

Gender differences in the pathways to higher education

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It is well known that far fewer men than women enroll in tertiary education in the United States and other Western nations. Developed nations vary in the degree to which men are underrepresented, but the Organization for Economic Co-operation and Development (OECD) average lies around 45% male students. We use data from the OECD Education at a Glance statistical reports, the Program for International Student Assessment (PISA), and the World Values Survey to explain the degree to which men are underrepresented. Using a multiple regression model, we show that the combination of both the national reading proficiency levels of 15-y-old boys and girls and the social attitudes toward girls attending university can predict the enrollment in tertiary education 5 y later. The model also shows that parity in some countries is a result of boys' poor reading proficiency and negative social attitudes toward girls' education, which suppresses college enrollment in both sexes, but for different reasons. True equity will at the very least require improvement in boys' reading competencies and the liberalization of attitudes regarding women's pursuit of higher education. At this time, there is little reason to expect that the enrollment gap will decrease, given the stagnating reading competencies in most countries.

education | gender gap | reading | discrimination

In the majority of member nations in the Organization for Economic Co-operation and Development (OECD), fewer men than women enroll in tertiary education (across all subjects). In the United States, as an example, there were 2.4 million fewer men than women pursuing some form of postsecondary education in 2017 (Fig. 1). The potential for adverse social and economic outcomes associated with such large numbers of men who are ill-prepared for the modern workforce is well documented (1–4), and thus an understanding of this phenomenon is not only of scientific interest but also has broad social and policy implications.

Although men's underrepresentation in tertiary education is common across developed nations, there is substantive cross-national variation in the extent of their underrepresentation, suggesting multiple factors are contributing to this phenomenon. Approaching the issue from an international perspective enables consideration of broad social, as well as individual-level, contributors to the gender differences in tertiary enrollment. We propose a model that can explain the degree to which men are underrepresented in tertiary education across nations and that identifies the minimal changes that are needed to reach more equitable outcomes for both men and women.

Before the 1990s, men were overrepresented in tertiary education in most OECD nations, but the gap closed and then reversed. Historical changes in social attitudes toward girls' and women's education might explain why enrollment reached parity, but it cannot explain why men are now underrepresented in most developed nations. To explain this, we theorize that three separate mechanisms are at work; namely, 1) social attitudes toward women's education, 2) women's reading achievement, and 3) men's reading achievement.

Across the wide range of tertiary fields, from the arts to engineering, reading fluency, and comprehension are critical to the preparation for and success in all of them (e.g., textbooks, examination questions, or coursework instructions). The advantages of girls and women in reading competencies have been well documented (5–9) and are observed in all developed nations where they have been measured (10). Importantly, this gender reading gap is not a new phenomenon (5, 11), and thus cannot fully explain the more recent underrepresentation of men in tertiary education.

We tested the hypothesis that men's underrepresentation in tertiary education is a function not only of their weaker reading abilities but also of today's less discriminatory attitudes toward girls' achievement (Fig. 2). To do this, we examined enrollment data published by the OECD (12), national reading scores taken from the Program for International Student Assessment (PISA) (13–15), and national levels of the social attitude toward girls' university education, taken from the World Values Survey (16).

Using linear regression, we aimed to predict the national enrollment levels of men in tertiary education based on the national averages of adolescent boys' and girls' PISA reading scores and the national averages of social attitudes (i.e., “A university education is more important for a boy than for a girl”; Fig. 2). We used data sets with between 11 and 18 countries (for a complete list, see *SI Appendix, Table S1*) that included a total of 446,559 boys and girls (*SI Appendix, Table S2*). In order to align the PISA cohorts (of 15- and 16-y-olds) to the tertiary education enrollment data, we matched the PISA data collected in 2006, 2009, and 2012 with respective tertiary education enrollment

Significance

In most developed nations, fewer men than women enroll in postsecondary education, with the potential for long-term disruptions in social cohesion and economic development. The underrepresentation of men in college began in the 1990s and has frequently been discussed in national policy debates. To date, there is no comprehensive explanation as to why the underrepresentation of men is more severe in some countries than in others. Using data from 18 nations, we show that the underrepresentation of men is related both to secular changes in attitudes toward women's education and to boys' disadvantages in reading comprehension. Increasing men's engagement in postsecondary education will require significant improvement in boys' reading competencies.

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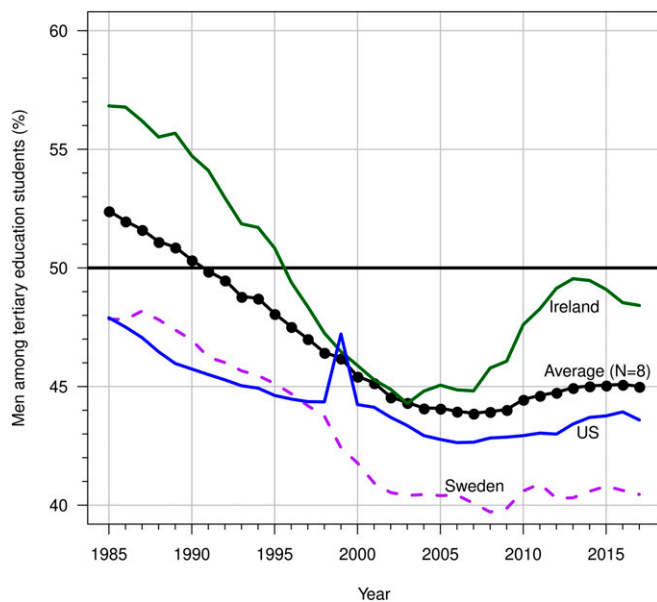


Fig. 1. The percentage of men among students enrolled in tertiary education (all age groups). Averaged data (black dots) from 8 OECD nations for which data for all years between 1985 and 2017, inclusive, were available. Of these, Sweden had the lowest percentage of men in 2017 (dashed) and Ireland the highest (green). The other included nations were Austria, Denmark, Finland, Spain, the United Kingdom, and the United States (US). See *Materials and Methods* for further details.

data 5 y later (i.e., 2011, 2014, and 2017). World Values Data were based on representative samples ($n = 28,207$) from the same nations for which PISA data were available. Data sets can be found in the *SI Appendix*.

We found that for each of the three periods, the percentage of men enrolled in tertiary education was well predicted by social attitudes and reading competencies (with adjusted R^2 ranging from 0.35 to 0.82; Table 1). In nations in which citizens had less discriminatory attitudes toward girls' university education and in which girls performed well in reading, more women than men enrolled in tertiary education. The enrollment gap declined in nations in which boys performed well in reading.

The results have important implications for better understanding men's and women's pursuit of tertiary education. Poor reading abilities are a more substantive impediment for men than for women, whereas discriminatory social attitudes are a more substantive impediment for women than for men. The importance of considering the differential influence of these factors is illustrated by Mexico, which has nominally achieved parity in tertiary education (in 2017, 49% of tertiary education students were men). Our model shows that this parity results from having one of the least positive attitudes toward women's university attendance combined with Mexican boys not reading as well as Mexican girls (Cohen's $d = 0.3$). In other words, in Mexico, both boys and girls are considerably disadvantaged, but their disadvantages cancel each other out in terms of enrollment, leading to apparent equity. The implication is that there are many women in Mexico who are well suited for university but who do not enroll because of discriminatory social attitudes. At the same time, there are more men than women in Mexico who cannot pursue college because of relatively poor reading competencies.

Second, the model allows prediction of the conditions that will remove barriers for men and women and result in parity in tertiary enrollment. If social attitudes for college attendance were equally positive for boys and girls in all OECD nations, without changes in reading competencies (Fig. 3A), the percentage of

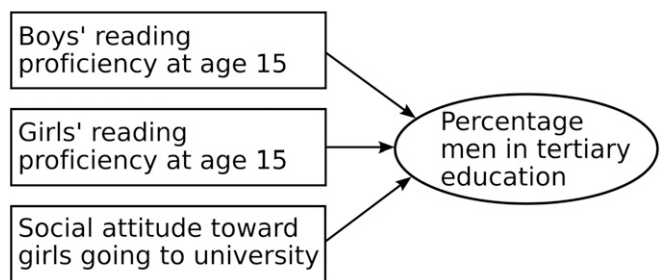


Fig. 2. Model of the main national-level variables that can predict the percentage of men enrolled in tertiary education. Because boys' reading proficiency at age 15 y is lower than that of girls, the percentage of men in tertiary education is below 50%. The discriminatory attitude toward girls attending university reduces men's underrepresentation. The existence of these opposite forces disadvantages both sexes but in different ways.

men in tertiary education would drop from 46% to between 35% and 42% ($M = 39\%$). If social attitudes remained unchanged while reading competencies reached parity, the international enrollment average would move close to parity ($M = 51\%$; Fig. 3B). With equity in both social attitudes and reading competencies, the situation would be similar to that found today (Fig. 3C). Moving beyond this impasse (to reach parity in enrollment) will require increasing the overall levels (for boys and girls) of reading competencies, in addition to achieving equity in social attitudes and parity in reading outcomes. With equal valuation of boys' and girls' college enrollment, nations that increase overall reading performance to the best found in the world for boys (a PISA reading score of 539 in 2006 in Korea) can expect a male enrollment rate of only 38% (*Materials and Methods*). Boys' (and girls') reading scores would need to be 700 PISA points to reach parity in university enrollment (*SI Appendix*; note that the OECD average lies around 500 PISA points). This is consistent with earlier findings that the gender gap in reading achievement becomes smaller at higher competency levels (17); that is, equity can only be reached by raising all student's reading skills.

The practical implication of our model is that equity in tertiary enrollment is well out of reach at this time. There is no good reason to expect that national reading levels (for either sex) will be raised much in the coming decade. This is because in the past decade (2009 to 2018), the majority of countries saw no increase in reading proficiency, and some previously much praised

Table 1. N s, adjusted R^2 , and standardized regression coefficients (β s) for the three different cohorts of 15-y-olds and their enrollment in tertiary education 5 y later

Period	Countries (N)	Adjusted R^2	Reading proficiency of boys (β)	Reading proficiency of girls (β)	Social value (importance of girls attending university) (β)
2006 to 2011	11	0.82	2.811	-2.234	-0.764
2009 to 2014	18	0.63	2.225	-1.778	-0.717
2014 to 2017	17	0.35	2.015	-1.851	-0.473

All beta coefficients were statistically significant ($P < 0.05$). The β s for girls are negative, because as girls' reading achievements increased, the percentage of men in tertiary education 5 y later decreased. The social values coefficients are negative because more women enroll in tertiary education in nations with positive attitudes toward girls' pursuing a university education.

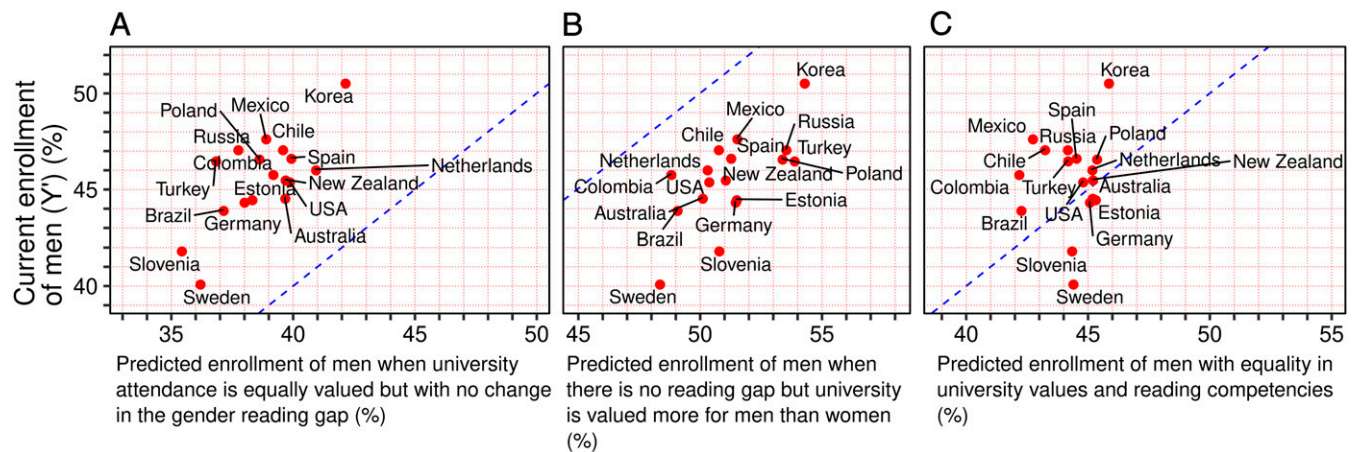


Fig. 3. Predicted result of achieving equity in social attitudes and reading competencies. All points are predictions based on the regression model for the 2012 through 2017 period. On the y axis, the model's predicted enrollment based on actual scores (Y'). The dashed blue line is the identity line ($x = y$). On the x-axis, the prediction under various conditions. (A) If university education is equally valued for boys and girls. (B) If boys and girls score equally in reading competencies (i.e., both groups score at the national average). (C) Equality in both social values and reading competencies. Note that ideal values in these two parameters still lead to an enrollment gap.

educational systems (including Finland and Iceland) experienced declines (10); only 11% of surveyed nations saw an increase in reading proficiency for both boys and girls (10). Although immediate changes are unlikely, the first steps toward equity in tertiary education would include educational policies that focus on increasing reading skills in both boys and girls, and at the same time raising aspirations for girls. The need for the latter is not obvious from the enrollment numbers themselves, but this is because boys' relatively poorer reading competencies mask the fact that girls still experience discriminatory attitudes in some countries.

While our model explains a significant proportion of the international variance in men's university enrollment, there are likely other contributing factors that we were unable to measure but would have improved our model. Generally, schools are less accommodating for boys than girls, in part because the school environment is a better match to the behaviors and attitudes of girls than boys (18). Aside from the general school environment and reading competencies, one well-documented but overlooked factor that might increase boys' and men's engagement with schooling is expansion of high-stakes assessments and curricula that capitalized on their visuospatial and mechanical reasoning abilities.

Visuospatial and mechanical reasoning abilities are important for achievement in the physical sciences and engineering, as well as in many vocations that require some tertiary education, but not necessarily a university degree (19–25). Individuals who excel in these areas (i.e., they are relatively better at spatial/mechanical reasoning than mathematics or reading) are more likely to be disengaged from school, less likely to attend tertiary education, and often less accomplished professionally, even if their overall mathematics and reading competencies are above average (19, 25). There are more boys than girls with this profile, and curricula changes that provide opportunities to capitalize on their strengths and corresponding interests might improve their overall engagement in primary and secondary schooling, as well as increase their numbers in tertiary education (26, 27). This is not to say that reading competencies are not critical: they are. Rather, improvements in overall reading competencies might not need to be as substantive as our models suggest to increase men's engagement in tertiary education if there were more opportunities for boys and men to capitalize on their spatial and mechanical strengths in educational settings.

Materials and Methods

Samples. Fig. 1 displays enrollment in tertiary education data for the period 1985 through 2017. This figure is based on two separate datasets downloaded from <https://stats.oecd.org>. Dataset 1, with data from 1985 through 2012, inclusive, can be found under the theme "Education and Training"/"Education at a Glance"/"Archive database"/"Student's enrolled by age." Dataset 2, with the additional data from 2013 through 2017, inclusive, can be found under the theme "Education and Training"/"Education at a Glance"/"Student's, access to education and participation"/"Enrolment by Age" (these data are also provided in the *SI Appendix*).

For the regression analyses, we used data from the PISA (cycles 2006, 2009, and 2012), Education at a Glance (2011, 2014, and 2017), and the World Values Survey (wave 6 collected in the period 2010 through 2014, which are the newest available data). Note that in different cycles, different countries and regions participated, as shown in *SI Appendix, Table S2*.

Representative samples of adolescents between the ages of 15 y and 3 mo and 16 y and 2 mo were tested in the PISA assessments. All participating children should have completed at least 6 y of formal schooling. All test material was translated, and where necessary, specific concepts were adjusted to the local culture. We analyzed national averages for reading comprehension of boys and girls, as published in the PISA reports (13–15) and also reported in the *SI Appendix* file.

To combine PISA cycles with tertiary enrollment data 5 y later, we chose the 2006, 2009, and 2012 PISA datasets and combined these with the OECD enrollment data 5 y later (i.e., 2011, 2014, and 2017, respectively). Although PISA data across this period are available for up to 68 countries and regions, we only included countries for which we had data for PISA, OECD enrollment, and the World Values Survey (see *SI Appendix, Table S1* for details).

Finally, from the World Values Survey (cycle 6), we took the 5-y average score for the statement "A university education is more important for a boy than for a girl."

Note that this statement captures bias against girls relative to boys, and thus not exclusively against girls. Participants had to choose one of four possible answers (Likert scale): strongly agree (1 point), agree (2 points), disagree (3 points), and strongly disagree (4 points). Data from the World Values Survey were collected over the period 2010 through 2014 in (up to) 18 countries for which also PISA and OECD enrollment data are available. We calculated the weighted average for each of these countries (these data are available in the *Dataset S1*). All World Values Survey data are available via <http://www.worldvaluessurvey.org>.

The OECD collates enrollment in tertiary education and publishes these data via its website (<https://stats.oecd.org/>) and Education at a Glance reports. We took data from 19- to 22-y-olds, because this is the range of ages of students who participated in a PISA-assessment 5 y earlier (depending on when exactly the PISA assessment took place in the year it was

administered). Polish tertiary enrollment data for 2011 were wrongly reported, and therefore not included.

Data Analysis. We used the statistical software R (<https://www.r-project.org>, version 3.6.1, function “lm”) for all regression analyses.

In the main article, we state that the best national reading PISA score for boys was 539 PISA points for Korea (in the 2006 PISA). We state that at this score (i.e., the same score for both boys and girls), the predicted male enrollment would be 38% when the valuation of university education for boys and girls is equal (i.e., a four-point score for the social attitude variable). This is based on using the (unstandardized) regression coefficients as follows:

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$$\text{Calculation Step 1: Predicted male enrollment} = 1.013671 + \text{boys_reading_score} * 0.002746 + \text{girls_reading_score} * -0.002053 + \text{social_attitude_score} * -0.250714$$

$$\text{Calculation Step 2: Predicted male enrollment} = 1.013671 + 539 * 0.002746 + 539 * -0.002053 + 4 * -0.250714 = 0.38 = 38\%$$

Note that the supplementary spreadsheet file (*SI Appendix*) gives readers the opportunity to engage with these models interactively.

Data Availability. All used data are provided in a spreadsheet document (*SI Appendix*).

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