

Education, Employment, and Life Expectancy: A Cross-National Analysis of Social Determinants of Health

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ABSTRACT

Life expectancy is an indicator of health of the population and is influenced by social, economic, environmental and health system factors. Although there has been an improvement in longevity, disparities between countries and socioeconomic status remain. The present study investigated the relationship between education level and employment-to-population ratio with life expectancy at birth. We performed a cross-national observational study with country-year data from global health and socioeconomic databases. The analytical data set included 1,795 country-year observations from 171 countries from 2000 to 2021. The outcome was life expectancy at birth, and the explanatory variables were educational attainment and employment-to-population ratio. Descriptive statistics described patterns by World Bank income groups. Comparisons between income groups were made using Kruskal–Wallis tests, and associations were tested using Spearman rank correlation. Multivariate OLS regression models with hierarchical structure were adjusted for socioeconomic group, WHO region and calendar year. Mean life expectancy was 77.19 ± 6.54 years, educational attainment was $82.38 \pm 21.58\%$, and employment-to-population ratio was $56.15 \pm 9.95\%$. Life expectancy rose from 62.68 years in low-income countries to 81.34 years in high-income countries. Educational attainment was positively correlated with life expectancy ($p = 0.577$, 95% CI 0.540–0.608; $p < 0.001$), whereas employment showed no association ($p = 0.003$; $p = 0.891$). In the fully adjusted model, education remained positively associated with life expectancy ($\beta = 0.620$, 95% CI 0.249–0.990; $p = 0.001$), but employment was not ($\beta = -0.128$; $p = 0.201$). R^2 increased from 0.484 to 0.761. The results underscore the role of education in population-level determinants of longevity.

Keywords: Education Employment, Life Expectancy, Social Determinants Of Health, Health Inequalities, Socioeconomic Inequalities, Global Health, Cross-National Analysis

Introduction

Life expectancy is one of the most popular indicators of the health of a population added in this study Robine and Ritchie as it captures mortality at each stage of the life cycle and offers an interpretable measure of longevity at the population level adding by Heuveline. Although there has been significant progress in survival over the past few decades, this progress has not been uniform across the global insight by Meara, Leather. There remains a significant variation between countries in life expectancy, which is a measure of the potential for life extension and reflects inequalities in economic resources, education, living conditions, access to health care, social protection and other structural determinants of health as in many studies Organization. It is therefore important to understand the social conditions that underlie these differences in order to explain variation in

population health, as contributed by Robine and Ritchie. The social determinants of health framework acknowledge that health is not just the result of health care services added by Wyber, Vaillancourt but the result of social and economic conditions where people are born, grow, learn, work, and age studied by Reynolds and Ross the distribution of material resources, opportunities, risks and protective conditions across the life course are shaped by structural factors, these processes can lead to systematic differences between countries and socioeconomic groups in morbidity and mortality at the population level. Thus, variations in life expectancy can be seen as part of the wider social and economic inequalities concluded by Mackenbach, Valverde. Education is an important structural determinant of health. Education can play a role in health through a number of interrelated pathways such as health literacy, employment, income, social mobility, decision making and access to health promoting resources argued in these studies Nutbeam and Lloyd. Education might also help people access, comprehend, and utilize health information and negotiate complex health systems. This

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could lead to more positive health outcomes at the population level in countries with higher levels of education sighted by the link between education and economic development and other social determinants, however, should not be overlooked and is important to take into account when exploring the relationship between education and longevity adding by Hannum E [1-19].

The association of socioeconomic position with health is more nuanced than employment alone, as it is another core element of socioeconomic position added by Glymour, Avendano the job can generate income, social integration, economic security and access to social protection. In contrast, poor work conditions such as insecure work, occupational risks, low wages, too many hours, psychosocial stress, and insufficient workplace protections can have a negative impact on health described in Cerf. Therefore, the employment-to-population ratio gives only information on labour market participation and does not reflect the quality, security or health impacts of employment insight in Kühn this distinction is relevant for cross-national comparison, as there is a significant variation in the structures of labour markets. Education and employment are often seen together as social determinants of health; however, their associations with population longevity may differ. Furthermore, the observed associations can be significantly affected by national income, geographic region, and changes over time adding by Talukdar, Seenivasan. Cross-national longitudinal data offer a chance to study these relationships in a wide variety of socio-economic environments while controlling for significant differences across countries insights in Mazzonna [20-25].

The present study thus investigated the links between educational attainment, employment to population ratio and life expectancy at birth in the countries during the period 2000-2021. Specifically, we sought to: [1] describe distribution of life expectancy and the two social determinants in the analytical sample; [2] compare education and employment across World Bank income groups; [3] quantify the unadjusted associations of education and employment with life expectancy; and [4] assess if the association between education and employment with life expectancy remained after controlling for income group, WHO region and calendar year.

Methods

Study Design and Data Sources

We performed a cross-national observational analysis of country-year data from 2000 to 2021. Data were harmonized from internationally recognised databases on global health, education, labour-market and socioeconomic data. Data on life expectancy indicators were mainly gathered from the World Health Organization (WHO) Organization (4). The indicators related to education and employment were selected from well-known global development and labour-market data sources. Contextual variables were added to include world bank income group classifications and WHO regional classifications in this data study Organization (4). Standardized country identifiers and calendar year were used to harmonize the individual source datasets. The final master dataset included country-year data on various health and social indicators. Only the variables needed to answer the prespecified research questions were extracted for the present study.

Study Variables

Outcome Variable

Life expectancy at birth (years) was the main outcome. Life expectancy at birth is the average number of years a newborn is likely to live, based on the age-specific mortality rates experienced during a particular period of time and assuming that death rates remain constant throughout the person's life. The higher the number, the longer the population life expectancy.

Educational Attainment

Educational indicator is the education level completed (at least primary) among the population aged ≥ 25 years (%). This measure is the percentage of the adult population (25 years and older) with at least primary education. The higher the value, the more highly educated the adult population is.

Employment

Employment was measured as the employment-to-population ratio, which is the proportion of people aged ≥ 15 years who are in employment (%). This indicator is the percentage of the working age population that is in the labour force and gives a population figure of labour force participation.

Contextual Variables

Three contextual variables were added to the analytical framework to capture wider socioeconomic, geographical and temporal differences: World Bank income group, WHO region, and calendar year. The World Bank income group was divided into low income, lower middle income, upper middle income and high income. WHO region was defined based on the WHO analytical dataset, which includes six WHO regions. To account for temporal variation in life expectancy and social determinants over the study period, Calendar year was included.

Data Preparation

The contributing sources' data was harmonized at the country-year level. The country identifier was standardized to allow linkage between datasets and the temporal identifier was year. These were identified in the master dataset and were converted to numeric where applicable. Observations with missing data for one or more of the three main variables were dropped from the complete case analytical sample. The analytical sample was 1,795 country-year observations for 171 countries, and observations were made between 2000 and 2021. In the case of multivariable regression, observations were also required to have complete data for the model variables. This led to a regression sample of 1,772 observations from 169 countries.

Statistical Analysis

Life expectancy, education, and employment rate were used to calculate descriptive statistics. The distributions of observations across World Bank income groups and WHO regions were summarized and continuous variables were summarized using the mean, standard deviation, median, interquartile range, minimum and maximum. The Kruskal-Wallis test was used to measure differences in life expectancy, educational attainment and employment to population ratio between the World Bank income groups, due to the non-parametric approach for group comparison and the cross-national distributions. Spearman rank correlation coefficients were used to examine the relationship

between each social determinant and life expectancy. The correlation coefficients were presented as 95% confidence intervals with p-values. Next, in table 1 hierarchical ordinary least-squares regression models were fitted to explore the relationship between the social determinants and life expectancy, sequentially adding contextual variables.

Table 1: Hierarchical Regression Model Specifications

Model	Adjustment variables
Model 1	Educational attainment + employment-to-population ratio
Model 2	Educational attainment + employment-to-population ratio + World Bank income group
Model 3	Educational attainment + employment-to-population ratio + World Bank income group + WHO region
Model 4	Educational attainment + employment-to-population ratio + World Bank income group + WHO region + calendar year

Also, regression coefficients, 95% confidence intervals, p-values, R² and adjusted R² were presented. Heteroskedasticity-consistent standard errors were used for the primary regression analysis. Sensitivity analyses were conducted to test the robustness of the results by excluding 2020-2021 data, and by using country-level averages. Standard errors by country clusters were also investigated as a more conservative method of dealing with repeated observations across countries. All statistical tests were conducted in two ways and statistically significant p values were set at < 0.05.

Statistical Software

Python with the Google Colab environment was used for all data management, statistical analysis and graphical visualization. For data management and numerical computation, pandas and NumPy were used; for statistical testing, correlation analysis, and regression modelling, SciPy, statsmodels, and Matplotlib and Seaborn were used for graphical visualization.

Ethical Considerations

This study was based on publicly available data in an aggregated format, and there was no interaction with human subjects or identifiable personal information. Therefore, no individual informed consent was required nor was institutional ethical approval required to access these publicly available aggregated data for secondary analysis.

Results

The final analytical sample included 1,795 observations of countries over time (country-year observations) from 171 countries from 2000 to 2021. As presented in Table 1, mean life expectancy at birth was 77.19 ± 6.54 years, with a median of 78.53 years (IQR 75.02–82.04) and a range of 45.70–87.37 years. Mean educational attainment was $82.38 \pm 21.58\%$, with a median of 91.49% (IQR 73.10–99.31). The mean employment-to-population ratio was $56.15 \pm 9.95\%$, with a median of 56.79% (IQR 49.84–61.78).

Most observations (900, 50.1%) were from high-income countries. There were 505 observations from upper-middle income countries (28.1%), 284 from lower-middle income

countries (15.8%) and 83 from low-income countries (4.6%). For 23 observations (1.3%) income classification was not available. There was also uneven distribution of observations by WHO regions. The European Region accounted for 831 observations (46.3%), followed by the Americas (422; 23.5%), African Region (181; 10.1%), Western Pacific Region (155; 8.6%), Eastern Mediterranean Region (141; 7.9%), and South-East Asia Region (65; 3.6%).

As shown in Figure 1, the overall demographic and socioeconomic composition of the analytical sample is summarized in Table 1 and the baseline distribution of the three main study variables is presented, table 1 therefore provides the overall demographic and socioeconomic composition of the analytical sample and the baseline distribution of the three main study variables.

Table 2: Characteristics of the Analytical Sample

Variable	N	Mean $\pm$ SD	Median (IQR)	Range
Life expectancy at birth (years)	1,795	77.19 ± 6.54	78.53 (75.02–82.04)	45.70–87.37
Educational attainment (%)	1,795	82.38 ± 21.58	91.49 (73.10–99.31)	8.54–100.00
Employment-to-population ratio (%)	1,795	56.15 ± 9.95	56.79 (49.84–61.78)	20.78–87.38

The overall distribution of life expectancy is shown in Figure 1. There is significant variation in longevity by country-year observation with the majority of observations clustered at relatively high levels of life expectancy, but with a lower tail representing country-year observations with much shorter expected survival.

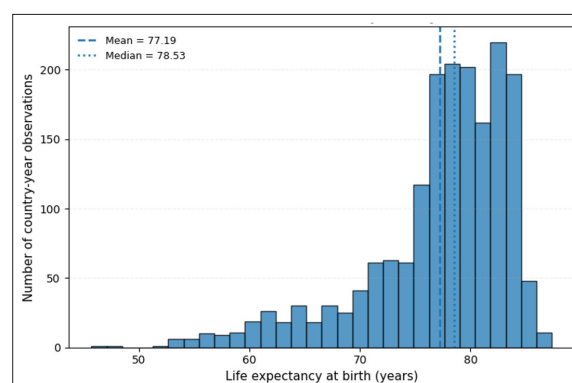


Figure 1: Distribution of Life Expectancy at Birth Across the Analytical Sample

Socioeconomic Gradient Across Income Groups

There were significant variations in life expectancy according to income group (Table 2). The average life expectancy was 62.68 ± 4.79 years in low-income countries. In lower-middle-income countries, it rose to 70.63 ± 6.25 years, while in upper-middle-income countries, it went up to 75.97 ± 4.48 years and reached 81.34 ± 2.76 years in high-income countries. So, the gap between the mean life expectancy of the low-income and high-income groups was about 18.66 years.

This socioeconomic gradient was even more evident for educational attainment. The mean attainment in low-income countries was $32.16 \pm 15.59\%$, lower-middle-income countries $60.60 \pm 20.97\%$, upper-middle-income countries $80.79 \pm 15.91\%$, and high-income countries $95.11 \pm 7.81\%$. The employment gradient was not as uniform. The mean employment-to-population ratio was $62.71 \pm 13.01\%$ in low-income countries, $55.04 \pm 14.27\%$ in lower-middle-income countries, $54.99 \pm 9.40\%$ in upper-middle-income countries and $56.41 \pm 7.79\%$ in high-income countries. Overall, the socioeconomic gradient was thus clearly stronger for life expectancy and educational attainment and less monotonic for employment participation, as summarized in Table 2.

Table 2: Life Expectancy and Social Determinants Across World Bank Income Groups

Income group	N	Lifeexpectancy Mean $\pm$ SD	Education, Mean $\pm$ SD	Employment, Mean $\pm$ SD
Low-income	83	62.68 ± 4.79	32.16 ± 15.59	62.71 ± 13.01
Lower-middle-income	284	70.63 ± 6.25	60.60 ± 20.97	55.04 ± 14.27
Upper-middle-income	505	75.97 ± 4.48	80.79 ± 15.91	54.99 ± 9.40
High-income	900	81.34 ± 2.76	95.11 ± 7.81	56.41 ± 7.79
Kruskal–Wallis H	—	1063.420	901.684	34.167
P-value	—	<0.001	<0.001	<0.001

This income-group trend in life expectancy is shown graphically in Figure 2. The figure demonstrates a clear gradient in life expectancy from low income to high income countries, with higher mean life expectancy with higher income.

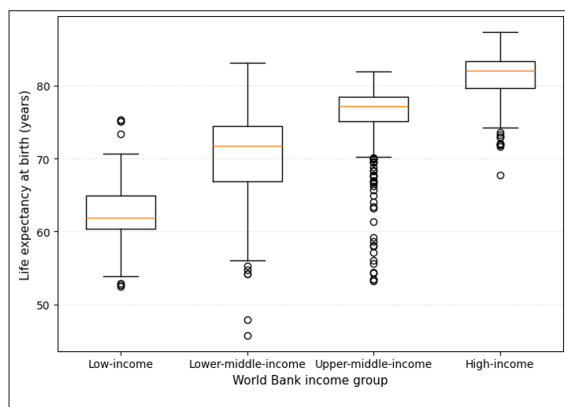


Figure 2: Life Expectancy Across World Bank Income Groups

The Kruskal–Walli's analysis showed that there were statistically significant differences in the three variables among the income groups. Differences were significant for life expectancy ($H = 1063.420$, $p < 0.001$), educational attainment ($H = 901.684$, $p < 0.001$), and employment-to-population ratio ($H = 34.167$, $p < 0.001$). The results presented here show a strong association between country income classification and both the distribution of population health and social determinants within the analytical sample, provided a list of correlations between social determinants and life expectancy.

Correlations Between Social Determinants and Life Expectancy
The correlation analysis showed significantly different patterns with regard to education and employment (Table 3).

There was a moderate positive correlation between educational attainment and life expectancy. The Spearman correlation coefficient between country-years and life expectancy was $\rho = 0.577$ (95% CI 0.540–0.608; $p < 0.001$), suggesting a positive correlation between country-years and life expectancy. This association was also evident visually, as in the case of Figure 3. Overall, the scatter plot shows a positive correlation between education level and life expectancy, with higher levels of

education generally associated with longer life expectancy. While there is a good deal of variation around the trend, the direction of association is definitely positive, and the outcome variable is life expectancy at birth (in years).

Table 3: Spearman Correlations Between Social Determinants and Life Expectancy

Predictor	N	Spearman's ρ	95% CI	P-value
Educational attainment (%)	1,795	0.577	0.540–0.608	<0.001
Employment-to-population ratio (%)	1,795	0.003	–0.045–0.052	0.891

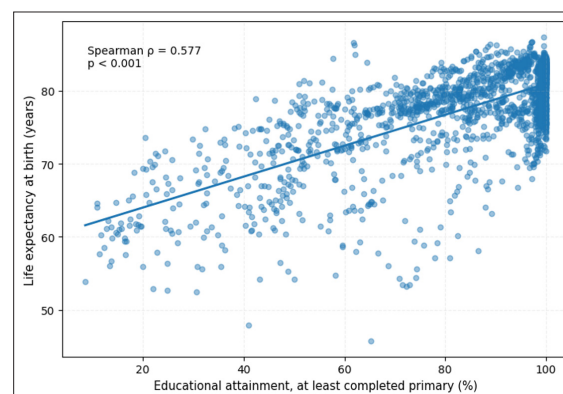


Figure 3: Association Between Educational Attainment and Life Expectancy

By contrast, there was almost no monotonic relationship between employment-to-population ratio and life expectancy. The Spearman correlation was $\rho = 0.003$ (95% CI –0.045–0.052; $p = 0.891$).

This lack of association is also evident in Figure 4, which shows that employment observations do not show an overall trend of increasing or decreasing life expectancy but are widely dispersed throughout the range. Combined, Table 3 and Figures 3–4 illustrate a stark difference between the two social determinants: while there was a significant positive link between

educational attainment and life expectancy, there was little unadjusted link between aggregate employment participation and life expectancy.

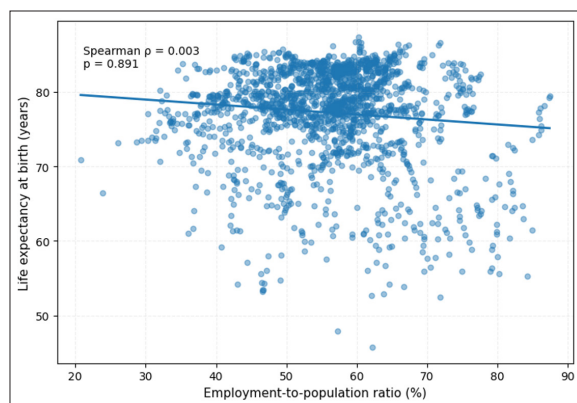


Figure 4: Association Between Employment-to-Population Ratio and Life Expectancy

Multivariable regression

To determine if the relationship between education and life expectancy remained after controlling for other socioeconomic, geographic and temporal factors, the hierarchical regression analysis was performed (Table 4).

Educational attainment was strongly positively associated with life expectancy in Model 1 ($\beta = 4.590$, 95% CI 4.357–4.823; $p < 0.001$), which contained only these two variables. Employment-to-population ratio was not statistically significant ($\beta = 0.224$, 95% CI –0.009–0.458; $p = 0.060$).

The introduction of World Bank income group in Model 2 caused a significant drop in the education coefficient from 4.590 to 1.496 (95% CI 1.165–1.826; $p < 0.001$). However, this association was still present.

After additional adjustment for WHO region in Model 3, the education coefficient was 1.029 (95% CI 0.655–1.403; $p < 0.001$).

In the fully adjusted model (education, employment, income group, WHO region and calendar year), life expectancy was still positively associated with educational attainment ($\beta = 0.620$, 95% CI 0.249–0.990; $p = 0.001$).

In contrast, in the fully adjusted model, employment to population ratio was not statistically significant ($\beta = -0.128$, 95% CI –0.324 – 0.068; $p = 0.201$).

The explanatory power of the models was also improved in the progressive adjustment. Model 2 explains 62.8% of the observed variation in life expectancy, while Model 3 explains 73.9% and Model 4 explains 76.1% of the observed variation in life expectancy.

Table 4: Hierarchical Multivariable Regression of Life Expectancy

Predictor	Model 1 β (95% CI)	Model 2 β (95% CI)	Model 3 β (95% CI)	Model 4 β (95% CI)
Educational attainment	4.590 (4.357–4.823)	1.496 (1.165–1.826)	1.029 (0.655–1.403)	0.620 (0.249–0.990)

Employment-to-population ratio	0.224 (–0.009–0.458)	–0.166 (–0.386–0.055)	–0.054 (–0.258–0.151)	–0.128 (–0.324–0.068)
R ²	0.484	0.628	0.739	0.761
Adjusted R ²	0.484	0.627	0.738	0.760
N	1,772	1,772	1,772	1,772

Model 1: Adjusted for educational attainment and employment-to-population ratio.

Model 2: Additionally, adjusted for World Bank income group.

Model 3: Additionally, adjusted for WHO region.

Model 4: Additionally, adjusted for calendar year.

Note: The β is the regression coefficient, the CI is the 95% confidence interval. The following regression estimates were adjusted and are shown graphically in figure 5. The figure indicates that there is a positive adjusted association between educational attainment, and the 95% confidence interval is still above the null value. The confidence interval for the employment-to-population ratio, however, crosses the null value, which is consistent with the fact that the employment-to-population ratio is not statistically significant in the fully adjusted model. The overall regression results suggest that the education–life expectancy relationship was still significant after controlling for the major contextual factors, while the employment-to-population ratio was not.

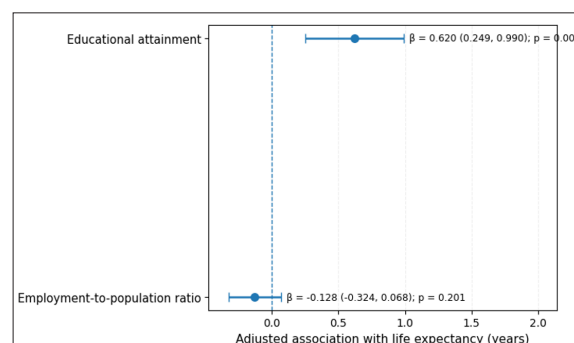


Figure 5: Fully Adjusted Associations with Life Expectancy

Sensitivity analyses

To determine if the main results were sensitive to alternative analytical specifications, sensitivity analyses were conducted (Table 5).

The confidence interval for the primary model was widened and the coefficient for education was no longer statistically significant ($\beta = 0.620$, 95% CI –0.314–1.553, $p = 0.193$) when country-clustered standard errors were used. The employment coefficient similarly remained non-significant ($\beta = -0.128$, 95% CI –0.668–0.412; $p = 0.642$).

The educational association was still positive and statistically significant ($\beta = 0.513$, 95% CI 0.128–0.897; $p = 0.009$) when observations for 2020–2021 were not included. Employment remained non-significant ($\beta = -0.171$, 95% CI –0.378–0.037; $p = 0.107$).

The education coefficient was positive ($\beta = 1.135$) but not significantly different from zero (95% CI: –0.250–2.519; $p = 0.108$) at the country average level. Employment also remained non-significant ($\beta = -0.480$, 95% CI –1.161–0.200; $p = 0.167$).

Hence, the direction of the education association was always positive, as can be seen in Table 5, though the statistical precision of the analyses was diminished when fewer independent country-level observations were available and/or more conservative error structures were used.

Table 5: Sensitivity Analyses

Analysis	Predictor	N	β	95% CI	P-value	R ²
Primary Model 4	Educational attainment	1,772	0.620	-0.314–1.553	0.193	0.761
Primary Model 4	Employment-to-population ratio	1,772	-0.128	-0.668–0.412	0.642	0.761
Excluding 2020–2021	Educational attainment	1,585	0.513	0.128–0.897	0.009	0.772
Excluding 2020–2021	Employment-to-population ratio	1,585	-0.171	-0.378–0.037	0.107	0.772
Country-level averages	Educational attainment	169	1.135	-0.250–2.519	0.108	0.778
Country-level averages	Employment-to-population ratio	169	-0.480	-1.161–0.200	0.167	0.778

Note: β = regression coefficient; CI = confidence interval.

Discussion

Principal Findings

This cross-national study of 1,795 country-year observations in 171 countries showed that there was a clear positive relationship between educational attainment and life expectancy, while the overall employment-to-population ratio was not independently associated with life expectancy. There was also a significant socioeconomic gradient: the difference in life expectancy between low- and high-income groups was around 19 years. A similar gradient across income groups was observed with education, which also underpinned the importance of socioeconomic factors on shaping population longevity.

This relationship between education and life expectancy was still present when the analysis was adjusted for income group, WHO region and calendar year. The education coefficient, however, dropped from 4.590 in the basic model to 0.620 in the fully adjusted model; this suggests that a significant amount of the crude association was accounted for by the socioeconomic, geographic, and temporal factors. The results highlight the need to view education within a social and economic framework, and not as a single factor that influences health of the population.

Education and Life Expectancy

The positive relationship between education level and life expectancy is in line with the social determinants of health framework. There is a potential association between higher education and higher health literacy, better socioeconomic resources, better employment opportunities and better ability to access and navigate health services. Education can also impact on social mobility and life course material disadvantage.

It's important to note that the association does not imply causality. The drop in the regression coefficient after adjustment suggests that education is highly correlated with income, geography, and socioeconomic development in general. So, this observed relationship is probably due to several complex pathways and not just due to education.

Employment and Life Expectancy

Unlike education, employment-to-population ratio had essentially no unadjusted correlation with life expectancy or statistically significant independent association in the multivariable models. The conclusion does not imply that work is a non-issue in terms of health. Instead, the employment-to-population ratio is a general indicator of labour-market activity and does not reflect job quality, income, job security, occupational risks, working conditions or social protection.

Future analyses are therefore needed to incorporate more detailed indicators of employment conditions to better measure the link between work and population health.

Socioeconomic Inequalities In Life Expectancy

One of the most striking results of the study was the difference in life expectancy between the lowest and highest income groups, which was almost 20 years. The existence of a parallel socioeconomic gradient in education implies that educational attainment is part of a social and economic advantage gradient of population longevity.

But the differences in income by education cannot explain the gap in income by income group. There are also significant differences in countries in terms of healthcare infrastructure, social protection, public-health capacity, housing, nutrition, environmental conditions, and other living conditions. The results thus confirm a multidimensional perspective on health inequalities, where education is one of the social determinants.

Policy Implications

The results underscore the need for an equity dimension in population health policy in relation to access to education. Enhancing educational outcomes can bring more than just learning, as an improved health literacy, socioeconomic mobility, and access to health-promoting resources can also result. Employment policies should not only include labour-force participation, but also job security, wages, occupational safety, working conditions and social protection.

The significant socioeconomic disparities in life expectancy also suggest that efforts to address global health inequalities need to go beyond health systems, social protection, education and infrastructure, and living conditions.

Strengths and Limitations

The advantages of this study include the use of a large cross-national data set, assessment of education and employment at the same time, hierarchical adjustment for income group, WHO region, and calendar year, and a number of sensitivity analyses.

There are some restrictions to be borne in mind. The causal inference is not possible with the observational country-level design, and repeated observations within countries could be non-independently observed. Country-level estimates also do not necessarily reflect individual-level relationships. Further, the education measure did not capture the quality of education or years of schooling, and the employment measure did not capture the quality or security of the job. There may also have been measurement error or selection bias due to differences in data availability, measurement, and reporting by country and year.

Future Research

Longitudinal, individual-level and subnational data should be leveraged in future research to explore more critically temporal pathways and inequalities within countries. More holistic indicators of education and employment quality should also be included. Furthermore, the combination of education and employment with other social determinants (such as access to health care, social protection, housing, nutrition, environmental conditions and income inequality) might offer a more comprehensive understanding of population longevity disparities.

Conclusions and Recommendations

Limitations

The results of this study should be interpreted with a number of caveats. Firstly, the analysis is observational and ecological, so it is limited in terms of causal inference. Educational attainment was associated with higher life expectancy in the primary multivariable analysis, but these results do not prove that higher education leads to longer life expectancy. Confounding by residual factors, reverse causality, measurement error and unmeasured structural factors may have influenced the associations observed.

Second, repeated country-year observations were included in the analysis, which could lead to the statistical non-independence of observations from the same country in different years. The country-clustered standard errors were considered as a sensitivity analysis but did not yield narrower confidence intervals, nor did it increase the statistical precision of the education estimate. This discovery suggests that the strength and statistical significance of the observed association is partly a function of the way within-country correlation is dealt with.

Third, there are important limitations of measures of education and employment. The proportion of adults (aged 25 and over) with at least primary education was used to measure educational attainment. It does not account for years of schooling, quality of schooling, learning outcomes, or for secondary and tertiary

school completion. Likewise, the employment to population ratio offers information on participation in the labour market but not about the quality of jobs, job security, risks at work, wages, working hours, informal employment or social protection.

Fourth, it is possible for significant inequalities to be masked at the national level. Average values at the country level do not provide adequate information about the variation in socioeconomic groups, geographic areas and other population subgroups. Therefore, the results should be interpreted as the population-level associations and should not be directly extrapolated to individual-level associations.

Fifth, international data sets can vary in data availability, methods of measurement, reporting and time coverage. While a uniform analytical framework was used, these differences could cause measurement error and lead to uncertainty in cross-national comparisons.

Last, the sensitivity analyses suggest that the statistical significance of the education–life expectancy association was sensitive to the analytical specification. This association was still statistically significant when 2020–2021 was omitted, but not when country-clustered standard errors or country-level averages were used. However, the association continued to be positive, meaning that the results should be interpreted with caution and should not be interpreted as a causal factor for longevity, but rather as an important population-level correlate.

Conclusions

This study shows that there were significant socioeconomic disparities in life expectancy between countries in the period from 2000 to 2021. There was a clear gradient in population longevity, with mean life expectancy rising progressively from low-income countries to high income countries, from 62.68 years to 81.34 years.

Life expectancy was moderately positively associated with educational attainment and this remained the case in the primary fully adjusted regression model. On the other hand, employment to population ratio was not significantly related to life expectancy. These results indicate that education could offer better population-level information on longevity than employment alone.

But the significant drop in the education coefficient after adjusting for income group, WHO region, and calendar year suggests that the education coefficient is closely connected with the wider socioeconomic and geographic environment. The sensitivity analyses also illustrate that the level of statistical precision of the association can differ depending on how repeated country observations are treated.

In summary, the results confirm the value of education in the context of the social determinants of health. Achieving greater equality in life expectancy is unlikely to be achieved by a single factor, but by working on opportunities for education, socioeconomic security, employment status, access to health services, social protection and the broader environment in which populations live.

Recommendations

There are several recommendations that can be made based on the results of this study. First, the efforts must be made to improve the right to education in a more equitable way. Policies should focus on increasing access to quality education and decreasing educational disadvantage, especially in areas where levels of education and life expectancy are relatively low.

Second, the education policy needs to be linked with the overall public health policy. Education must be accompanied by interventions to improve access to healthcare, socioeconomic security, social protection, housing, nutrition, sanitation and other factors that affect the health of populations.

Third, employment policies should be directed towards quality of work, not participation in employment. Job security, adequate remuneration, occupational safety, working conditions and access to social protection should be given greater consideration.

Fourth, health-equity policies should target populations with a wider socioeconomic disadvantage. The significant life expectancy differences between income groups suggest there is a need to tackle multiple structural determinants, in addition to healthcare interventions.

Fifth, there is a need to enhance the routine measurement of social determinants of health in international and national health-monitoring systems along with health outcomes. More detailed and disaggregated data would help to identify inequalities and better target health-equity interventions.

Lastly, future studies should use longitudinal, multilevel, and individual-level designs to better understand the temporal relationships and explore the pathways between education and employment and population health. More specific indicators of educational quality and employment conditions should also be included in future studies to address the limitations of broad national indicators.

Overall, the findings of this study reveal significant socioeconomic differences in life expectancy and evidence of a positive relationship between educational attainment and life expectancy in the main country-year analysis. The results also suggest that employment participation per se is not enough to explain the link between work and population health. Reducing inequalities in longevity, therefore, needs to be a holistic and multi-sectoral approach, taking into account the interconnections between education, working conditions, socioeconomic security, health, and other conditions of living.

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