A higher level of education amplifies the inverse association between income and disability in the Spanish elderly

Antonio Abellán · Ángel Rodríguez-Laso · Rogelio Pujol · Laura Barrios

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Abstract

Background and aims This paper aims to estimate if the education level modifies the association of income with disability prevalence in the elderly. Education can have a confounding effect on income or interact with it as a health determinant. It is important to analyze the relationship between socio-economic status and disability in older people, because it helps to better understand health inequalities and organize appropriate social policies.

Methods The study is based on the Survey on Disability, Personal Autonomy and Dependency Situations (Spanish National Statistics Institute). Binary logistic regression models are adjusted (bivariate, adjusted for gender and age, with all variables and with the interaction between income and education levels). A bad adjustment of the model is detected and a scobit link is added, which helps to differentiate disabled and non-disabled individuals better.

Results People with difficulty in carrying out activities of daily living are much older, frequently women and with low education and income levels. The significant interaction between education level and income means that the odds of being disabled is 43 % less in people of high income compared with people of low income if they are well educated, while it is only 21 %, among those with low education.

Conclusion A higher education level amplifies significantly the inverse association between income and disability in the Spanish elderly, what suggests that those with higher education will profit more than those with lower education from universal economic benefits policies aimed at the disabled, increasing health inequalities between groups.

Keywords Education · Income · Disability · Health inequality · Aged · Spain

Introduction

In general, people with a higher socio-economic status tend to live longer and healthier lives. There is abundant literature on the decisive role that socio-economic status (education, occupation, income) plays in elderly people’s health conditions, and in particular in their disability [1–3].

A person’s occupation and income during their working life are regarded as being usually associated with the level of education they have attained beforehand. It is hard to assess the influence of one or other socio-economic factor or whether these factors are combined in some way. Ascertaining whether there is any interaction in how these factors affect disability is scientifically relevant and would also provide explanations about the origin of disability inequalities in old age. This approach fits into the life course epidemiology [4].

People with higher incomes are less prone to disability for different reasons, because income generally leads to a better functional health, lessens individuals’ exposure to risk factors, and provides the resources necessary to treat a
poor state of health or makes it easier to modify one’s environment to promote autonomy [5–7].

In the relation between education, income and health, there can be several scenarios theoretically. Education can interact and/or have a compensatory effect on income as a health determinant [8]. The better prepared, who have higher incomes, also know more about health protective factors (behaviors and lifestyles, cognitive skills, psychological disposition), improve the use of preventive actions or care, and benefit more from social, technological and household improvements, which could enable them to delay the onset of disability; these same features can also result in better prepared people taking better advantage of their available financial resources; or, to put it another way, it can lead to the less prepared not benefitting as much from increased financial resources. However, it could be that the better prepared, for the same reasons (lifestyles, etc.) improve their health, regardless of income (their knowledge lets them understand the disability process better, and make better decisions to prevent and treat it).

Upon reaching the threshold of old age, people already have a set level of education, which is usually acquired in the early stages of their lives and have assured sources of income via pensions or other financial resources; in addition, most no longer have a job. These circumstances are very favorable for studying the socio-economic determinants of disability because they limit reverse causality; in other words, a poor functional health conditions one’s education, job and income. In addition, exploring the factors that determine the difficulties in performing activities of daily living makes most sense in old age, when they are most frequent [9, 10]. In Spain, the proportion of the population aged 65 and over was 16.3 % in 2008, 9.2 % of whom had difficulty in performing basic activities of daily living [11]. There is evidence of social inequalities in health and policies are still needed to reduce them [12, 13]. Analyzing simple education and income indicators can contribute to better studying inequality, organizing social policies and advancing the development of social welfare [14].

This article aims to estimate the extent to which the level of education interacts with income in the production of disability in older people. Our hypothesis is that the level of education modifies that association between income and disability, but the literature does not allow us to predict the direction of that association and its intensity.

Methods

Data source

This cross-sectional descriptive study is based on the Survey on Disability, Personal Autonomy and Dependency Situations (EDAD in Spanish), the third major disability survey conducted in Spain by the National Statistics Institute (Instituto Nacional de Estadística, INE) [11, 15]. In short, it is a stratified, two-stage nationally representative sample, obtained in 2008; the first stage units are the census tracts, and the second stage are the main family dwellings. The sample size was 96,075 households where information was collected on 258,187 people aged from 0 to 104 years.

For this study, the sample was restricted to non-institutionalized people aged 65 and over, whose age at the onset of the disability was more than 65 years. The aim is to take people who begin to be functionally impaired after reaching the threshold of old age, as we consider that any disability arising before that age is not representative of the disability commonly experienced by older people. This is also intended to avoid reverse causality: most people have already retired by the age of 65 and, if the disability occurs after that age, we can assume that their levels of income have been determined before the onset of such disability.

Variables

Dependent variable: a person is classified as experiencing disability if they answer that they have severe difficulty or are unable to perform at least one of the six basic activities of daily living (BADLs): getting into/out of bed; walking inside the house; bathing/showering; using the toilet (urinating/defecating); dressing; eating. For each activity, respondents were asked: do you face a significant difficulty performing this activity? The levels of difficulty are: no difficulty, moderate, severe and cannot do it. People who reported the last two levels were selected because they were strongly associated with a need for help.

Main independent variables: level of education in two categories: low (up to completed primary school included) and high (completed secondary or higher education). Income in two categories: low (below 625 euros a month per consumption unit) and high (above that threshold). The threshold chosen is the median of the income per consumption unit. This income is calculated to account for economies of scale in households and obtained by dividing the total household income (including the interests produced by savings and rents obtained from property) by the number of consumption units or individuals; units are calculated using the modified OECD scale and the INE calculation methodology [16]. The main independent variables were first considered as discrete ordinal variables and then dichotomous variables. The bivariate analysis showed that relationships with disability were clearer when the effects were expressed as dichotomous.

Adjustment variables: gender and age (continuous). When adjusting the different models, we calculated the
mean-centered age to avoid multicollinearity problems with its square, which has been used for achieving linearity with the logit.

Statistical analysis

First, bivariate analyses were conducted of each of the independent variables with the dependent variable. Then, several binary logistic regression models (logit link) were applied to the weighted sample: bivariate; adjusted for gender and age; and finally with all the variables and the interaction between level of education and income. The odds ratio (OR) and its confidence intervals (CI) were calculated for each variable.

After the model was adjusted, the atypical residuals were seen to accumulate in individuals without disability. In other words, the model was less accurate when predicting the probability of disability in healthy individuals. This pattern of residuals, coupled with the huge imbalance in the proportion in the sample of individuals with and without disabilities, led us to think we were wrong to assume the symmetry underlying the logit link, which presupposes that the predicted probabilities are symmetric about 0.5. Therefore, another method that takes into account the detected asymmetry had to be sought.

The method chosen was to fit a new model using a scobit link between the dependent variable and the other variables. The scobit link helps to better classify individuals, such that individuals predicted with disabilities will be differentiated better from individuals predicted as healthy, because adding an auxiliary parameter decreases the predicted probabilities of individuals without disabilities; therefore, the scobit link is more robust and discriminates better than the logit link [17]. The different requirements of the models were also checked: goodness of fit (McFadden’s R2, Pearson’s X2); absence of multicollinearity (VIF—variance inflation factors) and presence of outliers and/or influential values (standardized Pearson residuals and leverage values).

To capture the survey design effect, a complex sample analysis was performed. All the analyses were carried out with the Stata 12.0 statistical package.

Results

The initial number of individuals in the study was 45,553 (43.7 % male), of whom 4096 had no information on some of the variables (9.0 %), and so were discarded, meaning that the final number of individuals in the study was 41,457. Of these, 3970 had disabilities (9.6 %). Of the missing cases, 99.3 % did not respond to income, 43.6 % were male, and 8.2 % were disabled. The descriptive data are shown in Table 1. The people who have difficulties in performing activities of daily living are older because their average age is 83.2 years compared to an average of 74.4 years in people who do not have difficulties; more of them are women (71.2 %); and they have a low level of education and income (91.3 and 60.5 %, respectively). All comparisons of variables between people with and without difficulties are statistically significant at \( p < 0.001 \) (Table 2).

Table 1 Description of study variables

<table>
<thead>
<tr>
<th>Total ((n = 41,457))</th>
<th>Without disability ((n = 37,487))</th>
<th>With disability ((n = 3,970))</th>
<th>(p)</th>
<th>With disability (\text{row} %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age</td>
<td>75.2</td>
<td>74.3</td>
<td>83.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>95 % confidence interval</td>
<td>75.1–75.3</td>
<td>74.3–74.4</td>
<td>82.8–83.3</td>
<td></td>
</tr>
<tr>
<td>Column %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% men</td>
<td>43.7</td>
<td>45.2</td>
<td>29.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>% women</td>
<td>56.3</td>
<td>54.8</td>
<td>70.9</td>
<td></td>
</tr>
<tr>
<td>% low education level</td>
<td>83.4</td>
<td>82.5</td>
<td>91.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>% high education level</td>
<td>16.6</td>
<td>17.5</td>
<td>8.3</td>
<td></td>
</tr>
<tr>
<td>% low income</td>
<td>54.4</td>
<td>53.7</td>
<td>60.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>% high income</td>
<td>45.6</td>
<td>46.3</td>
<td>39.4</td>
<td></td>
</tr>
</tbody>
</table>

Source: INE: Survey on Disability, Personal Autonomy and Dependency Situations (EDAD), 2008

Table 3 shows the fit of different bivariate logistic models (first block in column) of each of the main dependent variables. Older people [OR 1.22 (CI 95 % 1.21–1.23)] and women [OR 1.16 (CI 95 % 1.14–1.18)] are most likely to be disabled, and people with a higher level of education [OR 0.38 (CI 95 % 0.34–0.43)] and income [OR 0.72 (CI 95 % 0.66–0.78)] are less likely. The blocks in columns 2 and 3 show that the association of level of education with disabilities after adjusting for age and sex weakens [OR 0.58 (CI 95 % 0.51–0.67)], while the level of income association hardly changes [OR 0.71 (CI 95 % 0.65–0.77)], and both remain significant.
Table 4 presents the final model. Compared to the logit model (not shown), the scobit model reveals the same signs of the estimated coefficients for the adjustment and independent variables, but the intensity of the associations drops slightly with the dependent variable. The age and sex associations remain as strong as in the previous models: age has an OR of 1.21 for its mean-centered value, and an OR of 0.997 for its square of the mean-centered value. Being a woman increases the odds ratio of having a disability by 9%. The interaction between education and income is significant ($p = 0.016$). The effect of this interaction shows that in people with low educational level, the odds of having a disability are 21% lower in those with high income than in those with low income [OR 0.79 (CI 95% 0.72–0.88)]; while in people with a high level of education, these odds are 43% lower [OR 0.57 (CI 95% 0.40–0.81)]. In another model (not shown), the triple education, income and sex interaction was not significant ($p = 0.769$); also, when separate models were used for men and women, the interaction between income and educational level was not statistically significant in either of the two models. The scobit link does not dramatically change the goodness of being classified as experiencing or not experiencing disability, and also predicts lower probabilities of experiencing disability for the non-disabled: the ratio of the average of the predicted probabilities for those with disabilities to the average of the probabilities predicted for those without any is 16.3 in the scobit link compared to 3.1 logit link; so, the scobit model is more discriminatory.

Figure 1 shows the predicted probabilities of disability according to this final model. People with low education level and low income have a probability of being disabled of 10.7%; this probability is 8.7% if they have high income; that is similar to people with high education level and low income (9.1%); people with both high education and income have a probability of 5.5% of being disabled.

**Discussion**

The adjustment variables are associated with the prevalence of disability as expected: women and older people are more likely than not to have disabilities. People with a higher level of education are less likely to experience disability than those with a lower level [18, 19]. The association is weakened when adjusting for sex and age, probably because the studies are heavily stratified by sex and age in the Spanish population. The result of the quadratic term of age in the final model indicates that as people get older, the association between age and disability becomes more moderate. In this population, experiencing disability is associated with income as expected: the higher one’s income, the less likely one is to experience disability. The most remarkable finding is the existence of an interaction between education level and income, in which education level significantly amplifies the association of higher income with less disability. When the level of education is higher, higher income is associated with a

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Percentage of population according to income and level of education; in brackets, prevalence of disability in each group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low education level</td>
</tr>
<tr>
<td></td>
<td>(n = 34,557)</td>
</tr>
<tr>
<td>Low income</td>
<td>59.5 (11.1)</td>
</tr>
<tr>
<td>High income</td>
<td>40.5 (9.7)</td>
</tr>
<tr>
<td>$p &lt; 0.001$</td>
<td></td>
</tr>
</tbody>
</table>

Source: INE; Survey on Disability, Personal Autonomy and Dependency Situations (EDAD), 2008

Column percentages of population

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Bivariate models, adjusted for age and gender, of disability and socio-economic variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Bivariate models</td>
</tr>
<tr>
<td></td>
<td>BADL difficulty</td>
</tr>
<tr>
<td></td>
<td>2. Education level</td>
</tr>
<tr>
<td></td>
<td>OR</td>
</tr>
<tr>
<td>Centered age</td>
<td>1.22</td>
</tr>
<tr>
<td>Squared centered age</td>
<td>0.997</td>
</tr>
<tr>
<td>Woman (ref. men)</td>
<td>1.16</td>
</tr>
<tr>
<td>High education level (ref. low)</td>
<td>0.38</td>
</tr>
<tr>
<td>High income (ref. low)</td>
<td>0.72</td>
</tr>
</tbody>
</table>

$n = 41,457$

BADL basic activities of daily living, OR odds ratio, CI 95% 95% confidence interval, ref reference category
stronger decrease in the prevalence of disability; when the
level of education is low, this decrease is not so strong.
This highlights that people with fewer (educational and
financial) resources are more vulnerable to disability in any
of the scenarios. In any case, our results are cross-sectional
and cannot be used to establish causal relationships; the
conclusions must be prudent. In addition, although the ra-
tios between prevalences are big, the differences are
smaller, due to the low disability prevalences overall.

The predicted probabilities of disability (Fig. 1) confirm
the interaction (the lines of each level of education are not parallel) and show a compensating effect between education and income: the probability of being disabled for people with more education and less income is similar to that of people with less education and more income.

This finding suggests that in a context such as Spain,
with a low level of education among older people (9.3 % illiterate, 40.2 % of people with incomplete primary school and 33.9 % with primary school or an equivalent), providing extra income across the board could have the effect of increasing health inequalities, because people with a
better level of education would stand to benefit most. Re-
ducing these inequalities would involve focusing society’s
efforts on people with the lowest income. This is the per-
petuation of inequality debate [20–23]. It is easier to im-
prove older people’s financial circumstances than their formal education, so our findings support the adoption of certain measures to reduce the prevalence of disability. For example, one measure could be to increase monetary support (with minimum supplements for pensions or oth-
ers) for poorer households or to reduce their costs through free prescriptions or discounts on medicines and other health expenses, or also through price discounts in trans-
port and other public services [24]. These measures should help to reduce inequality in disability among the groups studied, although other authors say that although more social justice can be attained, it is less clear that health inequalities will be reduced [25]. By contrast, measures such as providing universal economic benefits might not be an appropriate strategy, because people with a higher level of education would benefit most. This latter circumstance might have occurred in the development of the Spanish Dependency Act [26], in the autonomous regions that have significantly applied widespread economic benefits, rather than a portfolio of services adjusted to the degree of dis-
ableity, even though the Act reserved economic benefits to exceptional cases (Article 18). At the end of 2010, financial benefits made 48.4 % of any kind of help to dependent people [27]. Indiscriminate policies might have a perverse effect. More contrast studies are required to confirm or reject this hypothesis.

An effort that our results also suggest would be to in-
crease the education provided from the earliest stages of
life [28]. Education acts in various ways: first, it creates
more job opportunities, providing access to better jobs and
better pay; second, it develop skills, habits and behaviors

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**Table 4** Final Scobit model of disability and socio-economic variables

<table>
<thead>
<tr>
<th>BADL difficulty</th>
<th>Final scobit model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
</tr>
<tr>
<td>Centered age</td>
<td>1.21</td>
</tr>
<tr>
<td>Squared centered age</td>
<td>0.997</td>
</tr>
<tr>
<td>Woman (ref. men)</td>
<td>1.09</td>
</tr>
<tr>
<td>High education level (ref. low)</td>
<td>0.38</td>
</tr>
<tr>
<td>High income (ref. low)</td>
<td>0.79</td>
</tr>
<tr>
<td>Education level × Income</td>
<td>0.72</td>
</tr>
</tbody>
</table>

Interaction effect: high income (ref. low)

- With low educational level | 0.79 | 0.72–0.88 |
- With high educational level | 0.57 | 0.40–0.81 |

Model p value

| Pseudo-R2 (McFadden’s) | <0.001 |

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**Fig. 1** Probability of disability predicted by the final scobit model
that allow individuals to maintain a healthier lifestyle [29, 30]; it is related to better cognitive development, including memory, at the end of life [31].

Limitations and strengths. Apart from its cross-sectional nature, this study only looks at the associations with disability for basic activities. It would be interesting to confirm the findings for instrumental activities. There was a significant percentage of losses, primarily related to the level of income. Moreover, the selected individuals are less prone to disability. If, as described [32], fewer people with a higher level of income have taken part, our results may have underestimated the associations. The study was conducted among people living in family dwellings; including institutionalized people could present another scenario, albeit very small in size. The exclusion of people under the age of 65 has limited the potential impact of reverse causality, but there may be people in whom a chronic disease acquired before that age, and manifested later on, may have conditioned their income before reaching the age of 65. One of its strengths is the use of a very large representative sample that revealed interaction between independent variables. Using a scobit technique allows to correct the problems faced in logistic regression modeling that has a very unbalanced dependent variable.

Conclusion

A higher level of education significantly amplifies the inverse association of income with disability in Spanish older people, suggesting that people with a higher level of education would gain more than those with lower level of education from universal policies of cash benefits. This will result in an increase of health inequality. Unequal income redistribution policies should be accompanied by an accumulation of educational resources from the early stages of life to reduce inequality in the face of disability risk.

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Conflict of interest The authors declare that they have no conflict of interest.

Human and Animal Rights All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed consent Informed consent was obtained from all individual participants included in the study.

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