

**Cross-national assessment of the associations between higher education and all-cause and diabetes-specific mortality: evidence from 35 OECD countries**

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## Introduction

Diabetes mellitus is the 8<sup>th</sup> leading cause of death worldwide, with an estimated 1.5 million deaths directly attributed to this disease each year (World Health Organization, 2016). It is a complex condition and is socially mediated. The social gradient of diabetes and other potentially preventable health outcomes is well established in the literature and increasingly recognized in diabetes care guidelines (Crowshoe et al., 2018; Hill et al., 2013). One aspect of the social gradient is education. Education has been deemed a “root cause” of health inequalities by some researchers; Mirowsky and Ross (2003) argue that greater education leads to occupational, social, and economic advantages that translate into healthier behaviours and lifestyles. Epidemiological research refers to education as a “social vaccine” for illnesses. Some argue that this effect is limited to countries that are later in the epidemiological transition (Smith et al., 2015). Several studies have looked at individual education levels and health outcomes, often arguing a causal link (Behrman, 2015; Monetz & Friendman, 2015; Viner et al., 2017). This research investigates the relationship between education and health outcomes from a cross-national comparative perspective. Specifically, we aim to see if the relationship between tertiary-level education and mortality holds at the population level in selected countries characterised by relatively higher burden of chronic non-communicable diseases, including diabetes.

The findings here suggest that the classic inverse relationship between education and mortality exists at the aggregate level of national statistics for 35 member states of the Organisation for Economic Cooperation and Development (OECD). However, researchers and decision-makers should use caution when considering education as a “social vaccine” for health outcomes; there are obvious improvements in health outcomes on a national scale for some aspects of health, but population education is also observed to occur alongside poorer health outcomes by other measures. In particular, we found that the social vaccine theory holds true for all-cause mortality and non-communicable diseases such as diabetes and ischaemic heart disease; however, greater education was also related with a marked increase in mental health mortality rates.

## **Research design**

### ***Data source***

This research uses health and social indicators from the *OECD Health Statistics 2017* database (OECD, 2017). All 35 OECD member nations are included in the analysis (see Appendix A). Data are categorized according to international classifications to enhance comparability of statistics and evidence. All indicators include both population totals as well as sex-stratified figures.

### ***Education indicator***

The education indicator used was the proportion of the working-age population (25-64 years) with tertiary education. The reference year for the education data varies slightly from nation to nation, but is the most recent year with complete data for all countries. Generally, this was either 2015 or 2016. Since education systems vary from country to country, tertiary education is categorized by the International Standard Classification of Education (ISCED) 2011 (Appendix B). This includes short-cycle tertiary education designed to prepare individuals for the labour market, as well as degree programs at both the undergraduate and graduate levels.

### ***Health indicators***

Health outcomes are examined through various mortality indicators. While this does not include morbidity or other impairment, death statistics generally tend to be more complete compared to other measures of health status. Mortality rates are based on 2012 figures, since this was the most recent year that all 35 member states of the OECD had publicly reported data. The data comprise age-standardised mortality rates. Age standardisation accounts for the difference in age structures of populations, and is useful for comparing characteristics across different countries. The OECD uses 2010 as the reference population for standardisation of death rates. Cause of death is based on the International Classification of Diseases, 10<sup>th</sup> Revision (ICD-10).

First, we include the all-cause mortality rate (age-standardised per 100,000 population) to get a general view of education against overall health.

Second, we look at mortality for diabetes mellitus and two other non-communicable health conditions: ischaemic heart diseases, and mental and behavioural disorders. The diabetes mellitus indicator includes type 2 diabetes (the most common form of the disease, making up about 90% of cases of diabetes), type 1 diabetes, drug or chemical induced diabetes, and other types of diabetes due to genetic defects or underlying conditions. Deaths due to gestational diabetes and metabolic disorders specific to newborns are excluded.<sup>1</sup> The ischaemic heart disease indicator includes deaths attributable to angina, acute myocardial infarction, ST-elevation myocardial infarction (STEMI), non-STEMI heart attack, and other acute and chronic ischaemic heart diseases and related complications.<sup>2</sup> Deaths due to mental health and behavioural disorders include a broad range of mental illness, such as dementia, drug and alcohol related disorders, schizophrenia, mood disorders, anxiety and stress disorders, and eating disorders.<sup>3</sup>

Lastly, we include indicators for communicable diseases and for external causes of death for comparison. Mortality rates for communicable diseases include deaths due to HIV/AIDS, tuberculosis, hepatitis, and other parasitic and infectious diseases.<sup>4</sup> External causes of death include, but are not limited to, the following: transport accidents, falls, intentional self-harm, assault, and natural disasters.<sup>5</sup>

### ***Statistical analysis***

We conducted correlation analysis through visual presentations (scatterplot diagrams) and calculation of the Pearson's correlation coefficient for population tertiary education

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<sup>1</sup> For more information on the group of metabolic conditions classified under diabetes mellitus in the ICD-10 included in this mortality rate, see: <http://apps.who.int/classifications/icd10/browse/2016/en#/E10-E14>.

<sup>2</sup> For more information on the group of conditions classified under ischaemic heart diseases in the ICD-10 included in this mortality rate, see: <http://apps.who.int/classifications/icd10/browse/2014/en#/I20-I25>.

<sup>3</sup> For a full list of mental health and behavioural disorders included in this mortality rate, see: <http://apps.who.int/classifications/icd10/browse/2016/en#/V>.

<sup>4</sup> For a full list of parasitic and infectious diseases included in this mortality rate, see: <http://apps.who.int/classifications/icd10/browse/2016/en#/I>.

<sup>5</sup> For a full list of external causes included in this mortality rate, see: <http://apps.who.int/classifications/icd10/browse/2016/en#/XX>.

attainment against the numerous mortality measures described above. The correlation coefficient (denoted by “*r*”) measures the strength and direction of a linear relationship between two variables. Its value ranges between -1 and +1, and can be interpreted as: -1 = perfect negative correlation, 0 = no correlation, +1 = perfect positive correlation.

## **Results**

### ***Description of national education and mortality levels***

Descriptive charts of the education and health indicators in the OECD countries are included in Appendices C and D, respectively. There is substantial variation in both education levels as well as mortality outcomes. Educational attainment ranges from 16.8% of working-age Mexicans to 56.3% of Canadians having a tertiary-level education (Fig. C1). The bottom countries in terms of tertiary education attainment are: Mexico, Italy, Turkey, Chile, and Czech Republic. The most educated countries are: Canada, Japan, Israel, the United Kingdom, and the United States. Educational disparities by sex are also widely varied. The widest gender education gap is in Estonia, and this with a gap favouring women: the percentage of working-age women with a tertiary education is 18.9 points higher than men (48.1% of women versus 29.2% of men) (Fig. C2). Women have the greatest education shortfall in Switzerland, where they fall 9.5 percentage points behind men (36.5% of women versus 45.9% of men). The least educated women (15.8%) in the OECD are in Mexico; likewise, fewer men (17.9%) are educated in this country.

The nations with the greatest all-cause mortality rates appear to be concentrated in Eastern Europe: Latvia, Hungary, Slovak Republic, Poland, Estonia, and Czech Republic (Fig. D1). The lowest mortality rates appear in Japan, Australia, Switzerland, Iceland, Canada, and France.

Diabetes imposes a considerable mortality burden in Mexico (Fig. D2), which is the country with the highest prevalence of diabetes among OECD countries (World Health Organization, 2016). The Mexican mortality rate related to diabetes is 144.5 per 100,000 population, more than three times greater than the next highest national rate, which is found in Turkey (43.6 per 100,000). Relatively fewer reported diabetes-attributed deaths are observed in

Japan (7.1), Finland (7.5), and Greece (7.8). The age-standardised diabetes mortality rate in Canada (19.5) lies close to the median rate for the 35 OECD countries (19.3).

In terms of selected other non-communicable conditions, ischaemic heart disease kills proportionately the most people in Eastern European nations: Latvia (356.5), followed by Slovak Republic (317.9) and Hungary (309.6) (Fig. D3). The lowest death rates from heart disease are in Japan (37.7), France (41.6), and Korea (43.2). Recorded mortality rates due to mental health and behavioural disorders range from 0.9 per 100,000 population in Greece to 53.3 in the United Kingdom (Fig. D4).

Mortality related to infectious diseases is found to be greatest in Israel (38.5) (Fig. D5). The next highest rates are approximately half as high, in Mexico (23.1) and the United States (22.2). The lowest rates of infectious disease mortality are seen in the Slovak Republic (3.9), Slovenia (4.6), and Finland (4.7). External causes account for proportionately more deaths in Latvia (86.4), Estonia (84.3) and Mexico (74.4), and fewer deaths in Turkey (24.8), Spain (26), and Israel (27.7) (Fig. D6).

### ***Correlation analysis of education and mortality***

The correlation analysis demonstrates a clear trend towards countries with greater proportions of the population with tertiary educations having lower all-cause mortality rates (Table 1). In this way, education can be seen as a social vaccine. The inverse relationship is similar for both sexes, but appears to be stronger for males ( $r=-0.57$ ) compared to females ( $r=-0.39$ ). Scatterplot diagrams visually illustrating the relationships between education and different mortality indicators can be found in Appendix E.

With regard to diabetes-attributable mortality, the expected relationship exists within the data for the 35 OECD countries: more highly educated populations also have lower mortality ( $r=-0.43$ ). In the case of diabetes, the effect was greater for females than males ( $r=-0.48$  and  $-0.31$ , respectively). We also ran the analysis excluding Mexico, since this country appeared to be an outlier for diabetes mortality (Fig. E4) and has low education numbers in the OECD context. Education was still revealed as a protective factor for health ( $r=-0.36$ ) among the remaining 34 member states (not shown).

**Table 1: Correlation coefficients for the relationship between tertiary educational attainment and selected mortality indicators, by sex, 35 OECD countries**

	All-cause mortality rate	Mortality rate for selected causes				
		Diabetes mellitus	Ischaemic heart disease	Mental health and behavioural disorders	Infectious and parasitic disease	External causes of death
<b>Total</b>	-0.51	-0.43	-0.31	0.51	0.16	-0.08
Female	-0.39	-0.48	-0.21	0.44	0.14	0.24
Male	-0.57	-0.31	-0.42	0.50	0.17	-0.28

Source: OECD Health Statistics and authors' calculations.

Results show that more highly educated populations also have lower mortality from ischaemic heart diseases ( $r=-0.31$ ), but the relationship is less strong than that observed for diabetes (which itself is a risk actor for heart disease), especially among the female population.

Mental health and behavioural disorders do not follow the expected pattern of education as a social vaccine. A strong direct association is found, with countries having more educated people simultaneously experiencing higher mortality from mental health and behavioural disorders ( $r=+0.51$ ). This association holds for both males and females.

The correlation coefficients for education versus mortality due to infectious diseases ( $r=0.16$ ) or due to external causes ( $r=-0.08$ ) suggest only weak relationships, compared to the two non-communicable conditions considered here. Sex-stratified results present little difference in the nature or strength of the relationship of education with infectious disease mortality. In contrast, when it comes to external causes of death, whereas in the male population being more highly educated is associated with lower mortality ( $r=-0.28$ ), a greater proportion of highly educated women is associated with higher mortality ( $r=+0.24$ ). Absolute rates of external cause mortality tend to be lower among females than males (Figs. E17 and E18, respectively).



## Discussion

Our analysis of comparable health and social statistics from 35 OECD countries revealed the expected relationships of lower all-cause mortality and diabetes-attributable mortality with higher educational attainment at the population level. Health outcomes including mortality are often described as following a social gradient. Several other factors such as healthcare resourcing, healthy public policy, genetic predisposition and ethnic composition, and built environment and other socioecological characteristics can also be at play, but are beyond the scope of the present study. Moreover, some nuance to the results is revealed by considered a gendered analysis. In the case of diabetes, the social gradient is found to be greater for females than males.

Certain other health conditions, notably ischaemic heart disease, also appear to be protected by having a more educated society, although the relationship is less strong than that observed for diabetes. On the other hand, deaths attributed to mental health and behavioural disorders occur relatively more frequently in countries with greater proportions of working-age adults with tertiary education. Research elsewhere has suggested that university-educated individuals are diagnosed with such disorders at a far greater rate than the rest of the population (e.g., Eisenberg et al., 2007).

There are some limitations to this research. Tertiary education was measured in quantitative terms only, and not in terms of the quality of learning or health-promoting school initiatives. Health outcomes were assessed by mortality alone, and not morbidity or quality of life. Given medical advances and the long lasting nature of chronic disease, people with diabetes and other chronic disease may live many years with their condition, potentially leading to loss of wellbeing and ability to work or perform activities of daily living.

Despite a perception of the OECD being a group of (relatively homogeneous) high-income countries, member states represent a wide diversity of social, economic, political, and cultural contexts from North and South America to Europe and Asia-Pacific. Many of these countries have developed market economics, but the group also includes emerging countries like Mexico and Turkey. This diversity is reflected in the range of results found here, despite some common trends. While lower mortality rates for (potentially preventable) diabetes and

heart disease are generally found to be associated with increased tertiary education at the aggregate level of national statistics, caution should be exercised when considering education as a “social vaccine” for chronic non-communicable diseases. Mortality due to mental health and behavioural disorders is a notable exception to the pattern. In addition, opposing trends by gender are observed for mortality due to external causes. This analysis presents interesting exploratory results, but more research is needed to better understand the underlying factors influencing relationships between education and diabetes-related and other health outcomes at the population level.

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## **Appendix A: Countries included in the analysis**

The 35 member nations of the OECD (as of May 2018) are:

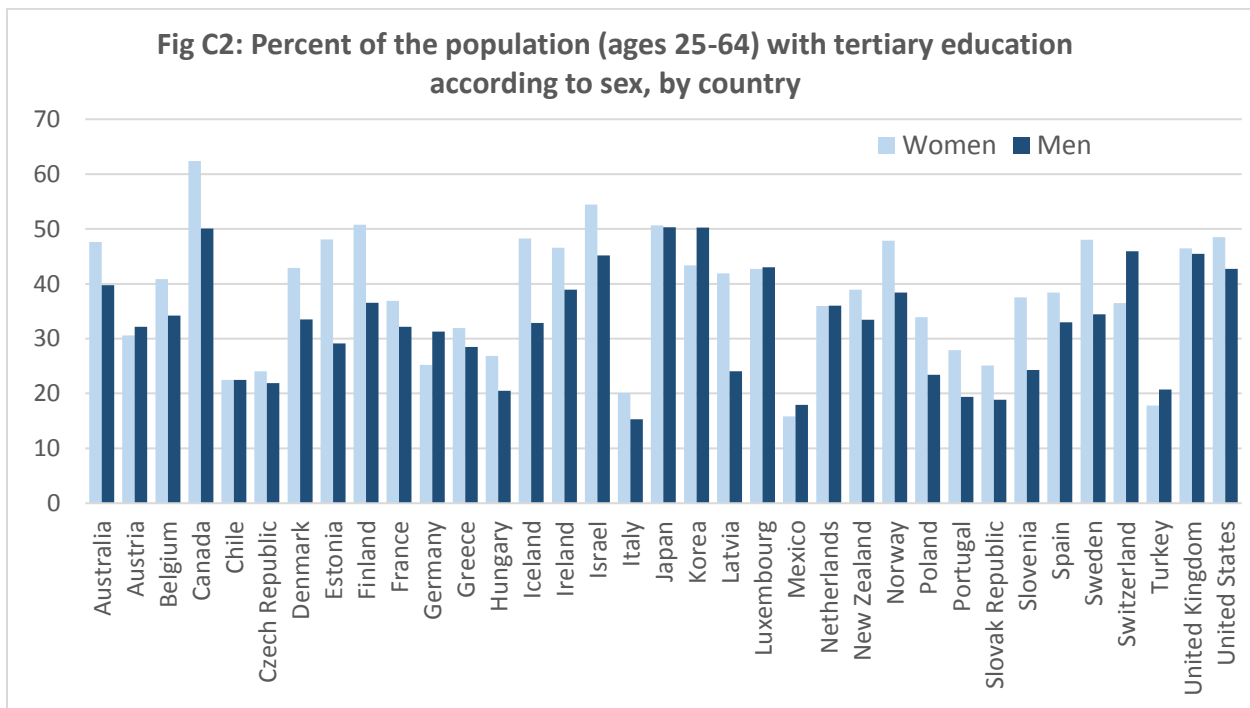
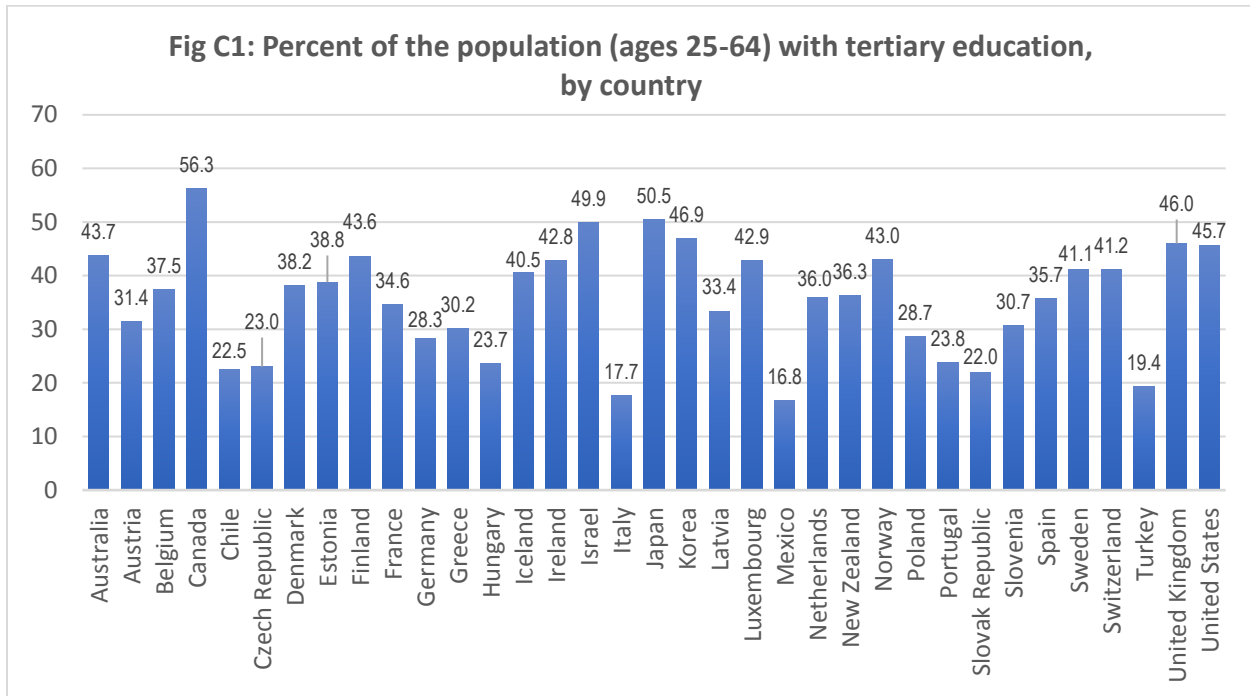
1. Australia
2. Austria
3. Belgium
4. Canada
5. Chile
6. Czech Republic
7. Denmark
8. Estonia
9. Finland
10. France
11. Germany
12. Greece
13. Hungary
14. Iceland
15. Ireland
16. Israel
17. Italy
18. Japan
19. Korea
20. Latvia
21. Luxembourg
22. Mexico
23. Netherlands
24. New Zealand
25. Norway
26. Poland
27. Portugal
28. Slovak Republic
29. Slovenia
30. Spain
31. Sweden
32. Switzerland
33. Turkey
34. United Kingdom
35. United States.

## **Appendix B: Education levels in ISCED 2011**

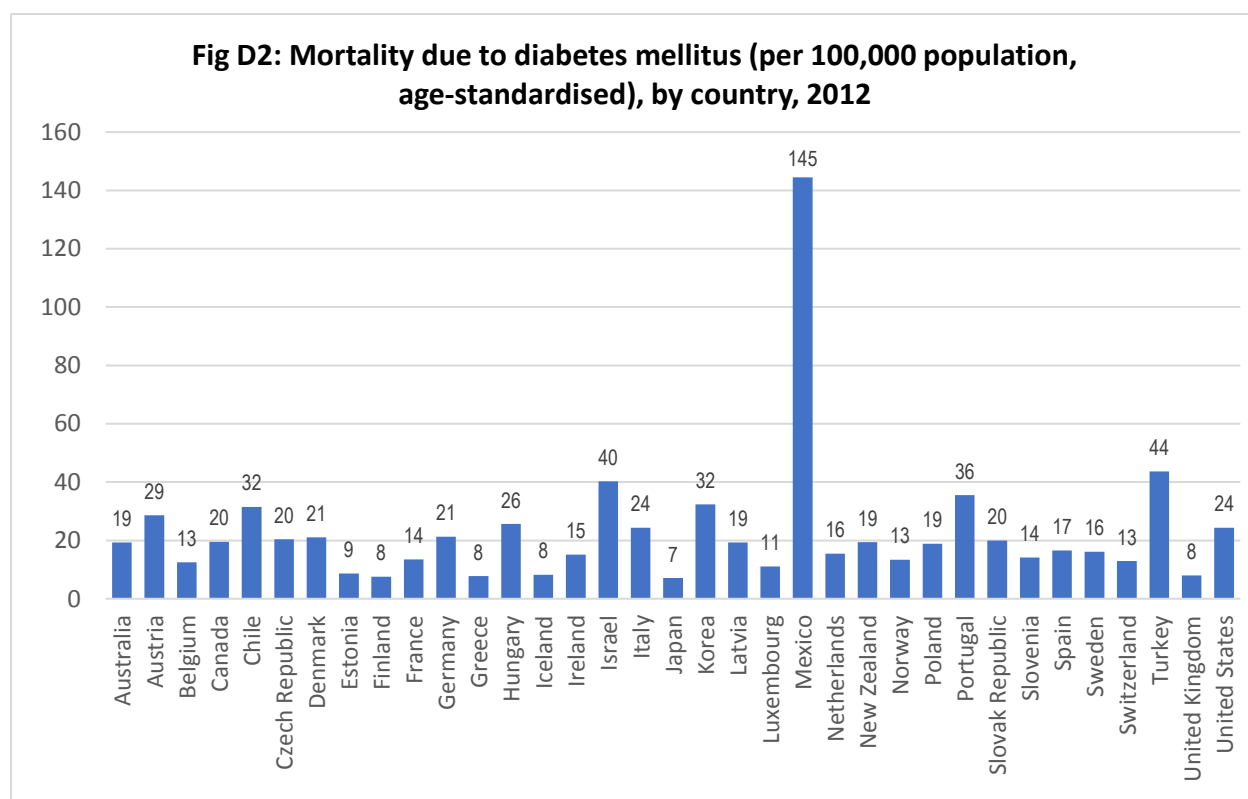
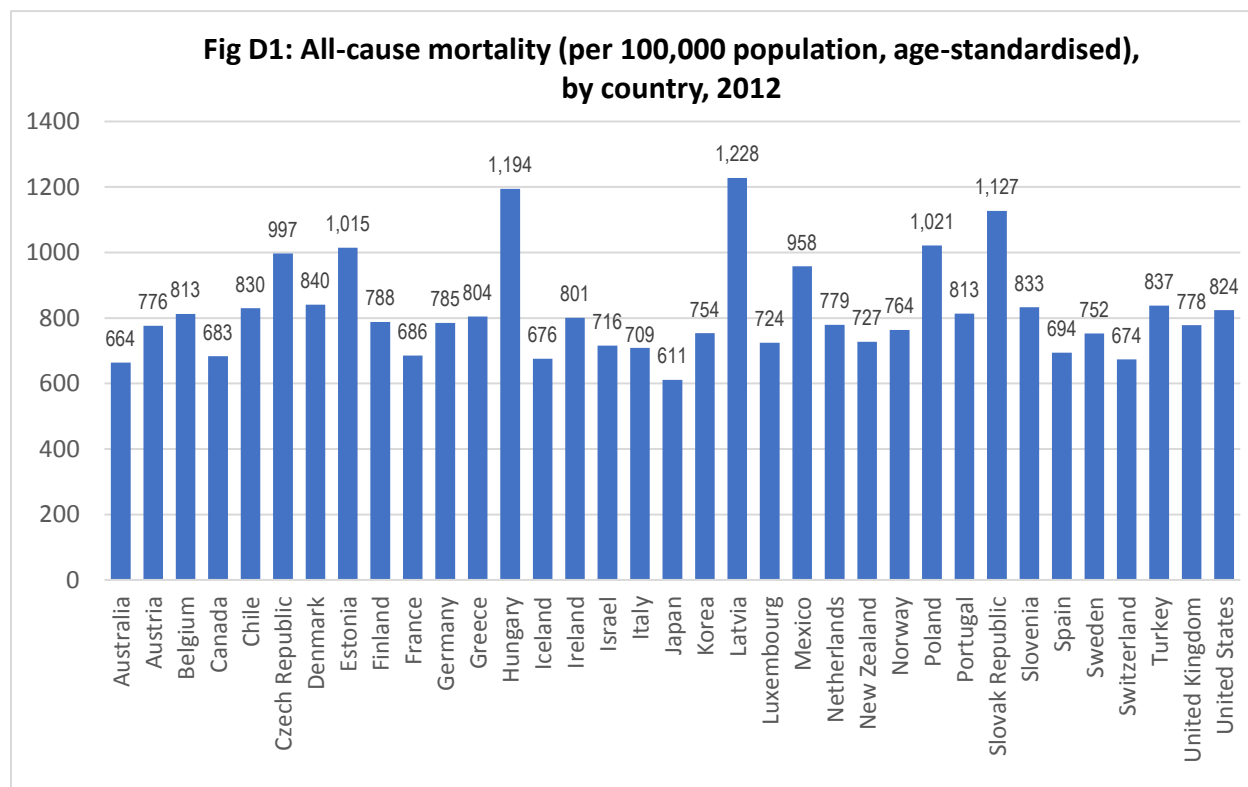
Levels of education classified for purposes of statistical organization and reporting in the 2011 revision to the International Standard Classification of Education (ISCED), maintained by the United Nations Educational, Scientific and Cultural Organization (UNESCO), are:

- 0 Early childhood education
- 1 Primary education
- 2 Lower secondary education
- 3 Upper secondary education
- 4 Post-secondary non-tertiary education
- 5 Short-cycle tertiary education
- 6 Bachelor or equivalent level
- 7 Master or equivalent level
- 8 Doctoral or equivalent level
- 9 Not elsewhere classified.

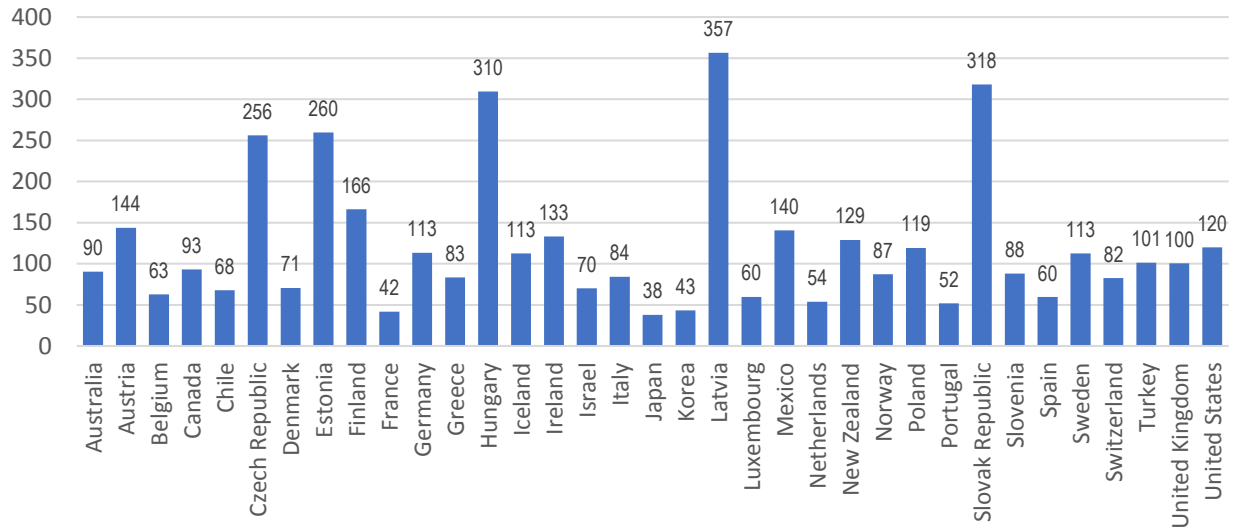
## Appendix C: Descriptive charts of education indicators



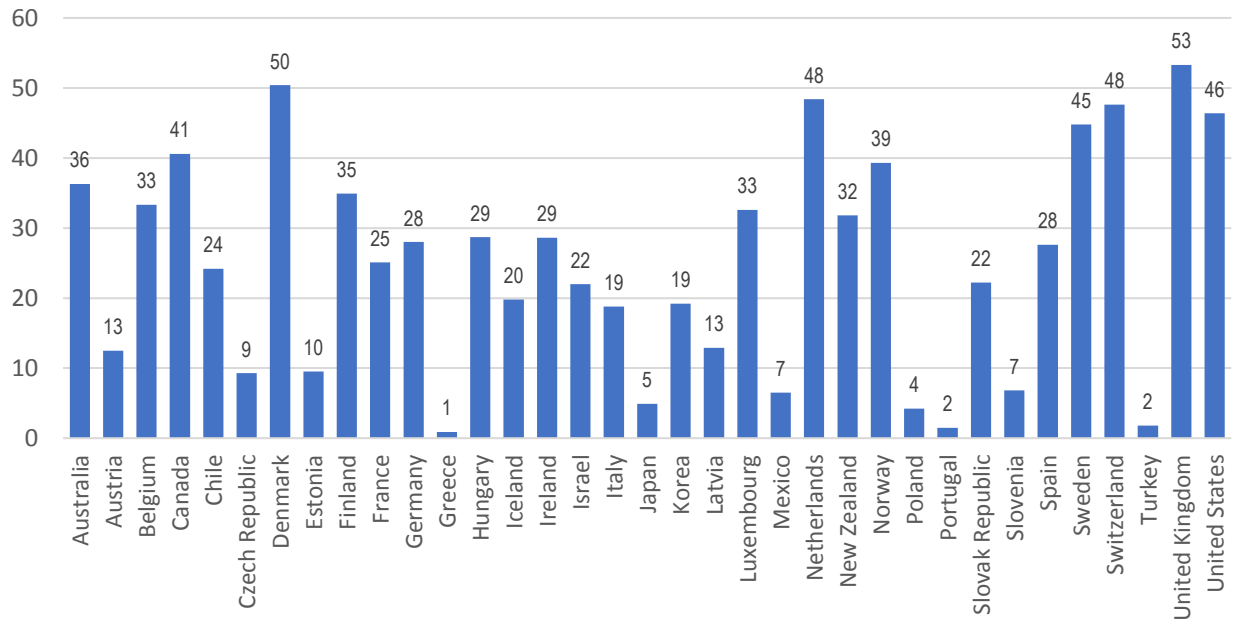
## Appendix D: Descriptive charts of mortality indicators



**Fig D3: Mortality due to ischaemic heart disease (per 100,000 population, age-standardised), by country, 2012**

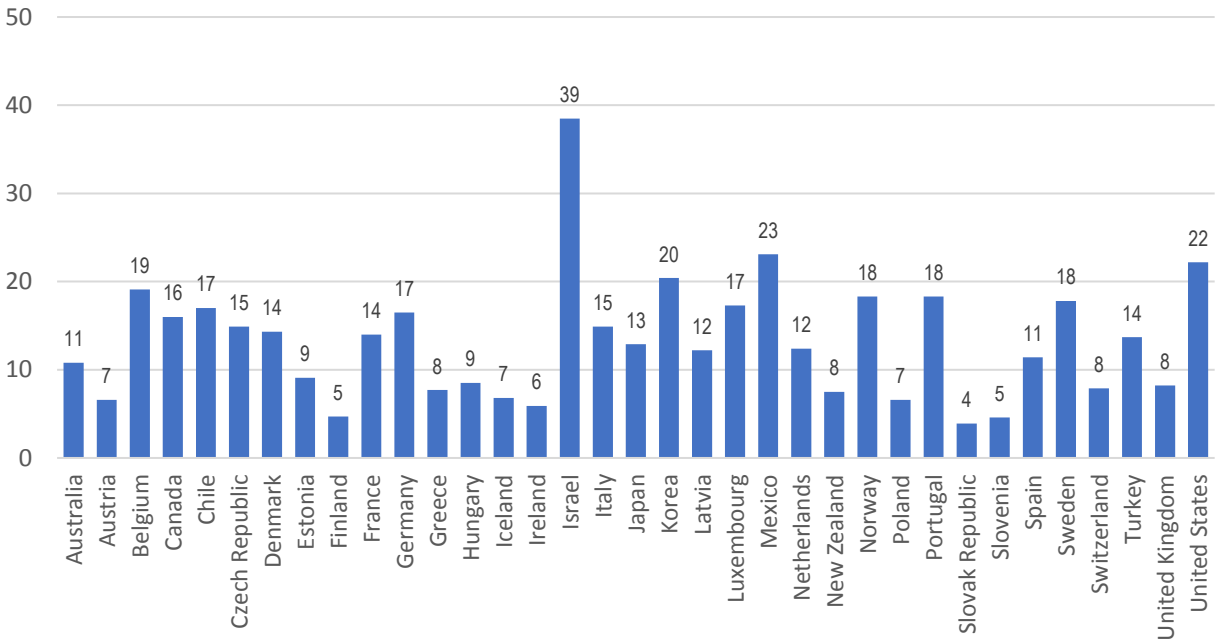


**Fig D4: Mortality due to mental health and behavioural disorders (per 100,000 population, age-standardised), by country, 2012**

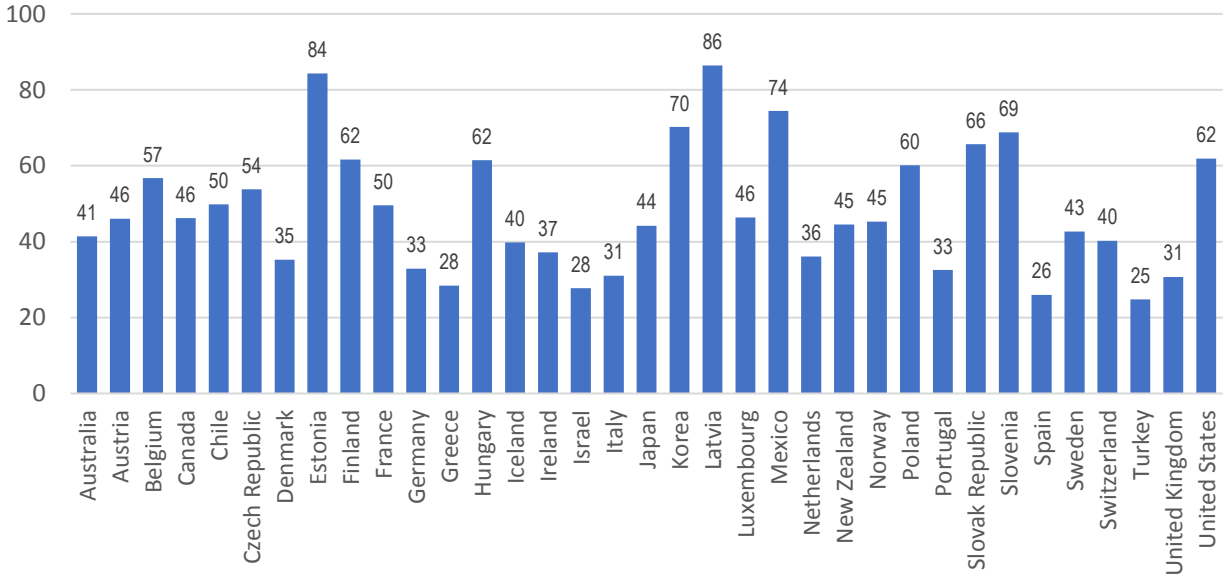




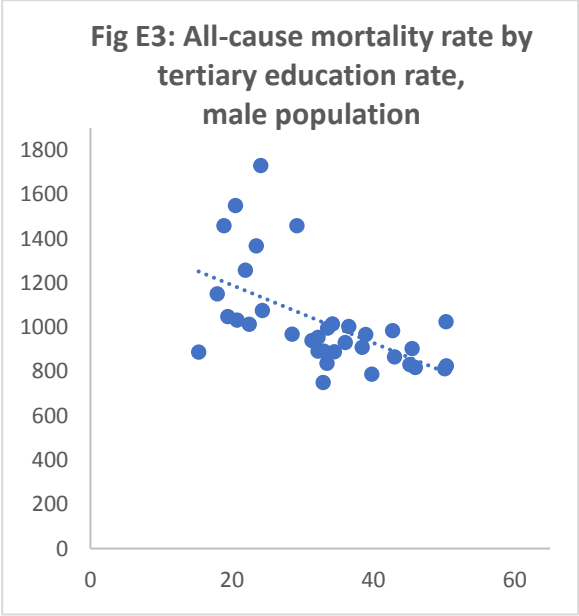
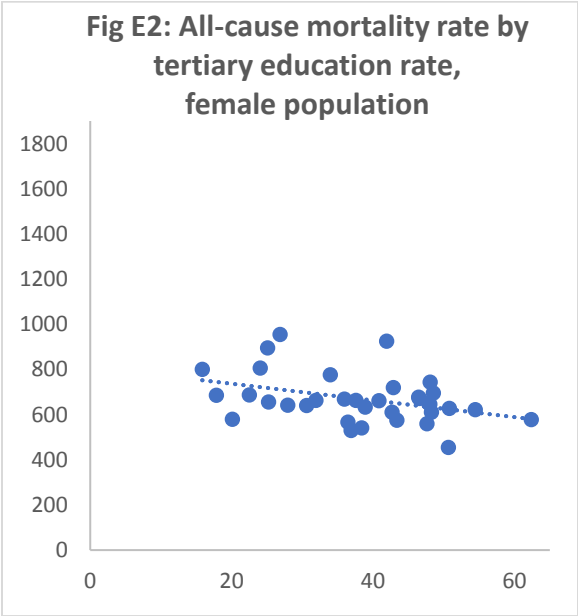
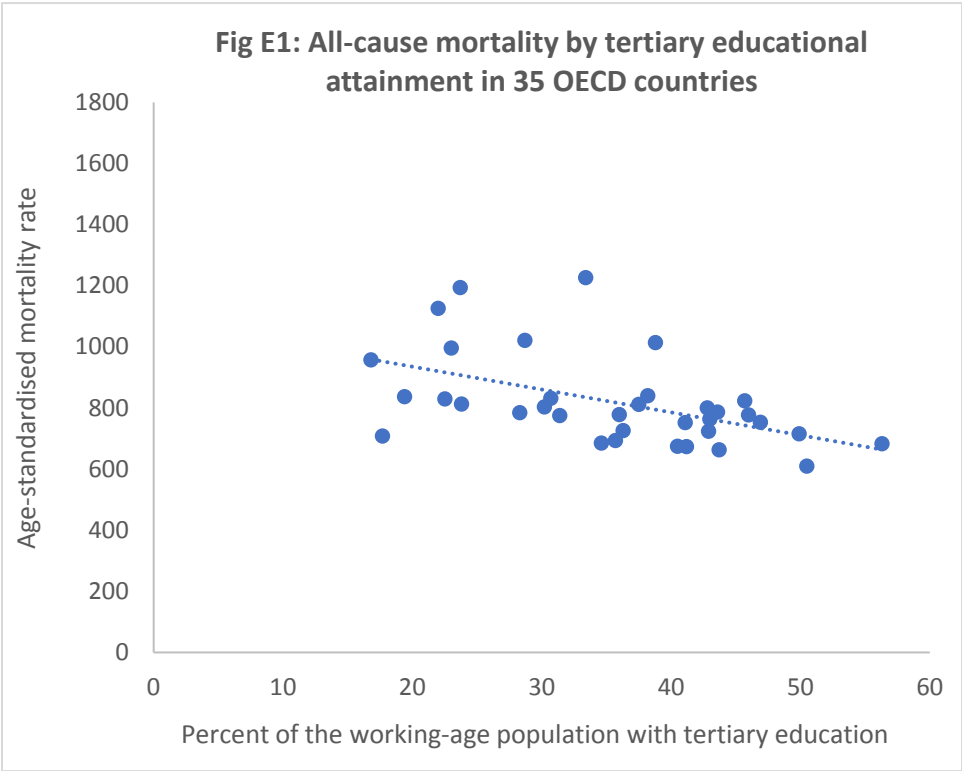
**Fig D5: Mortality due to infectious and parasitic disease (per 100,000 population, age-standardised), 2012**



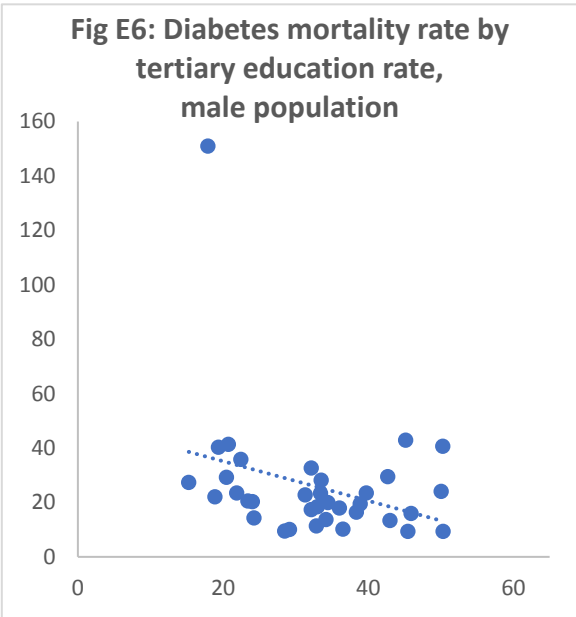
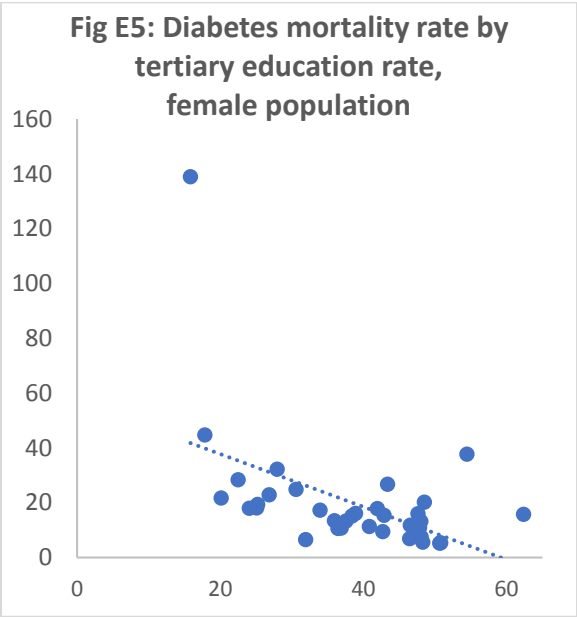
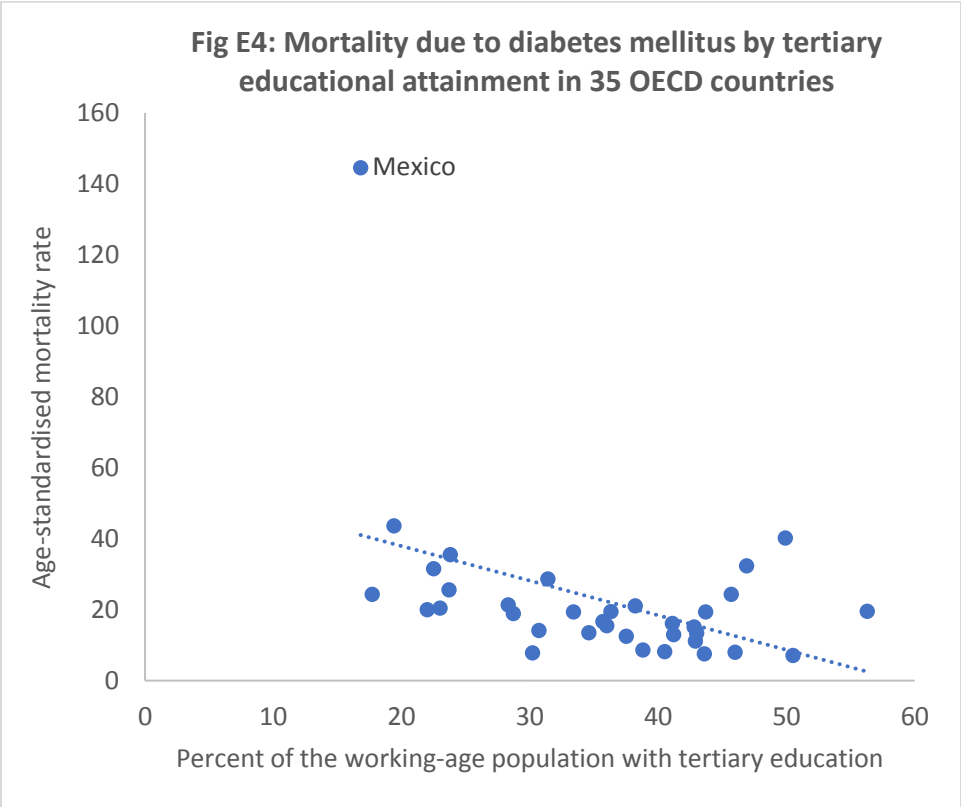
**Fig D6: Mortality due to external causes (per 100,000 population, age-standardised), 2012**

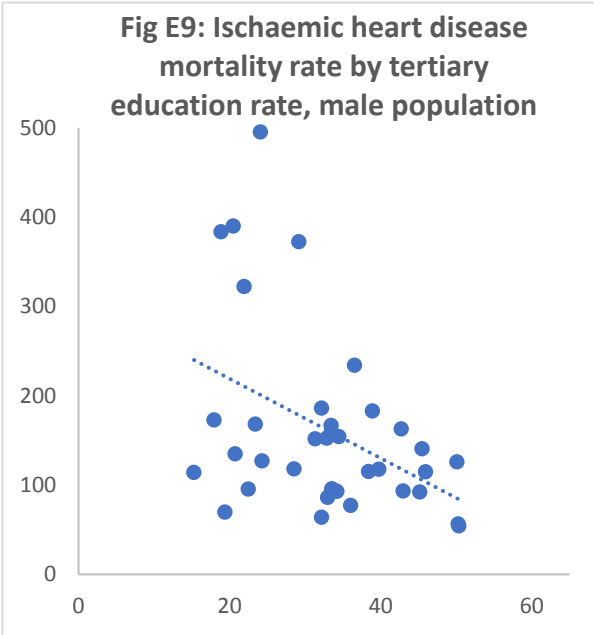
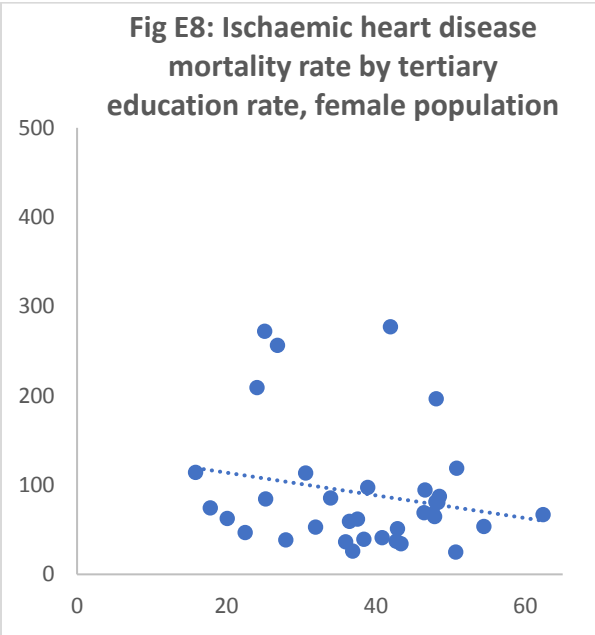
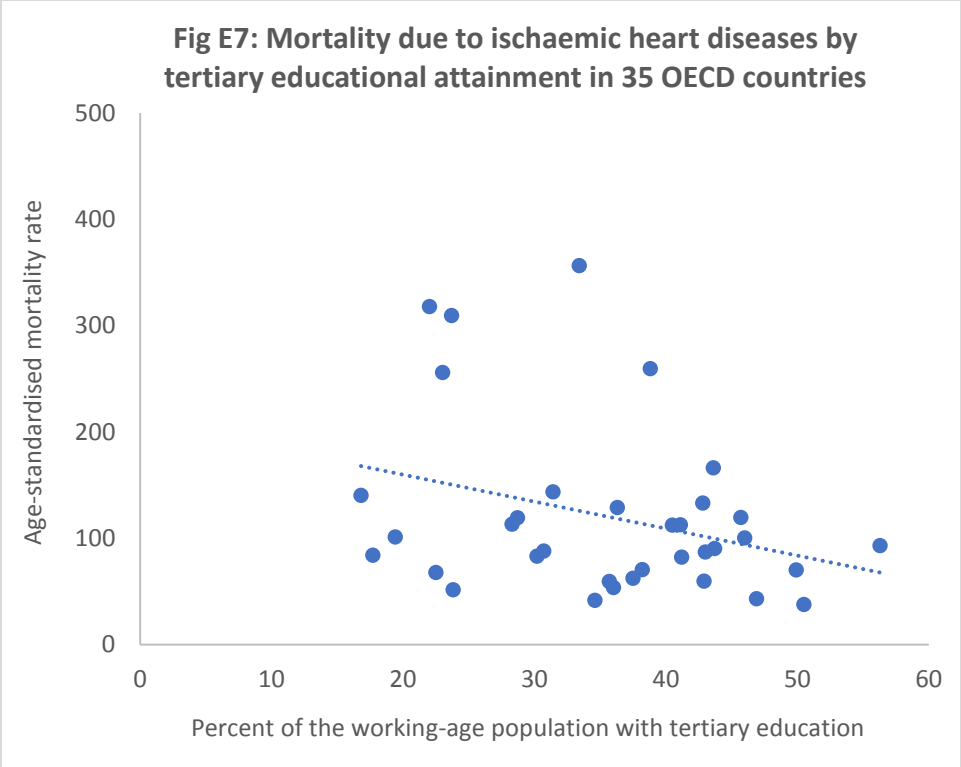


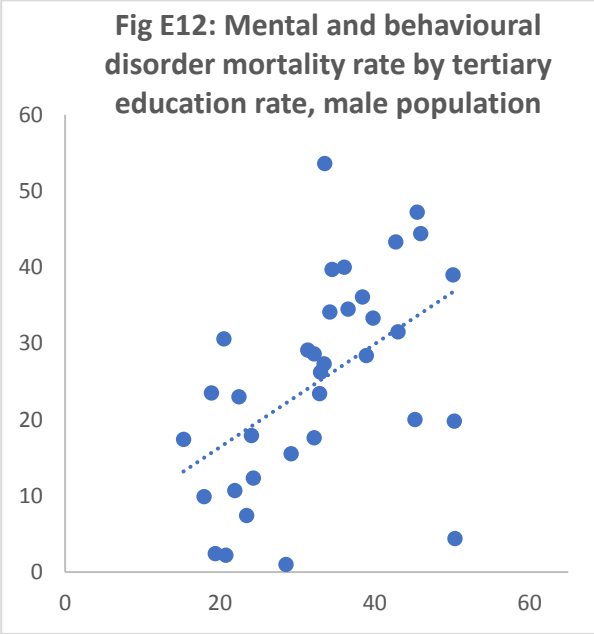
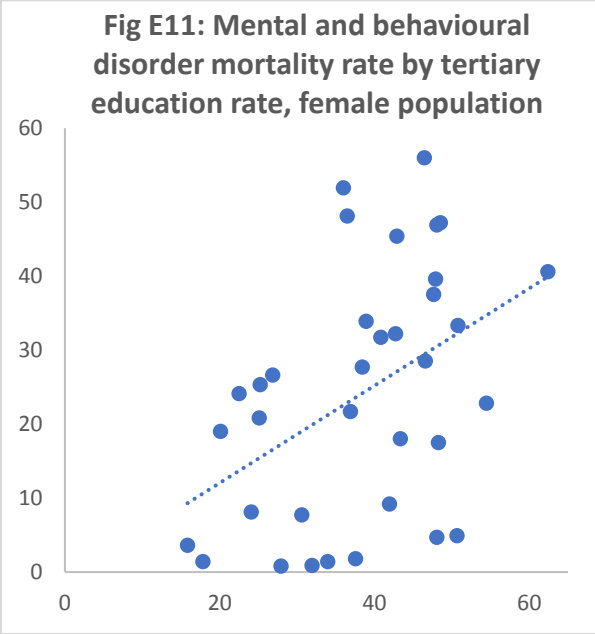
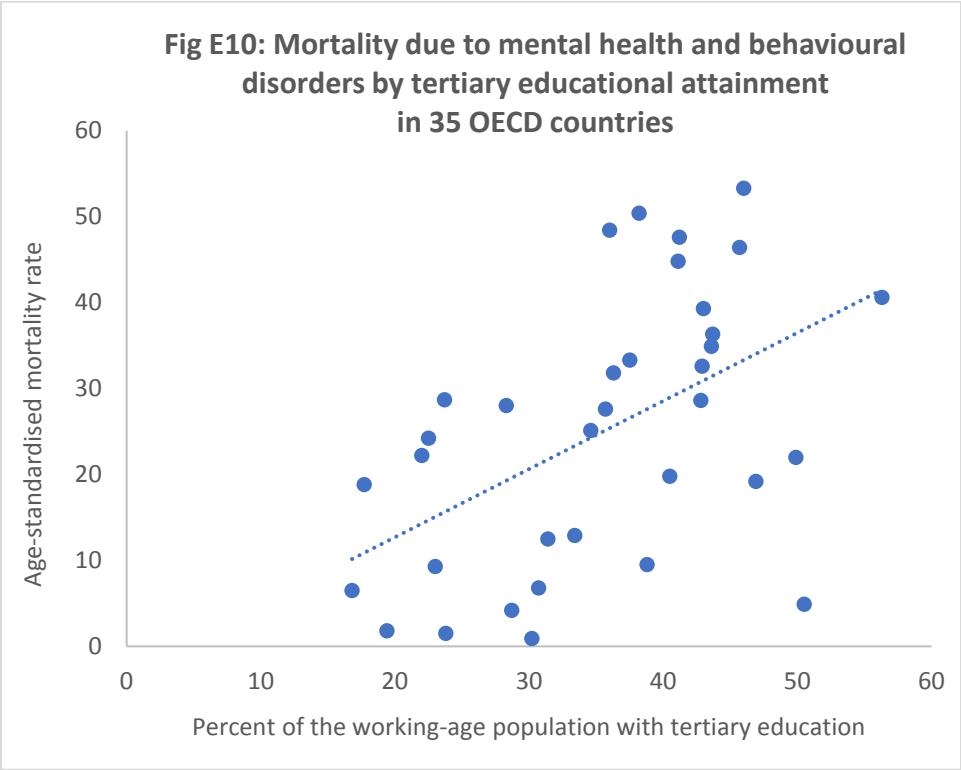
**Appendix E: Scatterplots of the relationships between education and mortality**

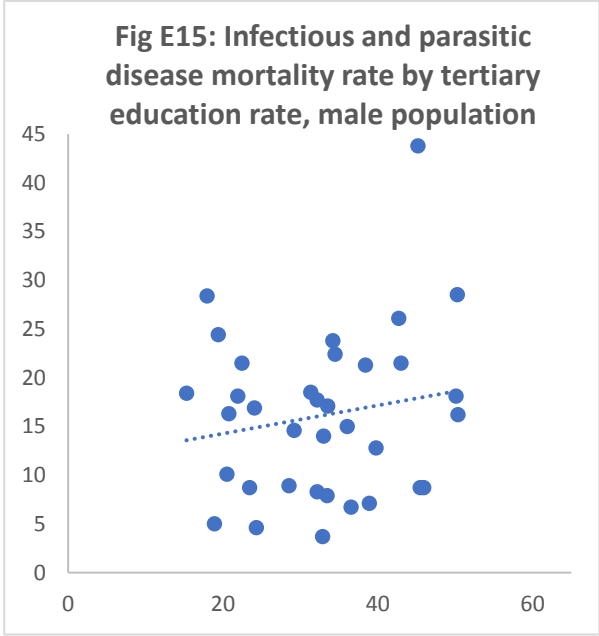
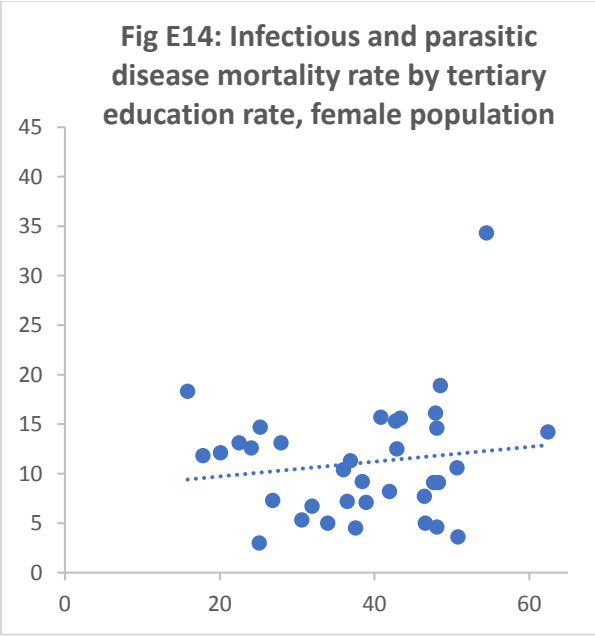
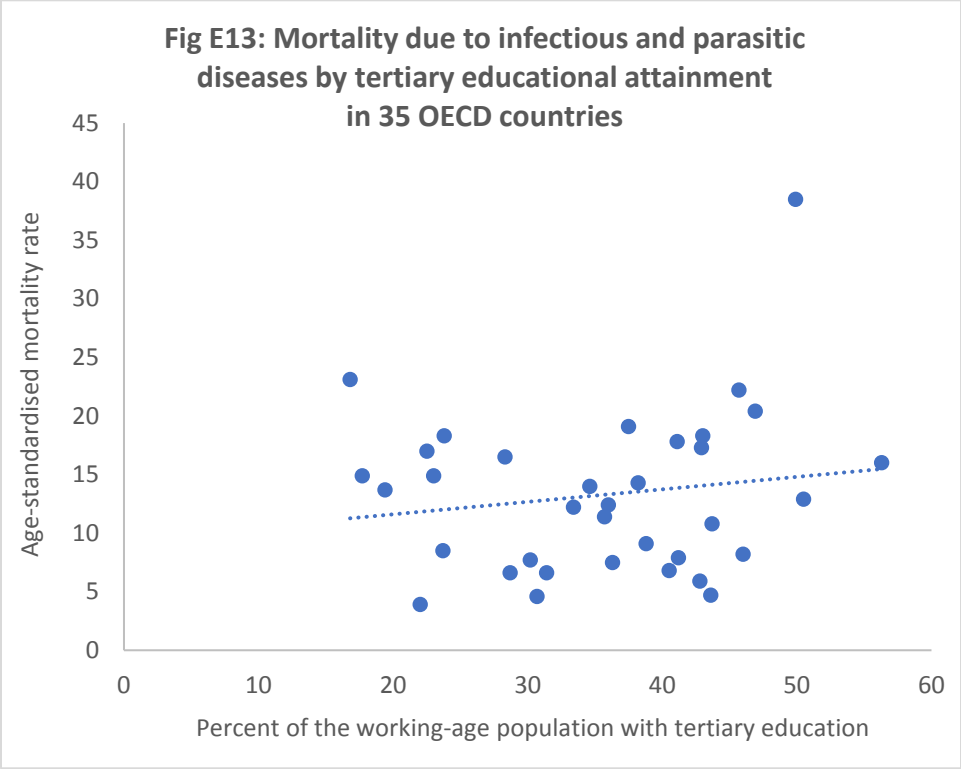


Note: Lines on the charts illustrate the best-fit straight line through the data.

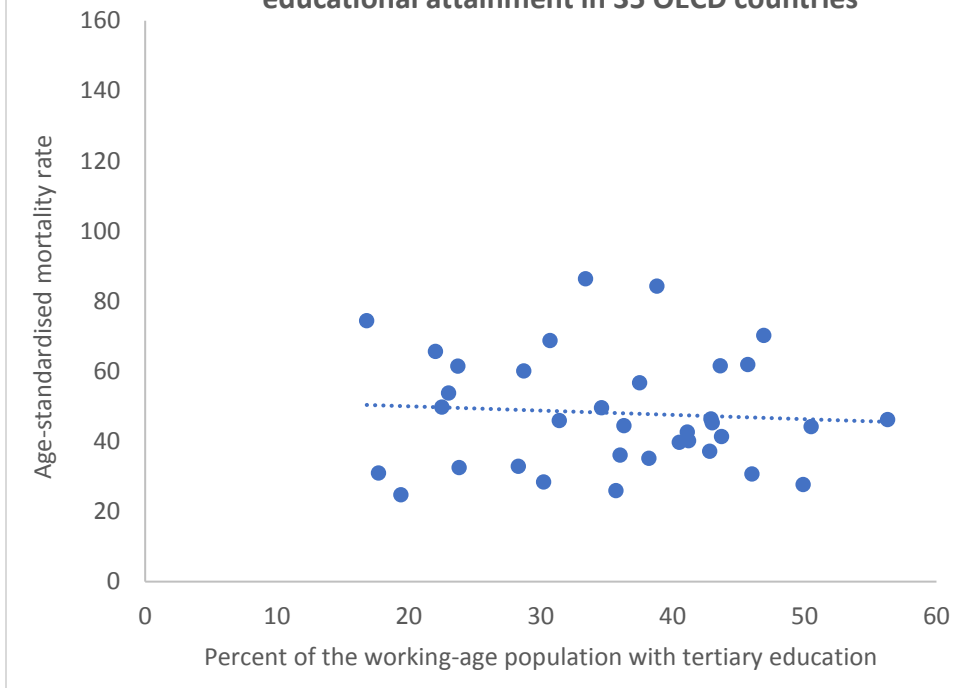




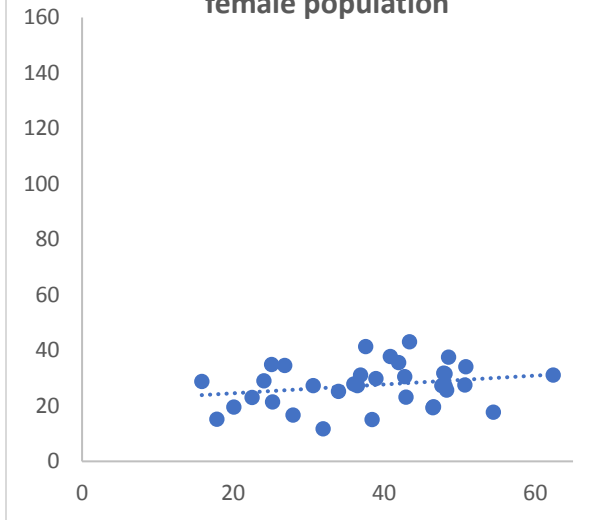




**Fig E16: Mortality due to external causes by tertiary educational attainment in 35 OECD countries**



**Fig E17: External cause mortality rate by tertiary education rate, female population**



**Fig E18: External cause mortality rate by tertiary education rate, male population**

