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The contribution of intellectual abilities to young adult's educational differences in health care use – A prospective cohort study

Maren Kraft[a,*,1], Koos Arts[b], Tanja Traag[b], Ferdy Otten[b], Hans Bosma[a]

[a] School for Public Health and Primary Care (CAPHRI), Department of Social Medicine, UM, CAPHRI, PO Box 616, Maastricht, MD 6200, The Netherlands
[b] Statistics Neteherlands, P.O. Box 4481, Heerlen, CZ 6401, The Netherlands

ABSTRACT

Objectives: To examine the contribution of 12-year olds' intellectual abilities to educational differences in health care use in young adulthood. The focus on this life-course phase, including the socioeconomic circumstances in which the participants were brought up, allows an in-depth examination of the influence of important social mobility processes.

Methods: A large dataset of 10,400 participants was used to establish the relationship between intellectual abilities in early 2000 (when the participants were 12 years of age) and the educational differences in health care use in 2012 (when the participants were 24 years of age). Outcome variables, i.e. educational attainment and hospital admissions, GP costs, hospital costs, and medication use, were matched from national registers. Logistic regression analysis was used to determine educational differences in health care use, unadjusted and adjusted for the intellectual abilities.

Results: The educational differences in health care use varied by type of usage (e.g. low education — high hospital admission: OR = 2.89, CI = 2.27, 3.67; low education — high medication use: OR = 1.49, CI = 1.30, 1.71). Also, independent of parental socioeconomic status, intellectual abilities contributed substantially to the educational differences in health care use. The percentage reduction of the ORs after adjustment for intellectual abilities ranged between 1.84% and 38% and was on average almost 25%.

Conclusion: Educational differences in health care use in young adulthood appear partly based on prior differences in intellectual abilities. Further research is needed with longer follow-ups during people's life-courses. Additionally, we need more insight in how this evidence can effectively be used in the complex challenge of tackling socioeconomic differences in health.

1. Introduction

Intelligence has been referred to as the elusive fundamental cause of social class inequalities in health (Gottfredson, 2004). Several studies have shown that intelligence has an effect on diverse life-course outcomes, such as socioeconomic success, decisions we make in daily life (Gottfredson, 1997), longevity (Calvin et al., 2011; Deary, Weiss, & Batty, 2010; Deary, Whiteman, & Starr, 2004), and risks of morbidity (Der, Batty, & Deary, 2009). Individual differences, such as differences in intellectual abilities, might thus also contribute to the development of socioeconomic health differences (SEHD), i.e. the generally poor health outcomes for people in lower socioeconomic positions (Gottfredson, 2004). Much research addresses the influence of intelligence on SEHD. Whereas some studies found a marked reduction in SEHD after controlling for intelligence (Batty, Der, Macintyre, & Deary, 2006; Batty et al., 2009; Bosma, Traag, Berger-van Sijl, van Eijk, and Otten, 2007; Bosma, van Boxtel, Kempen, van Eijk, and Jolles, 2007), suggesting relevant confounding by intellectual abilities, others found no evidence for such a contribution (Singh-Manoux, Ferrie, Lynch, & Marmot, 2005; Bosma, Traag, et al., 2007; Bosma, van Boxtel, et al., 2007)

Mackenbach (2012) hypothesized that the increased opportunities for social mobility might be an important determinant of SEHD. Attaining a higher socioeconomic position compared to your parents (inter-generational) or compared to where a person started (intra-generational) is increasingly based on personal characteristics, such as intellectual abilities, rather than, as in previous times, on one's own socioeconomic family background. Individual differences, such as

* Corresponding author.
E-mail addresses: m.kraft@maastrichtuniversity.nl (M. Kraft), k.arts@cbs.nl (K. Arts), t.traag@cbs.nl (T. Traag), f.otten@cbs.nl (F. Otten), hans.bosma@maastrichtuniversity.nl (H. Bosma).
[1] Present address: Friedensplatz 8, 53111 Bonn, Germany.

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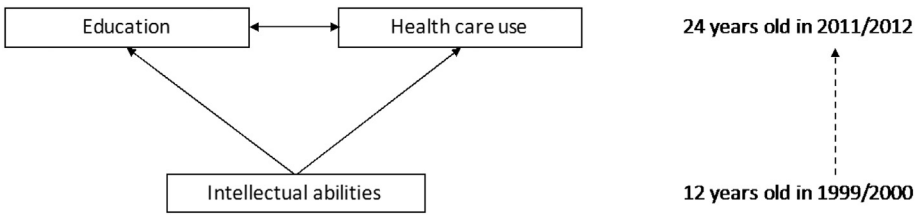

Fig. 1. Working model of the association between intellectual abilities in 2000 (at the age of 12) and educational differences in health care use in 2011/2012 (at the age of 24). The Netherlands, 1999–2012.

intellectual abilities, are formed in early life and might not only be of relevance for one's school and occupational career (socioeconomic attainment), but also for one's health-related career and life-course. As most of the prior research focused on adult population groups, there is thus a need to look at younger populations as well. During adolescence and young adulthood, important processes of social mobility take place during which intellectual abilities are allowed to have an important influence.

Using national registers and data from 19,391 Dutch youngsters, we set out to examine to what extent intellectual abilities at the age of 12 contribute to (or confound) the association between the attained educational level (as an indicator of socioeconomic position) and various indicators of health care use (both at the age of 24) and to examine the extent to which these associations are independent of the parental socioeconomic position. (See Fig. 1.)

2. Methods

2.1. Study population

The Secondary Education Pupil Cohort 1999 (VOCL'99), conducted by Statistics Netherlands (CBS) and the Groningen Institute for Education Research (GION), provides data of a random selection of Dutch secondary schools. In total 126 schools, out of 246, agreed to take part in the study (Kuyper, Lubbers, & Van der Werf, 2003). A sample of 19,391 participants from 825 school classes participated in filling in questionnaires at baseline in 1999/2000 (Traag, 2012). Information about the parental socioeconomic position, ethnicity, and marital status was collected through questionnaires for the parents at baseline. Any further information about the participants, available from national registers, has been linked to the VOCL'99 cohort. Linked data included information about the participants when they were approximately 24 years of age: hospital admissions, general practitioner (GP) costs, hospital costs, medication use, final attained educational level. Parental income (used as covariate) in 2003 has been linked to the VOCL'99 cohort as well. After the exclusion of missing cases due to death (N = 58), incomplete intelligence tests (N = 6545), and missing covariates (N = 5093), 10,400 participants (53.6%) remained for the analyses. More in-depth information can be found in Kraft, Traag, Arts, Otten, and Bosma (2016).

2.2. Measures

To link data to the VOCL'99 cohort, gender, date of birth and the postcode of participants were first used as key codes. Using these key codes, the participants were linked uniquely to the Dutch municipal population register (GBA). The GBA can link the matched codes with the health care use registers and socioeconomic registers. For every successful link from the national registers via the GBA to the VOCL'99 cohort, a unique record identification number (RIN) was created (Willenborg & Heerschap, 2012). The success rate of linking was 99.8% for the participants' data and 99.3% for the parental income measure.

2.3. Health care use

Four indicators for health care use were available. First, hospital admissions (no, yes) of participants were registered at the National Medical Registration (Landelijke Medische Registratie (LMR) in Dutch) in 2011 (2012 data were not sufficiently reliable and were therefore not used) (De Bruin et al., 2003). The LMR derives from Dutch Hospital Data (DHD) and includes all academic, general and categorical hospitals, except for centers for rehabilitation, asthma, and epilepsy. Deliveries without complications, part-time treatment for psychiatric illnesses, and daytime rehabilitation treatment were not registered. Only one of the two categorical cancer clinics in the Netherlands is represented in the LMR. In total, the LMR has sample coverage of about 84%. Second, although related to the previous hospital admission variable, hospital costs additionally indicate the severity of the diseases for which participants had been hospitalized. Third, registered costs related to the use of services of GPs were used. Both, hospital and GP costs were assessed in 2012. To the extent that these services are covered by the Dutch basic insurance, the costs are reimbursed by the health insurance companies [Zorgverzekeringswet (ZVW)] (Statistics Netherlands, 2015a). The two cost variables were summed and subsequently dichotomized into 80% of participants with the lowest costs and 20% of participants with the highest costs. Last, any reimbursed medication under the statutory basic medical insurance was used as fourth health outcome, assessed in 2012 (College voor Zorgverzekering, CvZ) (Statistics Netherlands, 2015b).

2.4. Attained educational level

The highest attained level of education at the end of the follow-up provides a measure for the socioeconomic position of the participants. The educational level, for which participants received a certificate, ranging from primary to university education (13 ordinal categories according to the 'Standaard Onderwijsindeling' (SOI) in Dutch) was determined in 2012 (Statistics Netherlands, 2015c). The variable was recoded into thirds (using tertiles). Although income data were also available, these were not used, because the income at age 24 cannot yet be considered as a valid indicator of socioeconomic position at that age (Galobardes, Shaw, Lawlor, Lynch, & Smith, 2006). In our data, education and income correlated only little (Pearson correlation: 0.06).

2.5. Intellectual ability

Intellectual ability was measured using the Dutch intelligence test for educational purposes (Nederlandse Intelligentietest voor Onderwijsdoeleinden, NIO), which total score gives an index of general intelligence, also known as 'g'. Intellectual abilities were assessed when participants were approximately 12 years old and entered the second class of secondary education, in 2000. NIO has been developed to support decisions on finding an adequate school level for pupils. It has been shown to be both valid and reliable (Van Dijk & Tellegen, 2004). The total intelligence quotient (IQ) score is generated from six subtests classified as verbal (synonyms, analogies and categories) and symbolic (numbers, math and spatial awareness). Fluid intelligence, the inherent ability to solve new problems, as well as crystallised intelligence, the ability to use learned knowledge, can be determined from this assessment tool. Furthermore, it has been shown that the total IQ is strongly related to the Wechsler Intelligence Scale for Children (WISC-R) with a correlation of 0.69 (Van Dijk & Tellegen, 2004). The total IQ score was

categorised using tertiles.

2.6. Covariates

Potential confounders, i.e. age (mean = 12.56 years; SD = 0.48), sex (50.5% female), socioeconomic background (parental education level, parental income), ethnicity and parental marital status, were assessed at baseline. The level of parental education, ranging from 6 to 19 years (mean = 13.8; SD = 3.5) was assessed through questionnaires. Parental income defined as the equalised household income of the child's mother (expressed as percentile scores: mean = 56.5; SD = 25.8) was measured in 2003 (because 1999/2000 data were not available). The household income of the mother included fewer missing values compared to the household income of the father and it was assumed that children of divorced parents are more likely to live with their mother. According to the country of birth of parents and participants, ethnicity was categorised as native Dutch (84.8%), Non-Western (8.6%: Turkish, African, Asian and Latin-American) or Western (6.4%: European (excluding Dutch and Turkish people), North-American, Oceania, Japan and Indonesian) immigrants (Alders, 2001). Marital status of parents was categorised into married (80.4%) or non-married.

2.7. Statistical analysis

First, Pearson correlations and cross-tabulations between parental socioeconomic position and intellectual abilities were computed. Both parental education and parental income were dichotomized for use in the cross-tabulations (0 = 80% highest education or income versus 1 = 20% lowest education or income). Second, the odds ratios for the association of intellectual abilities with health care use and attained educational level were estimated by estimating multilevel logistic regression models (level 1: individual participant and level 2: school). Third, the odds ratios for the association between attained educational level and health care were estimated with similar models (model 0). The latter odds ratios were separately adjusted for intellectual abilities for estimating the extent of confounding by these abilities (model 1). The percent reduction of the odds ratio after control for intellectual abilities was calculated by the following formula: (OR Model 0 − OR Model 1)/(OR Model $_{0-1}$). All analyses were controlled for all covariates. In addition, the intra-class correlation (rho) has been computed for all multilevel logistic regression models. Finally, sensitivity analyses included analyses with continuous variables (instead of categorical variables) and the testing of interaction terms (between intellectual abilities and educational attainment and between intellectual abilities and parental socioeconomic position). STATA 14.0 and SPSS 24 were used.

3. Results

Parental education and income both correlated significantly with intellectual ability (0.315 and 0.172, respectively) (Table 1). The cross-tabulations confirmed the association: participants with lower educated parents had low intellectual abilities (52%) compared to participants with higher educated parents (28%). Similarly, the corresponding percentages for participants with poor or rich parents were 44 and 30, respectively.

Table 2 shows that low intellectual abilities had an adverse influence on both health outcomes and educational attainment. For instance, participants who had low intellectual abilities at the age of 12 had a 1.61 (CI: 1.39–1.86) times higher odds of using medication compared to people who scored high on intellectual abilities. Participants who had low intellectual abilities also had more than 5 times higher odds of attaining a low educational level at the age of 24 (OR = 5.58, CI: 4.57–6.82).

Table 3 shows that there were substantial educational differences in health care use at the age of 24 (Model 0). Participants' low educational attainment was, for instance, related to a 1.55 (CI: 1.36, 1.76) higher odds of high hospital costs. By adjusting for intellectual abilities (Model 1), the odds ratio of high hospital costs for the low educated participants decreased to OR: 1.40, CI: 1.22 to 1.61, representing a decrease of 27.3%. On average, the contribution of intellectual abilities to (or the confounding by intellectual abilities for) the association between education and health care use was 21.9%.

The interaction between the educational attainment and intellectual abilities was not statistically significant. The interaction between parental socioeconomic background and intellectual abilities was not significant either. In analyses with continuous variables, similar results were found, also regarding the estimates of the extent of confounding by intellectual abilities.

Table 1
Associations (Pearson correlation and cross-tabulations) between parental socioeconomic background and intellectual abilities. The Netherlands, 1999–2012.[a]

	Pearson correlation	Cross-tabulationsa	Intellectual abilities		
			High	Medium	Low
Parental education[b]	**0.315**	High	39.1%	32.7%	28.2%
		Low	18.3%	29.9%	51.8%
Parental income[b]	**0.172**	High	37.5%	32.3%	30.2%
		Low	25.2%	30.8%	44.1%

[a] Bold text indicates a statistically significant Pearson correlation.
[b] Both parental education and parental income were dichotomized for these cross-tabulations (0 = 80% highest education or income versus 1 = 20% lowest education or income).

4. Discussion

In a Dutch setting, this study assessed the potential contribution of 12-year olds' intellectual abilities to educational differences in health care use in young adulthood. Independent of the parental socioeconomic position, intellectual abilities at the age of 12 were found to be related to educational attainment and health care use after 13 years of follow-up. The contribution of (or confounding by) intellectual abilities to the educational differences in health care use was on average 21.9% but varied across health outcomes (3.8%–33.3%). These findings corroborate results from previous studies (Bond & Saunders, 1999; Calvin et al., 2011; Deary & Batty, 2006; Der et al., 2009; Singh-Manoux et al., 2005).

The endeavour to explain socioeconomic differences in health has appeared complex. Our research adds to the increasing body of evidence on the influence of (for long under-studied) individual differences on SEHD (Deary, 2011). Simultaneously, this knowledge raises many questions, including ones related to the implications for the development of intervention measures. The findings fit with the (somewhat understudied) indirect selection perspective on the explanation of socioeconomic differences in health. Due to individual characteristics, people self-select themselves into different socioeconomic groups in processes of social mobility (Blane, Smith, & Bartley, 1993; Mackenbach, 2012) and the same individual characteristics might also be related to different risks of poor health. Both the socioeconomic and health-related mechanisms indicate the importance of individual traits, such as intellectual abilities, for people's life-courses (including what educational level they attain and how much health care they use as a young adult). The findings on the influence of intellectual abilities support the belief that individual differences, in their contribution to socioeconomic differences in health, might be as fundamental as social and environmental differences (Abbema, Van Asseman, Kok, De Leeuw, & De Vries, 2004).

There is of course the moral dilemma of social darwinistic thinking. For example, given the partly genetic component in many individual characteristics, Mackenbach (2005) raised the question on how

Table 2
Odds ratios (95% confidence intervals) of health care use and educational attainment in 2011/2012 by intellectual abilities in 2000.[a]

	Health care use				Educational attainment
	High hospital admission	High GP costs	High hospital costs	High medication use	Low educational attainment
Intellectual abilities[b]					
Medium	1.09 (0.86–1.139)	**1.25 (1.09–1.43)**	**1.25 (1.10–1.43)**	**1.25 (1.09–1.45)**	**2.42 (1.99–2.96)**
Low	**1.53 (1.21–1.94)**	**1.59 (1.39–1.83)**	**1.53 (1.33–1.75)**	**1.61 (1.39–1.86)**	**5.58 (4.57–6.82)**
Rho (ρ)[c]	0.015	0.003	0.004	0.005	0.090

[a] Bold text indicates a statistically significant odds ratio.
[b] The reference group is high intellectual abilities, which equals an OR = 1.00.
[c] Rho is an estimate of the intra-class correlation (level 1: individual participants and level 2: school).

modifiable socioeconomic health differences actually are and whether or not there is a limit to the influence of policies. We, however, think that we should still seek to find ways to intervene upon the inequalities in opportunities and to avoid stigmatization and classism, and to use information on indirect selection in a positive way for the benefit of people in lower socioeconomic positions. For example, an individually tailored approach in early life, focussing on the development of "healthy" individual traits (Taylor, Repetti, & Seeman, 1993) might be an additional strategy to consider for intervention. Child and youth health care, although differently organised in different countries, might be a starting place for such interventions.

4.1. Limitations

We are aware that our study has some limitations. Firstly, rather than health status itself, use of health care services was measured and used at the outcome. Hence, it is important to frame our findings in terms of health care use and medical consumption rather than health per se. Secondly, although the NIO has been proven valid and reliable, it might still have underestimated the true intellectual abilities of the low educated young adults. Particularly, the verbal intelligence subtest might have been negatively biased for the low educated group, many of whom come from non-Dutch backgrounds (Van Dijk & Tellegen, 2004). Furthermore, IQ scores were not fully normally distributed (mean 103 and standard deviation 13 compared to 100 and 15 in a fully normal distribution); this indicates that the sample is slightly more intelligent than the general population. We are not sure about how this might have affected our findings. Thirdly, there is a high number of missing values for the NIO test. However, educational differences in health care use in the full sample were equally strong as in the sample without the participants with missing intelligence scores. Finally, education was used as the socioeconomic indicator. Future research should look at additional socioeconomic indicators, but these should also be chosen for being equally valid in the particular age group. In our case, income was for example not a usable indicator for the 24-year olds.

4.2. Conclusion

Educational differences in health care use in young adulthood, that are indicative of socioeconomic differences in health, appear partly based on prior differences in intellectual abilities. Further research is needed with longer follow-ups during people's life-courses. Additionally, we need more insight in how this evidence can effectively be used in what remains the complex challenge of tackling socioeconomic differences in health.

Ethical approval

Ethical approval is not required for this kind of study in the Netherlands. Since participants were neither subjected to interventions nor was a code of conduct imposed on them, the study does not fall under the Dutch Medical Research on Human Act (WMO). The Code of Conduct for health research with data (Code Goed Gedrag) has been followed. Participants were informed that participation is voluntary and that data are treated confidentially. Further, individuals are not traceable from published data.

Conflict of interests

Author MK declares that she has no conflict of interest. Author HB declares that he has no conflict of interest. Author TT declares that she has no conflict of interest. Author FO declares that he has no conflict of interest. Author KA declares that he has no conflict of interest.

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Table 3
Odds ratios (95% confidence intervals) of health care use by educational attainment, unadjusted (model 0) and adjusted (model 1) for intellectual abilities.[a,b]

	Hospital admission	GP costs	Hospital costs	Medication use
Model 0: The association between educational attainment and health care use unadjusted for intellectual abilities				
Medium	**2.26 (1.76, 2.90)**	**1.34 (1.17, 1.53)**	**1.29 (1.13, 1.48)**	**1.29 (1.12, 1.49)**
Low	**2.86 (2.25, 3.65)**	**1.73 (1.51, 1.96)**	**1.55 (1.36, 1.76)**	**1.51 (1.31, 1.73)**
Rho (ρ)[c]	0.004	0.004	0.004	0.006
Model 1: The association between educational attainment and health care use adjusted for intellectual abilities				
Medium	**2.24 (1.73, 2.89)**	**1.24 (1.08, 1.43)**	**1.20 (1.05, 1.38)**	**1.18 (1.02, 1.37)**
Low	**2.79 (2.16, 3.60)**	**1.56 (1.36, 1.79)**	**1.40 (1.22, 1.61)**	**1.34 (1.16, 1.55)**
Rho (ρ)[c]	0.003	0.003	0.004	0.006
Average reduction[d]	3.8%	23.3%	27.3%	33.3%

[a] Bold text indicates statistically significant odds ratio.
[b] The reference group is high educational attainment, which equals an OR = 1.00.
[c] Rho is an estimate of the intra-class correlation (level 1: individual participants and level 2: school).
[d] The percent reduction of the odds ratios between model 0 and 1 is calculated as follows: $(OR_{Model\ 0} - OR_{Model\ 1})/(OR_{Model\ 0–1})$. This was computed for the low education group.

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