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Locus of control, health and healthcare utilization

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ABSTRACT

In this paper we analyze the importance of individuals' locus of control for their health and healthcare use. We estimate the direct effects of locus of control. We also examine whether the effects of locus of control on health and healthcare use are explained by lifestyle choices and social capital. Our analysis reveals that individuals with an internal locus of control have better self-assessed health as well as physical and mental health. They rely less on medical care, both preventive and curative. Locus of control predicts health through different pathways, including social capital and health behaviors related to smoking, drinking and physical activity. Similar pathways can explain the link between locus of control and curative care but not necessarily preventive care. Interventions considering not only the direct but also the indirect effects of locus of control are promising avenues for promoting better health.

1. Introduction

Economists and other social scientists are becoming increasingly interested in the study of people's non-cognitive skills. Non-cognitive skills are often viewed as a form of productive human capital that can be influenced through purposeful investments in education, parental involvement as well as policy interventions (Cobb-Clark and Schurer, 2013; Boyce et al., 2013). Almlund et al. (2011), for example, develop an economic model that accommodates the role of non-cognitive characteristics in driving a battery of economic and social outcomes. They show that certain non-cognitive skills, such as the Big Five (agreeableness, conscientiousness, extraversion, neuroticism and openness to experiences), are powerful predictors of social and economic success and appear to be as important, if not more important, than cognition.

In this paper, we focus our attention on one specific non-cognitive skill, namely locus of control, and evaluate its links with health and healthcare use. Locus of control is a psychological concept capturing "whether or not the person perceives a causal relationship between his own behavior and the reward" (Rotter, 1966, p. 1). A distinction is often made between individuals with an internal versus external locus of control. Those with an *internal* locus of control believe that life's outcomes and the events they encounter are consequences of their own actions. In contrast, those with an *external* locus of control believe that life's outcomes are largely influenced by external factors such as fate, luck or other people (see e.g. Heckman et al., 2006; Cobb-Clark and Schurer, 2013; Schultz and Schultz, 2016).

Despite a growing body of literature on the link between locus of control and health outcomes, there is surprisingly little evidence on how locus of control relates to healthcare use. At the same time, little is known about whether certain health behaviors and lifestyles are pathways through which locus of control affects health and healthcare use. The current paper addresses this question by drawing longitudinal data from the Household Income and Labour Dynamics of Australia (HILDA) survey. The HILDA data are ideal for our purpose as they contain measures of locus of control, health, healthcare use and other personality characteristics for a large, nationally representative sample. The data also provide information on key health behaviors – smoking, drinking and physical activity – as well as social interaction and time allocation to various activities, thus allowing us to gain important insights in to the possible pathways linking an individual's perceptions of control to his/her health and healthcare use.

We are particularly interested in the following questions: Do individuals with a more internal locus of control have better self-assessed health as well as physical and mental health? Do they rely less on healthcare? What are the various possible pathways that could help explain the relationship between locus of control and health as well as

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healthcare use? Providing an answer to these questions is an important step in developing an understanding not only of whether locus of control matters, but why it matters.

A growing body of literature examines the relationship between health-related locus of control and health behaviors. Steptoe and Wardle (2001) provide an extensive review. Their review suggests that health-related locus of control plays, in fact, only a moderate role in explaining health behaviors. This may be because most studies look at correlations between health-related locus of control scores and health behaviors, making it difficult to assess any causal implications. Furthermore, most studies rely on small, non-representative samples, which tend to limit statistical power in the analysis.

A number of studies in psychology examine the link between locus of control and health outcomes. They find that locus of control is positively correlated with various health outcomes. Men and women with a strong sense of control have a reduced risk of obesity (Gale et al., 2008). They also report higher satisfaction with their own health (Mackenbach et al., 2002; Gale et al., 2008), and may face a lower risk of myocardial infarction (Stürmer et al., 2006). In addition, those with internal control tendencies are less prone to experiencing psychological distress and depression (Leung et al., 2000; Gale et al., 2008; Arraras et al., 2002).

While these previous studies contribute meaningfully to our understanding of the link between locus of control and health, they are often based on small samples of individuals with certain health conditions (e.g. cancer versus non-cancer patients, post-myocardial infarction patients) or those residing in specific locations. In addition, the previous studies do not formally analyze what drives the link between locus of control and health. Hence, they provide no guidance on the underlying mechanisms. Understanding such mechanisms is a novel contribution, and could have important implications for the design of health policies.

As well as being significant for the health psychology literature, our paper makes an important contribution to the economic literature. To the best of our knowledge, there are only two other economic analyses linking non-cognitive abilities (in particular, self-efficacy, future orientation and locus of control) with health habits. Using data from the US Panel Study of Income Dynamics, Chiteji (2010) shows that self-efficacy and future orientation are negatively associated with alcohol consumption and positively associated with the decision to exercise. However, in contrast to our study, Chiteji (2010) did not consider the link between locus of control and health, and the empirical implications of her model were not tested against alternative explanations.

Cobb-Clark et al. (2014) analyzed data from HILDA and found that men with an internal locus of control eat healthily and exercise more regularly. Men expect higher returns on their investments while women derive greater satisfaction from healthy habits. Cobb-Clark et al.'s (2014) findings shed light on the relationship between locus of control and health, but healthcare use is not a focus of their work. To fill this research void, we have considered three separate measures of healthcare use: two measures reflecting curative care and one capturing preventive care. Looking at both preventive and curative care is important as people who seek preventive care, such as health screening or vaccinations, do not necessarily have poor health but may instead be simply health conscious. We have also tested whether two forms of human capital investments – social capital and lifestyles – can explain how locus of control relates to health and healthcare use.

Our analysis reveals that locus of control is significantly related to health and healthcare use. Men and women with an internal locus of control have better self-assessed health, physical and mental health. They rely less on medical care, both preventive and curative. Maintaining healthy habits and the extent of social capital are possible reasons why those with an internal locus of control enjoy better health. Similar pathways can explain the link between locus of control and curative care but not necessarily preventive care. These results provide new insights into the benefits of locus of control and the importance of non-cognitive skills for people's lives in general.

2. Conceptual framework

We consider a simple conceptual framework of health production. According to Grossman (1972), health is part of human capital and can be increased by adopting specific health behaviors. The health stock, measured in terms of healthy time, provides both consumption benefits and greater earnings potential. That is, healthy time can be allocated to leisure activities, which has a positive impact on an individual's utility. But healthy time can also be used for work in the labor market, thereby increasing one's earnings. Grossman's (1972) model stimulated a large literature and several papers provided developments since then that shed light on how various factors, including socioeconomic status, education, social capital and discount rates, increase the stock of health capital (Bolin et al., 2003; Becker, 2007; Galama and Van Kippersluis, 2018).

We have adapted this framework by linking individuals' locus of control with their health and healthcare use. Emerging literature in economics links control beliefs with economic decision-making. Locus of control affects an individual's subjective beliefs about the probability that specific outcomes will occur, leading to personal and economic success in terms of educational attainment, employment, occupational choice and health behaviors (Coleman and DeLeire, 2003; Flouri, 2006; Heckman et al., 2006).

We hypothesize various pathways in order to explain how locus of control relates to health and healthcare use. We draw upon evidence from the economic literature highlighting the importance of two forms of human capital investments: lifestyle choices and social capital. Both factors are worth investigating because they are critical inputs in health production and relevant to health policies (Ohrnberger et al., 2017a; Kesavayuth et al., 2018a). Lifestyle choices are among the leading factors contributing to the burden of disease (WHO, 2009). Social capital, including social networks and social support, is conducive to better health (Smith and Christakis, 2008; Dour et al., 2014). Moreover, previous studies have shown that lifestyle choices and social capital are associated with perceptions of control (Cobb-Clark et al., 2014; Buddelmeyer and Powdthavee, 2016).

Thus, in our conceptual framework, individuals invest in social capital and adopt specific behaviors in order to increase their stock of health capital. Those with a more internal locus of control may invest more because their expected returns are higher. We have drawn sixteen waves of panel data from HILDA to estimate a reduced form equation linking locus of control with health and healthcare use. As well as being significant from an empirical point of view, our analysis would also be useful for aiding the design of interventions that promote people's health.

3. Data

Our data come from waves 2–17 of the Household Income and Labour Dynamics of Australia (HILDA) survey and span the years 2002–2017.[1] HILDA collects nationally representative, longitudinal information through both face-to-face interviews and self-completion questionnaires. The sample selected for the HILDA survey is intended to represent all Australian private dwelling residents sampled by a multi-staged approach. The sampling unit is the household, and household members are tracked over an indefinite period. The sample in wave 1 was automatically extended by adding (i) any new born or adopted children by members of the household and (ii) new members resulting from change in the composition of the original households. While all members of the selected households are defined as members of the sample, individual

[1] Data on locus of control are collected in waves 3, 4, 7, 11 and 15, while data on the number of doctor visits are collected in waves 9, 13 and 17; data on whether the respondent had been hospitalized are drawn from waves 4, 9, 13 and 17, and data on health check-ups come from waves 9, 13 and 17. We were not able to utilize the first wave of the HILDA survey as information on negative life events, one of our key variables, was collected from wave 2 onwards.

Table 1
The relationship between health measures.

	Good self-reported health	Good physical health	Good mental health	Long-term health condition	Hospitalized	More doctor visits	Health check-ups
Good self-reported health	100						
Good physical health	75.10	100					
Good mental health	71.20	80.30	100				
Long-term health condition	15.84	9.46	14.05	100			
Hospitalized	9.33	7.60	8.69	19.78	100		
More doctor visits	33.91	27.93	30.17	64.12	69.25	100	
Health check-ups	69.11	65.59	68.47	85.86	92.23	89.97	100

Note: The proportion of observations is reported using the *tab2* command in Stata. Good self-reported health is defined for respondents' answers in the categories of "good", "very good" and "excellent". Good physical health, good mental health and more doctor visits correspond to values above the sample mean.

interviews are only conducted with those aged 15 years and over.

The survey started in 2001 with participation of almost 14,000 individuals from 7,682 households. During the period 2001–2010, the fieldwork started in late July or August each year, and about 80% of the sample was collected in September and October. From 2011 onward, 80% of sample was collected in August and September. At present, with data released for wave 17 (2017) of the survey, HILDA follows more than 17,000 Australians each year. Watson and Wooden (2012) provide detailed information on the HILDA survey.

3.1. Estimation sample

We focus our attention on respondents aged 15–75 over our sample period. After excluding observations with missing answers to the questions required for our analysis, the final sample corresponded to an unbalanced panel of 16,284 individuals (8,171 males, 8,113 females), and 140,646 observations (71,345 males, 69,301 females).

3.2. Health measures

Health is captured by four separate measures: a single question on self-assessed health, a question on whether the respondent had any long-term health conditions, and multiple questions about physical and mental health. The question on self-assessed health asks: "In general, would you say your health is?" Answers are reported on a 5-point scale that ranges from 1 (excellent) to 5 (poor). We reversed the scale of possible responses so that higher values indicate better health. The self-assessed health measure is widely used in the literature and has been shown to be a good predictor of objective health outcomes including morbidity and mortality (e.g. Miilunpalo et al., 1997; Schnittker and Bacak, 2014).

We have also used the 36-item Short Form Survey (SF-36) to construct two separate measures – one for physical and one for mental health. Of the 36 items, 21 fall in the category of physical health and 14 are in the category of mental health.[2] Physical health is measured along 4 dimensions (physical functioning, role-physical, body pain and general health), and each dimension is provided in standardized form on a 0–100 scale with higher values representing better health. There are also 4 dimensions to mental health (social functioning, role emotional, mental health and vitality) with scores being again bounded between 0 and 100. We generate a summary measure for physical health by computing the average of the 4 physical health dimensions for each observation (e.g. Zhu, 2016). Similarly, we average the scores of the 4 mental health dimensions for each observation to construct a measure of mental health. The SF-36 measure is frequently used in the literature and is considered a good proxy for a person's health status (e.g. Brazier et al., 1992; Hemingway et al., 1997; Zhu, 2016).

[2] Appendix presents the exact wording of the SF-36 items.

We have also taken advantage of HILDA data on long-term health conditions. Individuals were asked "Do you have any long-term health condition, impairment or disability that restricts you in your everyday activities, and has lasted or is likely to last, for 6 months or more?" We constructed a binary indicator that takes the value 1 if the respondent stated that he/she had any long-term health condition, impairment or disability which restricted his/her everyday activities and has lasted or is likely to last for 6 months or more.

3.3. Healthcare use

Healthcare use is captured by three separate measures: two measures reflecting curative care and one capturing preventive care. Our first measure of curative care concerns the numbers of doctor visits in the past 12 months (i.e. outpatient care). The wording of the question is as follows: "Approximately how many times have you seen your family doctor or another general practitioner (GP) in the last 12 months?" Respondents were also asked whether, during the last 12 months, they had ever been a patient in a hospital overnight (i.e. inpatient care). Our second measure of curative care is thus a dummy variable that is equal to 1 if the respondent had been hospitalized in the last 12 months, and 0 otherwise. Information on preventive care comes from responses to the question: "Have you had any of the health check-ups and tests during the past 12 months?" We constructed a binary indicator that takes the value 1 if the respondent had at least one health check-up or test in the last 12 months, and 0 otherwise.

3.4. Consistency between health measures

Table 1 sheds some light on whether our health measures provide consistent outcomes. Looking across the columns of Table 1, we can see that people who reported themselves in good overall health were also likely to have good physical and mental health. That is, 75% of the observations in good self-assessed health appeared to have good physical health, and 71% of those were in good mental health. Likewise, 80% of the observations in good physical health had good mental health as well, and only 9% of those had a long-term health condition. In addition, the proportion of observations with a large number of doctor visits (i.e. above the sample mean) is twice as high among those who had a long-term health condition or were hospitalized compared to those who were in good self-reported health, good physical or mental health. Thus, there is evidence to suggest that our health measures provide largely consistent outcomes.

3.5. The locus-of-control measure

We define locus of control using the answers to seven questions. The questions are: (1) I have little control over the things that happen to me; (2) There is really no way I can solve some of the problems I have; (3) There is little I can do to change many of the important things in my life;

(4) I often feel helpless in dealing with the problems of life; (5) Sometimes I feel that I'm being pushed around in life; (6) What happens to me in the future mostly depends on me; and (7) I can do just about anything I really set my mind to do. Possible answers are on a 7-point scale that ranges from 1 (strongly disagree) to 7 (strongly agree).

Cronbach's alpha is 0.84 and suggests that the different locus-of-control questions are sufficiently closely related. This allows us to calculate a single index for locus of control by reversing the scores of questions 1 through 5 and adding the scores of questions 6 and 7. The total score thus ranges from 7 to 49 with higher values indicating a higher (more internal) locus of control. A similar index has been used in many other studies in the literature (see e.g. Semykina and Linz, 2007; Caliendo et al., 2015; Buddelmeyer and Powdthavee, 2016; Kesavayuth et al., 2018b).

3.6. Control variables

Previous studies suggest that socioeconomic factors are important determinants of health. Greater education has a positive association with health because it enables individuals to produce their health more efficiently (Grossman and Kaestner, 1997; Hahn and Truman, 2015). Married individuals are healthier, on average, and live longer than those who are single, divorced, separated or widowed (Robards et al., 2012). Employment has been found to have a protective effect on mental health (Noordt et al., 2014). By contrast, unemployment is associated with poorer health, most likely because ill individuals select themselves into unemployment (Bambra and Eikemo, 2009; Böckerman and Ilmakunnas, 2009). Income has a positive association with health (Doorslaer and Koolman, 2004). And those who are more future-oriented tend to invest more in their health (Becker, 2007). Increased family size has been found to have a positive effect on mental health but little effect on physical health (Ohrnberger et al., 2017a, b).

Moreover, personality traits such as the Big Five (agreeableness, conscientiousness, extraversion, emotional stability and openness) contribute in determining health outcomes (Friedman, 2000; Kesavayuth et al., 2015). Including them in our model would help to isolate the effects of locus of control on health (Almlund et al., 2011; Cobb-Clark et al., 2014). Finally, in line with previous studies, our health regression models control for age, gender, Australian states of residence and territories, and survey waves (Contoyannis et al., 2004; Hauck and Rice, 2004; Zhu, 2016; Ohrnberger et al., 2017b).

Because the health and healthcare use measures provide consistent outcomes, we have employed the same set of control variables for our healthcare use models as well. The choice of covariates is consistent with the literature on healthcare use (see e.g. Eibich, 2015; Zhang et al., 2018; Nolan et al., 2019). Details and summary statistics for all variables are provided in Table 2.

4. Empirical approach

Let H_{it} be a particular health or healthcare use measure of individual i at time t. Our empirical model is specified as follows:

$$H_{it} = a_0 + a_1 LC_{it} + a_2 X_{it} + a_3 T_t + u_i + \varepsilon_{it} \quad (1)$$

where LC_{it} represents locus of control, X_{it} is a vector of time-varying predictor variables including regional fixed effects, T_t is year fixed effects, u_i is the person-specific error and ε_{it} is the idiosyncratic error.

As usual, we assume that the two error terms u_i and ε_{it} are uncorrelated with the explanatory variables included in the model. However, this assumption is likely to be violated, especially with respect to the person-specific error u_i. There may be unobserved individual characteristics, such as discount rates and family background, that correlate simultaneously with a person's locus of control and his/her health. Thus, to estimate equation (1) we need to deal appropriately with time-invariant unobserved heterogeneity at the individual level.

The use of (i) fixed effects and (ii) random effects models allow us to deal with unobserved heterogeneity in the context of longitudinal data. We choose the second approach for two main reasons. First, random effects estimation is largely preferred in the literature when analyzing the effects of locus of control. Cobb-Clark and Schurer (2013) showed that any changes in locus of control over time are small, on average, and are largely unrelated to demographic, labor market and health events. The lack of sufficient *within* person variation makes the use of fixed effects estimation problematic.[3] In addition, using a random effects model has the advantage that the effects of important explanatory variables, which are either time-invariant or may not have repeated measurements available, are estimated.

We approach the estimation as follows. First, we constructed a cleaner locus-of-control measure by trimming the locus-of-control data at the 99th percentile,[4] and by removing observations with a significant number of negative life events.[5] Second, we followed Buddelmeyer and Powdthavee (2016) who recommend regressing LC_{it} on the socioeconomic and demographic variables that were also included in equation (1):

$$LC_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 T_t + v_i + e_{it} \quad (2)$$

where t refers to waves 3, 4, 7, 11 and 15 for which locus of control measures are available, and X_{it} is the same vector of control variables as in equation (1). We estimate equation (2) using the fixed effects estimator, and obtain the individual fixed effects, $\widehat{v}_i$. By construction, these fixed effects – or time-invariant locus of control – are *orthogonal* to changes in the various socioeconomic and demographic characteristics. Fig. 1 presents a simple plot of our adjusted locus-of-control measure against its pooled raw data counterpart.

Table 3 shows that locus of control is associated with age, income and higher education. Furthermore, individuals who score higher in their perceived locus-of-control scale live in smaller households and are more likely to be employed (as opposed to unemployed or out of the labor force), and married.[6] The estimated coefficient on being separated is relatively large: individuals who have been separated may feel less able to cope with the negative effects of separation. Thus they may perceive themselves as having less control over life's outcomes.

Equation (1) can then be written out as:

$$H_{it} = a_0 + a_1 \widehat{v}_i + a_2 X_{it} + a_3 T_t + u_i + \varepsilon_{it} \quad (3)$$

where $\widehat{v}_i$ is person-specific, time-invariant locus of control. For the reasons outlined earlier, equation (3) is estimated using a linear random effects model with robust standard errors clustered at the individual level (Cameron and Miller, 2015). We also included the person-specific means of the time-varying predictors as additional control variables in order to proxy the fixed effects (e.g. Mundlak, 1978; Chamberlain, 1982; Böckerman and Ilmakunnas, 2009; Cobb-Clark et al., 2014). For ease of interpretation, we standardized our continuous health measures (self-assessed health, physical and mental health, and the number of doctor visits) as well as the locus-of-control index so that the mean is 0 and

[3] Nikolaev (2018) provides an excellent discussion highlighting the advantages of a random effects model in estimating the effects of variables that do not vary substantially.

[4] Qualitatively similar results are obtained if we trim the sample at the 95th percentile or alternatively 'Winsorize' the locus-of-control data at the 99th or 95th percentile. These results are available upon request.

[5] Cobb-Clark and Schurer (2013) demonstrated that in the HILDA data some women became significantly more external after experiencing 12 or more negative life events. We removed 12,298 observations based on the same 12 negative life events.

[6] The Big Five personality measures were based on the average scores of four waves (5, 9, 13 and 17), allowing us to cover our sample period. Since these measures are time invariant, they naturally drop out from the fixed effects estimation.

Table 2
Descriptive statistics.

Variable	Description	Observations	Mean	S.D.
Self-reported health	0-5 scale; with 0 = poor health and 5 = excellent health	140,646	3.48	0.93
Physical health (SF-36)	0-100 scale; average score of 4 physical health dimensions	140,646	78.89	19.47
Mental health (SF-36)	0-100 scale; average score of 4 mental health dimensions	140,646	76.68	18.32
Long-term health condition	1 if the respondent has any long-term health condition, impairment or disability; 0 otherwise	140,646	0.22	0.42
Hospitalized	1 if the respondent has ever been a patient in a hospital overnight in the past year; 0 otherwise	35,965	0.11	0.32
Doctor visits	Number of doctor visits in the last 12 months	28,677	4.14	5.14
Health check-ups	1 if the respondent had any health check-ups or tests in the last 12 months; 0 otherwise	28,677	0.71	0.45
Locus of control	7-49 scale; total score of 7 questions (1–7 scale, with 1 = strongly disagree and 7 = strongly agree)	42,838	38.50	7.43
Age	Age of the respondent	140,646	42.29	16.25
Male	1 if male, 0 if female	140,646	0.51	0.50
Household size	Number of household members	140,646	2.97	1.46
Real household income	Logarithm of yearly real household income in AUD with 2012 as the base year	140,646	11.23	0.72
College and above	1 if the respondent has higher education (college and above); 0 otherwise	140,646	0.57	0.50
Time preference	1 if future oriented; 0 otherwise	140,646	0.07	0.26
Marital status				
Legally married	1 if legally married; 0 otherwise	140,646	0.52	0.50
Living as a couple	1 if living as a couple; 0 otherwise	140,646	0.15	0.35
Separated	1 if separated; 0 otherwise	140,646	0.03	0.16
Divorced	1 if divorced; 0 otherwise	140,646	0.06	0.23
Widowed	1 if widowed; 0 otherwise	140,646	0.02	0.14
Never married and not living as a couple	1 if never married and not living as a couple; 0 otherwise	140,646	0.24	0.43
Employment status				
Employed	1 if employed; 0 otherwise	140,646	0.70	0.46
Unemployed	1 if unemployed; 0 otherwise	140,646	0.03	0.18
Not in the labor force	1 if out of the labor force; 0 otherwise	140,646	0.27	0.44
Big Five personality traits				
Extraversion	1-7 scale; average score of 6 questions (1–7 scale, with 1 = does not apply and 7 = applies perfectly)	36,933	4.42	1.08
Agreeableness	1-7 scale; average score of 4 questions (1–7 scale, with 1 = does not apply and 7 = applies perfectly)	36,933	5.38	0.91
Conscientiousness	1-7 scale; average score of 6 questions (1–7 scale, with 1 = does not apply and 7 = applies perfectly)	36,933	5.10	1.02
Emotional stability	1-7 scale; average score of 6 questions (1–7 scale, with 1 = does not apply and 7 = applies perfectly)	36,933	5.17	1.07
Openness	1-7 scale; average score of 6 questions (1–7 scale, with 1 = does not apply and 7 = applies perfectly)	36,933	4.25	1.05
Health behaviors				
Smoking frequency	0-3 scale; with 0 = no smoking and 3 = smoke daily	140,646	0.51	1.10
Drinking frequency	0-6 scale; with 0 = no drinking and 6 = drink daily	140,646	2.44	1.80
Physical activity frequency	0-5 scale; with 0 = not at all and 5 = everyday	140,646	2.64	1.51
Social contacts	0-6 scale; with 0 = less often than once every 3 months and 6 = everyday	140,646	3.52	1.45
Time use				
Outdoor tasks	Number of hours per week spent in outdoor tasks	140,646	3.86	5.61
Volunteer/Charity work	Number of hours per week spent in volunteer/charity work	140,646	0.94	2.86

standard deviation is 1.

We also confirmed that qualitatively similar conclusions can be obtained with non-linear models: a random effects probit model for the binary outcome variables on having a long-term health condition, having been hospitalized in the past year, and having had a health check-up in the past year, as well as a random effects ordered probit model for the ordinal outcome variable on self-assessed health.[7]

5. Results

Do individuals with an internal locus of control have better health than their external counterparts? Looking across the columns of Table 4, we can see that standardized locus of control, in which a positive deviation from the mean reflects a relatively more internal locus of control, is associated with better health outcomes. This implies that individuals with an internal locus of control report higher satisfaction with their own health, consistent with previous findings in the literature (e.g. Mackenbach et al., 2002; Gale et al., 2008). They also have higher levels of physical and mental health. And they are less likely to suffer from a long-term health condition. A standard deviation increase in internal sense of control is associated with an approximately 0.21 standard deviation increase in self-reported health and a 0.25 standard deviation increase in physical health. It is also associated with a 0.32 standard deviation increase in mental health and a 5.7 percentage point decrease in the likelihood of having a long-term health condition. The estimated coefficient on locus of control is statistically significant in all regression models at p-values < 0.01.

Up until now the analysis has focused on various health measures as

[7] These estimates are presented in section 6.4.

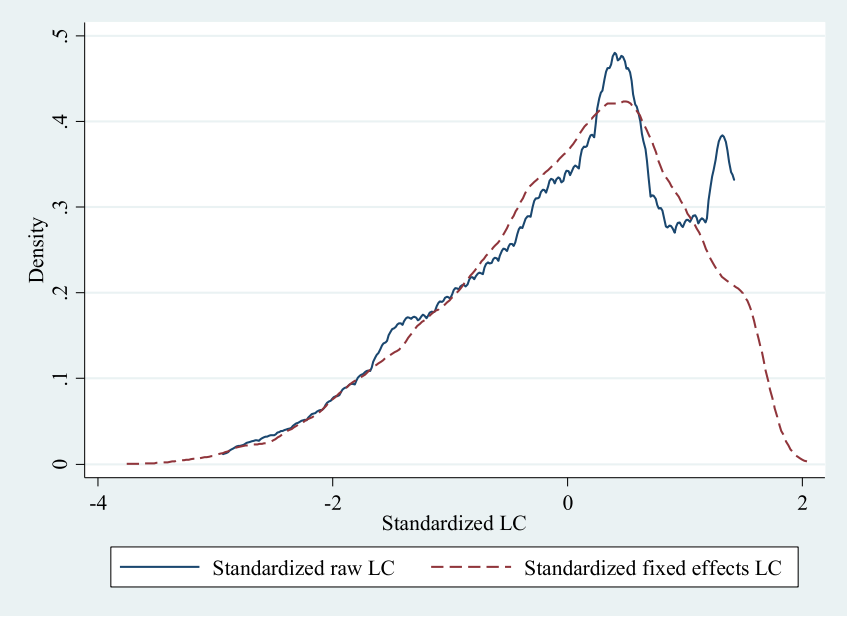

Fig. 1. A Kernel plot of standardized locus-of-control distributions.

the outcome variables of interest. To gain a deeper understanding of how perceptions of control relate to health, it would also be useful to consider measures of healthcare use. We do this in Table 5, which presents results for both curative care (outpatient and inpatient care) and preventive care (health check-ups). We find that those with an internal locus of control rely less on medical care. A standard deviation increase in internal sense of control is associated with an approximately 1 percentage point decrease in the probability of having been hospitalized or having had a health check-up as well as a 0.12 standard deviation decrease in the number of doctor visits. The coefficient estimates are highly significant at p-values < 0.01.

Table 3
The determinants of locus of control.

	Locus of control
Age	−0.129***
	(0.0350)
Age squared/100	0.111***
	(0.0312)
Household size	−0.287***
	(0.0425)
Real household income	0.218***
	(0.0756)
College and above	0.607***
	(0.1880)
Unemployed	−0.598***
	(0.2290)
Not in the labor force	−0.244**
	(0.1220)
Living as a couple	−0.1650
	(0.1650)
Separated	−1.701***
	(0.3260)
Divorced	−0.878***
	(0.3190)
Widowed	−0.5180
	(0.5360)
Never married and not living as a couple	−0.407*
	(0.2150)
N individuals	16,284
N observations	42,838

Note: *p < 0.1 **p < 0.05 ***p < 0.01. Control variables include Australian states of residence and territories, and waves. Robust standard errors are in parentheses.

Taken together, the results tell a consistent story: individuals with an internal locus of control are healthier than those with an external locus of control and rely less on healthcare, both preventive and curative.[8]

To shed some light on the magnitudes of these relationships take, for example, the average person in control beliefs and the person who is one standard deviation above the average. Table 4 suggests that the difference between these two groups of individuals is 0.25 standard deviations for physical health and 0.32 standard deviations for mental health. All things being equal, these estimates are about 1.8 and 2.4 times the effect of being out of the labor force versus being employed. Similar comparisons can be made with respect to our healthcare use measures.

Previous research suggests that the effects of locus of control may differ across gender (e.g. Sherman et al., 1997; Semykina and Linz, 2007; Cobb-Clark et al., 2014; Buddelmeyer and Powdthavee, 2016).[9] To examine whether gender differences matter in the link between locus of control and health as well as healthcare use, Table 6 provides separate estimates for men and women. We can see that both men and women with an internal locus of control have better health than their external counterparts. In addition, they are less likely to have been hospitalized, to have visited the doctor and to have had a health check-up.

The coefficient estimates for women are slightly larger than for men, except for health check-ups. To examine whether such differences are important in a statistical sense, we conducted a two-sample z-test. The z-test statistic indicated that in five out of seven cases men and women did not differ systematically. Exceptions were mental health and the number of doctor visits: locus of control had a larger positive impact on women rather than on men. Overall, these findings suggest that the equations relating locus of control, health and healthcare use seem to have a very similar structure between gender subgroups.

[8] Tables A1–A3 of the Appendix show that the results reported so far remain robust in the following cases: (i) accounting for the presence of attrition bias; (ii) using an alternative locus-of-control measure; and (iii) controlling for private health insurance.

[9] Previous studies suggest that men tend to be more internalized in their locus of control compared to women, but both genders are developing more external control tendencies over time (see e.g. Sherman et al., 1997, for a review of the literature).

Table 4
Locus of control and health.

	Self-reported health	Physical health	Mental health	Long-term health condition
Locus of control	0.214***	0.251***	0.325***	−0.0570***
	(0.0062)	(0.0065)	(0.0059)	(0.0025)
Male	−0.0438***	−0.0325***	0.100***	0.0433***
	(0.0118)	(0.0115)	(0.0104)	(0.0046)
Age	−0.0154***	0.0106***	−0.0117***	−0.00412***
	(0.0031)	(0.0030)	(0.0032)	(0.0013)
Age squared/100	−0.00728***	−0.0309***	0.0111***	0.0112***
	(0.0025)	(0.0026)	(0.0027)	(0.0012)
Household size	−0.00907***	0.0021	−0.0026	−0.0019
	(0.0031)	(0.0028)	(0.0032)	(0.0013)
Real household income	0.0159***	0.0105**	0.0253***	−0.0030
	(0.0045)	(0.0044)	(0.0050)	(0.0022)
Agreeableness	0.0191***	−0.0048	−0.0016	0.0033
	(0.0063)	(0.0062)	(0.0057)	(0.0025)
Conscientiousness	0.0677***	0.0533***	0.0518***	−0.0119***
	(0.0063)	(0.0059)	(0.0056)	(0.0024)
Emotional stability	0.0906***	0.0763***	0.160***	−0.00852***
	(0.0065)	(0.0063)	(0.0058)	(0.0025)
Extraversion	0.0200***	−0.0229***	0.0328***	0.00454**
	(0.0059)	(0.0057)	(0.0052)	(0.0023)
Openness to experience	0.0302***	−0.0033	−0.0586***	0.00681***
	(0.0063)	(0.0061)	(0.0055)	(0.0025)
Time preference	0.103***	0.0510***	0.0378**	−0.0092
	(0.0198)	(0.0186)	(0.0168)	(0.0079)
College and above	0.0056	−0.0251**	−0.0173	0.0078
	(0.0138)	(0.0121)	(0.0146)	(0.0057)
Unemployed	0.0190	−0.0003	−0.0810***	0.0218***
	(0.0123)	(0.0118)	(0.0151)	(0.0059)
Not in the labor force	−0.0558***	−0.137***	−0.133***	0.0503***
	(0.0084)	(0.0092)	(0.0097)	(0.0040)
Living as a couple	0.0225*	0.0161	−0.0016	0.0062
	(0.0120)	(0.0115)	(0.0127)	(0.0054)
Separated	0.0139	0.0326	−0.201***	0.0118
	(0.0204)	(0.0209)	(0.0258)	(0.0104)
Divorced	0.0159	0.0234	−0.0633**	0.0165
	(0.0221)	(0.0236)	(0.0275)	(0.0107)
Widowed	0.0469	0.0253	−0.200***	−0.0090
	(0.0340)	(0.0394)	(0.0468)	(0.0205)
Never married and not living as a couple	0.0222	0.0357**	−0.0578***	0.0152**
	(0.0164)	(0.0143)	(0.0170)	(0.0069)
N individuals	16,284	16,284	16,284	16,284
N observations	140,646	140,646	140,646	140,646

Note: *p < 0.1 **p < 0.05 ***p < 0.01. Control variables include the individual-specific means of all time-varying variables, Australian states of residence and territories, and waves. Robust standard errors are in parentheses.

6. Pathways

Our findings indicate that the extent to which people feel in control of life's outcomes is significantly related to their health and healthcare use. In this section we explore alternative explanations for these relationships. We consider the possibility that our results are mediated by two forms of human capital investments: social capital and lifestyle choices.

6.1. *Do those with an internal locus of control invest more in social capital?*

Previous research suggests that having a larger stock of psychological resources is beneficial for people's health (see e.g. Diener et al., 2017, for a review of the literature). If that is the case, one hypothesis is that individuals with an internal locus of control invest more in social relationships with friends and relatives, and this in turn may improve their health. In other words, they may have better health because they invest more in social capital.

To test whether locus of control matters for investments in social capital, we utilize standardized responses to the question "In general, how often do you get together socially with friends or relatives not living with you?".[10] Answers are reported on a scale that ranges from 0 (less often than once every three months) to 6 (every day). The results, which are presented in Table 7, suggest that those with an internal locus of control see their friends or relatives more often (Buddelmeyer and Powdthavee, 2016). The estimated locus-of-control coefficients follow the same pattern for males and females, with the corresponding magnitudes being relatively larger for females. To test for the presence of gender differences, we conducted a two-sample z-test, finding that males and females did not differ systematically.

All in all, these results indicate that men and women with an internal locus of control may have better health than their external counterparts because they invest more in social capital.

[10] We continue using the same econometric methodology as in the previous sections, estimating a linear random effects model in which the person-specific means of the time-varying predictors are included as additional control variables in order to proxy the fixed effects (e.g. Mundlak, 1978; Chamberlain, 1982; Cobb-Clark et al., 2014).

Table 5
Locus of control and healthcare utilization.

	Hospitalized	Doctor visits	Health check-ups
Locus of control	−0.0103***	−0.124***	−0.0115***
	(0.0021)	(0.0086)	(0.0030)
Male	−0.0150***	−0.157***	−0.168***
	(0.0038)	(0.0148)	(0.0060)
Age	−0.0014	−0.0102	0.0141***
	(0.0018)	(0.0065)	(0.0029)
Age squared/100	0.00375**	0.0213***	−0.00637**
	(0.0017)	(0.0063)	(0.0026)
Household size	0.0022	−0.0214***	−0.0153***
	(0.0024)	(0.0071)	(0.0037)
Real household income	−0.0036	−0.0114	0.0155***
	(0.0042)	(0.0129)	(0.0055)
Agreeableness	0.00893***	0.0433***	0.0128***
	(0.0021)	(0.0085)	(0.0032)
Conscientiousness	−0.00358*	−0.0055	0.00804***
	(0.0020)	(0.0075)	(0.0031)
Emotional stability	−0.0105***	−0.0955***	−0.0306***
	(0.0022)	(0.0086)	(0.0033)
Extraversion	0.00998***	0.0514***	0.0127***
	(0.0018)	(0.0072)	(0.0029)
Openness to experience	−0.0112***	−0.0342***	−0.0030
	(0.0020)	(0.0079)	(0.0031)
Time preference	−0.0014	−0.0563**	0.0122
	(0.0066)	(0.0226)	(0.0100)
College and above	0.0226**	0.0968***	0.0295*
	(0.0092)	(0.0345)	(0.0163)
Unemployed	0.0223**	0.0534	0.0459***
	(0.0109)	(0.0408)	(0.0170)
Not in the labor force	0.0863***	0.136***	0.0329***
	(0.0074)	(0.0235)	(0.0091)
Living as a couple	−0.0521***	−0.0958***	−0.0126
	(0.0098)	(0.0315)	(0.0149)
Separated	−0.0225	−0.0228	−0.0072
	(0.0163)	(0.0566)	(0.0239)
Divorced	−0.0338**	−0.0653	−0.0379
	(0.0172)	(0.0612)	(0.0239)
Widowed	−0.0232	0.0159	−0.111***
	(0.0287)	(0.0735)	(0.0342)
Never married and not living as a couple	−0.0774***	−0.160***	−0.0471**
	(0.0118)	(0.0380)	(0.0191)
N individuals	15,884	14,592	14,592
N observations	35,965	28,677	28,677

Note: *p < 0.1 **p < 0.05 ***p < 0.01. Control variables include the individual-specific means of all time-varying variables, Australian states of residence and territories, and waves. Robust standard errors are in parentheses.

6.2. Do those with an internal locus of control invest more in healthy behaviors?

Cobb-Clark et al. (2014) showed that individuals with an internal locus of control are more likely to maintain healthy habits. Thus, one possibility is that individuals who feel more in control of life's outcomes enjoy better health simply because they invest more in healthy behaviors.

To test whether locus of control matters for health behaviors, Table 8 estimates separately by a gender a set of random effects regressions in which the dependent variables are standardized responses to questions about the frequency of three key health behaviors – smoking, drinking and physical activity. The frequency of smoking comes from asking the question: "Do you smoke cigarettes or any other tobacco products?" Possible answers include 0 (I have never smoked or I no longer smoke), 1 (I smoke less often than weekly), 2 (I smoke at least weekly but not daily), and 3 (I smoke daily). The frequency of drinking is taken from responses to the question "Do you drink alcohol?", with answers ranging from 0 (I have never drank alcohol or I no longer drink alcohol) to 6 (I drink alcohol every day). Respondents were also asked about physical activity, "In general, how often do you participate in moderate or intensive physical activity for at least 30 min?" Answers were reported on a scale from 0 to 5, where 0 indicates "not at all" and 5 indicates "every day".

We find that those with an internal locus of control smoke less frequently while drinking and exercising more frequently, consistent with Cobb-Clark et al. (2014). It is worth noting that the variable on drinking does not capture the amount of alcohol consumed. Thus increasing the frequency of alcohol consumption may not necessarily harm one's health if moderate amounts are consumed (see e.g. Ziebarth and Grabka, 2009). The estimates on locus of control follow the same pattern for males and females. A test of equal coefficients does not reject the null hypothesis that males and females are the same in how locus of control relates to heath behaviors.

Overall, these results suggest that men and women with an internal locus of control may enjoy better health because they invest more in healthy behaviors.

6.3. Do those with an internal locus of control pursue a more active lifestyle?

An alternative explanation is that individuals with internal perceptions of control have better health because – in addition to maintaining healthy habits (in relation to smoking, drinking and physical activity) – they are also more likely to pursue an active lifestyle.

To test this hypothesis, we analyze whether an individual's locus of control relates to his/her participation in outdoor tasks and volunteering/charity work. Both these outcome variables are derived from responses to a question that asks individuals to indicate how much time they allocate to outdoor tasks and volunteering/charity work in a typical week,[11] and are then standardized to mean 0 and standard deviation 1. The estimates, which are summarized in Table 9, suggest that men's, but not women's, locus of control is significantly related to the amount of time invested in outdoor tasks.[12] Interestingly, there is no relationship between locus of control and the amount of time allocated to volunteering and/or charity work.

Taken together, these results indicate that participation in outdoor activities might be a reason why those with an internal locus of control enjoy better health.

6.4. Testing for mediation effects

Our findings raise the possibility that the extent of social capital, healthy habits and outdoor activities may partly explain how locus of control relates to health and healthcare use. This can be investigated directly by conducting a mediation analysis in which the proposed mechanisms are included as additional regressors.

If the relationship between locus of control, health and healthcare use works through 'third' variables (so-called mediators), then we would expect that the estimated effect of locus of control decreases once these variables are controlled for in the regression models. In addition, the proposed mediators would remain significant. Appendix presents paths diagrams summarizing how mediation effects can be identified in our model (Baron and Kenny, 1986; MacKinnon et al., 2007).

Column 1 of Table 10 shows estimated locus-of-control coefficients when the possible mediators are not included in the regression models, while column 2 shows estimates on locus of control when the mediators

[11] Information on outdoor tasks, including home maintenance (repairs, improvements, painting, etc.), car maintenance or repairs and gardening, comes from asking the question: "How much time would you spend on each of the following activities in a typical week?" Based on the same question, information was drawn on volunteer/charity work (for example, canteen work at the local school, unpaid work for a community club or organization). Information on time allocation to outdoor tasks and volunteer/charity work is available in the HILDA survey from wave 2 onwards.

[12] A z-test of equal coefficients between males and females can be rejected in this case.

Table 6
Locus of control, health and healthcare utilization by gender.

Locus of control	Self-reported health	Physical health	Mental health	Long-term health condition	Hospitalized	Doctor visits	Health check-ups
Women	0.222***	0.263***	0.339***	−0.0591***	−0.0151***	−0.153***	−0.0103***
	(0.0086)	(0.0092)	(0.0084)	(0.0035)	(0.0031)	(0.0129)	(0.0040)
N individuals	8,113	8,113	8,113	8,113	7,912	7,267	7,267
N observations	69,301	69,301	69,301	69,301	17,772	14,236	14,236
Men	0.203***	0.236***	0.307***	−0.0536***	−0.00775***	−0.0986***	−0.0161***
	(0.0088)	(0.0089)	(0.0082)	(0.0034)	(0.0028)	(0.0110)	(0.0045)
N individuals	8,171	8,171	8,171	8,171	7,972	7,325	7,325
N observations	71,345	71,345	71,345	71,345	18,193	14,441	14,441

Note: ***p < 0.01. Control variables include age, age squared, household size, real household income, educational attainment, time preference, employment status, marital status, the Big Five personality traits, the individual-specific means of all time-varying variables, Australian states of residence and territories, and waves. Robust standard errors are in parentheses.

Table 7
Locus of control and social contacts.

	Social contacts	
	Women	Men
Locus of control	0.114***	0.109***
	(0.0084)	(0.0088)
N individuals	8,113	8,171
N observations	69,301	71,345

Note: ***p < 0.01. Control variables include age, age squared, household size, real household income, educational attainment, time preference, employment status, marital status, the Big Five personality traits, the individual-specific means of all time-varying variables, Australian states of residence and territories, and waves. Robust standard errors are in parentheses.

possible mediators are indeed statistically significant.

Application of the Sobel test is fairly straightforward and reveals that, in most cases, maintaining healthy habits and the extent of social capital are possible mediators.[14] Those with an internal locus of control invest more in healthy behaviors and social capital, which in turn positively influences their health. However, there is less evidence that outdoor tasks can explain the better health outcomes and the lower need for healthcare of those with an internal locus of control.

The analysis to this point has used linear models. As a robustness check, we estimated the specifications in Table 10 by taking into account the binary nature of the variables on having a long-term health condition, having been hospitalized in the past year, and having had a health check-up in the past year. We also treated self-assessed health, which is measured on a 5-point scale from 1 (poor) to 5 (excellent), as an ordinal variable. Accordingly, we estimated a random effects probit model for the binary outcome variables and a random effects ordered probit model for the ordinal outcome variable.

Table 8
Locus of control and health behaviors.

	Smoking frequency	Physical activity frequency	Drinking frequency
Women	−0.0358***	0.102***	0.0649***
	(0.0099)	(0.0085)	(0.0090)
N individuals	8,113	8,113	8,113
N observations	69,301	69,301	69,301
Men	−0.0313***	0.119***	0.0950***
	(0.0113)	(0.0087)	(0.0100)
N individuals	8,171	8,171	8,171
N observations	71,345	71,345	71,345

Note: See Table 7.

are accounted for. Looking across the columns, we can see that locus of control continues to be significantly related to health and healthcare use. However, once we control for the possible mediators in column 2, the coefficients on locus of control become smaller in magnitude, the only exception being health check-ups. The decreases in the locus-of-control coefficients range between 7% ('long-term health condition' regression) and 24% ('hospitalized' regression).

To test whether such reductions in the locus-of-control coefficients are also statistically significant, we conducted the Sobel test (Sobel, 1982; Krull and MacKinnon, 2001).[13] This test has been specifically developed for mediation analysis and allows us to examine whether the indirect effects of locus of control on our dependent variables via the

The estimates, presented in Table 11, suggest that locus of control continues to be significantly related to all of our health and healthcare use measures, and the relationships have the expected signs. With the exception of health check-ups, the estimated locus-of-control coefficients become smaller in magnitude once we control for the possible mediators in column 2, in line with our earlier findings. Further analysis using the Sobel test confirmed that the same set of possible pathways – social capital and lifestyle choices related to smoking, drinking and physical activity – can explain the better health outcomes and the lower need for curative care of those with an internal locus of control.

[13] The Sobel test is based on the statistic $t = ab/SE$, where a captures the relationship between locus of control and each potential mediator; b captures the relationship between each mediator and our dependent variable of interest, after controlling for the effect of locus of control (so ab is the indirect effect of locus of control on health or healthcare utilization); and SE is the standard error defined as $\sqrt{(a \cdot SEb)^2 + (b \cdot SEa)^2}$. The resulting t statistic can be compared to the normal distribution to determine its significance, with rejection rule $t < -1.96$ or $t > 1.96$ at the 95% confidence level.

[14] An exception to their role as potential mediators was observed for smoking and social contacts in relation to the number of doctor visits; and drinking in relation to self-assessed health and mental health. On the other hand, physical activity was shown to mediate all relationships between locus of control and our outcome variables.

Table 9
Locus of control and time use.

	Volunteer/Charity work	Outdoor tasks
Women	0.0124	−0.00217
	(0.0081)	(0.0071)
N individuals	8,113	8,113
N observations	69,301	69,301
Men	0.0136*	0.0347***
	(0.0083)	(0.0093)
N individuals	8,171	8,171
N observations	71,345	71,345

Note: See Table 7.

7. Concluding remarks

In this paper we analyzed the importance of individuals' locus of control for their health and healthcare use. We estimated the direct effects of locus of control. We also examined whether the effects of locus of control on health and healthcare use are mediated by lifestyle choices and social capital. This is a novel contribution and important in shedding light on not just whether, but why, locus of control matters for health and healthcare use.

We find that locus of control is significantly related to health and healthcare use. Men and women with an internal locus of control have better self-assessed health, physical and mental health. They rely less on healthcare, both preventive and curative.

We also presented evidence on the possible pathways underlying the identified relationships. The pathways through which locus of control influences health are social interaction with friends or relatives and lifestyle choices related to smoking, drinking and physical activity. These indirect effects are generated by the positive association of social interaction and health behaviors with control beliefs. Those with an internal locus of control invest more in healthy behaviors and social capital, which positively influences their health. Similar pathways apply to the relationship between locus of control and curative care but not necessarily preventive care.

Our paper is not without shortcomings. One limitation is that our mediation analysis accounted only for six possible pathways. Dietary choices that were not considered here may also be important inputs in health production. This implies that we are able to capture an upper bound of the direct effects of locus of control and a lower bound of its indirect effects (e.g. Ohrnberger et al., 2017a). Extending the analysis to consider a broader set of possible mediators is a promising avenue for future research.

Another potential limitation concerns the issue of reverse causality. Our empirical approach has addressed the possibility that unobserved characteristics influence both perceptions of control and health/healthcare use. But it is also possible that reverse causality exists: poor health may negatively affect locus of control, making one feel at the mercy of factors outside his/her control. If this is the case, we would only be able to detect a lower bound of the effects of locus of control, meaning that our results might suffer from attenuation bias. Future research should return to this issue, though we expect that our finding that locus of control matters for health and healthcare use will remain unchanged in a qualitative sense but may show stronger effects.

Our findings may also be useful for informing policy interventions. Our results highlight the importance of locus of control for health and healthcare use and suggest that internal perceptions of control matter not only directly, but also indirectly, through different pathways. The key pathways are healthy behaviors and social interaction. These pathways may be considered as intervention channels for improving people's health. Health policies aiming to encourage participation in physical activity and social interactions in the wider community may be particularly helpful in promoting better health.

In terms of the direct effects of locus of control, we know from

Table 10
Mediation analysis.

	Self-reported health		Physical health		Mental health		Long-term health condition		Hospitalized		Doctor visits		Health check-ups	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Locus of control	0.214***	0.191***	0.251***	0.230***	0.325***	0.300***	−0.0570***	−0.0529***	−0.0103***	−0.00783***	−0.124***	−0.109***	−0.0115***	−0.0114***
	(0.0062)	(0.0060)	(0.0065)	(0.0063)	(0.0059)	(0.0057)	(0.0025)	(0.0024)	(0.0021)	(0.0021)	(0.0086)	(0.0085)	(0.0030)	(0.0031)
Smoking frequency		−0.0650***		−0.0200***		−0.0372***		0.00727***		0.00522***		0.0125		−0.00945***
		(0.0037)		(0.0037)		(0.0040)		(0.0017)		(0.0020)		(0.0077)		(0.0031)
Drinking frequency		0.00655*		0.0471***		−0.00111		−0.0132***		−0.0134***		−0.0793***		−0.00766***
		(0.0038)		(0.0039)		(0.0041)		(0.0017)		(0.0020)		(0.0075)		(0.0029)
Physical activity frequency		0.142***		0.130***		0.128***		−0.0213***		−0.0141***		−0.0698***		−0.00497*
		(0.0028)		(0.0030)		(0.0031)		(0.0012)		(0.0018)		(0.0065)		(0.0026)
Social contacts		0.0377***		0.0283***		0.0794***		−0.00386***		0.00375**		−0.00894		0.00576**
		(0.0026)		(0.0026)		(0.0031)		(0.0012)		(0.0019)		(0.0070)		(0.0028)
Outdoor tasks		0.00500*		0.00385		0.0141***		−0.00244*		−0.00501**		−0.0141**		0.00386
		(0.0026)		(0.0030)		(0.0030)		(0.0014)		(0.0020)		(0.0067)		(0.0026)
N individuals	16,284	16,284	16,284	16,284	16,284	16,284	16,284	16,284	15,884	15,884	14,592	14,592	14,592	14,592
N observations	140,646	140,646	140,646	140,646	140,646	140,646	140,646	140,646	35,965	35,965	28,677	28,677	28,677	28,677

Note: *p < 0.1 **p < 0.05 ***p < 0.01. Control variables include age, age squared, gender, household size, real household income, educational attainment, time preference, employment status, marital status, the Big Five personality traits, the individual-specific means of all time-varying variables, Australian states of residence and territories, and waves. Robust standard errors are in parentheses.

Table 11
Mediation analysis using non-linear models.

	Self-reported health		Long-term health condition		Hospitalized		Health check-ups	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Locus of control	0.403***	0.368***	−0.327***	−0.303***	−0.0552***	−0.0406***	−0.0510***	−0.0511***
	(0.0119)	(0.0116)	(0.0142)	(0.0141)	(0.0116)	(0.0117)	(0.0129)	(0.0130)
Smoking frequency		−0.115***		0.0448***		0.0270***		−0.0329***
		(0.0064)		(0.0091)		(0.0100)		(0.0110)
Drinking frequency		0.00538		−0.0441***		−0.0410***		−0.0193***
		(0.0041)		(0.0057)		(0.0063)		(0.0073)
Physical activity frequency		0.182***		−0.0816***		−0.0527***		−0.0117
		(0.0036)		(0.0050)		(0.0069)		(0.0074)
Social contacts		0.0502***		−0.0151***		0.0146*		0.0207**
		(0.0035)		(0.0051)		(0.0075)		(0.0082)
Outdoor tasks		0.00151*		−0.00154		−0.00391*		0.00123
		(0.0009)		(0.0013)		(0.0020)		(0.0023)
N individuals	16,284	16,284	16,284	16,284	15,884	15,884	14,592	14,592
N observations	140,646	140,646	140,646	140,646	35,965	35,965	28,677	28,677

Note: See Table 10.

previous research that non-cognitive skills including locus of control are malleable over the lifecycle, especially at a young age (see Heckman et al., 2006). They can be altered through education, parental involvement and policy interventions. The importance of nurturing environments at a relatively young age is often highlighted in increasing the productivity of later investments in human capital. We have shown that locus of control is significantly related to health and healthcare use. Interventions that enhance internal perceptions of control are promising avenues for promoting better health.

The study of individuals' non-cognitive skills will likely continue to be a subject of intensive research in social sciences as intriguing questions remain. One fruitful direction for future research would be to study a broader set of possible mediators in the link between locus of control and health as well as healthcare use. Another interesting avenue for future research might be to examine the benefits of individuals' locus of control for their subjective well-being. Examining whether and why perceptions of control relate to satisfaction with life and domains of life (e.g. job and income) could have important implications for understanding more about the direct and indirect effects of locus of control. In future work we hope to explore some of these aspects.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.econmod.2019.06.014.

References

Almlund, M., Duckworth, A., Heckman, J.J., Kautz, T., 2011. Personality psychology and economics. In: Hanushek, E.A., Machin, S., Wößmann, L. (Eds.), Handbook of the Economics of Education, vol. 4. Elsevier, Amsterdam, pp. 1–181.

Arraras, J.I., Wright, S.J., Jusue, G., Tejedor, M., Calvo, J.I., 2002. Coping style, locus of control, psychological distress and pain-related behaviours in cancer and other diseases. Psychol. Health Med. 7 (2), 181–187.

Bambra, C., Eikemo, T.A., 2009. Welfare state regimes, unemployment and health: a comparative study of the relationship between unemployment and self-reported health in 23 European countries. J. Epidemiol. Community Health 63 (2), 92–98.

Baron, R.M., Kenny, D.A., 1986. The moderator–mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. J. Personal. Soc. Psychol. 51 (6), 1173–1182.

Becker, G.S., 2007. Health as human capital: synthesis and extensions. Oxf. Econ. Pap. 59 (3), 379–410.

Böckerman, P., Ilmakunnas, P., 2009. Unemployment and self-assessed health: evidence from panel data. Health Econ. 18, 161–179.

Bolin, K., Lindgren, B., Lindström, M., Nystedt, P., 2003. Investments in social capital – implications of social interactions for the production of health. Soc. Sci. Med. 56 (12), 2379–2390.

Boyce, C.J., Wood, A.M., Powdthavee, N., 2013. Is personality fixed? Personality changes as much as "variable" economic factors and more, strongly predicts changes to life satisfaction. Soc. Indicat. Res. 111 (1), 287–305.

Brazier, J.E., Harper, R., Jones, N.M., O'Cathain, A., Thomas, K.J., Usherwood, T., Westlake, L., 1992. Validating the SF-36 health survey questionnaire: new outcome measure for primary care. BMJ 305 (6846), 160–164.

Buddelmeyer, H., Powdthavee, N., 2016. Can having internal locus of control insure against negative shocks? Psychological evidence from panel data. J. Econ. Behav. Organ. 122, 88–109.

Caliendo, M., Cobb-Clark, D.A., Uhlendorff, A., 2015. Locus of control and job search strategies. Rev. Econ. Stat. 97 (1), 88–103.

Cameron, A.C., Miller, D.L., 2015. A practitioner's guide to cluster-robust inference. J. Hum. Resour. 50 (2), 317–373.

Chamberlain, G., 1982. Multivariate regression models for panel data. J. Econom. 1, 5–46.

Chiteji, N., 2010. Time preference, noncognitive skills and well being across the life course: do noncognitive skills encourage healthy behavior? Am. Econ. Rev. 100 (2), 200–204.

Cobb-Clark, D.A., Schurer, S., 2013. Two economists' musings on the stability of locus of control. Econ. J. 123 (570), F358–F400.

Cobb-Clark, D.A., Kassenboehmer, S.C., Schurer, S., 2014. Healthy habits: the connection between diet, exercise, and locus of control. J. Econ. Behav. Organ. 98, 1–28.

Coleman, M., DeLeire, T., 2003. An economic model of locus of control and the human capital investment decision. J. Hum. Resour. 38 (3), 701–721.

Contoyannis, P., Jones, A.M., Rice, N., 2004. The dynamics of health in the British household panel survey. J. Appl. Econom. 19 (4), 473–503.

Diener, E., Pressman, S.D., Hunter, J., Delgadillo-Chase, D., 2017. If, why, and when subjective well-being influences health, and future needed research. Appl. Psychol.: Health Well-Being 9 (2), 133–167.

Doorslaer, E.V., Koolman, X., 2004. Explaining the differences in income-related health inequalities across European countries. Health Econ. 13 (7), 609–628.

Dour, H.J., Wiley, J.F., Roy-Byrne, P., Stein, M.B., Sullivan, G., Sherbourne, C.D., et al., 2014. Perceived social support mediates anxiety and depressive symptom changes following primary care intervention. Depress. Anxiety 31 (5), 436–442.

Eibich, P., 2015. Understanding the effect of retirement on health: mechanisms and heterogeneity. J. Health Econ. 43, 1–12.

Flouri, E., 2006. Parental interest in children's education, children's self-esteem and locus of control, and later educational attainment: twenty-six year follow-up of the 1970 British Birth Cohort. Br. J. Educ. Psychol. 76 (1), 41–55.

Friedman, H.S., 2000. Long-term relations of personality and health: dynamisms, mechanisms, tropisms. J. Personal. 68 (6), 1089–1107.

Galama, T.J., Van Kippersluis, H., 2018. A theory of socio-economic disparities in health over the life cycle. Econ. J. 129 (617), 338–374.

Gale, C.R., Batty, G.D., Deary, I.J., 2008. Locus of control at age 10 years and health outcomes and behaviors at age 30 years: the 1970 British Cohort Study. Psychosom. Med. 70 (4), 397–403.
Grossman, M., 1972. On the concept of health capital and the demand for health. J. Political Econ. 80 (2), 223–255.
Grossman, M., Kaestner, R., 1997. Effects of education on health. In: Behrman, J., Stacey, N. (Eds.), The Social Benefits of Education. University of Michigan Press, Ann Arbor, pp. 69–123.
Hahn, R.A., Truman, B.I., 2015. Education improves public health and promotes health equity. Int. J. Health Serv. 45 (4), 657–678.
Hauck, K., Rice, N., 2004. A longitudinal analysis of mental health mobility in Britain. Health Econ. 13 (10), 981–1001.
Heckman, J.J., Stixrud, J., Urzua, S., 2006. The effects of cognitive and noncognitive abilities on labor market outcomes and social behavior. J. Labor Econ. 24 (3), 411–482.
Hemingway, H., Stafford, M., Stansfeld, S., Shipley, M., Marmot, M., 1997. Is the SF-36 a valid measure of change in population health? Results from the Whitehall II study. BMJ 315 (7118), 1273–1279.
Kesavayuth, D., Ko, K.M., Zikos, V., 2018b. Locus of control and financial risk attitudes. Econ. Modell. 72, 122–131.
Kesavayuth, D., Liang, Y., Zikos, V., 2018a. An active lifestyle and cognitive function: evidence from China. J. Econ. Ageing 12, 183–191.
Kesavayuth, D., Rosenman, R.E., Zikos, V., 2015. Personality and health satisfaction. J. Behav. Exp. Econ. 54, 64–73.
Krull, J.L., MacKinnon, D.P., 2001. Multilevel modeling of individual and group level mediated effects. Multivariate Behav. Res. 36 (2), 249–277.
Leung, T.W., Siu, O.L., Spector, P.E., 2000. Faculty stressors, job satisfaction, and psychological distress among university teachers in Hong Kong: the role of locus of control. Int. J. Stress Manag. 7 (2), 121–138.
Mackenbach, J.P., Simon, J.G., Looman, C.W., Joung, I.M., 2002. Self-assessed health and mortality: could psychosocial factors explain the association? Int. J. Epidemiol. 31 (6), 1162–1168.
MacKinnon, D.P., Fairchild, A.J., Fritz, M.S., 2007. Mediation analysis. Annu. Rev. Psychol. 58, 593–614.
Miilunpalo, S., Vuori, I., Oja, P., Pasanen, M., Urponen, H., 1997. Self-rated health status as a health measure: the predictive value of self-reported health status on the use of physician services and on mortality in the working-age population. J. Clin. Epidemiol. 50 (5), 517–528.
Mundlak, Y., 1978. On the pooling of time series and cross section data. Econometrica 46 (1), 69–85.
Nikolaev, B., 2018. Does higher education increase hedonic and eudaimonic happiness? J. Happiness Stud. 19 (2), 483–504.
Nolan, A., McCrory, C., Moore, P., 2019. Personality and preventive healthcare utilisation: evidence from the Irish longitudinal study on ageing. Prev. Med. 120, 107–112.
Noordt, M.V., Ijzelenberg, H., Droomers, M., Proper, K.I., 2014. Health effects of employment: a systematic review of prospective studies. Occup. Environ. Med. 71 (10), 730–736.
Ohrnberger, J., Fichera, E., Sutton, M., 2017a. The relationship between physical and mental health: a mediation analysis. Soc. Sci. Med. 195, 42–49.
Ohrnberger, J., Fichera, E., Sutton, M., 2017b. The dynamics of physical and mental health in the older population. J. Econ. Ageing 9, 52–62.
Robards, J., Evandrou, M., Falkingham, J., Vlachantoni, A., 2012. Marital status, health and mortality. Maturitas 73 (4), 295–299.
Rotter, J.B., 1966. Generalized expectancies for internal versus external control of reinforcement. Psychol. Monogr. 80 (1), 1–28.
Schnittker, J., Bacak, V., 2014. The increasing predictive validity of self-rated health. PLoS One 9 (1), e84933.
Schultz, D.P., Schultz, S.E., 2016. Theories of Personality. Cengage Learning.
Semykina, A., Linz, S.J., 2007. Gender differences in personality and earnings: evidence from Russia. J. Econ. Psychol. 28 (3), 387–410.
Sherman, A.C., Higgs, G.E., Williams, R.L., 1997. Gender differences in the locus of control construct. Psychol. Health 12 (2), 239–248.
Smith, K.P., Christakis, N.A., 2008. Social networks and health. Annu. Rev. Sociol. 34, 405–429.
Sobel, M.E., 1982. Asymptotic confidence intervals for indirect effects in structural equation models. Socio. Methodol. 13, 290–312.
Steptoe, A., Wardle, J., 2001. Locus of control and health behaviour revisited: a multivariate analysis of young adults from 18 countries. Br. J. Psychol. 92 (4), 659–672.
Stürmer, T., Hasselbach, P., Amelang, M., 2006. Personality, lifestyle, and risk of cardiovascular disease and cancer: follow-up of population based cohort. BMJ 332 (7554), 1359.
Watson, N., Wooden, M., 2012. The HILDA Survey: a case study in the design and development of a successful Household Panel Survey. Longitudinal Life Course Stud. 3 (3), 369–381.
World Health Organization, 2009. Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks. World Health Organization.
Zhang, Y., Salm, M., van Soest, A., 2018. The effect of retirement on healthcare utilization: evidence from China. J. Health Econ. 62, 165–177.
Zhu, R., 2016. Retirement and its consequences for women's health in Australia. Soc. Sci. Med. 163, 117–125.
Ziebarth, N.R., Grabka, M.M., 2009. In vino pecunia? The association between beverage-specific drinking behavior and wages. J. Labor Res. 30 (3), 219–244.