



BMJ Open Educational inequalities in adult mortality: a systematic review and meta-analysis of the Asia Pacific region

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ABSTRACT

Objectives In this study, we aim to analyse the relationship between educational attainment and all-cause mortality of adults in the high-income Asia Pacific region.

Design This study is a comprehensive systematic review and meta-analysis with no language restrictions on searches. Included articles were assessed for study quality and risk of bias using the Joanna Briggs Institute critical appraisal checklists. A random-effects meta-analysis was conducted to evaluate the overall effect of individual level educational attainment on all-cause mortality.

Setting The high-income Asia Pacific Region consisting of Japan, South Korea, Singapore and Brunei Darussalam.

Participants Articles reporting adult all-cause mortality by individual-level education were obtained through searches conducted from 25 November 2019 to 6 December 2019 of the following databases: PubMed, Web of Science, Scopus, EMBASE, Global Health (CAB), EconLit and Sociology Source Ultimate.

Primary and secondary outcome measures Adult all-cause mortality was the primary outcome of interest.

Results Literature searches resulted in 15 345 sources screened for inclusion. A total of 30 articles meeting inclusion criteria with data from the region were included for this review. Individual-level data from 7 studies covering 222 241 individuals were included in the meta-analyses. Results from the meta-analyses showed an overall risk ratio of 2.40 (95% CI 1.74 to 3.31) for primary education and an estimate of 1.29 (95% CI 1.08 to 1.54) for secondary education compared with tertiary education.

Conclusion The results indicate that lower educational attainment is associated with an increase in the risk of all-cause mortality for adults in the high-income Asia Pacific region. This study offers empirical support for the development of policies to reduce health disparities across the educational gradient and universal access to all levels of education.

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INTRODUCTION

Research in public health often fails to examine how the societal conditions we live in shape our health and life chances. These societal conditions in which we are born and grow include our education, income,

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ The present study provides the most up-to-date collection of evidence regarding educational inequalities in adult all-cause mortality for the high-income Asia Pacific Region.
- ⇒ The present systematic review used a global, language-unrestricted search strategy to gather all available data.
- ⇒ The present systematic review and meta-analysis is the first to our knowledge to use harmonised education groups for this region, allowing more comparable effect sizes.
- ⇒ This study employed a random-effects meta-analysis model, giving a more robust estimate given the high levels of heterogeneity.
- ⇒ High levels of heterogeneity in the meta-analysis likely are due to the differences between the populations within the studies and differences between methodologies and measurements used.

employment status, housing and work conditions, and have great and complex influences on our subsequent health and disease status.¹ While it may seem intuitive that those making a larger income would experience better health than someone living in poverty, the social determinants also act on a gradient, as that with every additional year of education health status improves. As a result, research to explain and measure inequities in health is needed to guide policy changes aimed at not only closing the gap between the most and least advantaged groups, but ultimately by reducing the inequalities between groups across the social gradient in health.

Education is often used as a proxy measure for socioeconomic status (SES) in health inequalities research, as it is relatively constant after young adulthood while having a significant impact on later measures of SES. It is also influenced through parental characteristics and therefore, to some degree, can act

as an indicator of early-life socioeconomic conditions.² Though having a higher level of education may help one by increasing prospects of a good job with a decent income and thus improving access to a healthy lifestyle, the exact pathways in which education influences health are complex and intertwining. Egerter *et al*³ described the pathways in which educational attainment affects one's health through health knowledge and behaviours, health-care access, working conditions, income, social network and social standing.

Despite the growing focus on health inequalities, this field has been dominated by research describing trends in North American and European countries, often leaving other contexts under-researched. In the Asia Pacific region, specifically Japan, South Korea, Singapore and Brunei Darussalam, research into health inequalities gained increasing attention in the 1990s and early 2000s, with most research conducted in Japan and South Korea. While comparative studies are rare, one study comparing educational inequalities in mortality between Japan and the USA found that the magnitude of the inequalities was similar.⁴ This suggests that the intensity of such inequalities may be similar to those in Europe and the USA. Traditionally, this region has had the longest life expectancies (LE), relatively little inequality and tight supportive social networks.⁵ When comparing LE by welfare regime, the East Asian regime had higher average LE than the traditionally high LE of Scandinavian welfare regimes, suggesting that other social and cultural factors may be of importance in this region.⁶ However, as rapid economic growth driven by drastic technological innovation and growing globalisation contribute to the high LE and improved population health, inequalities also rise.⁷ If we want to reduce inequalities, prevent the widening of the health gap and diminish disparities across the social gradient, we first need to quantify the level of inequality so we can monitor these trends over time and enact policies that reduce these unjust inequities.

Therefore, the aim of this study is to analyse the relationship between educational attainment and all-cause mortality of adults in the high-income Asia Pacific region, consisting of Japan, South Korea, Singapore and Brunei Darussalam. This region has been classified by the Global Burden of Diseases, Injuries and Risk Factors Study led by the Institute for Health Metrics and Evaluation by epidemiological similarity and geographic closeness. This analysis focuses on relative inequalities in mortality, which may paint a dire picture of widening inequalities despite targeted public health interventions. However, in reality, the absolute rates of mortality often have drastically improved, and inequalities in absolute terms are often seen to have actually reduced over time.⁸ Therefore, it is important to consider that both reductions in overall mortality rates, and compositional changes in education groups may contribute to rising relative inequalities in mortality, despite improvements in absolute inequalities.⁸

METHODS

Search strategy and selection criteria

A literature search was conducted using the databases PubMed (NIH/NLM), Web of Science (Clarivate), Scopus (Elsevier), EMBASE (Elsevier), Global Health (CAB-EBSCO), EconLit (EBSCO) and Sociology Source Ultimate (EBSCO) from 25 November 2019 to 6 December 2019 by experienced librarians. The search was limited to records published since 1980 without any language limitations. The search was constructed using key terms: education, socioeconomic status, health inequalities, adult, mortality, all-cause mortality and death. The specific search string contains commonly related terms and synonyms to the key terms above. Rather than using the Boolean term "AND" for the search string, we used proximity searching. Setting the proximity to 10 ensures the two words or blocks must occur within ten words of each other, yielding a more relevant and manageable result through a higher bar for inclusion in the search results. The literature search string used is provided in online supplemental appendix A. A handsearch for relevant articles not found through database searching was conducted by searching the reference lists of obtained articles such as literature reviews and narrative reviews.

Abstracts of articles found through the literature search were screened by two independent reviewers. In the case of disagreement, a third independent reviewer determined the final decision. During the abstract screening, all articles that mentioned social group analysis were included. This was done as many studies may not explicitly state educational attainment as a measure examined, but rather simply state 'socioeconomic variables'. During full article reading, two reviewers independently screened each article for inclusion, with a third review used in case of disagreement. The inclusion and exclusion criteria are summarised in [table 1](#) according to the SPIDER (Sample, Phenomenon of Interest, Design, Evaluation, Research type) framework. Articles were assessed for risk of bias and quality by one reviewer independently using the Joanna Briggs Institute (JBI) Critical Appraisal checklists for the study's design (cohort or cross-sectional).^{9 10} Studies received a score of 1 if the criterion was met and 0 if not, or if it was unclear. The scores were added together and classified into equal quality categories based on the maximum score possible. For cohort studies, the fair category included scores from 0 to 3, good quality was scores from 4 to 7 and excellent was scores from 8 to 11. For cross-sectional studies, the categories for fair, good and excellent were determined from scores ranging from 0 to 2, 3 to 5 and 6 to 8, respectively.

All relevant data were extracted using a standardised extraction template. The template includes information such as location (country or region), date(s), sample sizes, method of measuring exposure (education) and outcome (mortality), confounders adjusted for in the multivariable analysis, effect measure estimates, educational groups definition according to study, corresponding years of education and others. Extractors used ISCED mappings¹¹

Table 1 SPIDER (Sample, Phenomenon of Interest, Design, Evaluation, Research type) framework for inclusion and exclusion criteria

SPIDER framework	Inclusion criteria	Exclusion criteria
Sample	Sample size and characteristics were not a criterion for inclusion in this review Age 18 years or older	Sample size and characteristics were not a criterion for exclusion in this review Age less than 18 years
Phenomenon of Interest	Adult mortality according to educational attainment All-cause mortality	Indices using education aggregated with other indicators Cause-specific mortality
Design	All study designs other than the two listed in exclusion criteria	Case-crossover and ecological studies
Evaluation	Individual-level measures Relative inequality measures: relative risk, HR, OR, rate ratio, logistic coefficients	Aggregate-level measures Measures: Standardised incidence ratio, standardised mortality ratio, time-to-event ratio, incidence, rate and risk difference
Publication type	Publication type is not an inclusion criterion	Comment, editorials or letters

to determine corresponding numerical years of education for articles that reported only education categories. Illiterate was considered 0 years of education, while literate was considered ≥ 1 year. Articles were extracted independently by reviewers due to the large number of records. A quality control random sample of 10% of the extractions from each reviewer were extracted in duplicate by experienced reviewers. Following data extraction, articles which contained data for the High-Income Asia Pacific region were selected for inclusion into this study.

Effect Size Computation

Primary education was classified as middle school education or less, equal to 0–9 years of schooling. Secondary education was classified as high school, equal to 10–12 years of schooling and tertiary education was classified as a college education or higher, equal to 13 years of schooling or more. Risk ratios (RR) and 95% CIs were calculated for an overall effect size for each study, using the raw population numbers for each educational group with the tertiary educational group used as the reference category. The primary factors for effect size calculation and therefore inclusion into the meta-analysis were: (1) the design of the study and (2) availability of data needed for effect size calculation and (3) the study's educational attainment grouping. Three articles met the requirements to be included in the meta-analysis but used the same underlying dataset. Due to this, we excluded two^{12 13} of the articles which used only one wave of the NHANES survey and therefore had a smaller sample size and less follow-up time than the article from Khang and Kim which remained in the analysis.¹⁴ A random-effects model with inverse variance weighting was used to complete the meta-analysis. To assess for the presence of publication bias, where smaller studies with only highly significant effect sizes are more likely to be published, funnel plots are usually created and examined for asymmetry. However, funnel plots are only appropriate for detecting publication bias when studies included in the meta-analysis come from one underlying

population.¹⁵ As the number of studies included in our meta-analysis is below the threshold for statistical tests for funnel plot asymmetry to be reliable, and our population does not come from one single underlying population and rather is a heterogeneous population, a funnel plot would not be appropriate for this meta-analysis.¹⁵ Statistical analyses were completed using RStudio with R V.4.0.3 and the 'meta' R package.^{16 17}

Assessing heterogeneity and sensitivity analyses

As heterogeneity is expected between included studies due to the variation between participants' characteristics and settings, a test for heterogeneity was conducted. This was first done by using Cochrane's Q test to assess heterogeneity, and the heterogeneity was then quantified by using an I^2 statistic. As recommended by Cochrane, a p value of less than 0.1 was considered statistically significant heterogeneity.¹⁸ The degree of heterogeneity in the I^2 statistic was determined as being low (0%–25%), medium (25%–75%) or high (75%–100%).¹⁸ A random-effects model was chosen a priori for the meta-analysis to account for the expected high levels of heterogeneity and give a more robust estimate. To assess whether the choice of tertiary education as the reference group in the meta-analysis influenced the results, we conducted a sensitivity analysis with secondary education as the reference category. This did not alter the main findings and the results from the sensitivity analysis are available in online supplemental appendix B, online supplemental figures B1 and B2.

Patient and public involvement

Due to the global nature of the systematic review strategy, it was not feasible to involve the public in the design or conduct of this study.

RESULTS

The literature search yielded 15 017 records after the first-degree removal of duplicates. The handsearching

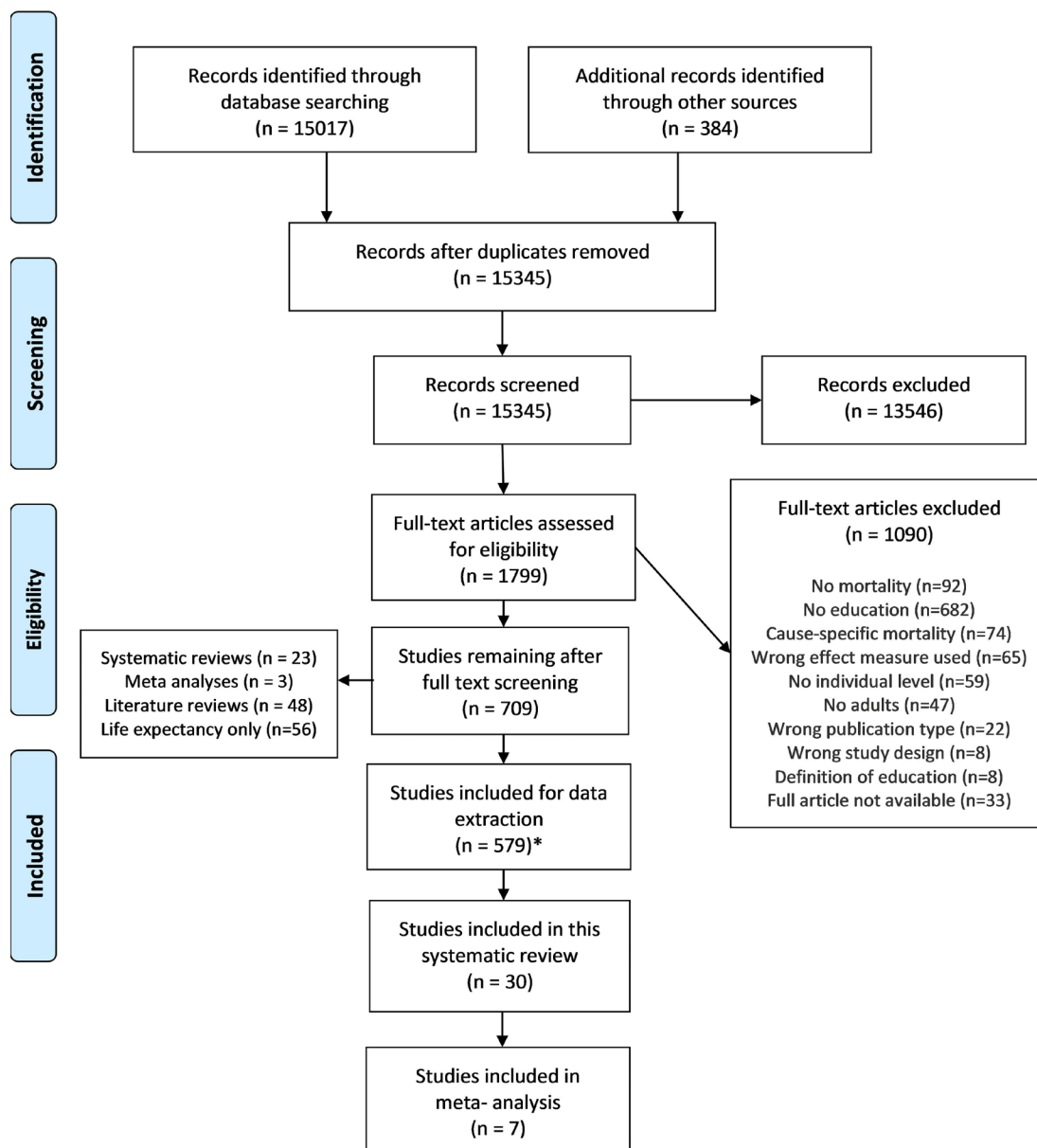


Figure 1 PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram. *Twelve extractions from one book.

of reference lists of relevant records yielded an additional 384 records and after duplicate removal, 15 345 records continued to the abstract screening phase. Of these, 1799 articles were assessed for eligibility in the full-text screening, and 579 articles met the criteria for data extraction for the global review. In total, 30 articles were conducted in one or more countries within the high-income Asia Pacific region as shown in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram in [figure 1](#). Of the 30 studies included in this synthesis, 24 are longitudinal cohort studies, 5 are cross-sectional studies using unlinked death certificate data, and 1 is a prospective pooled cohort analysis.

Study characteristics

[Table 2](#) gives an overview of the descriptive characteristics of the included studies. One study is a prospective pooled

cohort study that uses data from both Japan, South Korea and Singapore.¹⁹ Aside from the pooled cohort study, 14 studies each (48.3%) were conducted in Japan and South Korea, 1 study (3.45%) was conducted in Singapore and no studies were conducted in Brunei Darussalam. A majority (19) of the studies were representative of the entire population (63.3%), while others were representative of specific cities, municipalities or population groups. Leaving 11 studies that were not representative of the entire population (36.6%). In total, two studies used data from as early as 1963 and 1970, while four studies included earliest data from the late 1980s, and 26 studies included data from the 1990s and onwards. Among the cohort studies, five studies (20%) were classified as ‘good’ quality through the JBI risk of bias and quality critical appraisal checklists, while 20 (80%) were of ‘excellent’

Table 2 Descriptive characteristics of included studies

Author	Data source	Years of study	Sample size	Ages	Male population	No of deaths	Representative of population?	Max years Follow-up	JBI score	Quality category
Japan										
Chiu ⁴	NUJLSOA	1999–2009	6171	65+	43%	n.d.	Yes	11	6	Good
Fujino ⁴⁰	JACC Study	1988–1998	39 999	40–79	42%	6628	Yes	11	9	Excellent
Minagawa ⁴¹	NUJLSOA	1999–2009	13 225	65+	n.d.	1434	Yes	10	10	Excellent
Tani ⁴²	JAGES	2010–2013	15 449	65+	46%	754	No	3.8	8	Excellent
Sugisawa ⁴³	N/A	1987–1990	1943	60+	46%	161	Yes	3	7	Good
Ishizaki ⁴⁴	Saku Longitudinal Study on Ageing	1992–1998	8090	65+	43%	n.d.	No	6	10	Excellent
Iwasaki ⁴⁵	Komo-Ise Study	1993–2000	5629	40–69	100%	338	No	7	11	Excellent
Nishi ²⁰	AGES 2003 Cohort Study	2003–2007	14 668	65+	48%	1218	No	4	9	Excellent
Ito ²¹	JPHC Study Cohort I	1990–2003	39 228	40–59	48%	2430	No	13	10	Excellent
Honjo ⁴⁶	JACC Study	1988–2009	16 692	40–60	0%	1019	No	20	9	Excellent
Hirokawa ²²	Jichi Medical School Cohort Study	1992–2002	11 081	18+	39%	588	No	10	9	Excellent
Honjo ²⁵	JACC Study	1990–2006	57 109	40–65	43%	6054	Yes	16	7	Good
Liang ⁴⁷	N/A	1987–1999	7174	60+	45%	724	Yes	12	11	Excellent
Iwasa ⁴⁸	Longitudinal Interdisciplinary Study on Ageing	1991–2000	2447	52–77	42%	264	No	7	11	Excellent
South Korea										
Jung-Choi ⁴⁹	N/A	1990–2004	70 167 890	25–64	50%	1 415 287	Yes	N/A	5	Good
Khang and Kim ¹⁴	The 1998 & 2001 KNHANES	1998–2012	10 137	30+	46%	1219	Yes	12	10	Excellent
Kim and Khang ¹³	The 1998 NHANES	1998–2003	5607	30+	47%	264	Yes	6	9	Excellent
Khang ²⁹	The 1998 & 2001 NHANES	1998–2005	8366	30+	n.d.	310	Yes	8	8	Excellent
SUH ⁵⁰	N/A	1999–2002	1245	65+	43%	158	No	3.5	7	Good
Lim ⁵¹	N/A	1995–2010	81 354 834	30–59	50%	348 208	Yes	N/A	5	Good
Kim ²³	KLIPS	2003–2008	19 305	19+	50%	424	Yes	6	8	Excellent
Son ⁵²	N/A	1993–1997	16 923 772	20–64	n.d.	287 001	No	N/A	5	Good
Bahk ²⁷	N/A	1970–2010	152 101 958	25–64	50%	614 910	Yes	N/A	4	Good
Khang and Kim ¹²	NHANES	1998–2003	5437	30+	n.d.	242	Yes	6	9	Excellent

Continued

Table 2 Continued

Author	Data source	Years of study	Sample size	Ages	Male population	No of deaths	Representative of population?	Max years Follow-up	JBI score	Quality category
Khang and Kim ⁵³	The 1998 NHANES	1998–2002	5607	30+	n.d.	197	Yes	4	8	Excellent
Khang ⁵⁴	N/A	1995–2000	15 177 375	35–64	50%	462 776	Yes	N/A	5	Good
Khang ⁵⁵	KLIPS	1998–2003	1574	50+	100%	176	Yes	5	7	Good
Kim ²⁴	KMSMS	1994–2014	70 713	40+	61%	5618	Yes	20	8	Excellent
Singapore										
Ma ⁵⁶	1992 Singapore National Health Survey	1992–2001	3492	18+	48%	108	Yes	9	10	Excellent
Pooled Cohort Analysis										
Yang ¹⁹	Asia Cohort Consortium† Japan	1963–1993	280 192	19+	45%	59 822	Yes	15.8	8	Excellent
Yang ¹⁹	Asia Cohort Consortium‡ South Korea	1992–1993	13 697	25+	100%	894	No	15.6		
Yang ¹⁹	Asia Cohort Consortium§ Singapore	1993–1999	63 247	19+	44%	10 682	Yes	11.5		

*Cross-sectional.

†JACC, JPHC, Life Span Study Cohort, Miyagi Cohort (Miyagi) Ohsaki National Health Insurance Cohort Study (Ohsaki), Takayama Study (Takayama).

‡Seoul Male Cancer Cohort (SeoulM).

§Singapore Chinese Health Study.

AGES, Aichi Gerontological Evaluation Study; JACC, Japan Collaborative Cohort Study; JAGES, Japan Gerontological Evaluation Study; JBI, Joanna Briggs Institute; JPHC, Japan Public Health Center; KLIPS, Korean Labor & Income Panel Study; KMSMS, Korean Metabolic Syndrome Mortality Study; (K)NHANES, (Korea) National Health and Nutrition Examination Survey; N/A, not available; NUJLSOA, Nihon University Longitudinal Study of Aging.

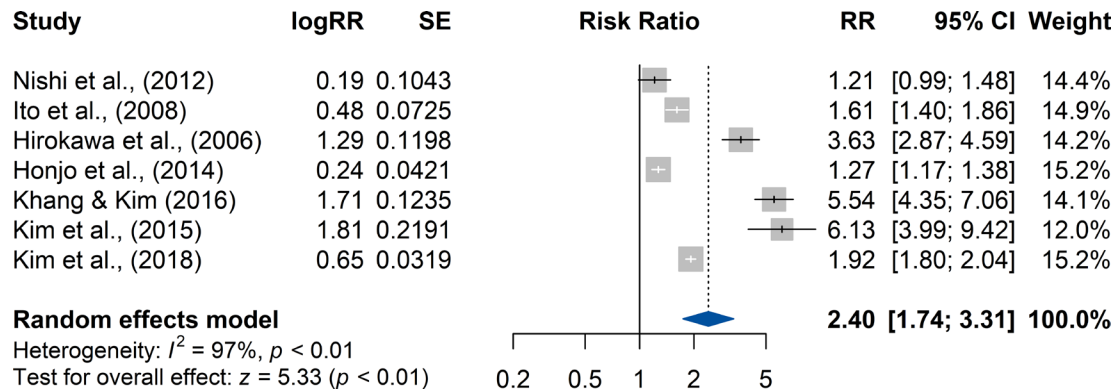


Figure 2 Forest plot for primary education versus tertiary education. Primary education equates to middle school or less (0–9 years), while tertiary education equates to college or higher (≥ 13 years). Tertiary education is the reference category. RR, risk ratio.

quality and 0 studies were of ‘fair’ quality. For cross-sectional studies, all five (100%) scored in the ‘good’ quality category. The risk of bias and study quality scores and categories are presented for each included study in table 2 and individual scores for each quality assessment criterion are presented in online supplemental appendix C, online supplemental table C1 and C2.

Analysis of the association between educational attainment and mortality

Seven studies covering 222 241 individuals and 17 551 deaths allowed for analysis of all-cause mortality by harmonised educational categories. Figure 2 shows the risk of mortality by primary educational status with the tertiary educational category used as the reference category. The individual studies with the calculated (unadjusted) RR and 95% CIs, and the overall random-effects estimate are listed along with a forest plot visualisation of the studies’ estimates. For the studies included in the meta-analysis, six studies (86%) were categorised as ‘excellent’ quality^{14 20–24} through the risk of bias and quality assessment, while one study (14%) was of ‘good’ quality,²⁵ and no studies were of ‘fair’ quality.

The overall estimate indicated that individuals with primary education had 2.40 times the risk for all-cause mortality compared with tertiary educated individuals

(95% CI 1.74 to 3.31, $z=5.33$, $p<0.01$). In this analysis, RRs ranged from 1.21 to 6.13, with one estimate including the null value.¹⁷ The Q statistic was statistically significant ($Q=236.98$, $p<0.01$), and the I^2 value estimates that about 97% of the variation across studies is due to heterogeneity, rather than chance, both of which suggest significant heterogeneity.

Figure 3 illustrates the meta-analysis and forest plot using secondary education compared with tertiary education (reference) in mortality risk. In this analysis, the overall effect estimate shows a statistically significant increase in the risk of mortality by secondary education, with a 29% increase in risk ($z=2.87$, $p<0.01$). Meaning those with 10–12 years of schooling had 1.29 times the risk of mortality compared with those with 13 or more years of schooling. However, multiple studies did not show as clear of an increase in risk as in previous analyses. Three of the seven studies’ effect sizes or 95% CI included the null value of 1, indicating a non-statistically significant or null effect of secondary education on the risk of mortality in these estimates. The Q statistic was statistically significant ($Q=57.50$, $p<0.01$), and the I^2 value estimates that about 90% of the variation across studies is due to heterogeneity, both of which suggest significant heterogeneity.

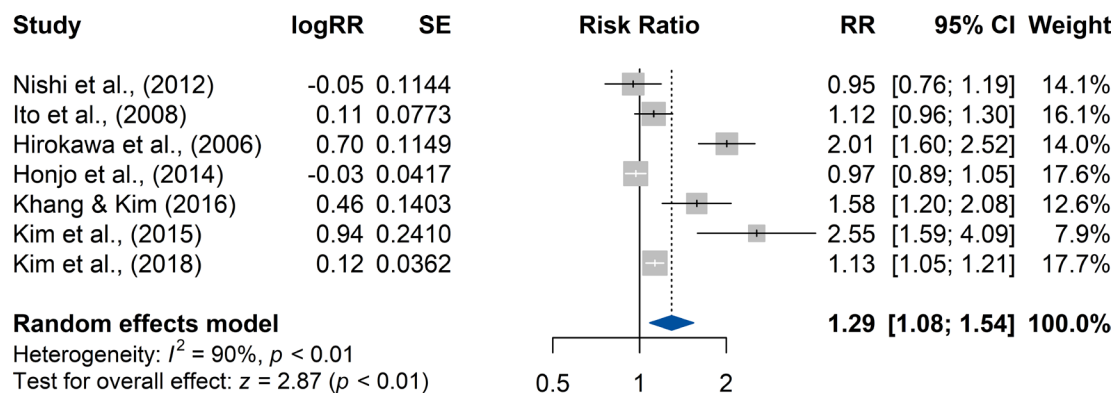


Figure 3 Forest plot for secondary education versus tertiary education. Secondary education equates to high school (10–12 years), while tertiary education equates to college or higher (≥ 13 years). Tertiary education is the reference category. RR, risk ratio.



DISCUSSION

This study provides a comprehensive systematic review with meta-analysis describing the influence of educational attainment on adult all-cause mortality in the high-income Asia Pacific region. The results reveal that lower educational attainment is associated with a significant increase in the risk of mortality for adults in the high-income Asia Pacific region. Despite impressive improvements in health and living conditions in the region in the past 50 years,^{5 26} the inequalities in educational attainment and mortality have persisted. Though overall mortality rates in the population have declined, trends in relative inequalities show a persistence and widening in the region.^{27 28} A study by Kasajima and Hashimoto²⁸ examined absolute and relative educational disparities in mortality in Japan and found relative educational inequalities in all-cause mortality persisted despite improvement in average mortality rates. Interestingly, the researchers found that absolute inequalities also widened for causes of mortality linked to lifestyle and behavioural factors, as well as an overall worsening of average mortality for vulnerable populations such as youth and women.²⁸ In South Korea, Bahk, Lynch and Khang²⁷ found compositional changes in educational groups as a likely cause of the increase in absolute inequalities in mortality and mortality decline, which may have contributed to the increase of relative inequalities. When using measures more robust to such compositional changes, researchers found stable trends for both relative and absolute inequalities in recent years.²⁷ The pathways in which these trends in all-cause mortality have developed may also be different when examining relative or absolute inequalities. Khang *et al*²⁹ found that when looking at relative educational inequalities in mortality, material factors explained 29% of the excess mortality risk compared with 78.6% of the absolute risk.²⁹ This shows how relative and absolute inequalities may develop differently, and while we may see worsening inequalities when measured on a relative scale, absolute inequalities may have remained stable or even improved.

Similar multinational studies of high-income countries in Europe have found large relative educational inequalities in all-cause mortality, as found in our study. Our estimates suggest a great relative disparity in total mortality for the lowest educated individuals compared with those with a college education or higher. Similarly, when estimating relative inequalities in Western European countries, Mackenbach *et al*³⁰ find an increase in risk of all-cause mortality between 57% and 115% for the lowest educated men compared with the highest educated men, and between 37% and 105% for the lowest educated women, in the years 2005–2009.³⁰ The researchers also examined the trends in absolute and relative inequalities for these high-income countries between 1990–1994 and 2005–2009, finding that while many countries have seen an increase in the relative educational inequalities for both men and women, many countries have also seen an impressive reduction in absolute educational inequalities in mortality.³⁰ When looking over a longer time period

(1979–2014), Mackenbach *et al*³¹ again find an almost universal widening of relative educational inequalities in mortality in Western Europe, likely resulting from decreasing mortality rates across the population.³¹ The trend of declining mortality and stable or declining absolute inequalities remained despite periods of economic crisis and increases in unemployment and poverty.³¹ Due to data restrictions, we were not able to examine long-term trends in relative inequalities in this analysis. If we assume the trends in the high-income Asia Pacific region follow the same pattern seen in other high-income countries such as in Western Europe, we could expect to see rising relative educational inequalities with declining overall mortality and perhaps stable or improving absolute inequalities, as seen in studies by Kasajima and Hashimoto²⁸ and Bahk, Lynch and Khang.²⁷ There is still a need however for further analysis into educational inequalities in this region and analyses into the long-term trends in both relative and absolute terms.

To the best of our knowledge, one other systematic review and meta-analysis of educational inequalities in all-cause mortality for the Asian context has been completed.³² This review included, among others, Japan, South Korea and Singapore, with 11 studies from these countries in the meta-analyses. Researchers compared the highest available education level to the lowest level in each study, finding an overall RR of 1.29 (95% CI 1.17 to 1.43) for those with ‘low education’ compared with those with ‘high education’ in their subgroup consisting of Japan, South Korea, and Singapore.³² Overall, the results from Vathesatogkit, Batty and Woodward³² support the results found in our analyses, however, their overall estimate includes the highest adjusted estimate from each study, while ours is based on unadjusted estimates, likely contributing to the lower estimate compared with ours. All included studies in the meta-analysis from Vathesatogkit, Batty and Woodward³² except one, which did not meet our inclusion criteria, were included in our review—suggesting that the review process was thorough, and all relevant literature was included. Therefore, this study provides both an updating of the existing literature review and provides new knowledge on the relationship between education and health in this region, through harmonised educational groups.

Previous research has hypothesised the good health of Japan as being a result of high levels of collectivism, social cohesion and job security.³³ Before the introduction of neo-liberal market reforms, employers in Japan and South Korea relied heavily on long-term workers with seniority-based wage systems. Through this framework, employees enjoyed relatively high levels of job security and low levels of income inequality between workers. However, due to the introduction of these reforms sparked by economic crisis, employers began shifting to non-regular workers and pay-per-performance schemes, resulting in rising insecurity and inequality with fewer social insurance protections for workers and weakening social cohesion.³⁴ This may have increased inequalities in South Korea as

the relative risk of mortality for men of low education in 1980 was 3.44, increasing to 6.41 in 2000 after the introduction of these market reforms, when compared with highly educated men.²⁷

Perhaps because of this transformation, the educational systems have seen skyrocketing competitiveness and high-income and middle-income families are drastically outperforming low-income families on education.^{35–37} The phenomenon of ‘shadow education’ or private supplemental educational lessons referred to as *juku* in Japan and *hagwon* in South Korea is by no means new or isolated to East Asian countries. The percentage of average monthly household educational expenditure on private supplementary education shows an unequal and rising trend across income quintiles from 2002 to 2013 in Singapore.³⁸ The wealthiest 20% increased their educational expenditures by 1.49% during this 10-year timespan, while the poorest 20% increased their expenditure by 0.62%. These expenditure trends and skyrocketing competition may result in the educational system being a reproducer of class status instead of a mechanism for social mobility and may lead to an increase in future inequalities.³⁴ On the one hand, education can be used as a powerful tool to eliminate inequities and promote social mobility, while on the other hand, when middle-income and high-income families drastically outperform low-income families on supplemental schooling, education is used to reproduce and exacerbate inequities in society.

Implications and future research

By demonstrating a gradient effect of education on mortality, we offer empirical support for policies that aim to improve morbidity and mortality across all socioeconomic groups rather than focus on closing the gap between the most and least advantaged groups. We also demonstrate strong support for policy aimed at improving access to education for all, from primary through higher education, as we see a significant impact of education on the health and life of all individuals.

Although this review offers valuable empirical evidence, further research is needed on this topic and region. Additional longitudinal data are also needed, especially in South Korea, Singapore and Brunei Darussalam. Further research is also needed to examine the mechanisms in which education influences health and mortality, although this requires a rich, comprehensive evidence base, and so far, is not feasible in this region. This review makes an essential step in the identification and monitoring of educational inequalities in mortality in the high-income Asia Pacific region, and future research is needed to monitor these trends across time and eventually to reduce disparities in health, allowing all individuals the opportunity to live a long healthy life.

The results and interpretations of this review should be taken with consideration to its limitations. We cannot be sure that our conclusions apply to countries with data restrictions, namely Singapore and Brunei Darussalam. As all the studies

relied on self-reported education levels, we cannot rule out the potential for response bias in some individuals if they could not accurately remember their total years of education or their highest level of educational attainment. Additionally, the high levels of heterogeneity in the analysis should not be ignored. This is most likely due to the differences between the populations within the studies and differences between methodologies and measurements used. While it is not surprising that there are high levels of heterogeneity in the meta-analysis, due to the between country nature of the study and the inability to control for all confounders within the primary studies, the interpretation of this meta-analysis should be taken with caution as we cannot be sure the effect seen from these studies would be the same for the entire population either within or outside of the region studied.

To our knowledge, this is the most up-to-date review of educational attainment and adult mortality conducted in this region. This study benefits from using education as a measure of SES, as this is a consistent and early indicator of an individual's SES.³⁹ This review also used a thorough global search without language restriction allowing for near-complete coverage of all relevant articles. Additionally, the meta-analysis used harmonised educational categories in estimating the adult all-cause mortality. Lastly, this study employed a random-effects model, giving a more robust estimate given the high levels of heterogeneity.

CONCLUSION

This study provides empirical evidence to support the association between educational attainment and adult all-cause mortality in the high-income Asia Pacific region. We see a gradient effect of education on mortality as with every step up the educational ladder, individuals experience a reduced risk of mortality. Overall, these results offer a basis for evidence-based policy decisions to reduce health disparities across the educational gradient and improve access to education from primary to higher education. Further research is needed to expand the limited research base in this region, to allow for consistent monitoring of these trends, and to support further policy changes aimed at reducing health disparities.

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and CW. Statistical analyses were completed by KCB. The manuscript was drafted by KCB and revised by TAE, MB and KS. KCB accepts responsibility for the finished work as the guarantor. All authors approved of final draft to be submitted.

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