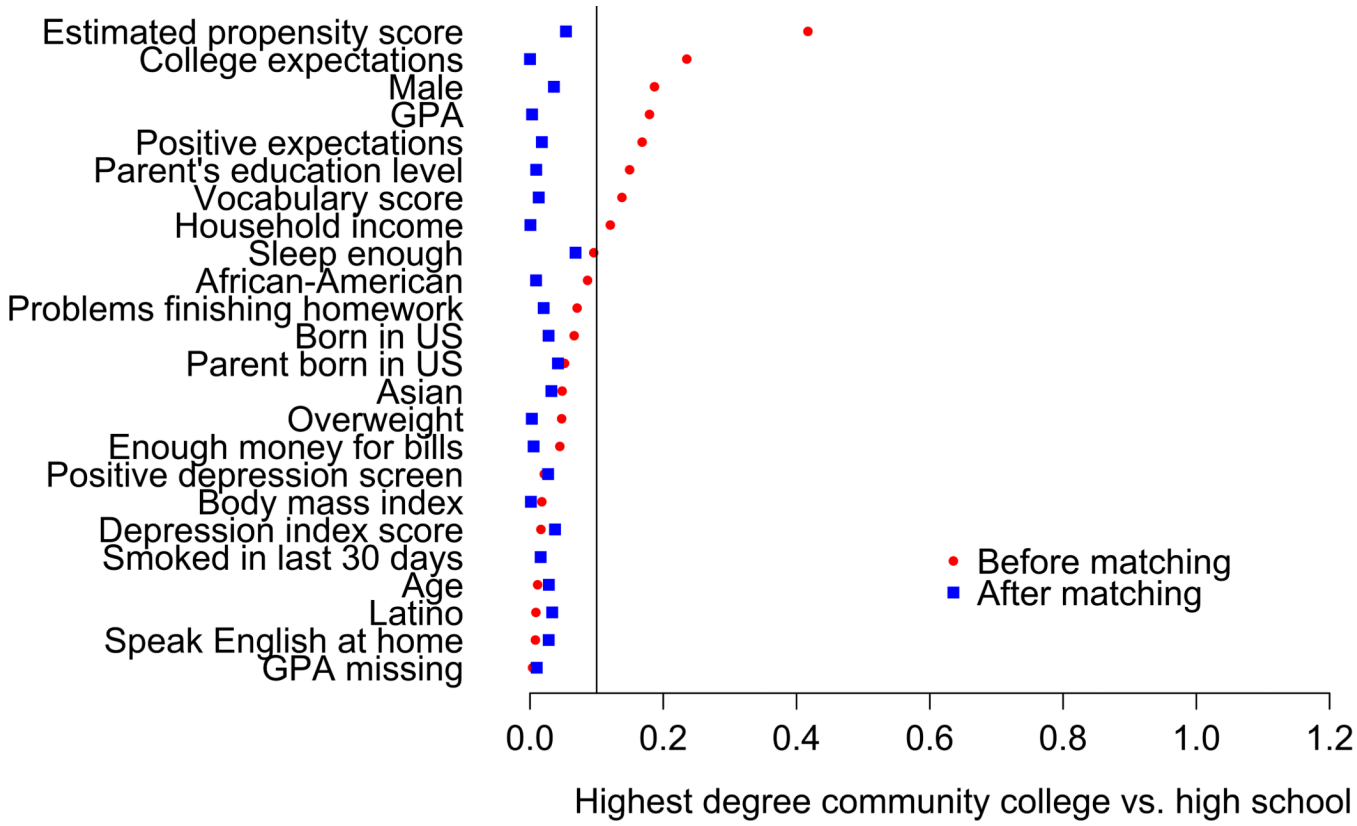

Figure 2.

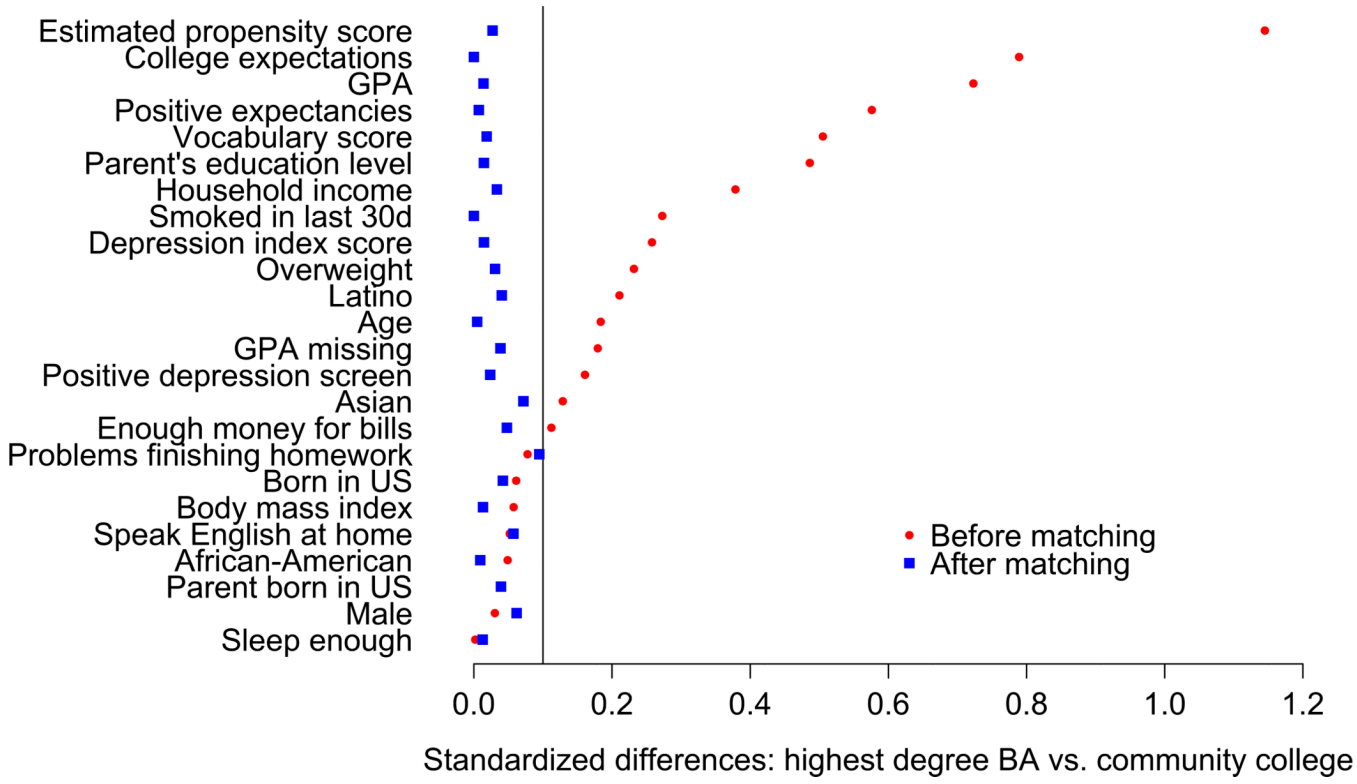

Figure 3.

Table 1

Health status in 2008, comparing respondents whose highest degree is a sub-BA credential (associates degrees and community college certificates) versus high school diploma, and BA versus a sub-BA credential. Incidence rate ratios estimated from multivariate regression with Poisson working model: no matching and matching on baseline factors. Each entry represents the result of one regression. Entries are sorted in order of significance.

	No matching		After matching	
	IRR (95% CI)	**P**	**IRR (95% CI)**	**P**
Highest degree sub-BA versus high school diploma				
	(n=7999)		(n=4830)	
Daily smoking	0.84 (0.75, 0.95)	**	0.84 (0.75, 0.96)	**
Sleep problems	0.97 (0.81, 1.16)		0.94 (0.77, 1.14)	
Depression	0.99 (0.87, 1.12)		1.01 (0.88, 1.17)	
Obese	1.00 (0.92, 1.09)		0.99 (0.91, 1.08)	
Hypertension, stage 2	1.03 (0.88, 1.21)		1.00 (0.83, 1.22)	
Hypertension, stage 1	0.98 (0.89, 1.09)		0.99 (0.87, 1.13)	
High cholesterol	0.95 (0.75, 1.20)		0.97 (0.75, 1.26)	
Highest degree BA versus sub-BA				
	(n=5718)		(n=3635)	
Daily smoking	0.43 (0.35, 0.52)	****	0.40 (0.29, 0.56)	****
Sleep problems	0.63 (0.49, 0.82)	***	0.83 (0.61, 1.12)	
Depression	0.69 (0.58, 0.83)	****	0.62 (0.49, 0.79)	****
Obese	0.84 (0.77, 0.93)	***	0.86 (0.76, 0.97)	**
Hypertension, stage 2	0.78 (0.61, 1.01)	+	0.98 (0.75, 1.28)	
Hypertension, stage 1	0.91 (0.78, 1.05)		1.06 (0.88, 1.28)	
High cholesterol	1.22 (0.95, 1.57)		1.10 (0.79, 1.54)	

+ $p \leq 0.1$,

* $p \leq 0.05$,

** $p \leq 0.01$,

*** $p \leq 0.001$,

**** $p \leq 0.0001$

All regressions used the following factors, measured at baseline in 1995: demographics (gender, age, Latino/Asian/African-American ethnicity/race, home language is English, parent nativity), academic factors (GPA, vocabulary test score, expectations of college attendance), socioeconomic factors (parent educational level, parent has enough money for bills), and health status (sleeping enough, body mass index, overweight status, smoking status, depression screen result, depression index (CES-D)).