Assessing the relationship between education and delay discounting and future planning in U.S. adults

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ABSTRACT. Background and Objectives: Education has been linked to mortality, but the relationship is poorly understood. The current study assessed whether delay discounting and future planning may be potential mediators in the education-mortality pathway.

Methods: N = 681 U.S. adults completed an online survey. Linear and logistic regression models were specified to determine the relationships between education, delay discounting, and future planning. Models were repeated among participants with positive health attributes that may also mediate the education-mortality pathway (i.e., currently employed, had high social support, had high health literacy, and were lifetime non-smokers).

Results: In the delay discounting task, participants with a high school education or less required \$13.70 more than other participants ($p = 0.002$). The odds of having a future 10-year plan were 49% lower among participants with a high school education or less (95% CI = 0.28, 0.95). The relationships remained among those with positive health attributes.

Conclusions: High delay discounting and low future planning may explain, in part, the inverse relationship between education and mortality risk reported elsewhere. Programs encouraging students to complete an undergraduate education and that directly decrease delay discounting or increase future planning are needed.

Keywords: education, delay discounting, future planning, mortality

Introduction

Education is associated with mortality. In the United States (U.S.), 145,000 deaths per year may be attributed to attaining less than a high school education,¹ and at 25 years old, individuals with a college degree can expect to live 13 years longer than those with less than a high school education.² Moreover, it was estimated that 48% of deaths among men and 38% of deaths in women could be prevented if the mortality rate of college graduates applied to all education groups.³

The relationship between education and mortality is approximately linear, although mortality risk declines faster after completing a high school education,⁴ and disparities between education groups may be widening.⁵ While life expectancy has been increasing among all White men and college educated White women in the U.S., decreases have been noted among White women without a high school education.⁶

Mortality risks vary widely between U.S. states though, suggesting local environments influence the relationship.⁷ For example, the risk of death from not completing high school was 40% greater relative to those with a college degree in Arizona but 104% greater in Maryland, and mortality rate disparities based on education have grown in some states while simultaneously shrinking in other.

The effect of education on mortality risk may be universal, as similar results have been reported in numerous countries. The mortality risk for men 50 to 64 years old in Switzerland who were without a college education was 74% greater than comparable men with a college degree,⁸ and the mortality risk was two times greater between non-college educated adults and college educated adults in the Netherlands.⁹ In a records-based study of 35 million Italian adults, the mortality rate was 49% lower in college educated men and 37% lower in college educated

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women relative to their non-college educated counterparts,¹⁰ and using South Korean death records, college educated men and women lived 16.2 years and 7.7 years longer, respectively, than men and women with an elementary school education.¹¹

In the U.S., the importance of education has been emphasized in several ways. The Healthy People program included multiple educational goals in its most recent iteration.¹² These include increasing the proportion of students who complete a high school education within 4 years and increasing the percent of high school graduates who begin college during the next academic year. Further, President Biden has proposed expanding Title I grants, which provide financial assistance to schools with high proportions of students in poverty, by \$20 billion,¹³ and he has previously expressed support for providing 2 free years of post-high school education as part of a plan to ensure free tuition at community colleges.¹⁴ Globally, increasing education is a key pillar of the United Nations Sustainable Development Goals, which includes specific targets for secondary and tertiary educational attainment.¹⁵

Despite the attention and the known link to mortality risk, the mechanism of action for how education reduces mortality remains unclear, although there are several hypotheses. In the present study, education's association with future planning and delay discounting, which occurs when immediate rewards are deemed more valuable than long-term gain,¹⁶ were tested. Several studies have suggested a link between delay discounting and mortality. More immediate rewards are preferred among persons living in countries with lower life expectancies,¹⁷ and high time discounting rates were associated with lower rates of subjective survival probability.¹⁸ High delay discounting was also associated with higher mortality in HIV-positive adults in Kenya¹⁹ and among older adults with dementia in the U.S.²⁰ More generally, others

have suggested that cognitive skills and exposure to knowledge are potential mediators between education and mortality.²¹

Importantly, educational attainment has been previously linked to delay discounting,²² with greater future planning and lower delay discounting positively associated with academic achievement.^{23,24} Additionally, an analysis of several publicly available datasets suggested that persons with less than a high school education are less future oriented than those with a college degree; are more focused on short-term rewards versus long-term gains; and are less likely to plan for the future.²⁵

While the literature clearly and consistently links educational attainment with decreasing mortality risk, the reason why those with more education are less likely to die remains elusive. The current study sought to determine if educational attainment was associated with future planning and delay discounting, and it was hypothesized that there would be a positive and negative association, respectively. There are other proposed explanations, though, for the link between education and mortality. Some have suggested that education increases several forms of resource availability. For example, health literacy has been associated with education,²⁶ and higher education may make searching for and accessing health-related information easier.²⁷ Low health literacy has also been associated with greater hospitalization, fewer health screenings, lower health status, and overall mortality risk.²⁸ Others have suggested increases in social support may protect against unhealthy behaviors, enhance a person's ability to make positive behavior changes, and improve access to information.^{25,29} Further, education is strongly correlated with employment and income, and it is possible that increased financial resources among the more educated can explain any disparities.³⁰ Finally, disease disparities between education groups may be explained by different health behaviors, as higher smoking rates have

been reported in those with lower educational attainment.^{9,31} For these reasons, the analysis was duplicated only among persons with specific positive health attributes, which included those who were employed, had high social support, had greater health literacy, and who were lifetime non-smokers, in order to better isolate the relationships between education, future planning, and delay discounting.

Methods

Participant Recruitment

Participants were recruited from Amazon's Mechanical Turk (MTurk) platform, which is a web-based service where users complete tasks for small sums of money. A public invitation to the study's screening survey was posted on MTurk in December 2020. Study eligible individuals (i.e., 18 years old or older, living in the U.S., having an internet connection) immediately viewed a consent form, and if consent was provided, the study survey was administered. Participants received \$1.50 for survey completion. In total, 898 individuals responded to the public invitation; 799 (89%) met the inclusion criteria, provided consent, and completed the study; and 681 (76%) provided a complete record for inclusion in the current analysis. All data was provided via self-report, and the study was approved by the Johnson & Wales University Institutional Review Board.

Education

Educational attainment was measured using: *What is the highest level of education you have completed?* Response options were *less than high school, high school degree or equivalent, some college but no degree, Associate's degree, Bachelor's degree, Master's degree, and Doctoral degree*. For the analysis, responses were dichotomized to *high school education or less* and *more than a high school education*.

Dependent Variables

The dependent variables included delay discounting and having a future 10-year plan. Delay discounting was measured by asking participants if they want \$100 today or, in 25 increments, up to \$185 in 12 months.³² Participants who still selected the \$100 dollars today instead of the \$185 were coded as \$189, which would have been the next number available if the sequence continued. Future planning was measured using the prompt: *What do you think you will be doing...?* with ever increasing time frames (i.e., tomorrow, next week, next month, next year, five years from now, ten years from now).³³ Participants could select *I don't know* or one of several other options (e.g., *at school or college full time, working full time, retired, other*). Participant responses were collapsed across questions based on the earliest time frame the response *I don't know* was selected to create a dichotomous future 10-year plan variable. For example, if a participant selected *I don't know* in response to the question *What do you think you will be doing next year?*, the response was coded as not having a future 10-year plan.

Health Attribute Variables

The analysis was replicated only among participants with several positive health attributes suspected of explaining the relationship between educational attainment and mortality. Specifically, the analysis was repeated for participants who were currently employed, had high social support, had high health literacy, and were lifetime non-smokers. Employment status was assessed using *Are you currently...?* with response options *employed for wages, self-employed, out of work for 1 year or more, out of work for less than 1 year, a homemaker, a student, retired, and unable to work*. Participants were considered currently employed if they selected *employed for wage* or *self-employed*. Social support was measured using a single item that asked how many people the participant can readily count on for real help.³⁴

Participants selected responses from a 5-point Likert scale that included *0, 1, 2 to 5, 6 to 9, and 10 or more*. Participants who selected *2 to 5* or more were considered to have high social support. Health literacy was measured using the 5-item Calgary Charter on Health Literacy scale.³⁵ Responses to each item were measured on a 4-point Likert scale from *never* to *always*. Item-level responses were coded 0 to 3 and aggregated through summation to create a composite health literacy score. Participants with a composite score ≥ 8 , which is the top 50% of potential earned scores, were considered to have high health literacy. Smoking status was assessed using *Have you smoked at least 100 cigarettes in your entire life?* with response options *yes* and *no*. Participants who responded *no* were considered lifetime non-smokers.

Covariates

Age, sex, race, ethnicity, sexual orientation, and marital status were included as covariates in the analysis. Due to a low prevalence of some racial groups, race was dichotomized to *White* and *Black, Indigenous, People of Color* (BIPOC). Similarly, sexual orientation included *heterosexual* and persons who identify with the *Lesbian, Gay, and Bisexual plus* (LGB+) community, while the divorced, separated, and widowed marital status groups were also combined.

Statistical Analysis

The distributions of continuous variables were examined for skewness, and all were considered normally distributed. The main effect of education on delay discounting and future 10-year planning was assessed using linear and logistic regression models, respectively, that were adjusted for the covariates described above. Models were replicated using the strata described above (i.e., among only employed participants, among participants with high social support, among participants with high health literacy, and

among lifetime non-smokers). *Post hoc* sensitivity models were specified that compared having a high school education or less against specifically having a Bachelor's degree and specifically having an Associate's degree to determine if any education beyond high school influences delay discounting and future planning or if a cut-off is apparent. Statistical analysis was conducted with SPSS Version 27.0 (Armonk, NY: IBM Corp).

Results

A majority of the sample earned a Bachelor's degree or higher (77.7%), and 8.5% earned a high school degree or less (Table 1). Mean age was 36.1 years old (SD = 10.6), and participants were predominantly male (64.6%), White (64.9%), and non-Hispanic (76.4%) (Table 1). Approximately 30% of participants identified with the LGB+ community, and a majority were married or in a domestic partnership (62.3%).

Table 1. Descriptive statistics of socio-demographic variables

Variable	n (%)
Education	
Less than a high school degree	1 (0.1)
High school degree or equivalent	57 (8.4)
Some college	57 (8.4)
Associates degree	37 (5.4)
Bachelor's degree	416 (61.1)
Master's degree	109 (16.0)
Doctoral degree	4 (0.6)
Sex	
Female	241 (35.4)
Male	440 (64.6)
Race	
White	442 (64.9)
BIPOC	239 (35.1)
Ethnicity	
Non-Hispanic	520 (76.4)
Hispanic	161 (23.6)
Sexual Orientation	
Heterosexual	470 (69.0)
LGB+	211 (31.0)
Marital Status	
Single, never married	232 (34.0)
Married or domestic partnership	424 (62.3)
Divorced, separated, or widowed	25 (3.7)

On average, participants required \$137 (SD = 32.8) to wait 12 months, instead of taking \$100 immediately, in the delay discounting task (Table 2). Twenty-two percent of participants required more than \$185 to wait 12 months. Approximately 80% of participants had a future 10-year plan (Table 2). Nearly all participants (97%) were currently employed, and 75% of participants could rely on support from 2 or more people. Mean health literacy was 8.3 (SD = 2.9), which is greater than 50% of the total health literacy score that could be earned, and 43.6% of the sample were lifetime non-smokers.

Table 2. Descriptive statistics of the dependent variables

Variable	
Delay discounting (mean, SD)	\$137 (32.8)
Future 10-year plan (n, %)	
Yes	547 (80.3)
No	134 (19.7)
Employment (n, %)	
Yes	661 (97.1)
No	20 (2.9)
Social support (n, %)	
0 people	24 (3.5)
1 person	146 (21.4)
2 to 5 people	444 (65.2)
6 to 9 people	55 (8.1)
10 or more people	12 (1.8)
Health literacy (mean, SD)	8.3 (2.9)
Tobacco smoking (n, %)	
Yes	384 (56.4)
No	297 (43.6)

In the delay discounting task, participants with a high school education or less required \$13.70 more than those with some college education or more ($p = 0.002$) (Table 3). Educational attainment remained a statistically significant predictor when comparing those with a high school education or less versus only those with a Bachelor's degree ($b = 14.2$, 95% CI = 5.44, 23.0, $p = 0.002$), but was non-significant when compared against those with an Associate's degree ($b = 8.26$, 95% CI = -6.78, 23.3, $p = 0.278$).

The odds of having a future 10-year plan were 49% lower among participants with a high school education or less relative to the rest of the sample (95% CI = 0.28, 0.95) (Table 4). When limiting the sample to those with a high school education or less versus those with a Bachelor's degree, the results were similar (OR = 0.51, 95% CI = 0.27, 0.97, $p = 0.039$). However, the relationship was non-significant when comparing participants with a high school education or less against those with an Associate's degree (OR = 0.32, 95% CI = 0.10, 1.06, $p = 0.062$).

Education remained a significant predictor of delay discounting and future planning after restricting the analysis to several positive health attributes (Table 5). Among employed participants ($p = 0.003$), participants with high health literacy ($p = 0.004$), and lifetime non-smokers ($p = 0.015$), those with a high school degree or less required significantly more money in the delay discounting task. Among participants with high social support ($p = 0.011$) and lifetime non-smokers ($p = 0.027$), the odds of having a future 10-year plan were 60% lower among those with a high school degree or less.

Discussion

Attaining a high school education or less was associated with greater delay discounting and lower odds of having a future 10-year plan. Education remained a significant predictor of these outcomes even after restricting the analysis to several positive health attributes proposed to mediate the relationship between education and mortality, which suggests that delay discounting and future planning may be an independent mediator of that relationship. If delay discounting and future planning were not mediators, null results would be expected within persons with each positive health attribute. Moreover, substantial education beyond high school may be needed to see any effects as significant differences in delay discounting and

Table 3. Association between attaining a high school education or less and delay discounting

Variable		B	95% CI	p
Education	High school or less	13.7	5.14, 22.3	0.002
	Some college or more	.	.	.
Age		0.02	-0.23, 0.26	0.889
Sex	Male	-2.52	-7.51, 2.46	0.321
	Female	.	.	.
Race	BIPOC	-2.00	-7.34, 3.34	0.463
	White	.	.	.
Ethnicity	Hispanic	-15.8	-22.1, -9.62	< 0.001
	Non-Hispanic	.	.	.
Sexual Orientation	LGB+	-6.85	-12.4, -1.26	0.016
	Heterosexual	.	.	.
Marital Status	Married or domestic partnership	-4.05	-9.43, 1.33	0.139
	Divorced, separated, or widowed	9.19	-4.52, 22.9	0.188
	Single, never married	.	.	.

Table 4. Association between attaining a high school education or less and future planning

Variable		OR	95% CI	p
Education	High school or less	0.51	0.28, 0.95	0.034
	Some college or more	.	.	.
Age		1.01	0.99, 1.04	0.198
Sex	Male	1.10	0.73, 1.65	0.657
	Female	.	.	.
Race	BIPOC	0.69	0.45, 1.06	0.092
	White	.	.	.
Ethnicity	Hispanic	0.93	0.56, 1.53	0.768
	Non-Hispanic	.	.	.
Sexual Orientation	LGB+	1.07	0.67, 1.70	0.778
	Heterosexual	.	.	.
Marital Status	Married or domestic partnership	1.49	0.97, 2.82	0.067
	Divorced, separated, or widowed	1.36	0.41, 4.48	0.611
	Single, never married	.	.	.

Table 5. Effect of education on delay discounting and future planning stratified by positive health attribute*

Health Attribute	B/OR**	95% CI	p
Delay Discounting			
Current employment	13.7	4.77, 22.7	0.003
High social support	7.60	-2.45, 17.6	0.138
High health literacy	18.4	6.03, 30.7	0.004
Lifetime non-smokers	15.3	3.03, 27.5	0.015
Future Planning			
Current employment	0.56	0.29, 1.07	0.080
High social support	0.40	0.19, 0.81	0.011
High health literacy	0.53	0.20, 1.40	0.201
Lifetime non-smokers	0.40	0.17, 0.90	0.027

*Models adjusted for age, sex, race, ethnicity, sexual orientation, and marital status; **Regression coefficients are reported for the delay discounting models. Odds ratios are reported for the future planning models

future planning only occurred between participants with a high school education or less and those with a Bachelor's degree.

In order for delay discounting or future planning to be considered a potential mediator worth future research in the relationship between education and mortality, plausible explanations are needed for why education may decrease delay discounting and increase future planning, and why these constructs may be associated with mortality. Regarding the former, learned and innate mechanisms have been proposed. Learned mechanisms suppose that greater education causes increased activation of the pre-frontal cortex in the brain, which is the area responsible for planning and decision making.^{22,36,37} In the absence of extended education, pre-frontal cortex activity is diminished and decision making is more likely to originate in the limbic and para-limbic regions of the brain, which prioritize immediate rewards and reinforcers. Innate mechanisms suggest that persons with higher intrinsic intelligence are less likely to discount future events and more likely to plan for the future, as intelligence has been previously associated with both constructs.³⁸ In this explanation, the relationship between education and delay discounting is simply a consequence of the correlation between higher intelligence and educational success.³⁹

Plausible pathways between delay discounting, future planning, and mortality are also required. Here, research suggests that greater delay discounting and lower future orientation are associated with numerous negative health behaviors that increase mortality risk. Notably, tobacco smoking and greater body mass have been associated with greater delay discounting,^{40,41} and a meta-analysis concluded that delay discounting is significantly associated with suicide risk.⁴² Further, greater delay discounting and a lower likelihood of future planning has been previously linked to greater risk taking, increased impulsivity and a lack of

self-control^{43,44} which, in turn, have been linked to numerous adverse health behaviors, such as alcohol, cannabis, cocaine, MDMA, methamphetamine, opioid and tobacco use.⁴⁵ Finally, greater delay discounting and lower future planning have been associated with lower financial resources,⁴⁶ and income may have a nearly linear relationship with life expectancy.⁴⁷

Implications and Next Steps

Several steps may be taken in response to the current findings. First, longitudinal research is required to more conclusively determine if the education-mortality pathway is mediated by delay discounting or future planning. This is difficult as longitudinal studies with mortality as the primary outcome may require an excessively long time frame, and data sources often linked with mortality, such as death certificates or medical records, are unlikely to contain measures of delay discounting or future planning. An alternative is to calculate objective probabilities of survival, based on current health behaviors, current and past disease diagnoses and past family disease history, or determine perceived survival probabilities as others have done.¹⁸

Second, current education initiatives monitored by the Healthy People 2030 program and advocated by President Biden may need enhancement to appreciably influence health and mortality through the proposed delay discounting/future planning pathway. Indeed, significant results only occurred after comparing participants with a high school degree or less against those with a Bachelor's degree. The differences were not significant when compared against participants with an Associate's degree, suggesting that the Healthy People 2030 program should monitor college completion, in addition to college enrollment, and government programs should focus on ensuring students have the means to complete a full four-year Bachelor's degree.

Third, and alternatively, community or school-based interventions that directly decrease delay discounting and improve future planning can be implemented. A systematic review of 92 articles concluded that several successful interventions are available.⁴⁸ Learning-based approaches, which include techniques like reward bundling, where a single choice determines a bundle of next outcomes, modeling interventions based on social learning theory and direct instruction-based procedures, were considered the most reliable interventions.

Limitations

There are several limitations to the study. The study is cross-sectional, and true casual or mediated pathways cannot be determined. The effect on mortality was also not directly tested, and it is assumed, based on prior research, that variables associated with education may be potential mediators of education's impact on mortality. The study also used an online convenience sample, and there are known differences between online samples and samples recruited via other means.⁴⁹ For this reason, the sample may not be representative of all U.S. adults. The study also did not purposefully sample those with a high school education or less. This led to lower numbers of participants in that education group and may have limited study power.

Conclusions

Educational attainment was significantly associated with delay discounting and future planning, where individuals with a high school education or less had greater delay discounting and lower odds of future planning. The relationships remained even after restricting the analysis to several positive health attributes, suggesting that education is directly associated with delay discounting and future planning rather than an indirect association via a separate measured variable. Consequently, high delay

discounting and low future planning may explain, in part, the inverse relationship between education and mortality risk reported elsewhere. Programs encouraging students to complete an undergraduate education and programs that directly decrease delay discounting or increase future planning are needed.

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Conflicts of Interest

The author has no conflicts of interest.

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