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Socioemotional Skills, Education, and Health-Related Outcomes of High-Ability Individuals

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Abstract

We estimate the effects of education and five well-established socioemotional skills on essential life outcomes including health behaviors, health-related lifestyles, earnings, as well as general and mental health. We supplement results in papers that treat socioemotional skills as a single-dimensional variable and find important heterogeneity that a one-dimensional representation does not capture. By combining factor-analytic modeling with a powerful procedure to account for multiple-hypothesis testing, we control for the ability bias, for the measurement error in proxies of socioemotional skills, and for the family-wise error rate. We also contribute to the still controversial discussion about the causal effect of education on health-related outcomes by using alternative methods to the use of natural experiments. We use the Terman data, a unique longitudinal study.

A version of this paper was presented to the 6th Annual Health Econometrics Workshop in Toronto; to the 5th ASHEcon Conference in Los-Angeles; to the IZA/OECD/World Bank Workshop on Cognitive and Noncognitive Skills in Bertinoro, Italy; to the Singapore Economic Review Conference; to the Empirical Micro Lunch at the University of Wisconsin at Madison; and to the Vanderbilt Empirical Applied Micro Work-In-Progress Lunch. We thank participants of these meetings for their productive feedback. We are also grateful to Laura Argys, Gabriella Conti, Thomas Deleire, Erik Meijer, and Chris Taber for their comments and suggestions, which greatly contributed to progress with this paper. Peter Savelyev gratefully acknowledges support from the Grey Funds at the Department of Economics, Vanderbilt University, and support from the ERC at the University of Chicago on early stages of working with the Terman data. Kegon Tan gratefully acknowledges support of the Human Capital and Economic Opportunity Global Working Group sponsored by the Institute for New Economic Thinking. Authors have no potential conflicts of interest and follow the COPE publication ethics requirements. The Terman data are provided by the ICPSR, Ann Arbor, MI. The views expressed in this paper are those of the authors and do not necessarily reflect the views of the funders. Supplementary materials may be retrieved from https://my.vanderbilt.edu/petersavelyev/2012/01/web-appx-terman.
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Socioemotional Skills, Education, and Health-Related Outcomes of High-Ability Individuals*

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Abstract

We estimate the effects of education and five well-established socioemotional skills on essential life outcomes including health behaviors, health-related lifestyles, earnings, as well as general and mental health. We supplement results in papers that treat socioemotional skills as a single-dimensional variable and find important heterogeneity that a one-dimensional representation does not capture. By combining factor-analytic modeling with a powerful procedure to account for multiple-hypothesis testing, we control for the ability bias, for the measurement error in proxies of socioemotional skills, and for the family-wise error rate. We also contribute to the still controversial discussion about the causal effect of education on health-related outcomes by using alternative methods to the use of natural experiments. We use the Terman data, a unique longitudinal study.

Key words: college education, Big Five personality taxonomy, health behaviors, lifestyles, earnings, health

JEL codes: I12, J24

1 Introduction

This paper serves three purposes. First, we shed new light on the powerful role of socioemotional skills in the formation of essential life outcomes by bringing important heterogeneity into the picture. Instead of studying the role of a one-dimensional aggregate of socioemotional skills, we investigate the role of an established five-dimensional taxonomy of personality. Second, we concentrate on health-related outcomes (health-behaviors, lifestyles, earnings, and health), and contribute to understanding the behavioral mechanisms through which socioemotional skills and education affect health and longevity. Finally, we contribute to the discussion in the health economics literature about the effect of education on health.

A seminal paper by Heckman, Stixrud, and Urzúa (2006) showed that socioemotional skills are as important as cognitive skills in forming essential life outcomes. A subsequent paper by Conti, Heckman, and Urzúa (2010) specifically concentrates on health-related life outcomes. More recently, Heckman, Humphries, Urzúa, and Veramendi (2014) document effects on several health-related outcomes with a focus on the sequential nature of education choices. We join these authors in supporting the claim that socioemotional skills play a major role in determining health-related outcomes. We complement their results and find heterogeneity of the effects captured by five-dimensional representation of socioemotional skills. We use unique data that combines observations of IQ and personality in early life with a long follow-up to test effects at multiple stages in life (observations are available till age 86). Further, we address the issue of multiple-hypothesis testing due to the large number of similar outcomes explored.

The literature in psychology reports numerous correlations between the Big Five personality and health-related outcomes. In particular, Conscientiousness is strongly correlated with beneficial health behaviors and other health-related outcomes, while Neuroticism is strongly correlated with harmful health behaviors (e.g., Friedman, 2000; Goodwin and Friedman, 2006). Our work adds to this literature (1) by providing estimates that can be interpreted as causal under assumptions of the model, (2) by accounting for measurement error in measures of skills and thus avoiding the attenuation bias, and (3) by adjusting inference under multiple hypothesis testing.

There is evidence documented in the literature that college education and socioemotional skills affect longevity (e.g., Buckles et al., 2013; Savelyev, 2014). However, the mechanisms behind these effects are still not well understood. Our empirical results shed light on these mechanisms since we establish the effects of IQ, socioemotional skills, and college education on life outcomes that, according to the literature, are plausible determinants of longevity. In line with this literature, we find associations in the Terman data between longevity and outcomes such as heavy drinking, body mass, earnings, group memberships, divorce, as well as general and mental health (see Figures 1–3).[1]

[Figures 1–3 here]

Finally, we contribute to the body of evidence showing causal effects of education on health, an important but still controversial question in the health economics literature. Papers examining this question largely use various natural experiments as a source of identification. In this paper, we take an alternative approach to natural experiments. We

[1] In the Terman data we lack statistical power that is needed for a complete mediation analysis. We leave the longevity mediation analysis to the paper in progress using the Wisconsin Longitudinal Study that has a much larger sample (Hong, Savelyev, and Tan, 2014), but describes a different population and lacks a number of variables that the Terman data have such as childhood measures of personality.

believe this to be a useful source of additional information, given the limitations of natural experiments[2] and the existing controversy over the causal status of education in affecting health.[3] Our identification strategy is based on explicitly modeling latent skills that are expected to contribute to the ability bias. We follow Carneiro, Hansen, and Heckman (2003) and Heckman, Pinto, and Savelyev (2013) and use a parametric version of matching on both observable background controls and unobservable skills. We acknowledge that this approach has its own limitations.

We use the Terman life-cycle data of children with high ability. Children born around 1910 were selected from schools in California for their high IQs. The data prospectively covers the period from 1922 to 1991, and combines high-quality measures of IQ and personality obtained around age 12, personality around age 30, as well as life-cycle measurements of health and health-related outcomes. The combination of early measures of IQ and socioemotional skills with a life-cycle follow-up is unique and ideally suited for studying developmental origins of health.

For each outcome of interest, we jointly estimate a linear-in-parameters outcome equation with a factor model that links latent skills to multiple noisy psychological measures. We adjust each single-hypothesis p-value to strongly control for the family-wise error rate following Romano and Wolf (2005). Our results differ by gender. For males, we find strong evidence of multiple links between skills, education, and essential life outcomes. Education and Conscientiousness are health-beneficial, while Openness and Neuroticism

[2]The limitations of natural experiments include issues with validity, monotonicity, weak instruments, loss of power, and identification of the effect only for the group that is induced to change behavior by the instrument (e.g., Cameron and Trivedi, 2005; Carneiro et al., 2011; Heckman and Vytlacil, 2005, 2007).

[3]While some papers claim a causal effect of compulsory education on health or longevity (Grossman, 2004; Grossman and Kaestner, 1997; Lleras-Muney, 2005; van Kippersluis et al., 2011), some others find that there is hardly any effect (Albouy and Lequien, 2009; Clark and Royer, 2013; Mazumder, 2008).

are health-harming. We find mixed effects for Extraversion and Agreeableness. IQ does not play a large role within this high-IQ sample but still shows some effects. For females, we have substantial evidence only for the heath-beneficial effect of education and health-harmful effect of Neuroticism. Table I summarizes these qualitative results.

[Table I here]

2 Data Description

Research presented in this paper is based on the Terman data (Terman, 1986), which prospectively follows a group of about 1,500 males and females from public schools in California from 1922 to 1991. The subjects were selected for IQs above 140.

The availability of early life personality measures in the Terman data enables the construction of latent factors that are close to the contemporary and well-established Big Five taxonomy of personality (Martin and Friedman, 2000). Big Five personality taxonomy is described in detail in John and Srivastava (1999). In short, Openness is a propensity to be intellectual and open to new experiences and ideas; Conscientiousness is a propensity to be organized, thoughtful about the future, and following rules; Extraversion is a propensity to be energetic to the social and material world; Agreeableness is a propensity to be pro-social; and Neuroticism is a measure of emotional instability. Our measures of Openness, Conscientioueness, and Extraversion are observed at about age 12. We supplement these data with measures of Agreeableness and Neuroticism observed at about age 30 to complete the Big Five. Table II summarizes the raw measures by factor.[4].

[4]Web Appendix A contains additional technical details of our treatment of factors.

[Table II here]

While the sample is homogenous in that the subjects are all highly intelligent, personality measures show a wide variation. In fact, there is no evidence that the subjects differ significantly from the general population with regards to measures of personality (Friedman et al., 1993; Terman and Sears, 2002). The possible exception is Openness, which is known to be linked to IQ, unlike other personality traits (Ackerman and Heggestad, 1997; DeYoung et al., 2005). The Terman study has an attrition of less than 10%, which is quite low for a 70-year-long prospective study.

The wealth of information in the Terman data is remarkable. Some 4,500 measurements include the family background, parental investment in children, personality, health measures in childhood and adolescence, and household economic status, among other important determinants of health behavior and education attainment of the subjects. Table III presents health-related outcomes that we explore in this paper including health behaviors and their proxies, lifestyles, earnings, and general heath measures. Many of these outcomes were observed at multiple points of the life cycle.[5] Table IV describes education, IQ, and background variables.

[Tables III and IV here]

We exclude: subjects who were not born in the period 1904–1915 (to cut small number of respondents born too far away from the main cohort to minimize possible cohort effects); subjects who are missing both parent and teacher personality ratings in 1922; subjects who are high-school dropouts; rare subjects with serious diseases in their early life, such as chorea or Hodgkin's disease; and subjects without the education level in-

[5]We thank Miriam Gensowski for providing her calculations of earnings profiles (Gensowski, 2013).

formation. Aside from subjects excluded due to missing data, these restrictions remove outliers[6] and help minimize possible reverse causality between education and health.[7]

3 Methodology

3.1 Statistical Model

We use a linear model to examine the effects of college education and socioemotional skills on health-related outcomes. Let H^k be the kth health-related outcome available in the Terman data, $k \in \{1, ..., K\}$. We are interested in estimating a system of equations:

$$H^k = a^k D + \boldsymbol{b}^k \boldsymbol{\Theta}^{SE} + c^k \Theta^C + \boldsymbol{d}^k \boldsymbol{X} + \epsilon^k \tag{1}$$

$$\boldsymbol{M} = \psi \boldsymbol{\Theta}^{SE} + \pi A + \boldsymbol{\gamma} \boldsymbol{X} + \boldsymbol{\eta}, \tag{2}$$

where letters represent: D, the completed college indicator; $\boldsymbol{\Theta}^{SE}$, the five latent socioemotional skills; Θ^C, cognitive skills as measured by IQ;[8] $\boldsymbol{X}$, the control variables; $\boldsymbol{\eta}$ and ϵ^k, are mutually independent i.i.d. error terms; $\boldsymbol{M}$ is a vector of personality measures;[9] A, age at which personality was measured; and ψ, a matrix of factor loadings. Identifi-

[6] For example, 16 subjects who were high school dropouts despite extraordinary IQ.

[7] For example, subjects with serious early health problems that may have severely affected their schooling choice. Due to resampling methods that we use, controlling for dummies that are equal to one only for a few people is not the best option due to the risk of perfect collinearity in a number of resampling draws.

[8] We only have one measure of IQ, and so we cannot include intelligence into the factor model due to data limitations. Since this is a study of high-IQ people with diverse socioemotional skills, the effect of IQ is of secondary importance. A possible attenuation bias may lead to some underestimation of the true effect of IQ.

[9] Model (2) is written in a simplified way to save notation. Actually, while some measures are continuous, some others are binary, for which we use a logit model representation. Thus, some elements of vector $\boldsymbol{M}$ are latent variables, which generate a measure equal to 1 if they are above zero and zero otherwise.

cation of such factor models is standard (e.g., Anderson and Rubin, 1956).[10] We estimate system (1-2) for each $k \in \{1, ..., K\}$ allowing us to identify the effect of latent factor $\boldsymbol{\Theta}^{SE}$ on H^k whilst accounting for measurement error in measures, which is explicitly modelled in (2).[11] We estimate these systems of equations using the maximum likelihood approach (e.g., Muthen 1983).

We further estimate a restricted model that omits the socioemotional skills

$$H^k = a_r^k D + c_r^k \Theta^C + \boldsymbol{d}_r^k \boldsymbol{X} + \epsilon_r^k, \tag{3}$$

and compare the coefficient of determination (R^2) of models (1) and (3).

Multiple-Hypothesis Testing Problem and the Stepdown Procedure A major challenge in exploring treatment effects on multiple outcomes is accounting for false rejections due to the multiplicity of single hypotheses being tested (e.g., Westfall and Young, 1993). It is well known that as the number of single hypotheses under consideration increases, the probability that at least one of them is falsely rejected given that all of them are true (family-wise error rate) quickly goes up. While this problem is well-recognized in genetics research, in which thousands of single hypotheses are tested, in the economics literature this problem is largely neglected despite substantial probabilities of false rejection. To solve this problem, we use the stepdown algorithm by Romano and Wolf (2005), a powerful procedure that provides adjusted p-values for each individual test.

[10] Appendix A contains technical details about the measurement system (2), specifically about restrictions on matrix ψ that make the factors interpretable as the Big Five.

[11] Theoretically, it might be beneficial to estimate equations (1) for all k simultaneously. In practice, this approach leads to a complex model with too many degrees of freedom, which is numerically difficult to estimate.

The grouping of hypotheses into families for which p-values get adjusted is up to the econometrician. In principle, we could consider a family that contains all single hypotheses that are tested in this paper, but this approach is overly-conservative, leading to the opposite problem: we risk accepting most if not all of the truly-rejected hypotheses.

We can improve power by using a-priori information and by asking more precise research questions. Following Heckman, Moon, Pinto, Savelyev, and Yavitz (2010), we account for multiple-hypothesis testing within each group of single hypotheses that are clustered a priori by type of outcome. This way we account for the multiplicity of similar outcomes over time. For example, based on prior research, we expect that education should negatively affect heavy drinking, while Extraversion should have the opposite effect, but we are less sure at which age. So, we form a family of heavy drinking variables measured at various ages. We also provide groupings of (1) all lifecycle-aggregated outcomes together and (2) all midlife outcomes together. This way, we account for the multiplicity of hypotheses on diverse health-related outcomes (1) over the lifecycle and (2) at midlife, by which time people should have substantial variation in both health and addiction capital stocks.[12]

Assumptions for Causal Interpretation and Limitations For the identification of the effect of education, we relax the traditional conditional independence assumption and replace it by its generalization: conditional on both observables $\boldsymbol{X}$ and unobservables $\boldsymbol{\Theta}$, education choice is orthogonal to potential health-related outcomes with and without a college degree (Carneiro, Hansen, and Heckman, 2003; Heckman, Pinto, and Savelyev,

[12]Readers can find more technical information about the stepdown procedure in Web Appendix B.

2013). This generalization comes at the expense of imposing our parametric and structural assumptions.

The limitation of this approach is that if some important confounding factor is still not controlled for, results should be interpreted as conditional associations. Since Terman data has an extraordinary number of relevant observable background variables plus the IQ and comprehensive personality measures, we can expect that the omitted variable bias is small and possibly negligible. Likewise, to identify the effects of each skill, we rely on controlling for other skills and the wealth of background controls.

A conservative view on these results is to consider them as associations conditional on an extraordinarily rich set of observables and unobservables. Such associations are a thought-provoking source of knowledge since so many important potential confounders are excluded from the interpretation of the association.

4 Empirical Results

We present a summary of our main results for health-related outcomes in Tables V and VI. Each cell in the tables shows the regression coefficient representing an effect of a skill (or education) on a health-related outcome. The effects are calculated for changes in skills by one standard deviation (or for changes in education status from "'no college education" to "college education"). Asterisks denote the stepdown-adjusted statistical significance level. The *p*-values are adjusted for multiple hypothesis testing within blocks of outcomes of the same type such as all available heavy alcohol drinking-related

outcomes across the life cycle.[13] Coefficients from the same block are marked by bold frames. Coefficients with p-values above 0.15 are not shown in summary tables since we can hardly statistically distinguish them from zero.[14] The results are color-coded so that green (or light grey in print) refers to effects that are considered in the literature to be beneficial for longevity (such as a decrease in heavy drinking or an increase in physical activity), and red (or dark grey in print) refers to adverse effects.

[Tables V–VI here]

One quick way to analyze these summary tables is to study the color distribution over the table, and notice that some skills show multiple effects that are beneficial for health, while some others are of the opposite sort. We discuss these patterns below.

Summary of Effects by Type for Males Our results show that college education and childhood Conscientiousness conditional on college education (a direct effect) act on outcomes in a health-beneficial way, Neuroticism and Openness are disadvantageous, while Extraversion, Agreeableness, and IQ show mixed effects (see Table V).

Both Conscientiousness and education reduce heavy drinking over the life cycle and protect against divorce. Education also increases earnings over the life cycle and enhances physical activity.[15] Conscientiousness reduces mental difficulty and increases general health at age 50. We interpret beneficial effects of Conscientiousness and Education as a consequence of better self-control and better decision-making including better matches on the marriage market, better job choices, better health investment choices, and

[13] Physical exercise, BMI, and smoking are exceptions as we know them at only one specific age.

[14] Tables C-I–C-VII of the Web Appendix show all coefficients, standard errors, and p-vales, both adjusted and unadjusted.

[15] Gensowski (2013) finds the effect of adult Conscientiousness on earnings. While we confirm this result (not documented in this paper), we find no such effect of childhood Conscientiousness.

better persistence in maintaining positive health habits.[16]

Openness acts in a very similar health-adverse way as Neuroticism for this population. We can expect adverse effects for Neuroticism, which is well-known to be unproductive in various ways. Yet Openness is often viewed as a productive trait associated with being intellectual, curious, creative, and open-minded. In this paper we condition on IQ and other Big Five personality characteristics and find adverse health effects of Openness, which are the price to pay for creativity, open-mindedness, and a desire for new experiences. In particular, a desire for new experiences may imply less interest in keeping a stable partner, which may explain effects on divorce-related outcomes: "ended up divorced" and "divorced at least twice." Neuroticism increases the same divorce outcomes as well as "never married" outcome likely because it is harder for an emotionally-unstable man to find a good match or to keep relationships and family well-being on a mutually satisfactory level. For both open and neurotic people we can see effects on reduced physical activity and on heavy drinking.

Finally, Extraversion, Agreeableness, and IQ show mixed effects. Extraversion shows persistent positive effects on heavy drinking (probably since social events are complementary with alcohol consumption), but, at the same time, greater earnings (markets value social skills that come with more frequent communication experience) and lower mental difficulties (socializing is beneficial for mental health).

Agreeableness increases membership in organizations in 1950 but has strong and persistent negative effects on earnings. While job markets generally appreciate agreeable workers, we can expect that agreeable people are less likely (1) to ask for salary

[16]We cannot rule out additional or alternative interpretations that are consistent with the data.

raises while threatening to switch to another employer; (2) to move to another job while sacrificing the family's geographic preferences or careers for one's own career advancement, and (3) to be promoted into leadership positions that require a degree of mental toughness and readiness for difficult decisions that may upset some co-workers.

Finally, it is remarkable that we see some effects of IQ, though weak and mixed, despite the extraordinary intelligence of the Terman population. We see a modest and borderline statistically significant positive effect on earnings.[17] There is also an effect on heavy drinking around age 30 and some mixed effects on social participation.

Summary of Effects by Type for Females For females, we reject only a few hypotheses. We can see that education consistently encourages group membership among women over the life cycle, improves their general health at least in young adulthood, has an effect on earnings at age 40, and decreases the likelihood of divorce. Both education and Neuroticism reduce the incidence of an overweight BMI. Interestingly, we observe no such effects for males. To provide one possible explanation to the effect of Neuroticism, a neurotic female may worry more about her physical appearance compared to a more emotionally stable one, leading to a reduced likelihood of being overweight either through a balanced calories intake or through an eating disorder.

This result is in line with the literature. Cervera et al. (2003), for example, find a positive association between neurotic personality and eating disorders in girls 12–21 years old (anorexia, bulimia, and related disorders). Authors note that eating disorders are much more prevalent among females. We also see some effects of extraversion on heavy

[17] The effect on earnings is in line with Gensowski (2013).

drinking, the same effect as for men. Unlike for men, the only effect of Openness for women that we observe is health-beneficial: a reduction in heavy drinking.

Summary of Lifetime and Midlife Outcomes We adjust inference for two alternative groups of outcomes: (1) outcomes aggregated over the life cycle whenever information for such aggregation is available; (2) all available outcomes at midlife. As we can see from Table VII, most key results discussed above survive this more conservative adjustment.[18]

[Table VII here]

For males, as above, we see evidence that Conscientiousness and education are health-beneficial, while Openness and Neuroticism are not (see Panels A and B). Education diminishes lifetime heavy drinking and divorce, while increasing lifetime earnings, as well as earnings and social participation at midlife. Conscientiousness decreases heavy drinking and mental health problems both at midlife and over the lifecycle. It diminishes the likelihood of ever smoking and has some borderline statistically significant effect on ever being divorced. Neuroticism decreases earnings and increases general health at midlife. It also has a negative effect on both lifetime and midlife mental health. Greater Openness diminishes both lifetime and midlife mental health. Agreeableness leads to lower earnings, again both over lifetime and at midlife. Extraversion leads to greater lifetime earnings and to superior mental health at midlife. Greater IQ leads to greater social activity and superior earnings at midlife (a borderline statistically significant effect).

For females, as above, we again see a beneficial role of education and an adverse role of Neuroticism (see Panels C and D). Education increases lifetime general health

[18]Note that some of variables in Tables V and VI are neither lifetime nor mid-life, and so the sets of available behavior types that are tested in Tables V, VI, and VII somewhat differ.

and midlife social activity, with some borderline statistically significant negative effect on lifetime divorce. Neuroticism diminishes mental and general health, both over the lifetime and at midlife.

Socioemotional Skills vs. Traditional Controls The importance of socioemotional skills is comparable to the combined role of education, IQ, and detailed background controls for many of the health-related outcomes of high-ability individuals. Figure 4 presents the R^2 statistic for two outcome equations: the full model (1) and the restricted model (3) that omits socioemotional skills. The results suggest that omitting socioemotional skills leads to a dramatic reduction in R^2 for most of health-related outcomes. The reduction is around 50% or higher for heavy drinking, physical exercise, and mental health. It is about 25% or higher for overweight and divorce, general health, and earnings. For smoking and organization memberships, the reduction is about 15% or higher. We acknowledge that in a more heterogeneous sample, traditional controls are expected to explain a higher share of variance.

[Figure 4 here]

5 Discussion

Education and Health Our paper uses a methodology that serves as an alternative to natural experiments in order to provide additional evidence that education has effects on health-related outcomes health-related outcomes. Results are in line with a number of effects documented in the literature: effects on reducing heavy drinking

(Conti and Hansman, 2013; Crum et al., 1993; Droomers et al., 1999), increasing earnings (Card, 1999), lowering divorce rates (Stevenson and Wolfers, 2007), and encouraging physical activity (Conti and Hansman, 2013; Conti et al., 2010).

Socioemotional Skills and Health Literatures in health psychology and epidemiology have provided a lot of thought-provoking evidence on correlations between Big Five factors and health-related life outcomes. However, a causal interpretation of these results is often complicated by obvious possibilities for confounding effects. We demonstrate robustness of many of these results to using extraordinarily rich background controls, controls for the IQ and other personality traits from the Big Five taxonomy, and strong control for the family-wise error rate. Finally, we show that some of these results are persistent over the lifecycle.

Our results are consistent with the literature with regard to the effects of socioemotional skills (see Bogg and Roberts (2004); Droomers et al. (1999); Friedman (2000); Friedman et al. (1993)). Many of the effects of Conscientiousness and Neuroticism on health-related outcomes that we estimate are large and statistically significant. Estimated coefficients reflect a substantial percentage of sample means for most outcomes. Our results therefore confirm the positive effects of Conscientiousness on health, while for Neuroticism, we add to a growing body of evidence that it is a major determinant of health-related outcomes (Lahey, 2009). The negative association between Agreeableness and earnings and positive association between Extraversion and drinking alcohol are widely recognized patterns (Cookson, 1994; Flory et al., 2002; Heineck and Anger, 2010; Judge and Livingston, 2011; Mueller and Plug, 2006). We confirm these findings

conditional on a substantial set of controls, IQ, and other socioemotional skills.

We also contribute to the discussion about the the relationship between Openness and health. The findings of this literature are mixed perhaps because Openness is a mixture of various facets that may relate to health differently (see Eldesouky (2003) for a survey). In particular, Openness is known to be substantially loaded on IQ. While we know that intellect is productive for health, Openness to certain risky health behaviors might be counterproductive. In our study, we control for intellect twice: (1) by using a sample of high-IQ people, and (2) by controlling for their childhood IQs in the regression thus identifying the role of Openness conditional on the IQ, which our results suggest to be adverse for health.

Data Limitations While our data are rich in terms of the variables we observe, it has a modest sample size, which influences this paper in two main ways. First, we make linear parametric assumptions for the statistical models capturing the measurement system for socioemotional factors, as well as for the equations modeling health-related outcomes. Second, even though this paper suggests important health-related mechanisms through which education and socioemotional skills affect longevity, the sample is too small to allow for a reliable mediation analysis in this regard. Also, due to the lack of measures of Agreeableness and Neuroticism in childhood we have to use such measures in young adulthood and interpret the resulting estimates with caution.

Implications of an Unusual Sample and External Validity The results in this paper are based on a historical sample of people with exceptional IQs. We have access to early

measures of psychological skills and high-quality life-cycle data at the expense of dealing with both an unusual and deceased cohort.

Effects of education and skills may differ with the level of intelligence, and so it is useful to know such effects for different levels of IQ, including the limiting case of very high IQ. This knowledge helps us verify some claims made in the literature. While Auld and Sidhu (2005), who use parental education as an IV for education in affecting health, suggest that education is only productive for health at its low levels and only for low-IQ people, we find that education is highly productive at the college level even for people with extraordinarily high IQs.

Another benefit of selection on high IQ is that it reduces the potential of IQ to confound the effects of education on health. For the Terman sample we can be sure that their IQs were more than enough to finish college.

We do not claim applicability of the results to the general population, but the results may be applicable to a much larger population with high IQs, though not necessarily as high as in Terman subjects. Indeed, if health choices are not specific to extraordinarily high IQs, we can expect similar results to hold for less-exceptional populations.

Application to more recent cohorts presents another challenge. Social norms toward many of these health behaviors have changed dramatically over time, especially for women. In addition, there has been an increased amount of available information on how these health behaviors affect health and longevity, as well as many technological innovations that private individuals can make use of to improve their health. All of these changes may affect the magnitude of the effects. That said, many of the qualitative results summarized in Table I are likely to survive since we can expect many mechanisms

to remain the same. For instance, educated and conscientious people still care about their health today as they did in the generation of Terman's subjects. Since we now have the potential to do more good to our health through the informed choices we make, the effects of education and skills may well be even stronger today than we observe in the Terman data.

6 Conclusions

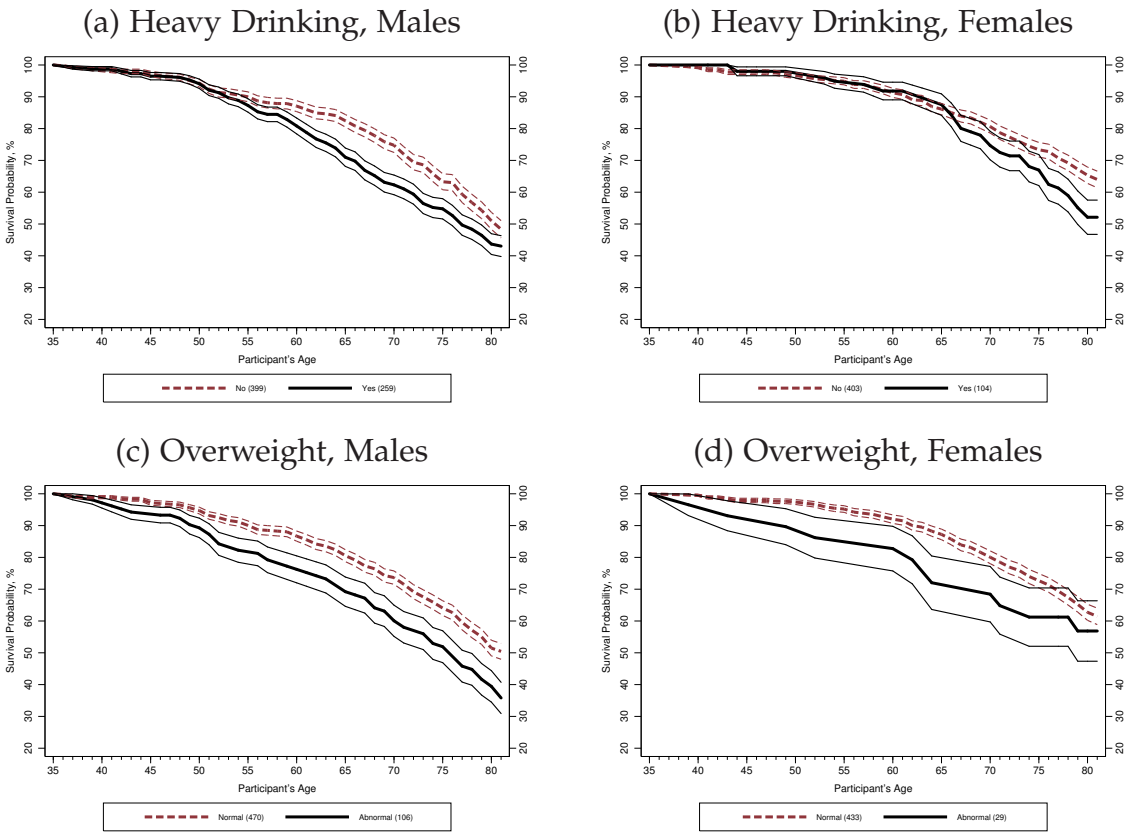
The importance of socioemotional skills in the analysis of health is gaining recognition among economists. We contribute to this emerging literature by investigating the role of five-dimensional socioemotional skills on health-related outcomes based on a unique life-cycle prospective dataset with cognitive and socioemotional skills measured early in life and find that their effects are substantial.

We also find that education has a statistically significant effect on several important health-related outcomes. This adds new evidence from the Terman data to the mixed results in the literature regarding the effect of education on health. We also find that the role of socioemotional skills in explaining health outcomes is comparable to that of education, IQ, and background controls combined, at least for a sample of high-IQ people. This strong result establishes socioemotional skills as an important aspect of human capital that should receive greater attention from economists.

The findings with regard to socioemotional skills open up a new dimension for public policy. Conditional on the availability of socially-acceptable and cost-effective policy interventions, we can improve health by remediateing, for instance, the extreme lack of

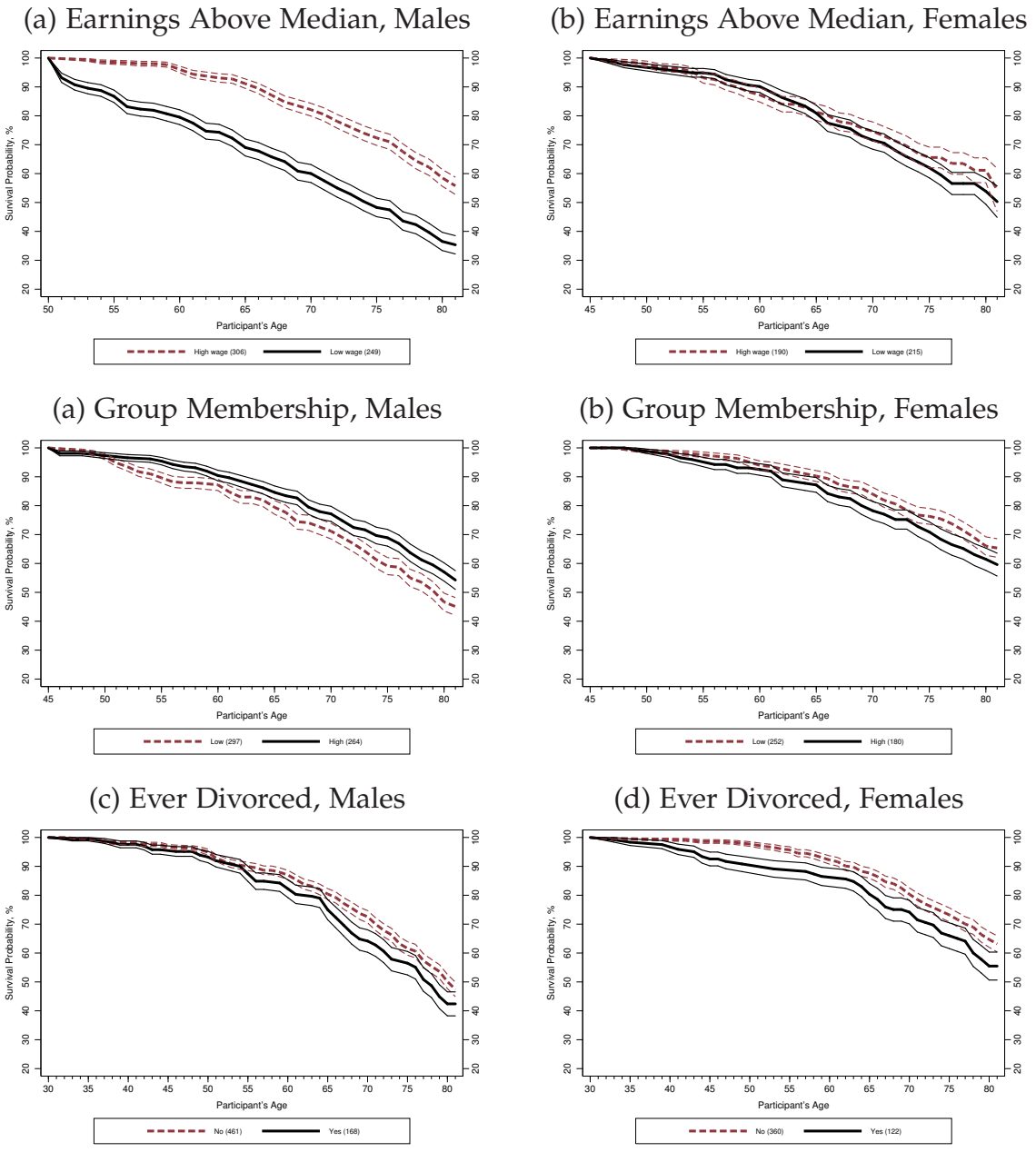
Conscientiousness and Emotional Stability, the inverse of Neuroticism. Effects of Agreeableness, and Extraversion on health-related outcomes are mixed, while Openness is known to be productive outside of health domain, hence we may be less sure about these skills as potentially valuable policy targets.

Figure 1: Survival by Health Behaviors and Their Proxies



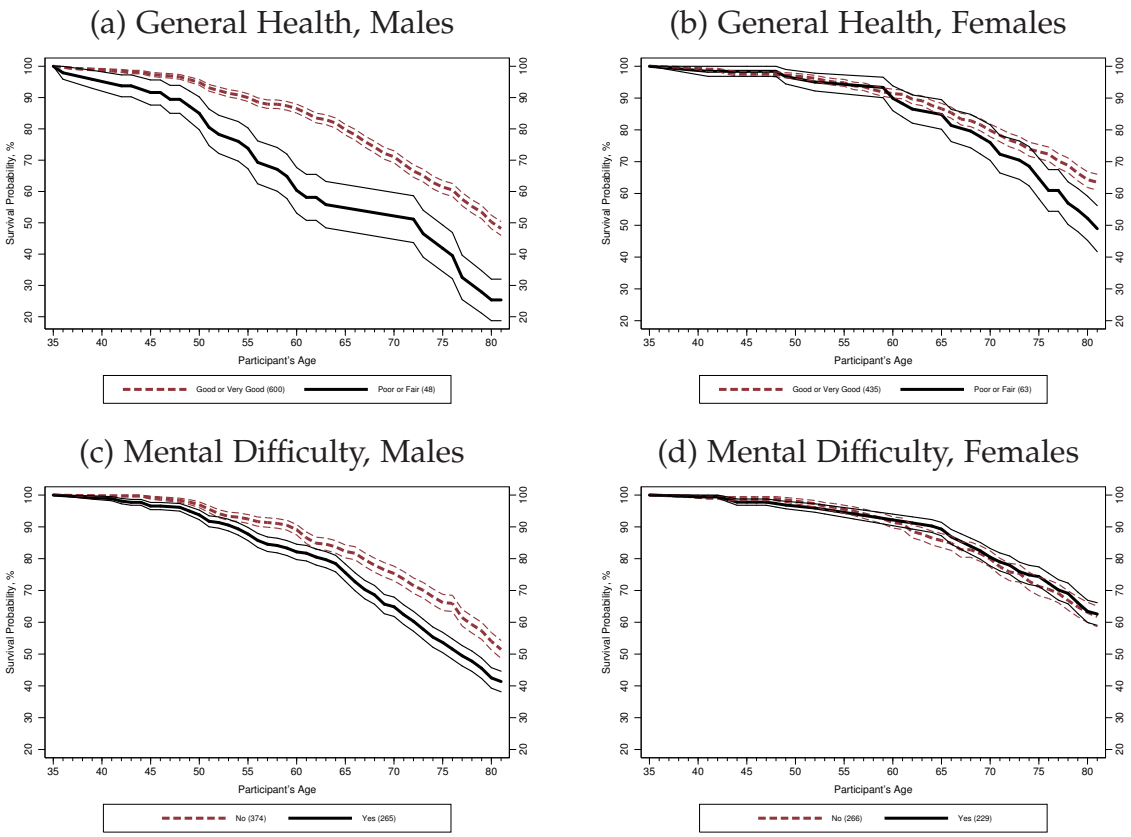
Notes: Heavy drinking is an indicator whether the subject has ever reported drinking heavily over the period of 1940–1960. Overweight refers to subjects who had a BMI above 25 in 1940. Survival graphs are based on life-table calculations; standard errors above and below the estimate are represented by the thinner lines. Calculations are based on the Terman data.

Figure 2: Survival by Earnings and Lifestyles



Notes: For earnings, "high" refers to above the median earnings, while "low" refers to earnings at or below the median. Note that median earnings of women in this sample are zero. For group membership in 1950, "high" refers to subjects having a greater number of organization memberships than the median, "low" for at or below the median. "Ever divorced" indicates whether the subject was divorced at least once. Survival graphs are based on life-table calculations; standard errors above and below are represented by the thinner lines. Calculations are based on the Terman data.

Figure 3: Survival by Self-Reported Health



Notes: General health is an index constructed from self-reported health measures ("energy level," "vitality," "physical health.") It indicates whether the subject experienced poor or fair health over the years 1940–1960. Mental difficulty indicates whether or not the subject experienced any mental difficulty over the years 1950–1960. Survival graphs are based on life-table calculations; standard errors above and below the estimate are represented by the thinner lines. Calculations are based on the Terman data.

Table I: Qualitative Summary of Health-Beneficial Effects Implied by Empirical Results

	Males		Females	
Determinant	Effect Sign	Strong evidence	Effect Sign	Strong evidence
A. Socioemotional skills				
Conscientioiousness	+	yes		
Openness	-	yes	-	
Extraversion	+/-	yes	-	
Agreeableness	+/-	yes	+/-	
Neuroticism	-	yes	-	yes
Cognition (IQ)	+/-		-	
B. Formal education				
College education or above	+	yes	+	yes

Notes: "+" and "−" denote health-beneficial and adverse health effects respectively. "+/−" denote mixed health effects. "yes" summarises greater confidence that authors have in corresponding effects, as described in the data analysis. The greater confidence is based on strength of effects, their statistical significance, and multiplicity of rejected hypotheses that support the same conclusion. Calculations are based on the Terman data.

Table II: Raw Measures Clustered by Corresponding Factors

		Males				Females			
Variable	year	mean	std. error	min	max	mean	std. error	min	max
Openness									
Desire to know	1922	10.39	0.077	3	13	10.09	0.096	1	13
Originality	1922	9.56	0.088	2	13	9.29	0.102	1	13
Intelligence	1922	10.79	0.069	1	13	10.68	0.078	6	13
Conscientiousness									
Prudence	1922	8.55	0.096	1	13	9.19	0.104	1	13
Conscientiousness	1922	9.41	0.101	1	13	10.25	0.101	2	13
Truthfullness	1922	9.75	0.097	1	13	9.97	0.106	2	13
Extraversion									
Fondness for large groups	1922	7.58	0.099	1	13	8.16	0.111	1	13
Leadership	1922	7.48	0.086	2	13	8.04	0.098	2	13
Popularity with other children	1922	7.49	0.086	2	13	8.16	0.101	2	13
Agreeableness									
Easy to get along with	1940	7.26	0.068	2	11	7.15	0.077	2	11
Avoids arguments	1940	0.525	0.021	0	1	0.694	0.022	0	1
Critical	1940	0.594	0.022	0	1	0.447	0.025	0	1
Tactful	1940	0.561	0.022	0	1	0.698	0.023	0	1
Unfeeling	1940	0.449	0.022	0	1	0.278	0.022	0	1
Domineering	1940	0.412	0.022	0	1	0.289	0.023	0	1
Inflated opinion of self	1940	0.360	0.025	0	1	0.239	0.025	0	1
Neuroticism									
Miserable	1940	0.215	0.018	0	1	0.249	0.021	0	1
Touchy	1940	0.373	0.021	0	1	0.355	0.023	0	1
Has periods of loneliness	1940	0.250	0.018	0	1	0.273	0.021	0	1
Lonely when with others	1940	0.230	0.018	0	1	0.228	0.020	0	1
Remorseful and regretful	1940	0.194	0.017	0	1	0.228	0.020	0	1
Lacks self-confidence	1940	0.242	0.019	0	1	0.470	0.025	0	1
Worrys about humiliating experiences	1940	0.352	0.020	0	1	0.401	0.023	0	1
Emotionally unstable	1940	0.203	0.017	0	1	0.279	0.022	0	1
Easily hurt	1940	0.404	0.022	0	1	0.448	0.024	0	1
Hard to be serene	1940	0.094	0.013	0	1	0.101	0.015	0	1
Moody	1940	5.87	0.080	1	10	6.21	0.093	1	11
Sensitive	1940	6.61	0.074	1	10	6.89	0.076	3	11
Estimation Sample			680				527		

Notes: Following prior work by psychologists Friedman et al. (2010, 1995, 1993), our measures for Openness, Conscientiousness, and Extraversion are averages of teacher's and parent's ratings. Measures of Agreeableness and Neuroticism are self-reported. Calculations are based on Terman data. Web Appendix A contains additional technical details about this grouping of factors.

Table III: Health-Related Outcomes

	Males		Females	
Variable	mean	std. error	mean	std. error
Health Behaviors and proxies				
Heavy Drinking of Alcohol in 1940	0.267	(0.018)	0.102	(0.014)
Heavy Drinking of Alcohol in 1950	0.118	(0.013)	0.038	(0.009)
Heavy Drinking of Alcohol in 1960	0.347	(0.021)	0.167	(0.018)
Ever drank heavily, 1940–60	0.394	(0.019)	0.205	(0.018)
Ever smoked, 1991	0.521	(0.037)	0.425	(0.036)
Physical Excercise, 1982	0.176	(0.021)	0.173	(0.021)
Overweight BMI, 1940	0.183	(0.016)	0.063	(0.011)
Lifestyles				
Never married, 1922–86	0.061	(0.009)	0.085	(0.012)
Married once and still married, 1922–86	0.576	(0.019)	0.417	(0.022)
Ended up divorced, 1922–86	0.064	(0.009)	0.121	(0.014)
Ever divorced, 1922–86	0.267	(0.017)	0.253	(0.018)
Divorced at least twice, 1922–86	0.063	(0.009)	0.059	(0.010)
# of organizations in 1940	2.435	(0.069)	2.506	(0.083)
# of organizations in 1950	2.714	(0.090)	1.565	(0.078)
# of organizations in 1960	3.423	(0.112)	2.567	(0.124)
Ever a member of any organization, 1940–60	0.937	(0.010)	0.900	(0.014)
Earnings				
Earnings at age 40, 1945–57	62.23	(1.84)	11.54	(0.80)
Earnings at age 50, 1955–67	71.50	(2.17)	16.08	(1.01)
Earnings at age 60, 1965–77	62.00	(2.58)	15.33	(1.12)
Lifetime earnings discounted at 3%, 1922–86	1,116	(26.2)	272	(12.3)
Health Measures				
Ever had mental difficulty, 1940–60	0.415	(0.019)	0.463	(0.022)
Never poor or fair health, 1940–60	0.926	(0.010)	0.873	(0.015)
Estimation Sample	680		527	

Notes: Earnings are annual, in thousands of 2010 US dollars, net of tuition and taxes. Calculations are based on the Terman data.

Table IV: Education, IQ, and Background Variables

		Males		Females	
variable	year	mean	std. error	mean	std. error
Education and IQ					
Bachelor's degree or above	1922–68	0.734	(0.017)	0.686	(0.020)
IQ[(a)]	1922	149.3	(0.405)	148.5	(0.446)
Subject's Background					
Normal birth or no birth problems mentioned[(b)]	1922	0.571	(0.019)	0.629	(0.021)
No breastfeeding[(b)]	1922	0.091	(0.011)	0.085	(0.012)
Childhood health[(c)]	1922	8.526	(0.075)	9.027	(0.083)
Childhood energy[(c)]	1922	8.219	(0.073)	8.834	(0.078)
Participation in World War II	1945	0.410	(0.019)	-	-
Combatant in World War II	1945	0.093	(0.011)	-	-
Age in 1922	1922	11.84	(0.112)	11.80	(0.122)
Cohort 1904–1907	1922	0.237	(0.016)	0.172	(0.016)
Cohort 1908–1911	1922	0.468	(0.019)	0.467	(0.022)
Cohort 1912–1915	1922	0.296	(0.018)	0.361	(0.021)
Parental Background					
Mother deceased by 1922	1922	0.028	(0.006)	0.032	(0.008)
Father deceased by 1922	1922	0.081	(0.010)	0.074	(0.011)
Parents divorced by 1922	1922	0.050	(0.008)	0.047	(0.009)
Father has at least a Bachelor's degree	1922	0.291	(0.017)	0.253	(0.019)
Parental finances are adequate	1922	0.371	(0.019)	0.384	(0.021)
Parental social standing is below average	1922	0.253	(0.017)	0.153	(0.016)
Mother is employed	1922	0.126	(0.013)	0.132	(0.015)
Father is a professional	1922	0.243	(0.016)	0.276	(0.019)
Parent born abroad	1922	0.304	(0.018)	0.267	(0.019)
Parent born in Europe	1922	0.218	(0.016)	0.202	(0.017)
Amount of private tutoring (log)[(d)]	1922, 28	0.105	(0.014)	0.344	(0.026)
Amount of home investment (log)[(d)]	1922	0.450	(0.014)	0.409	(0.016)
Estimation Sample		680		527	

Notes: [(a)]The best estimate of the IQ is provided by survey organizers and is based on all available information including Stanford Binet and Terman Group Tests. [(b)]Conditions at birth and breastfeeding were reported by parents retrospectively at the start of the study. [(c)]Based on the average of teachers' and parents' ratings, each on the scale from 1 to 13. [(d)]Amounts of time investments from age 2 to age 7 are transformed using natural logarithm: $\ln(1 + \text{investment amount})$. Calculations are based on the Terman data.

Table V: Summary of Effects on Health-Related Outcomes by Type, Males

	C	O	E	A	N	IQ	Education
A. Health behaviors and their proxies							
1940–1960 Ever Drank Heavily	-.055 **		.061 **				-.109 **
1940 Heavy Drinking	-.046 *		.044			.057 **	-.086
1950 Heavy Drinking			.040 **		.039 *		-.090 **
1960 Heavy Drinking	-.072 **	.056	.044 *				-.077
1940 Overweight				-.034		-.023	
1982 Physical Activity, Freq.		-.044 *			-.066 **		.108 *
1991 Ever Smoked	-.107 **						
1940–1960 Any Organization							.084 ***
1940 Number of Organizations						-.175 *	.245
1950 Number of Organizations				.258 *			1.172 ***
1960 Number of Organizations						.327 **	1.501 ***
Never Married	.023				.024		
Married Once and Still Married	.056 *						.120 **
Ended up Divorced	-.023 *	.050 ***			.024		
Ever Divorced	-.055 *						-.137 **
Divorced at least Twice	-.044 **	.031 *			.025		
B. Earnings							
Lifetime earnings, 3% discount			79.908 **	-94.713 **		44.431	209.191 ***
Earnings at age 40				-6.556 ***		3.280	14.585 ***
Earnings at age 50			4.122	-6.787 **	-6.553 **	4.758 *	19.788 ***
Earnings at age 60			5.814 *		-7.466 **		30.530 ***
C. Mental Health (MH)							
Ever Poor/Fair MH	-.071 ***	.085 ***	-.051 *		.134 ***		
1940 Mental Difficulty	-.078 ***	.086 ***	-.077 ***		.120 ***		
1950 Mental Difficulty	-.040 *				.111 ***		
1960 Mental Difficulty	-.080 ***	.091 ***	-.101 ***		.120 ***		
D. General Health (GH)							
Never Poor/Fair GH		-.032 *			-.021		
1940 General Health					-.279 ***		
1950 General Health	.135 **	-.152 **	.096		-.242 ***		
1960 General Health					-.211 ***		

Notes: Letters denote: C, Conscientiousness; O, Openness; E, Extraversion; A, Agreeableness; N, Neuroticism. Coefficients are reported with accompanying statistical significance represented by stars, where ***,** and * indicates $p < 0.01, 0.05, 0.10$ respectively. A coefficient with no star refers to $p < 0.15$, while a blank cell refers to a coefficient with p-value above 0.15. p-values are calculated using bootstrap techniques, and further adjusted using the stepdown procedure in Romano and Wolf (2005). Coefficients shaded green (light grey in print) and red (dark grey in print) denote beneficial and adverse implications for health. Calculations are based on the Terman data. See Tables C-I–C-VII of the Appendix for a full set of results used for the summary.

Table VI: Summary of Effects on Health-Related Outcomes by Type, Females

	C	O	E	A	N	IQ	Education
A. Health behaviors and their proxies							
1940–1960 Ever Drank Heavily		-.073 **	.054 *				
1940 Heavy Drinking				-.041 *			
1950 Heavy Drinking							
1960 Heavy Drinking		-.060 *	.049				
1940 Overweight					-.037 *		-.074 *
1982 Physical Activity, Freq.							
1991 Ever Smoked							
1940–1960 Any Organization							.066 **
1940 Number of Organizations							.789 ***
1950 Number of Organizations							.877 ***
1960 Number of Organizations						-.352 **	1.213 ***
Never Married							.074 ***
Married Once and Still Married							.129 *
Ended up Divorced							
Ever Divorced							-.111 **
Divorced at least Twice							-.054 *
B. Earnings							
Lifetime earnings, 3% discount							
Earnings at age 40							3.946 *
Earnings at age 50							
Earnings at age 60					-4.650 ***		
C. Mental Health (MH)							
Ever Poor/Fair MH					.152 ***		
1940 Mental Difficulty					.137 ***		
1950 Mental Difficulty					.134 ***		
1960 Mental Difficulty					.123 ***		
D. General Health (GH)							
Never Poor/Fair GH					-.044 ***		.116 ***
1940 General Health				-.133 *	-.318 ***		.283 **
1950 General Health				-.094	-.267 ***		.172
1960 General Health					-.241 ***		

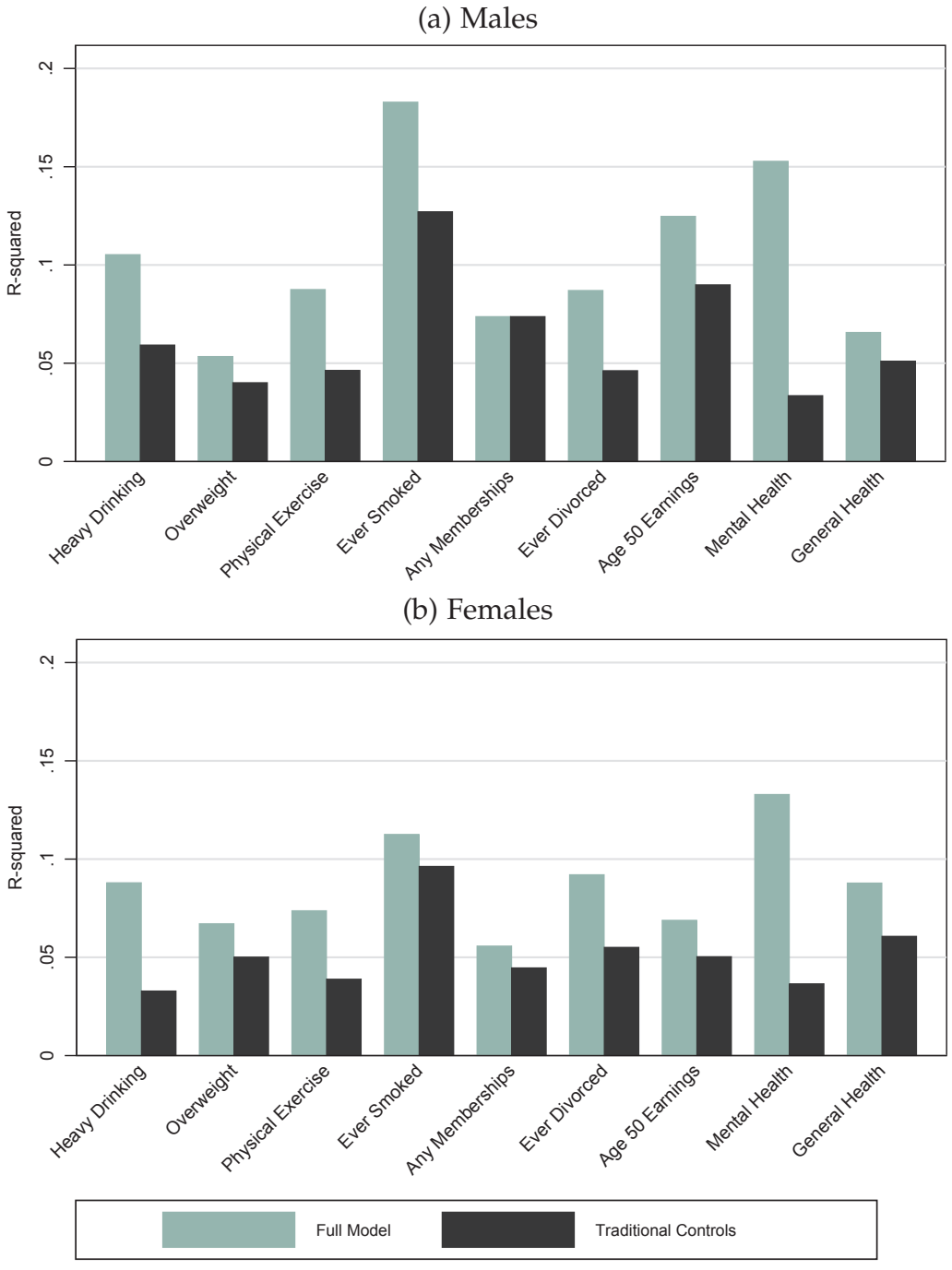
Notes: Letters denote: C, Conscientiousness; O, Openness; E, Extraversion; A, Agreeableness; N, Neuroticism. Coefficients are reported with accompanying statistical significance represented by stars, where ***, ** and * indicates $p < 0.01, 0.05, 0.10$ respectively. A coefficient with no star refers to $p < 0.15$, while a blank cell refers to a coefficient with p-value above 0.15. p-values are calculated using bootstrap techniques, and further adjusted using the stepdown procedure in Romano and Wolf (2005). Coefficients shaded green (light grey in print) and red (dark grey in print) denote beneficial and adverse implications for health. Calculations are based on the Terman data. See Tables C-I–C-VII of the Appendix for a full set of results used for the summary.

Table VII: Summary of Lifetime and Midlife Outcomes

	C	O	E	A	N	IQ	Education
A. Lifetime Outcomes, Males							
1940–1960 Ever Drank Heavily	-.055						-.109 *
1991 Ever Smoked	-.107 **						
1940–1960 Any Organization							
Ever Divorced	-.055						-.137 ***
Lifetime earnings, 3% discount			79.908 *	-94.713 *			209.191 ***
Ever Poor/Fair MH	-.071 *	.085 ***			.134 ***		
Never Poor/Fair GH							
B. Midlife Outcomes, Males[(a)]							
Drank Heavily	-.072 **						
# of Organizations						.327 **	1.501 ***
Earnings				-6.787 *	-6.553 **	4.758	19.788 ***
Mental Health	-.080 **	.091 ***	-.101 ***		.120 ***		
General Health					-.211 ***		
C. Lifetime Outcomes, Females							
1940–1960 Ever Drank Heavily							
1991 Ever Smoked							
1940–1960 Any Organization							
Ever Divorced							-.111
Lifetime earnings, 3% discount							
Ever Poor/Fair MH					.152 ***		
Never Poor/Fair GH					-.044 *		.116 **
D. Midlife Outcomes, Females[(a)]							
Drank Heavily							
# of Organizations						-.352 **	1.213 ***
Earnings							
Mental Health					.123 ***		
General Health					-.241 ***		

Notes: Letters denote: C, Conscientiousness; O, Openness; E, Extraversion; A, Agreeableness; N, Neuroticism. Coefficients are reported with accompanying statistical significance represented by stars, where ***,** and * indicates $p < 0.01, 0.05, 0.10$ respectively. A coefficient with no star refers to $p < 0.15$, while a blank cell refers to a coefficient with p-value above 0.15. p-values are calculated using bootstrap techniques, and further adjusted using the stepdown procedure in Romano and Wolf (2005). Coefficients shaded green (light grey in print) and red (dark grey in print) denote beneficial and adverse implications for health. Calculations are based on the Terman data. [(a)]"Midlife" corresponds to age around 50 based on measurements in 1960. See Tables C-VIII–C-X of the Appendix for a full set of results used for the summary.

Figure 4: Coefficient of Determination (R^2) Comparison



Notes: For each health-related outcome, R^2 is reported for the full model and the model omitting latent socioemotional skills. Calculations are based on the Terman data.

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