Master of Public Health

Master de Santé Publique

Assessing Health Impacts of Education Quality Interventions: A Systematic Literature Review

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List of acronyms

RCT	Randomized Control Trial
OECD	Organization for Economic Co-operation and Development
NGO	Non-governmental organization
UNICEF	United Nations Children's Fund
SES	Socio-economic Status
BMI	Body Mass Index
EU	European Union
ABC	Abecedarian Project
PPP	Perry Preschool Program
IY-TCM	Incredible Years Teacher Classroom Management
FAME	Family Education
FAST	Families and Schools Together
CDC	Centers for Disease Control and Prevention

Abstract

Introduction: The relationship between education and health has been studied for many years, but only recently have causal studies become available. This review of the current literature gives an overview of this causal relationship. It highlights the importance of investigating the quality and characteristics of the education being attained, and how these qualities effect the education/health gradient.

Methods: A review of the scientific literature was conducted to explore the relationship between policies and interventions targeting the quality of education and their impacts on health. This literature search was performed using the following databases: MEDLINE, Social Policy Practice, ERIC, PsychINFO, HMIC, and Global Health. Studies were eligible for this review if they described a school-based intervention targeting education quality (i.e.. smaller classroom size, having multiple teachers in the class, teachers being trained by certain intervention programs, etc.), and measurement of a health outcome.

Results: Of the 6,020 studies identified by the above-mentioned databases, 55 studies were identified for the initial inclusion through either title or abstract relevance. During the secondary round of inclusion after full-text review, 25 studies were included in the final review.

Conclusion: Results were categorized by education level at time of intervention (early childhood, primary school, or secondary school), outcome measure (mental health, risky behaviour, mortality, etc.), and significance. Interventions conducted during early childhood showed the most significant results for sustained health outcomes.

Resumé

Contexte: La relation entre l'éducation et la santé a été étudiée pendant de nombreuses années, mais ce n'est que récemment que des études causales sont devenues disponibles. Cette revue de la littérature actuelle donne un aperçu de cette relation causale, mais met en évidence l'importance d'étudier la qualité et les caractéristiques de l'éducation à atteindre, et comment ces qualités affectent le gradient éducation / santé.

Méthodes: Une revue systématique de la littérature scientifique a été menée pour explorer la relation entre les politiques et les interventions ciblant la qualité de l'éducation et leurs impacts sur la santé. Cette recherche documentaire a été effectuée à l'aide des bases de données suivantes: MEDLINE, Social Policy Practice, ERIC, PsychINFO, HMIC et Global Health. Les études étaient éligibles pour cette revue si elles décrivaient une intervention en milieu scolaire ciblant la qualité de l'éducation (c.-à-d. Une salle de classe plus petite, ayant plusieurs enseignants dans la classe, des enseignants formés par certains programmes d'intervention, etc.) et la mesure d'un résultat sur la santé.

Résultats: Sur les 6 020 études identifiées par les bases de données susmentionnées, 55 études ont été identifiées pour l'inclusion initiale par le titre ou la pertinence du résumé. Au cours du cycle secondaire d'inclusion après la revue du texte intégral, 25 études ont été incluses dans la revue finale.

Conclusion: Les résultats ont été classés par niveau d'éducation au moment de l'intervention (la crèche, l'école primaire ou secondaire), mesure des résultats (santé mentale, comportement à risque, mortalité, etc.) et importance. Les interventions menées pendant la petite enfance ont montré les résultats les plus significatifs pour des résultats de santé durables.

1. Introduction

1.1. Background

High-quality education has the power to affect children not only through their academic achievements, but follow them into their adulthood through a number of different pathways. (1)(2). As explained by the fundamental cause theory (FCT), social factors (such as education) increase the opportunity to obtain a good job, which means that individuals are able to secure not only a stable income, but have access to health insurance, live in safer environments, and ultimately have better health(3)(4). Another is the human capital theory (HCT), which views education as an investment that produces health through gained knowledge, skills, and reasoning (4). Lastly there is the signaling or credentialing perspective, which aims to explain the differences in health by those who have obtained a high school diploma versus a college degree, using the additional years of schooling as the cause for better health (4). This association between increased education attainment leading to increased health and longer life has been coined “the education-health gradient”(5)(2). Overall, the idea is by having more education, individuals are more likely to make healthier, more positive lifestyle choices, have less risky behaviour, and increase their attention to preventative care(6)(2). For this reason, education is considered one of the most important indicators of socio-economic status. Association itself is not enough to truly understand how this relationship between education and health operates, which is why the need to explore causality is imperative.

Continuing to build our knowledge on this well-documented causal relationship between education and health is important for a number of reasons. Firstly, it is through these causal relationships that policies are based and created. By expanding our understanding of how this relationship works, we can create more effective education policies. In addition to benefiting the individual, educational attainment has a significant influence on the socio-economic success of the community. As explained by Dana Mitra, a better educated population will have less unemployment, reduced dependence on public assistance programs, less crime, improved health, and greater income(7).

Association between education and health

Increasing educational attainment has become a key focus globally in the last century. For example according to the US Census Bureau, the percentage of the population aged 25+ with a high school diploma nearly quadrupled from around 24% in the 1940s to about 88% in 2015(8). This shows us the importance that has been placed on education through compulsory schooling laws, which in turn have created a more highly educated workforce. In the last few decades, hundreds of studies have been conducted

documenting the effects of higher educational attainment. One of the most influential is the work by Kitgawa and Hauser, who studied the relationship between mortality and a wide range of social factors in the US. They found large differences in mortality according to educational attainment(4). Most recently in 2020, the OECD conducted a study in which they analyzed the relationship between education and health between 1995 and 2015 from 26 OECD(6). They found that overall, adults with higher educational attainment had better health and lifespans than their less educated peers, as seen in the literature- Hummer and Lariscy (2011), Montez, Hummer, and Hayward (2012), Clark and Royer (2010), and Oreopoulos (2010) to name a few. As this association between health and education has been well documented, it is important to note the characteristics that shape the school and classroom settings.

Causal relationship between education and health

Though robust, a majority of this relationship has been studied in a quantitative manner- meaning the amount of time spent in school or level of education, and its effects on the above-mentioned outcomes. An example of this is shown from the study conducted by Dana Goldman and James P Smith in 2011 on the relationship between education and health, and how it has changed between the late 1970s and early 2000s among non-Hispanic whites aged 40-64 years. According to their study, the proportion of self-reported fair or poor health among those without a high school education differed from those with a college education by 25% in 1978 and increased to 36% in 2004(9). This association means that over the course of the 30 observed years, poor health became more common for those with less of an education. Because this study was conducted over such a long period of time, we can also say with confidence that this association was not likely caused by a random factor or event, and actually begins to build the case for a causal relationship, rather than just an association, between education and health. This is in line with Sir Austin Bradford Hill's famous criteria for evidence of a causal relationship, which includes temporality (the idea that an effect occurs after the cause) and consistency(10). Their study also found that those with advanced education reported less prevalence of chronic diseases such as arthritis, heart disease, high blood pressure, lung disease, and diabetes, while on the contrary, the population with less education experienced an increase of some of these conditions(9).

Another example of this causal relationship comes from David Cutler and Adriana Lleras-Muney in their 2006 study *Education and Health: Evaluating Theories and Evidence*. Here, the authors report that those with an additional four years of education had reduced mortality, risk of heart disease, and risk of diabetes(11). Moreover, those who

reported having more years of education were less likely to indulge in risky behaviours such as smoking, drinking heavily, using illegal drugs, or being overweight(11). According to another study conducted by Lleras-Muney in 2005 on the changes of compulsory school laws across the US between 1915 and 1939 and mortality rate using the US census in 1960, 1970, and 1980, each additional year of schooling lowered mortality rate over a ten year period by almost 60%(12).

Although the causal quantitative relationship between educational attainment and health has been well studied and established, a large and very important detail remains unanswered: How do the different qualities and characteristics within these schools or classrooms that make up this education affect these health outcomes? For example, are smaller classrooms better than larger ones? Does having multiple teachers in a classroom make a difference? What is the effect of training teachers or altering the content of the class in a particular way? Here is where the nature of this literature review lies.

Current situation

Currently, there are several organizations and programs throughout the world whose aim is to target school quality and investigate its effects on health and behaviour. One of the oldest and most well-known is the US-based Head Start program created in 1965, which targets early childhood education to provide health, nutrition, and parental services to low income children and families (13). According to the National Head Start Association, Head Start children were found to score higher than control groups of children across all cognitive and socio-emotional measures, as well as having lower body mass index (BMI), by the end of their kindergarten programs(13). Another very well-known example is the Abecedarian Project, a US based program created in the late 1970s which conducts RCTs with the aim to monitor the long term effects of high quality early care and education, particularly to disadvantaged children(14). In this project, children receive the intervention through age 5 and are continuously monitored in follow ups at age 12, 15, 21, 30, and 35. According to a recent publication, recipients of the Abecedarian curriculum scored higher on achievement tests, were more likely to attend a 4-year university and have a skilled job, were less likely to smoke marijuana, and reported fewer depressive symptoms than their peers(14).

1.2. Rationale

Longer schooling has been consistently associated with improved educational and socioeconomic outcomes, and ultimately improved health. However, there is still limited evidence that it is possible to improve health by intervening on education quality.

1.3. Review question

The aim of this systematic review is to assess the health impacts of education interventions targeting school quality conducted in all types of education settings using causal study designs.

1.4. Study objective

- To perform a systematic literature review and asses the health impact of education interventions

Primary Objectives:

- Assess the health impact of education quality through the following 3 pathways:
    - Higher educational attainment and cognitive reserve, greater employment potential, and higher income
    - Reduced risky health behaviours
    - Improved psycho-social resources (e.g., social class, parental factors, beneficial connections, less psychological stress

2. Methods

This study follows the Cochrane Database of Systematic Reviews approach to synthesize studies used in this review. Though all types of publications were included in the search, including not peer-reviewed or published, to avoid meta/publication bias the focus of this systematic review was on randomized control trials (RCTs) and quasi-experiments. RCTs were included (multi-arm, practical and parallel-group approach) because this study design is considered the gold standard in terms of internal validity and brings a strong emphasis on efficacy of interventions. Quasi-experiments (interrupted time series, instrumental variables, difference in differences, regression discontinuity design, and panel analysis if fixed effects) are included as they provide valuable information of real-world effectiveness of these programs.

2.1. Protocol and registration

Before this study was conducted, a protocol was developed and registered with PROSPERO, the international prospective register of systematic reviews. Furthermore, as the aim of this review was to evaluate the effects of interventions, the PRISMA

guidelines were used to report the results.

2.2. Eligibility criteria

Participants/ Population

This study is interested in individual-level data and includes results from all income regions (high-income and low-and-middle-income countries). Studies focusing on outcomes of teachers, parents, or institutions were excluded.

Interventions/ Exposures

The focus of this review is on studies that introduce an educational intervention aiming to increase education quality along a framework of Input, Process, Output, and Outcome. This framework was inspired by the frameworks of UNESCO and the OECD. Educational interventions covered early life/pre-school to higher education, allowing to follow a life-course approach to better understand if interventions given at certain points in time are more or less effective in terms of education and health outcomes.

The following interventions were excluded from the study:

• Quantitative schooling policies without additional education quality changes, e.g., compulsory schooling laws

• Policies that directly focus on health in educational setting (e.g., higher physical activity, campaigns against bullying), nutritional programs as well as programs that directly affect risky behaviour (e.g., smoking, drug abuse)

• Interventions without the explicit purpose of improving education/ educational circumstances (e.g., interventions who do not have effecting education as a primary objective)

Comparators/ Control

Studies were eligible if the counterfactual was what the children would receive in the absence of the intervention (the status quo).. Active control arms were also included as some research may consider it as unethical to conduct studies where the control group does not receive any further assistance.

Outcomes

Health outcomes remained generalized in the first round of searches. The main outcomes being searched for were the following:

- Higher educational attainment and cognitive reserve, greater employment potential, and higher income

- Reduced risky health behaviours
- Improved psycho-social resources (e.g., social class, parental factors, beneficial connections, less psychological stress

The measure of health outcomes varied between the 25 included studies, and ranged from self-reported health status, risky health behaviours such as smoking or drinking excessively, diagnosed diseases, and mortality. Before excluding studies for missing health outcomes, appendices were searched for measures that could be relevant for this study, as perhaps health was not a primary aim of the educational intervention, but still included as a secondary measure.

2.3. Information sources and literature search

The literature search was performed using a combination of the following databases:

- Public health: MEDLINE Ovid, PsychINFO, HMIC, Global health
- Education: ERIC
- Social policy: Social Policy and Practice
- Grey literature: Manual searches through reference lists, databases, and other various websites

Initially, a MEDLINE strategy was developed, and translated accordingly for the respective other libraries used in this search. Only studies written in English were included. Due to a high volume of search results, we included only studies published in the year 2000 or later, as that was the year that the United Nation's Millennial Development Goals were declared, listing "achieving universal primary education" as the 2nd out of 8 main targets.

Table 1 Articles search strategy

Overview search results
Sheet "Overview"
Last changed on: 10-Mär-2021

Library	Operator	Date	Name	Number of records
Medline	Ovid	3/10/21	Medline 16	2,647
HMIC	Ovid	3/10/21	HMIC 5	20
Social Policy & Practice	Ovid	3/10/21	Social Policy Practice 5	71
Global Health	Ovid	3/10/21	Global Health 6	1,442
PsycINFO	Ovid	3/10/21	PsychINFO 6	3,121
ERIC	EBSCO	3/10/21	ERIC 6	584

Total records found	7,885
Total records uploaded to Mendeley	7,885
Records automatically removed by Mendeley	7,140
Records manually removed due to duplicates	1,120
Total records after removal of duplicates	**6,020**

2.4. Selection process

After the search guides for each database were conducted, the first phase of the selection process was independently screened for title and abstract by two investigators (CM and FG)) using Rayyan. After removing any duplicates and independently including/excluding studies, the two investigators agreed on criteria for which studies to include in the second round of the selection process, which was comprised of reading the full texts of the included studies and either choosing to include or exclude at that point. This included specific components of the intervention, outcome, study design, study population, and study year.

2.5. Data extraction

A data extraction form was designed by the two investigators using Microsoft Excel in order to extract all of the relevant information from the included studies. In order to calibrate the judgement between the two investigators, the first three data extractions were done together as a team. The form was divided into two sections, one for RCTs and one for quasi-experiments. See Appendix 1 for the data extraction form.

2.6 Strategy for data synthesis

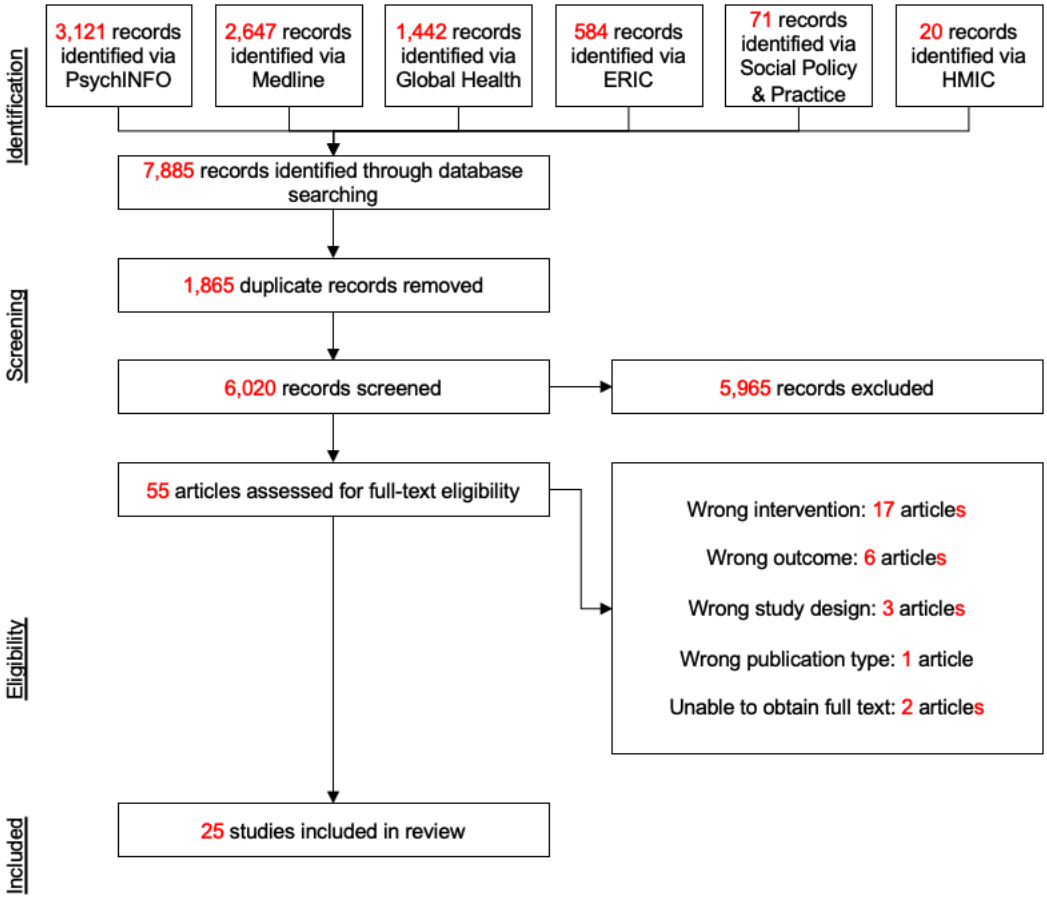
After completing the data extraction forms with relevant information, data was then summarized and categorized into a table with key results (Table 2 below). From there, outcome measures and intervention design were compared and synthesized using a textual narrative synthesis approach to investigate patterns or similarities/differences among the results. Textual narrative synthesis includes organizing the data in various homogenous themes/groups according to study characteristics and context which then is used to yield analytic results(15). Outcome measures are reported in means, counts, proportions, percentage, rates, and odds ratios.

3. Results

3.1. Description of studies

After removing the duplicates found among the results from the six databases used for this review, 6020 unique records were identified. The large quantity of records was due to broad search terms such as “mortality” or “education”, which yielded many results. Of those, only 55 met the inclusion criteria based on terms in the title and abstract. Upon reading the full text, another 30 studies were excluded, leaving 25 studies meeting the inclusion criteria. See Figure 1 for the PRISMA flow diagram of study identification and selection process.

Figure 1 PRISMA



3.2. Types of design and location of included studies

Table 2 below shows the overview information on the 25 included studies, as well as categories for the intervention type, start time, and targeted population. Most of the studies were RCTs (n=21, 84%), three used quasi-experimental design (12%), and one study was observational (4%). Most of the studies took place in the United States of America (n=18, 72%). Three were conducted in England (12%), two took place in Sweden (8%), and one in Portugal (4%). One study included data from 21 countries from the EU. The largest portion of interventions were conducted and focused on early childhood education, meaning from infancy until kindergarten enrollment (n=11, 44%). Eight studies targeted education interventions during primary school (32%). Interventions in secondary school were conducted in six studies (24%). Sample size varied from 21 students to over 220,000.

Among the 25 studies, four (16%) used the Abecedarian Project- an early life educational intervention + parenting skills intervention targeting children from infancy through age 5 through the use of educational "games" incorporated into the day that

focus on social, emotional, and cognitive areas of development (16). Two of the studies (8%) used the 4R's curriculum (Reading, Writing, Respect & Resolution), which aims to engage the imagination and creativity of children in grades pre-kindergarten to grade 5 to help develop critical skills such as empathy, community building, and conflict resolution(17). One of those studies, a dissertation by Sutton (2020), had an intervention group comprised of the 4R program + the MyTeachingPartner (MTP) program, a coaching approach that supports curriculum implementation by providing teachers with ongoing, personalized feedback and support centered on teacher-student interactions (18).

Head Start, a program created by the United States Department of Health and Human Services in the 1960s that provides early childhood education, health, nutrition, and parent involvement services to low-income children and families, had a total of five studies (20%). These included two preschool intervention studies (REDI program), one primary school intervention study (PATHS program), and two independent interventions (the Chicago School Readiness Project and Project STAR), which also fall under its umbrella.

One study compared the effects of the Families and Schools Together (FAST) Program, an after-school, multifamily support group, to the Family Education (FAME) Program, which sends behavioral parenting pamphlets home with the children and includes active follow-ups throughout the year. Two studies investigated the effects of low-income students winning lotteries and being admitted into high performing secondary schools (8%). One observational study was conducted analyzing the effects of class size. Two studies focused on high school at-risk youth using Rational Emotive Education (REE), a school-based cognitive therapy intervention targeting the reduction of disruptive behavior amongst African American males, while the other was an intensive residential program that targeted dropouts (ChalleNGe Program).

The Incredible Years Teacher Classroom Management (IY-TCM) program, a program created to strengthen teacher classroom management strategies and promote children's prosocial behavior and school readiness (reading skills) was used in three studies (12%). Another two well-known programs included in this study were the Perry Preschool Program (PPP), a longitudinal study which followed their students through age 40, and the CARE program. One study looked at the effect of tracking reforms across different cohorts throughout Europe. One implemented an intervention based on a formerly used

teaching concept from the 1940s-1970s in Sweden which was created with the focus to better help children with hidden disabilities such as dyslexia and dyscalculia.

Table 2 Overview of included studies

Primary intervention	####	*Note that this preliminary classification is based on our initial education quality framework as much as possible - some require details from full text for final classification*
Class size	3	
Classroom	4	
Cognitive/ social skil	2	
Curriculum	2	
Dropouts	1	
Family environment	2	
Holistic educational (	5	
Learning environmen	3	
Teacher quality	3	

Details on population	####	*Note that since based on abstracts only this preliminary classification is not mutually exclusive due to lack of details in abstract (e.g., disadvantaged families can also be ethnic minorities)*
Disadvantaged famili	9	
Ethnic minorities	3	
General	13	

Start of intervention	####	*Note that some interventions may span across several phases. Therefore, start of intervention was chosen*
Early childhood	11	
Primary education	8	
Secondary educatior	6	
Tertiary education	0	
Job education	0	

Primary intervention	Details on population	Start of intervention	First author	Year	Title
Cognitive/ social skills	Ethnic minorities	Primary education	Jones	2010	A school-randomized clinical trial of an integrated social-emotional learning and literacy intervention: impacts after 1 school year.
Classroom	General	Primary education	Sutton	2020	Academic and social-emotional classroom composition and the quality of classroom interactions in New York City public elementary schools.
Classroom	General	Primary education	Li-Grining	2010	Academic Outcomes of the Chicago School Readiness Project in First Grade: Do Children's Approaches to Learning Mediate Treatment Effects on Academic Skills?
Holistic educational enrichmen	Disadvantaged families	Early childhood	Campbell	2012	Adult outcomes as a function of an early childhood educational program: An Abecedarian Project follow-up.
Family environment	Disadvantaged families	Primary education	McDonald	2006	After-School multifamily groups: a randomized controlled trial involving low-income, urban, Latino children
Learning environment	Disadvantaged families	Secondary education	Dudovitz	2018	Assessment of exposure to high-performing schools and risk of adolescent substance use: a natural experiment.
Class size	General	Secondary education	Jakobsson	2013	Class-Size Effects on Adolescents' Mental Health and Well-Being in Swedish Schools
Holis educational enrichmen	Ethnic minorities	Early childhood	McLaughlin	2007	Depressive symptoms in young adults: the influences of the early home environment and early educational child care.
Cognitive/ social skills	Ethnic minorities	Secondary education	Kaplan	2019	Disrupting the school to prison pipeline: Rebt with African-American youth in a school setting.
Learning environment	General	Secondary education	Delaruelle	2019	Do comprehensive school reforms impact the health of early school leavers? Results of a comparative difference-in-difference design.
Holistic educational enrichmen	General	Early childhood	Muennig	2009	Effects of a prekindergarten educational intervention on adult health: 37-year follow-up results of a randomized controlled trial.
Classroom	Disadvantaged families	Early childhood	Bierman	2017	Enriching Preschool Classrooms and Home Visits with Evidence-Based Programming: Sustained Benefits for Low-Income Children
Teacher quality	Disadvantaged families	Early childhood	Seabra-Santos	2018	Promoting mental health in disadvantaged preschoolers: A cluster randomized controlled trial of teacher training effects.
Classroom	Disadvantaged families	Early childhood	Bierman	2020	Reducing Adolescent Psychopathology in Socioeconomically Disadvantaged Children With a Preschool Intervention: A Randomized Controlled Trial.
Dropouts	General	Secondary education	Bloom	2009	Reengaging High School Dropouts: Early Results of the National Guard Youth ChalleNGe Program Evaluation. Full Report
Learning environment	Disadvantaged families	Secondary education	Wong	2014	Successful schools and risky behaviors among low-income adolescents.
Teacher quality	General	Primary education	Ford	2012	Supporting teachers and children in schools: the effectiveness and cost-effectiveness of the incredible years teacher classroom management programme in primary school children: a cluster randomised controlled trial, with parallel economic and process evaluations.
Holistic educational enrichmen	General	Early childhood	Muennig	2011	The effect of an early education program on adult health: The Carolina Abecedarian Project randomized controlled trial.
Class size	General	Primary education	Wilde	2011	The effect of class size in grades K-3 on adult earnings, employment, and disability status: Evidence form a multi-center randomized controlled trial.
Class size	General	Early childhood	Muennig	2011	The effect of small class sizes on mortality through age 29 years: evidence from a multicenter randomized controlled trial.
Family environment	Disadvantaged families	Early childhood	Mclaughlin	2007	The impact of early educational child care and the affective quality of the home environment on early adolescent mental health.
Curriculum	General	Primary education	Humphrey	2018	The PATHS curriculum for promoting social and emotional well-being among children aged 7–9 years a cluster RCT
Curriculum	General	Early childhood	Ahlqvist	2019	capacity at the end of grade three using an alternative school curriculum.
Teacher quality	General	Primary education	Ford	2019	Training teachers in classroom management to improve mental health in primary school children the STARS cluster RCT
Holistic educational enrichmen	Disadvantaged families	Early childhood	Campbell	2008	Young Adult Outcomes of the Abecedarian and CARE Early Childhood Educational Interventions

3.3. Outcomes

Health Measures

Two-thirds of the included studies (n=17, 68%) measured mental health (including depression and anxiety). One quarter (n=7, 28%) measured risky behaviours such as substance abuse. The third most studied outcome was somatic or physical symptoms of illness, such as dizziness, headaches, and stomachaches (n=3, 12%). Social skills, overall health, and hospitalizations were each in two studies (n=2 times 3, 8% each category). Only one study used mortality to measure the health effect of the intervention (4%).

Method of measurement

Fourteen of the studies were conducted using questionnaires reported by someone other than the study individual (teachers, mental health counselors, parents, program assistants) (56%). Sixteen studies used self-reported data from the individuals in the study population (64%). Two studies used records gathered from databases such as the Social Security Administration (SSA) in the US or death certificates.

Patterns based on education level- Early Childhood Interventions

Eleven studies were conducted in the "early childhood" category, meaning the interventions targeted children from infancy to school age (kindergarten, or about age 5/6). Among this education level, almost every intervention saw positive results within their treatment group. ABC's results across their multiple studies showed that more individuals in the treated group rated themselves having excellent health, as well as reduced risky behaviours and rates of depression. Additionally, individuals in the ABC intervention group began smoking later and tried marijuana later than their control peers, had a more active lifestyle than their control peers, and reported less use of marijuana than the control group. One ABC study found no significant difference in mental health between their treated and control groups. PPP also showed positive results, with their intervention group reporting better overall health.

Similar to ABC, Project CARE's intervention group reported lower internalizing symptoms (depression, anxiety, sadness), a more active lifestyle, and a reduction in reported use of marijuana, compared to their control group. When comparing the intervention-specific interaction against one another, the size of the intervention/control group difference was significant, being five times greater in CARE than in the ABC study.

Despite showing some positive initial results with intervention groups reporting lower levels of anxiety and depression within their first follow ups, neither the Savsjo nor the IY-TCM intervention groups had sustained effects at their final follow ups. Additionally, the greatest reduction in the IY-TCM intervention group was found among children who had reported higher levels of mental health problems at their baseline, compared to children who had reported normal levels at their baseline.

Patterns based on education level- Primary School Interventions

Primary, or elementary school, was the target for eight of the studies. The results across the multiple interventions in this category do not show a consistent pattern. The 4R program had a positive association between intervention and health, meaning treated students reported less symptoms of depression after their intervention. FAST teachers rated their children with having more social skills and less aggressive behaviour than their FAME counterparts, though no significant difference was found regarding mental health changes in both interventions. Among the many Head Start programs, there were many mixed results. Initially, similar to Savsjo and IY-TCM, the PATHS program showed better psychological wellbeing for their intervention groups- but were not sustained through their follow ups. The Chicago School Readiness Project showed no significant

impact on their intervention group. Though many studies have been conducted showing the positive impact of smaller classrooms(19), Project STAR reported a higher mortality rate among their students in smaller classrooms through age 30. The authors hypothesized that this may be because the treated children were more extroverted, thereby exposing themselves to drinking, accidents, drownings, and firearms.

Patterns based on education level- Secondary School Interventions

Six studies took place during secondary, or high school. Similar to the results of the primary school interventions, the secondary school interventions also saw mixed results. Unlike the above-mentioned result in the primary school study on class size and increased mortality, the study conducted by Jakobsson (2013) showed no significant difference between class sizes and health. Both studies examining the health effect of being admitted to a higher performing secondary school reported less risky behaviour among their lottery-winning students. The large study conducted on EU tracking reforms in secondary school showed early school leavers reporting worst health than intermediate/higher educated groups, the gap between health increasing after implementation of the reform, and lastly the health of the intermediate/higher educated groups increasing with the raising of tracking age but decreasing for early school leavers. Similarly to Savsjo, IY-TCM, and PATHs mentioned above, the ChalleNGe program also ended up with mixed results. Although their intervention group showed an increase in health initially at the 9 month follow up, not only were these results not sustained, but they worsened as the intervention progressed, resulting in the intervention group having more overweight members than the control. As for risky business, again the intervention group initially saw less delinquency and convictions at the 9 month follow up, but ended up having no sustained effect, reporting a higher percentage of ever trying illegal drugs (besides marijuana), and showing no significant difference between alcohol and drug use between the intervention and control groups. The last secondary school intervention, REE, had similar results to ChalleNGe, with their intervention group having higher rates of depression and anxiety, and continuing to increase as the intervention progressed.

Table 3 Study characteristics and key results

Publication	Study Design	Sample size	Education level	Start of intervention	Country	Time frame being measured	Intervention	Health Outcome being measured	Method of measurement	Results
Jones et al. (2010)	RCT	Intervention- 515 Control- 427	3rd	Primary education	USA	Baseline - Autumn 2004 Follow up- Spring 2005	4R Intervention Program vs regular classroom (control)	Depression	Questionnaire, self-reported	Children in the intervention group reported significantly lower levels of depressive symptoms in spring 2005 compared to those in the control group.
Sutton (2020)	RCT	1803	3rd & 4th grade	Primary education	USA	Cohort 1: Baseline- Autumn 2015 Final follow up- Spring 2017 Cohort 2: Baseline- Autumn 2016 Final follow up- Spring 2018	4R + MTP Intervention Program vs regular classroom (control)	Depression & Anxiety	Behavioural Assessment System for Children (BASC) Internalizing Composite Scale	Classrooms were categorized into high risk, at risk, and low risk profiles based on social questionnaire results and academic performance. The at-risk category had the highest proportion of children at risk for depression and anxiety among the 3 categories.
Li-Grining, Haas (2010)	RCT	602	Preschool	Primary education	USA	Baseline- Preschool Follow up- Kindergarten	Chicago School Readiness Project vs regular classroom (control)	Social competence (anger, social skills, anxiety)	Social Competence and Behavior Evaluation (SCBE-30)	No significant impact of intervention on children's social competence.
Campbell et al. (2012)	RCT	Baseline- 111 Follow Up- 101	Early infancy child care facility (6 weeks old - 5 years old- mean entry age was 4.4 months)	Early childhood	USA	Intervention lasted from early childhood to grade 2, follow ups conducted at age 21 and 30	Abecedarian Project (ABC)- full time center-based child care and educational services from infancy until kindergarten entry vs regular classroom (control)	Mental health, Substance abuse, and Health status	Mental health- Achenbach System of Empirically Based Assessment Adult Self Report and Adult Behavior Checklist Substance abuse- Behavioral Risk Factor Surveillance System Questionnaire Health status- self rated on a 5 point scale from excellent to poor	Among the final follow up at age 30, there were not differences among treated and control group reports. In terms of mental health, there was no significant difference between the treated and control group. Though the treated group had a slightly higher percentage of individuals rate their health as "excellent" compared to the control group (69% and 59% respectively), there was no significant difference.
McDonald et al. (2006)	RCT	473 (FAST = 272 and FAME = 201)	1st - 4th grade	Primary education	USA	After exposure to the program, first- and second-year follow-up data were collected for both interventions	Families and Schools Together (FAST) or Family Education (FAME)	Depression & Anxiety	Teachers Report Form (TRF) of the Child BehaviorChecklist (CBCL) & the Social Skills Rating System (SSRS)	Though there were no significant differences between depression and anxiety between children in the FAST vs FAME intervention, teachers rated students assigned to FAST as having significantly more social skills and less aggressive behavior in the classroom than those in the FAME group.
Dudovitz (2018)	Quasi-Experiment	1270	8th/9th grade - 11th grade	Secondary education	USA	Data were collected from March 11, 2013, through February 22, 2017	Admission lottery into high performing high schools vs lottery losers (control)	Risky health behaviours (marijuana use, alcohol use, sexual activity, and delinquency	Questionnaire, self-reported	The intervention group reported less marijuana misuse than the control group as well as having fewer substance-using peers. Despite no significant difference among girls in both groups, boys in the intervention group reported significantly lower marijuana and alcohol use than the control group.
Jakobsson (2013)	Observational	2755	9th grade	Secondary education	Sweden	Cross-sectional data collected in April 2008	Class size	Anxiety, Sadness, Dizziness, Headaches, Stomachaches	Questionnaire, self-reported	There was no significant difference according to class size on the prevalence of mental health issues and well-being among the students.
McLaughlin (2007)	RCT	111	Early infancy child care facility (6 weeks old - 5 years old- mean entry age was 4.4 months)	Early childhood	USA	Intervention lasted from early childhood to grade 2, follow ups conducted at age 21 and 30	Abecedarian Project (ABC) - full time center-based child care and educational services from infancy until kindergarten entry vs regular classroom (control)	Depression	Questionnaire, self-reported (Brief Symptom Inventory)	Children in the intervention group reported fewer depressive symptoms than those in the control group. Results were statistically significant.
Kaplan (2019)	RCT	Baseline- 21 Follow up- 19	High School (aged 14 to 18)	Secondary education	USA	Baseline- winter of academic year of enrollment, follow up after 12 weeks	Rational Emotive Education (REE) twice per week for 12 weeks	Substance use/abuse, physical and mental health (depression and anxiety)	Self reported using the Problem Oriented Screening Instrument for Teenager (POSIT), as well as the Beck Youth Inventories (BYI-2)	Self-reported symptoms of depression and anxiety were higher in the follow up for the intervention group compared to their baseline data collection. Only depression results were statistically significant. Furthermore, the intervention group had a greater increase in depressive and anxiety symptoms compared to the control group.

Publication	Study Design	Sample size	Education level	Start of intervention	Country	Time frame being measured	Intervention	Health Outcome being measured	Method of measurement	Results
Delaruelle (2019)	Quasi-Experiment	220,408	Varied (Early school leavers- up to lower secondary education, Intermediate educated- upper secondary education, Higher educated- post secondary or higher	Secondary education	EU	Birth year 1927 - 1985 Follow up- 2016	Difference-in-difference approach that compares changes in health disparities between two groups of birth cohorts in countries with tracking reforms and those without (micro-level data from eight waves of the European Social Survey (biennial cross-sectional survey 2002–2016)	Overall health	Single question, self reported "How good is your health in general?"	Early school leavers reported worse health than the intermediate and higher educated groups. The gap in self-reported health between early school leavers and those with upper secondary/tertiary education increased slightly after the implementation of the tracking reform. The health of the intermediate and higher educated groups increased with raising the tracking age, but decreased for early school leavers.
Muennig (2009)	RCT	123	Preschool	Early childhood	USA	Intervention lasted 2 years. Follow ups were also conducted at age 27 and 40.	High/Scope Perry Preschool Program (PPP)- 2.5 hours of interactive academic instruction daily coupled with 1.5-hour weekly home visit vs regular classroom (control)	Multiple health outcomes (Self reported, diagnosed conditions, tertiary care use, preventative care, drug use)	Self resported- Overall health status was assessed as a combination of 3 binary variables: excellent or very good self-rated health, stopping work as a result of poor health, and death. Medical conditions used binary indicators.	Participants in the intervention group scored significantly higher than the control group on the overall measure of health status. Though the intervention group had lower rates of mortality and likilhood to engage in risky behaviour, results were not significant.
Bierman et al. (2017)	RCT	556	Preschool	Early childhood	USA	Intervention lasted 1 year. Follow-up data on child outcomes were collected 3.5 years later, when children were finishing second grade	First trial: REDI-C, teaching the Preschool PATHS curriculum, vs regular Head Start (control) Second Trial: REDI-C + REDI-P home visits & learning material vs mailed material to REDI-C group (control)	Mental health	Self reported as well as teacher rated using the School Readiness Questionnaire	Trial 1: The REDI-C intervention group showed significant sustained benefits for students on four of the five teacher-rated measures (classroom participation, social competence, student–teacher relationships, and reduced peer problems). Trial 2: The REDI-P + REDI-C led to additional improvements in children's mental health, most notably self-perceived social competence and peer problems in second grade. Both REDI-C (relative to control) and REDI-P + REDI-C (relative to control) significantly enhanced children's perceptions of their social competence in second grade.
Seabra-Santos et al. (2018)	Cluster-RCT	1030	Preschool	Early childhood	Portugal	Baseline - Autumn 2015 Follow up - Spring 2016	Incredible Years Teacher Classroom Management (IY-TCM) vs regular classroom (control)	Anxiety	Teachers completed the PKBS-2 behaviour rating scale for each student	Children in the intervention group reported significantly lower levels of anxiety in their follow ups compared to their baselines.
Bierman et al. (2020)	RCT	356	Preschool	Early childhood	USA	Intervention lasted 1 year. Follow-up data on child outcomes were collected in grade 7 and 9.	Head Start + REDI (PATHS curriculum) vs Head Start (control)	Emotional symptoms (worried, unhappy, depressed)	Teachers completed the Strengths and Difficulties Questionnaire (SDQ)	The intervention showed statistically significant effects on emotional symtpoms. By grade 9, significantly more students in the intervention group scored "normal" emotional symptoms compared to the control group.
Bloom et al. (2009)	RCT	Baseline- ~3,000. Final follow up- ~1200	High School (aged 16 to 18)	Secondary education	USA	17-month program is divided into three phases: the two-week Pre-ChalleNGe Phase, which is a demanding orientation and assessment period; a 20-week Residential Phase; and a one-year Postresidential Phase. Follow up data collected after 9, 21, and 36 months.	Admitted to the ChalleNGe program vs not admitted (control)	Overall health and risky behaviours	Questionnaire, self-reported	The intervention group reported better overall health, less obesity, and were less likely to have been arrested at the 9 month follow up. Though the health differences seen at the 9 month follow up were not sustained into the 21 month follow up, the intervention group did have significantly less convictions and number of delinquent incidents than the control group. By the 3 year follow up, there were no significant differences between the intervention and control groups in regard to delinquncy and convictions. As for health, the intervention group had a significantly higher amount of overweight participants than the control group. Rates of recent binge drinking and frequent use of marijuana/other illegal drugs were similar between the intervention and control groups. However, a higher percentage of the intervention group reported having ever tried illegal drugs besides marijuana compared to the control group.

Publication	Study Design	Sample size	Education level	Start of intervention	Country	Time frame being measured	Intervention	Health Outcome being measured	Method of measurement	Results
Wong et al. (2014)	Quasi-Experiment	930	8th/9th grade - 12th grade	Secondary education	USA	Recruited in 8th/9th grade, analysis 10th-12th grade	Admission lottery into high performing high schools vs lottery losers (control)	Risky behaviours (use of tobacco, alcohol, marijuana, and other drugs in the past 30 days, binge drinking, alcohol use at school, any drug use (excluding marijuana), carrying a weapon to school in the past 30 days, gang membership in the past 12 months, current pregnancy, multiple sexual partners, sex without condoms, sex without contraception, and alcohol or drug use with sex in the past 90 days.	Questionnaire, self-reported	There was no significant difference between the intervention and control group in any of the risky behaviours specifically. There was a slightly higher proportion of the control group students engaging in 1 or more of the 11 very risky behaviours compared to the intervention group. The intervention effect in engaging in very risky behaviour was higher among those in the control group compared to the intervention group.
Ford et al. (2019)	Cluster-RCT	Baseline- 2075 Last follow up- 1804	Year 1-4 (Kindergarten - 3rd grade)	Primary education	England	Baseline- autumn of the first year of enrollment (cohort 1: 2012, cohort 2: 2013, cohort 3: 2014), Follow up at 9, 18 and 30 months	Incredible Years teacher classroom management (IY-TCM) + economic and process evaluations vs regular classroom (control)	Well-being and mental health	Questionnaire completed by the child, parents and teacher completed the Strengths and Difficulties Questionnaire (SDQ)	Children in the intervention group showed improved mental health according to the teacher-reported questionnaire at the 9 month follow up, but not at the 18 and 30 month follow up. Specifically, the greatest reduction in the SDQ was for those children identified by their teachers as struggling with their mental health at the baseline, compared to children who were not identified as struggling at the baseline.
Muennig et al. (2011)	RCT	Baseline- 111 Follow Up- 104	Early infancy child care facility (6 weeks old - 5 years old- mean entry age was 4.4 months)	Early childhood	USA	Intervention lasted from early childhood to grade 2, follow up conducted at age 21	Abecedarian Project (ABC)- full time center-based child care and educational services from infancy until kindergarten entry vs regular classroom (control)	3 health measures (self- reported health problems since 15 years of age, depression, and number of hospitalizations in the past year) and 11 measures of behavioral risk factors (traffic safety, drug use, and access to primary care).	Depression was measured using the Brief Symptom Inventory	Individuals who received the ABC treatment had significantly better health and reduced behavioural risk factors by the age of 21. Notably, individuals in the intervention group reported an older age that they began regularly smoking, as well as when they first tried marijuana.
Wilde et al. (2011)	RCT	6325	Kindergarten - 3rd grade	Primary education	USA	Intervention lasted 4 years (1985-1989), follow up measurements collected between 1997-2008 (ages 18-28)	Project STAR (Student Teacher Achievement Ratio) small class size (13–17 students), regular class size (22–25 students) or regular classes with a certified teacher's aide.	Disability	Linked records to Social Security Administration (SSA) disability data	There were no significant differences between the intervention and control groups in respect to overall decreased disability or disability for any sub-group or in any year of adulthood.
Muennig et al. (2011)	RCT	6325	Kindergarten - 3rd grade	Early childhood	USA	Intervention lasted 4 years (1985-1989), follow up measurements collected between 1997-2008 (ages 18-28)	Project STAR (Student Teacher Achievement Ratio) small class size (13–17 students), regular class size (22–25 students) or regular classes with a certified teacher's aide.	Mortality	Linked records from Project STAR to death certificates using unique identifiers collected from STAR participants prior to randomization	Children assigned to small classes had significantly higher mortality than those assigned to regular classes over the 22 years of follow-up. There was a statistically significant decrease in mortality for every additional student in class.
McLaughlin (2007)	RCT	Abecedarian Project: Baseline- 111 Follow up- 99 CARE Project: Baseline- 62 Follow Up- 36	Infancy until kindergarten entry	Early childhood	USA	Intervention lasted from early childhood to grade 2, follow up conducted at age 6, 18, 30, 42 and 54 months of age, and finally 12 years of age	Abecedarian program (ABC) (4 cohorts- 1) preschool treatment group, 2) preschool control group, 3) preschool treatment plus school-age control group, 4) preschool control plus school-age treatment group) Project CARE (2 cohorts- 1) a child care treatment/family education plus school-age treatment group, 2) a family education plus school-age treatment group, 3) and a control group.)	Mental health & psychological well-being (depression/anxiety, somatic complaints)	Questionnaire- self reported, teacher and parent reported using the Child Behavior Checklist (CBCL) and Home Observation for the Measurement of the Environment (HOME)	There was no significant difference in parent-reported internalizing symptoms between the two intervention types (CARE and ABC). Individuals who received either one of the interventions reported lower internalizing symptoms than those in the respestive control groups.

Publication	Study Design	Sample size	Education level	Start of intervention	Country	Time frame being measured	Intervention	Health Outcome being measured	Method of measurement	Results
Humphrey et al. (2018)	Cluster-RCT	5218	Year 3-5 (2nd - 4th grade)	Primary education	England	Baseline at start of intervention, annually during the 2 year study period, then 12 and 24 months post-intervention	PATHS curriculum (which aims to promote self-control, emotional understanding, positive self-esteem, relationships and interpersonal problem-solving skills among 4- to 11-year-old children) vs regular classroom (control)	Mental health & psychological well-being	Questionnaire completed by the child on psychological wellbeing (Kidscreen-27), parents and teacher completed the Strengths and Difficulties Questionnaire (SDQ)	A small but statistically significant improvement in children's psychological well-being was initially found in the intervention group. However, these results were not maintained through the 12 and 24 month follow up.
Ahlqvist et al. (2019)	Cluster-RCT	177	Preschool - 3rd grade	Early childhood	Sweden	Preschool start, end of grade 3	Sälvsjö project- alternative curriculum (based on the old principles of curative education ("Heilpädagogie"), educational psychology and school psychiatry previously used in the Swedish Public School)	Depression & Anxiety	Questionnaire- self reported, teacher and parent reported using the Child Behavior Checklist (CBCL) as well as a questionnaire on ADHD according to DSM-IV	The children in the control group showed significantly more symptoms of anxiety and depression at school-start compared to the intervention group. By the end of grade 3, no differences were found among the two groups.
Ford et al. (2019)	Cluster-RCT	Baseline- 2075 Last follow up- 1804	Year 1-4 (Kindergarten - 3rd grade)	Primary education	England	Baseline- Autumn of intervention year Follow up- at 9, 18, and 30 months	Incredible Years teacher classroom management (IY-TCM) vs regular classroom (control)	Mental health	Questionnaire completed by the child, parents and teacher completed the Strengths and Difficulties Questionnaire (SDQ)	IY-TCM improved children's mental health at the 9 month follow up, but not at the 18 or 30 month. A subgroup of children who were classified by their teacher as struggling with their mental health at baseline had significant improvements at 30 months but not 18.
Campbell et al. (2008)	RCT	Abecedarian Project:Baseline: 111 Follow up: 104 CARE Project:Baseline- 66 Follow Up- 60	Infancy until kindergarten entry	Early childhood	USA	Intervention lasted from early childhood to grade 2, follow up conducted from 20-25 years old	Abecedarian (ABC) center-based intervention vs regular classroom (control), Project CARE center-based intervention plus family education treatment, CARE family education treatment alone, regular classroom (control)	Health, safety, and social maladjustment	Interview & various questionnaires including the Youth Risk Taking Survey (covering behaviors affecting the health of young people such as diet, physical activity, using automobile seat belts, avoiding substance abuse, and avoiding anti-social behaviors)	Participants recieving either of the center-based interventions reported an active lifestyle in young adulthood that was 3.92 times greater compared to participants from the control groups. The intervention-specific interaction was also significant, with the size of the intervention/control group difference being 5 times greater in CARE than in the ABC study. The CARE group reported the highest percentage of smokers of all the groups. There was a trend in both ABC and CARE toward a reduction in reported use of marijuana among those who recieved the center-based intervention. There were no significant intervention, study, or intervention-by-study differences among self-reported binge drinking, driving after drinking, violence, or breaking the law.

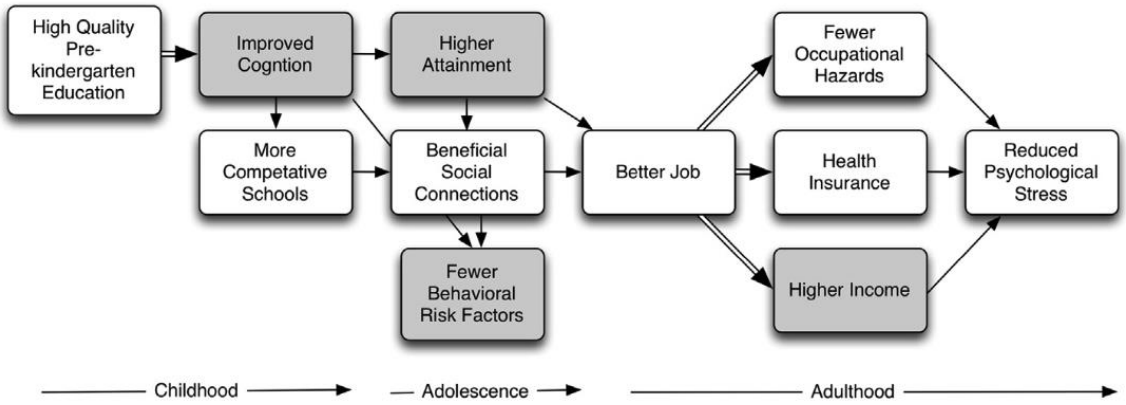
4. Discussion

Twenty-five studies were included in this review which assess the health impacts of education quality interventions from around the world. Thirteen out of the 25 studies reported statistically significant associations between education quality interventions and health outcomes (52%). Eight studies found no significant results between their intervention and control groups (32%). The remaining four studies showed mixed results- mostly of significant results during their initial follow ups, but nothing sustained (16%). The highest proportion of significant results came from early childhood interventions (n=7/11, 64%). Primary and secondary education level interventions each had three significant studies (n=3/8, 38% and n=3/6, 50% respectively). As for studies with mixed results, there were two within the primary education intervention category, and one each in early childhood and secondary

school intervention. Based on these results, interventions conducted in early childhood yielded the most successful results.

Peter Muennig speculates that this could be because children who perform better academically early in life are more likely to be tracked into more advanced placement classes later in life, which results in more opportunity to get into a competitive university(1). Furthermore, being tracked into more advanced courses can also lead to non-cognitive pathways for success through being in class with students more likely to work hard, not abuse drugs or alcohol, and motivate one another to continue to excel(1). Figure 2 below is Muennig's framework illustrating some of the ways that a high-quality educational intervention at an early age can improve health over the course of a child's lifetime. Shaded boxes represent evidence-supported causal relationships, while unshaded boxes are supported links by correlation alone. Single arrows represent correlation, while double arrows represent causation.

Figure 2 Conceptual pathways through which education works to improve health



The most frequently used health outcome measure used throughout this review was mental health (n=17, 68%). When reflecting on why the majority of the studies chose to assess the impact of these interventions on mental health, one explanation could be the role that mental health plays in overall health. According to the CDC, mental illness may increase the risk for many types of physical health issues, especially chronic ones such as stroke, heart disease, and diabetes(20). Additionally, Virginia Commonwealth University's Center on Society and Health explains that because people with higher levels of education typically hold higher paying jobs, they are often safe from economic hardships or stresses that could cause deteriorating health (21). Chronic exposure to these psychological stresses has been coined "allostatic load", and over long periods of time shows an association to diseases such as asthma, cardiovascular and gastrointestinal infections, and higher mortality(21). Another

reason could be the reverse effect that mental health plays on educational attainment. The Association for Children's Mental Health, an American advocacy group, states that only about 40% of students with a mental health disorder graduate from secondary school, compared to the US average of about 76%, and over 50% of students aged >14 drop out of secondary school(22). Risky behaviour was the second most used measurement of health (n=7, 28%), which makes sense as by definition, risky behaviour is an activity that increases the risk of disease or injury.

The most widely used method of measuring the above-mentioned health outcomes was via self-reported questionnaires (n=16, 64%). There are both many advantages as well as disadvantages in using this method. A key advantage is that it is simple and easy to use, requiring little to no need for additional staff to administer. Additionally, they are easier to compare and analyze. However, self-reported questionnaires are more likely to be subject to various biases and limitations such as ability for participants to assess themselves accurately and response bias or dishonesty. Just over half of the studies also used questionnaires administered by staff or teachers (n=14, 56%). By using trained staff, we are able to reduce the level of bias, and gain more accurate results. Two studies used data collected from the Social Security Administration, which comes with its own limitations, as some students may be unregistered and not have a Social Security Number.

The interventions conducted during early childhood (before kindergarten matriculation), saw the most positive results. Until their most recent follow up in 2014, ABC had been measuring health outcomes of their participants via questionnaires. They found that individuals in the intervention group benefitted from greater overall health than their control peers, as well as started smoking later in life. In their most recent follow up in 2014, ABC investigators decided to analyze blood samples of their participants and reported that those who had been in the intervention group had lower rates of pre-hypertension in their mid-30s, and lower risk for coronary heart disease within the next ten years(23). Furthermore, males in the intervention group had lower incidences of hypertension, obesity, and risk of diabetes and stroke. As ABC states in their most recent follow up report, this is the first time (to their knowledge) that biomarkers, as opposed to questionnaires, were used to assess health. This could be a new method of measuring health status, in addition to the qualitative questionnaires. Project CARE, PPP, and Head Start also saw positive results.

Both IY-TCM and Savsjo reported initial success among their intervention groups experiencing better health compared to their control groups, though neither study saw sustained results. The researchers from the IY-TCM study speculate that the lack of

sustained results could be caused by the relatively short duration of the intervention, as well as the single-teacher training approach, as opposed to a whole-school training approach. They conclude by anticipating a larger affect in the years to follow the intervention, when teachers are able to use and apply the skills they obtained in their training to their future classes. As for the Savsjo school project, researchers speculated that the initial success of the program could be due to the efforts made by the intervention group teachers in anticipation for the school year, which decreased as the intervention continued, leading to no difference between mental health issues among the intervention and control group. In addition, they state that their small sample size could have also affected these results.

Throughout all the early childhood interventions mentioned, a common success factor was the implementation of a family education program coupled with the school-based intervention. This can be seen in PPP, ABC, Project CARE, the Brookline Early Education Project, and the Child-Parent Center and Expansion Program(1). These results are supported by the literature(24)(25)(26). As the University of Wisconsin explains, this is because of the role that parenting plays in shaping the quality of a child's development, which includes their cognitive skills and health. This can explain why the most successful studies in this review were coupled with parenting education, to strengthen and support the home environment. Programs with parent-educational services reported better physical and emotional development of the children in intervention groups, as well as reduced youth substance abuse and rates of child abuse and neglect(27)(28)(29).

Elementary level educational interventions also had some significant results. The 4R program found statistically significant results among only two out of thirteen outcomes being measured. These included lower levels of children's hostile attributions and depression compared to the control group after the one year follow up. The researchers stated that they expect long term spillover effects for the depression outcome, particularly after more years of exposure to the program. The idea of more exposure to the intervention causing more lasting effects has also been a commonality among many of the studies in this review. In the FAST versus FAME study, investigators reported the FAST group as having more social skills and less aggressive behaviour compared to FAME. As discussed in the section about early childhood education interventions above, this could be due to the fact that the FAST program had a school and home-based component, compared to FAME's parent take-home pamphlets.

Head Start also saw some mixed results throughout their elementary level interventions. PATHS reported initial statistically significant improvements in children's psychological

wellbeing, however they weren't sustained through their two year follow up. Additionally, they found that moderate and high levels of implementation were associated with the largest improvements in psychological well-being. The Chicago School Readiness Project did not report any statistically significant differences among their intervention and control groups.

One particularly interesting result came from Muennig et al.'s Project STAR intervention in 2011. Although students randomized into smaller classrooms scored higher cognitive measures than the control group, mortality rate was higher for the intervention group through age 29 than the control. As explained by the researchers, there was also evidence of a dose-response effect between the total exposure to the intervention as well as the number of children in the class, which strengthens the evidence for a causal association. This is a very important result and point because it challenges studies with opposing results (Lleras-Munet 2005), policies, and regulations centered around class size limits.

When class size was investigated in a secondary school setting in the Jakobsson study, there was no significant differences in mental health problems and well-being according to classroom size. One of the reasons speculated by the investigators is that larger classrooms increase the likelihood of making friends, which could act as a protective factor against mental health issues. Expanding on the subject of classroom environment, two of the secondary education studies investigated the impact of low-income students being enrolled in high performing schools. Both studies found statistically significant results of their intervention groups having lower dropout rates and rates of engaging in risky behaviour. The researchers speculate that this could be due to a number of reasons: that better cognitive skills lead to better health through better knowledge of health and healthy decision making through academia, that higher performing schools are more likely to have a smaller population of "risky peers", that higher academic achievement would motivate students for a better future outlook, and that being in a school that required more work may leave less time to engage in these risky behaviours(30). The last secondary school intervention investigating school environment was a difference in difference design, examining the effect of policies delaying tracking age on health inequalities according to level of education. They found that reforms oriented toward comprehensive schooling improved health for those with secondary and tertiary education, but not those with lower levels of education(31). Therefore, delaying tracking age is negatively associated with the health outcomes of early school leavers. Additionally, they found that the gap of health inequality between early school leavers and higher educated groups is larger in countries with more comprehensive schooling systems compared to countries with earlier tracking systems. They speculated that early school leavers in countries with more comprehensive schooling systems may suffer more from

deprivation (and health related consequences) as compared to early school leavers in countries with highly tracked schooling systems, as they have spent more of their formative years in school around higher performing students. This may be caused by an adverse effect of trying to create an “equality of opportunity”, which in turn creates expectations that may not be met, and cause feelings of disappointment and frustration for the lower performing students who end up becoming early school leavers(31).

The last of the secondary school interventions were aimed at reducing disruptive behaviour in at-risk African-American males through the use of Rational Emotive Education (REE), and reengaging high school dropouts through the ChalleNGe Program. The REE intervention group found mixed results. In regard to behavioural incidents, students in the intervention saw a larger reduction in disruptive behaviour over the course of the treatment than the control group. On self-reported measures, students in the intervention group reported an increase in depression, anxiety, and anger, which contradicts the literature and prior research done using cognitive-behavioural interventions(32). The researcher’s explanation for the latter result is that the students probably gained skills that developed their self-awareness and ability to identify emotions throughout the treatment, and maybe weren’t so honest in their pre-treatment self-reporting(32). Again, this is a limitation and something to be taken into consideration when using self-reported questionnaires to measure health outcomes.

The final secondary education study was the ChallenNGe program, which like REE, found mixed results. Although intervention group members initially saw positive health benefits and decreased delinquencies and convictions at the first follow up at 9 months, these results were not sustained at the three year follow up. In fact, by the three year follow up, more intervention group members were categorized as overweight than the control group. Rates of substance use was also similar across intervention and control groups, though a higher percentage of intervention group members reported ever having tried illegal drugs besides marijuana. Program investigators report that many of the individuals in this study claimed that they struggled to maintain progress after they left ChalleNGe, which could explain why the three year results were not positive. In the post-intervention interviews at the three year follow up, many of the program members stated feeling an abrupt end to support upon the completion of the program, and could have benefited from more consistent and sustained mentoring. According to Deborah Caldwell et al., about 50% of mental health issues begin by mid-adolescence (age 14-17), which could also help explain the insignificant and mixed results coming from the secondary education group interventions, and why interventions implemented earlier on in a child’s life could prevent these issues from developing (35).

5. Strengths and Limitations

This systematic literature review on the health impacts of education quality interventions is one of the first of its kind. Reviews like this can be used to better investigate and develop and alter educational interventions, as well as influence educational policies. A limitation of this study is how broad the topic was, incorporating all levels of education and health outcomes. However, by keeping our main outcomes of interest broad, we were able to include a wide range of outcomes and get a big picture idea of the kinds of impact education can have on health, which I would argue ended up being a strength. Another limitation would be the mixed results obtained, which require further study. Despite these limitations, the methodological approach and extensive literature search enabled us to find the most relevant studies for this review.

6. Conclusion

Education has become one of the most important socio-economic factors that effects health. Having a better quality and longer education leads to higher job attainment, income, status, and wealth, opportunity to live in safe neighborhoods, and access to healthcare, which ultimately also leads to health. As explained by the OECD, unemployment rates are highest among those with lower levels of education, and individuals with lower education risk shorter life expectancy, engaging in risky behaviour, and poor health(33). Through years of study, the relationship between education and health has been identified as causal, and as such needed to be pursued for further understanding on exactly how that relationship functions(3).

As explained by Walsemann et al., educational attainment itself is not sufficient to truly understand the role that education plays in health status(2). Therefore, the aim of this systematic literature review was to better understand the current research on the health impact of education quality interventions. Although the association between education and health has been well studied and established for many years, there has been a large gap in the knowledge surrounding the quality and characteristics that make up this education. This is understandable, as schools have such varied characteristics- access to better resources, funding, opportunities, qualified teachers, and student to teacher ratios. After a thorough review, 25 papers were included in this study and analyzed for their patterns, interpretations, and future implications. To be able to better understand the long-term effects of these educational interventions, we followed a life-course approach, meaning our study included interventions from early infancy to higher education. The results of this review were mixed but give us a good idea of the current situation, and where the focus needs to be regarding educational interventions in the future.

We began by categorizing each study into one of the following three groups: early childhood (n=11), primary (n=8), and secondary education (n=6). Just over half of the studies reported statistically significant associations between education quality interventions and health outcomes (n=13, 52%). Not only did early childhood education yield the most studies in this review, but they also had the highest proportion of statistically significant results of all three categories of education (n=7/11, 64%), compared to primary (n=3/8, 38%)), and secondary (n=3/6, 50%). This was the first major finding from this review- that interventions conducted earlier in a child's life has the most significant impact on their health. Secondly, was that the interventions with the most success not only had a school-based aspect but included a family education portion. This allows students to continue their success from school to home, making it more likely that these changes will sustain throughout the child's life. There are many more characteristics, such as teacher-student ratios, length of school days or terms, school vs classroom-based interventions, and school resources (teacher wages, access to new learning resources, activities, advanced classes, etc.) that could each have a systematic review done on their respective topics. One future useful review discussed by Walsemann and Gee (2013) would be on studies that use the cumulative advantage approach, meaning the combination of the above mentioned characteristics. A study conducted in 2008 by Walsemann, Gee, and Geronimous on this topic found that students with more educational advantages had fewer health problems in their middle-age than those with fewer educational advantages(34). Furthermore, that this health gap widened over time.

Studying the qualities that positively and negatively affect our classrooms are important for a number of reasons, from the impact on each individual child, as well as the impact of our communities, country, and world. Most famously said by Nelson Mandela, "Education is the most powerful weapon which you can use to change the world." Equal opportunity to a good quality education is the root to equipping our communities with the knowledge and tools they need to not only obtain high paying jobs, secure stable incomes, have health insurance, and be able to choose and afford healthy lifestyle habits, but gain the ability to think and make the best decisions for themselves and their families. This case is especially true for our lower income, at-risk, and high-risk populations, who evidently benefitted the most from the interventions throughout this review. As public health professionals, it is imperative that we continue to study and understand the relationship between health and education quality, as to best create and implement policies and standards to help our communities reach their full potential. These studies provide us with the blueprints and enable us to incorporate evidence-based practices into our classrooms, and make quality, equitable education, possible for all students.

Appendixes

Appendix 1 Data Extraction Form

For RCTS:

Data extraction
Sheet "Data extraction RCT"
Last changed on: 18-May-2021 / DRAFT

Note: List each control and intervention arm separately

Study characteristics														
Study				Participants					Intervention		Outcome		Methodology	
Study number	Short citation	Study arm	Study design	Target population	Occupation	Education level	SES background	Country	Framework components	Description	Health outcome	Definition	Measurement tool (incl. data collection)	Measurement scale (description, type of data, direction of effect, cronbach alpha)

Study arm specifics																					
Participants				Continuous outcomes									Dichotomous outcomes							Other	
Number of participants at baseline	Mean age	Ethnicity percentages	Percent Women	First follow up timeframe (months)	Mean Score at First Follow Up	SD at first follow up	Number of participants at first follow up	End follow up timeframe (months)	Mean Score at End Follow Up (if applicable)	SD at final follow up	Number of participants at final follow up	Other timeframes	First follow up timeframe (months)	Number of participants at first follow up experiencing outcome	Number of participants at first follow up NOT experiencing outcome	End follow up timeframe (months)	Number of participants at last follow up experiencing outcome	Number of participants at last follow up NOT experiencing outcome	Other timeframes	Other outcomes	Comment

For Quasi-Experiments:

Data extraction
Sheet "Data extraction QE"
Last changed on: 18-May-2021 / DRAFT

Note: Result of each reported outcomes are in relation to specific control since due to reporting of the coefficient for the quasi-experimental analysis - state which control if several are available

Study characteristics														
Study				Participants					Intervention		Outcome		Methodology	
Study number	Short citation	Study arm	Study design	Target population	Occupation	Education level	SES background	Country	Framework components	Description	Health outcome	Definition	Measurement tool (incl. data collection)	Measurement scale (description, type of data, direction of effect, cronbach alpha)

Study arm specifics																					
Participants				Continuous outcomes									Dichotomous outcomes							Other	
Number of participants at baseline	Mean age	Ethnicity percentages	Percent Women	First follow up timeframe (months)	Mean Score at First Follow Up	SD at first follow up	Number of participants at first follow up	End follow up timeframe (months)	Mean Score at End Follow Up (if applicable)	SD at final follow up	Number of participants at final follow up	Other timeframes	First follow up timeframe (months)	Number of participants at first follow up experiencing outcome	Number of participants at first follow up NOT experiencing outcome	End follow up timeframe (months)	Number of participants at last follow up experiencing outcome	Number of participants at last follow up NOT experiencing outcome	Other timeframes	Other outcomes	Comment

Appendix 2 Detail of Search Strategy in MEDLINE Ovid

#	Query	Results
1	((education* or school*) adj1 (infrastructure* or framework*)).tw.	584
2	((educat* or school* or teach* or learn*) adj1 material*).tw.	8212
3	((teach* or educat* or instructor* or lectur* or professor*) adj1 quality).tw.	1861
4	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (expenditure* or funding* or financ*)).tw	880
5	((teacher* or educator* or instructor* or lecturer* or professor*) adj1 (wage* or benefit* or attract* or retention or incent* or salar*)).tw.	101
6	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (condition* or circumstance* or environment or environments or climate* or setting* or culture* or resourc*)).tw.	26974
7	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms or student*) adj1 (equalit* or injustic* or inequalit* or disparit* or diversit* or ethnicit*)).tw.	3681
8	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (object* or guid* or target*)).tw.	12854
9	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (admin* or supervisor* or govern* or facult*)).tw.	5591
10	((chang* or improv* or adjust* or adapt* or strength* or wors*) adj2 curriculum*).tw.	1936
11	((track* or de-track* or detrack*) adj2 (school* or class or classes or classroom or classrooms or curriculum* or student* or program* or intervention* or reform* or polic*)).tw.	1963
12	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (pedagog* or method* or practic* or approach* or deliver*)).tw.	39533
13	((Learn* or teach* or school* or educat* or class or classroom or classrooms or course or instruction*) adj1 language*).tw	3237
14	((class or classes or classroom or classrooms) adj1 (siz* or capacit* or proportion*)).tw.	3834
15	(Number* adj2 (student* or teacher*)).tw.	2587
16	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (outcome* or result*)).tw.	11841
17	((educat* or cognit*) adj1 (outcome* or improve* or performance*)).tw.	38131
18	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (attainment or priorit* or goal* or standard or standards or coordination)).tw.	13322
19	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (evaluation* or assessment*)).tw.	3436
20	((teach* or educat* or instructor* or lectur* or professor*) adj1 (appraisal* or prais* or judg* or feedback* or report* or evaluation* or assessment*)).tw.	7179
21	((Pre kindergarten* or Prekindergarten* or Pre-kindergarten* or Play-school* or Play school* or Playschool* or Kindergarten* or Pre-school* or Preschool* or Pre school* or day-care* or daycare* or day care* or child-care* or child care* or childcare* or early child* or early-child* or foundation year or universit* or college* or apprenticeship* or academic* or distan* learn* or advanced diploma*) adj2 (intervention* or reform* or polic* or initiative* or program*)).tw.	10295
22	((early-education* or early education* or elementary education* or secondary education* or tertiary education* or higher education* or contin* education* or further education* or company education* or middle-school* or middle school* or special education* or high school* or high-school* or adult education* or night-school* or night school* or part time education* or part-time education* or online education* or online-education* or vocational education*) adj2 (intervention* or reform* or program* or polic* or initiative*)).tw.	3920
23	Education* quality.tw.	605
24	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23	181375
25	(Physical health or health outcome* or morbid* or adult outcome* or youth outcome*).tw.	506731
26	((improv* or chang* or increase* or decreas*) adj2 health).tw.	88375
27	Hospitali?ation*.tw.	170311
28	(Death* or dead* or mortalit*).tw.	1541769
29	(mental adj1 (health or ill or illness* or disorder* or disease*)).tw.	208764
30	(depression* or depressive* or depressed).tw.	455639
31	disabilit*.tw.	196463
32	25 or 26 or 27 or 28 or 29 or 30 or 31	2637982
33	Randomized controlled trial.pt.	524786
34	controlled clinical trial.pt.	94093
35	placebo.ab.	215964
36	randomly.ab.	352840
37	randomi#ed.ab.	612731
38	clinical trials as topic.sh.	195061
39	trial.ti.	235876
40	RCT.tw.	23559
41	(cluster* adj2 randomi*).tw.	13449
42	((communit* adj2 intervention*) or (communit* adj2 randomi*)).tw.	8803
43	group* randomi*.tw.	3871
44	quasi*.tw.	69146
45	(natural* adj3 experiment*).tw.	7910
46	(non random* or non-random* or nonrandom*).tw.	40857
47	Non-Randomized Controlled Trials as Topic/	877
48	(before adj2 after).tw.	287831
49	Controlled Before-After Studies/	596
50	(case* and control*).tw.	520796
51	case?control.tw.	166
52	case-referent.tw.	660
53	Case-Control Studies/	297082
54	Interrupted Time Series Analysis/	1153
55	(interrupted time series or interrupted-time-series).tw.	3601
56	(instrumental variable* or instrumental-variable*).tw.	2793
57	(difference in difference* or difference-in-difference* or diff-in-diff*).tw.	3395
58	(regression discont* or RDD).tw.	1320
59	(panel analy* or panel data).tw.	3815
60	33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59	2358570
61	24 and 32 and 60	5636
62	(doctor* or physician* or midwif* or patient* or medical school or therapist* or nurse* or nursing).tw.	7554746
63	61 not 62	2883
64	limit 63 to english language	2834
65	limit 64 to yr="2000 -Current"	2682
66	exp animals/ not humans/	4797816
67	65 not 66	2647

Appendix 3 Detail of Search Strategy in ERIC

#	Query	Limiters/Expanders	Results
S56	S54 NOT S55	Limiters - Date Published: 20000101-; Language: English; Search modes - Boolean/Phrase	584
S55	AB (doctor* or physician* or midwif* or patient* or "medical school" or therapist* or nurse* or nursing) OR TI (doctor* or physician* or midwif* or patient* or "medical school" or therapist* or nurse* or nursing)	Search modes - Boolean/Phrase	53,428
S54	S24 AND S32 AND S53	Search modes - Boolean/Phrase	727
S53	S33 OR S34 OR S35 OR S36 OR S37 OR S38 OR S39 OR S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 OR S48 OR S49 OR S50 OR S51 OR S52	Search modes - Boolean/Phrase	36,304
S52	AB ("panel analy*" or "panel data") OR TI ("panel analy*" or "panel data")	Search modes - Boolean/Phrase	765
S51	AB ("regression discont*" or RDD) OR TI ("regression discont*" or RDD)	Search modes - Boolean/Phrase	530
S50	AB ("difference in difference*" or "difference-in-difference*" or "diff-in-diff*") OR TI ("difference in difference*" or "difference-in-difference*" or "diff-in-diff*")	Search modes - Boolean/Phrase	376
S49	AB ("instrumental variable*" or "instrumental-variable*") OR TI ("instrumental variable*" or "instrumental-variable*")	Search modes - Boolean/Phrase	364
S48	AB ("interrupted time series" or "interrupted-time-series") OR TI ("interrupted time series" or "interrupted-time-series")	Search modes - Boolean/Phrase	135
S47	AB "case-referent" OR TI "case-referent"	Search modes - Boolean/Phrase	69
S46	AB ("case-control" or "case control") OR TI ("case-control" or "case control")	Search modes - Boolean/Phrase	224
S45	AB ("case* and control*") OR TI ("case* and control*")	Search modes - Boolean/Phrase	48
S44	AB (before N1 after) OR TI (before N1 after)	Search modes - Boolean/Phrase	7,927
S43	AB trial* OR TI trial*	Search modes - Boolean/Phrase	15,147
S42	AB ("non random*" or "non-random*" or "nonrandom*") OR TI ("non random*" or "non-random*" or "nonrandom*")	Search modes - Boolean/Phrase	784
S41	AB (natural* N2 experiment*) OR TI (natural* N2 experiment*)	Search modes - Boolean/Phrase	443
S40	AB quasi* OR TI quasi*	Search modes - Boolean/Phrase	7,541
S39	AB "group* random*" OR TI "group* random*"	Search modes - Boolean/Phrase	138
S38	AB ((communit* N1 intervention*) or (communit* N1 randomi*)) OR TI ((communit* N1 intervention*) or (communit* N1 randomi*))	Search modes - Boolean/Phrase	631
S37	AB (cluster* N1 randomi*) OR TI (cluster* N1 randomi*)	Search modes - Boolean/Phrase	511
S36	AB RCT OR TI RCT	Search modes - Boolean/Phrase	563
S35	AB randomi?ed OR TI randomi?ed	Search modes - Boolean/Phrase	6,757
S34	AB placebo OR TI placebo	Search modes - Boolean/Phrase	795
S33	AB "controlled clinical trial" OR TI "controlled clinical trial"	Search modes - Boolean/Phrase	26
S32	S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31	Search modes - Boolean/Phrase	95,506
S31	AB disabilit* OR TI disabilit*	Search modes - Boolean/Phrase	52,834
S30	AB (depression* or depressive* or depressed) OR TI (depression* or depressive* or depressed)	Search modes - Boolean/Phrase	12,986
S29	AB (mental N1 (health or ill or illness* or disorder* or disease*)) OR TI (mental N1 (health or ill or illness* or disorder* or disease*))	Search modes - Boolean/Phrase	18,149
S28	AB (Death* or dead* or mortalit*) OR TI (Death* or dead* or mortalit*)	Search modes - Boolean/Phrase	11,775
S27	AB Hospitali?ation* OR TI Hospitali?ation*	Search modes - Boolean/Phrase	859
S26	AB ((improv* or chang* or increase* or decreas*) N1 health) OR TI ((improv* or chang* or increase* or decreas*) N1 health)	Search modes - Boolean/Phrase	3,059
S25	AB ("Physical health" or "health outcome*" or morbid* or "adult outcome*" or "youth outcome*") OR TI ("Physical health" or "health outcome*" or morbid* or "adult outcome*" or "youth outcome*")	Search modes - Boolean/Phrase	4,108
S24	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23	Search modes - Boolean/Phrase	508,076
S23	AB "Education* quality" OR TI "Education* quality"	Search modes - Boolean/Phrase	2,862
S22	AB (("early-education*" or "early education*" or "elementary education*" or "secondary education*" or "tertiary education*" or "higher education*" or "contin* education*" or "further education*" or "company education*" or "middle-school*" or "middle school*" or "special education*" or "high school*" or "high-school*" or "adult education*" or "night-school*" or "night school*" or "part time education*" or "part-time education*" or "online education*" or "online-education*" or "vocational education*") N1 (intervention* or reform* or program* or polic* or initiative*)) OR TI (("early-education*" or "early education*" or "elementary education*" or "secondary education*" or "tertiary education*" or "higher education*" or "contin* education*" or "further education*" or "company education*" or "middle-school*" or "middle school*" or "special education*" or "high school*" or "high-school*" or "adult education*" or "night-school*" or "night school*" or "part time education*" or "part-time education*" or "online education*" or "online-education*" or "vocational education*") N1 (intervention* or reform* or program* or polic* or initiative*))	Search modes - Boolean/Phrase	20,807
S21	AB (("Pre kindergarten*" or Prekindergarten* or Pre-kindergarten* or Play-school* or "Play school*" or Playschool* or Kindergarten* or Pre-school* or Preschool* or "Pre school*" or day-care* or daycare* or "day care*" or "child-care*" or "child care*" or childcare* or "early child*" or early-child* or foundation year or universit* or college* or apprenticeship* or academic* or "distan* learn*" or "advanced diploma*") N1 (intervention* or reform* or polic* or initiative* or program*)) OR TI (("Pre kindergarten*" or Prekindergarten* or Pre-kindergarten* or Play-school* or "Play school*" or Playschool* or Kindergarten* or Pre-school* or Preschool* or "Pre school*" or day-care* or daycare* or "day care*" or "child-care*" or "child care*" or childcare* or "early child*" or early-child* or foundation year or universit* or college* or apprenticeship* or academic* or "distan* learn*" or "advanced diploma*") N1 (intervention* or reform* or polic* or initiative* or program*))	Search modes - Boolean/Phrase	37,048
S20	AB ((teach* or educat* or instructor* or lectur* or professor*) N1 (appraisal* or prais* or judg* or feedback* or report* or evaluation* or assessment*)) OR TI ((teach* or educat* or instructor* or lectur* or professor*) N1 (appraisal* or prais* or judg* or feedback* or report* or evaluation* or assessment*))	Search modes - Boolean/Phrase	48,717
S19	AB ((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (evaluation* or assessment*)) OR TI ((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (evaluation* or assessment*))	Search modes - Boolean/Phrase	39,780
S18	AB ((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (attainment or priorit* or goal* or standard or standards or coordination)) OR TI ((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (attainment or priorit* or goal* or standard or standards or coordination))	Search modes - Boolean/Phrase	36,387
S17	AB ((educat* or cognit*) N1 (outcome* or improve* or performance*)) OR TI ((educat* or cognit*) N1 (outcome* or improve* or performance*))	Search modes - Boolean/Phrase	19,528
S16	AB ((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (outcome* or result*)) OR TI ((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (outcome* or result*))	Search modes - Boolean/Phrase	43,734
S15	AB (Number* N1 (student* or teacher*)) OR TI (Number* N1 (student* or teacher*))	Search modes - Boolean/Phrase	10,158
S14	AB ((class or classes or classroom or classrooms) N1 (siz* or capacit* or proportion*)) OR TI ((class or classes or classroom or classrooms) N1 (siz* or capacit* or proportion*))	Search modes - Boolean/Phrase	4,503
S13	AB ((Learn* or teach* or school* or educat* or class or classroom or classrooms or course or instruction*) N1 language*) OR TI ((Learn* or teach* or school* or educat* or class or classroom or classrooms or course or instruction*) N1 language*)	Search modes - Boolean/Phrase	58,898
S12	AB ((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (pedagog* or method* or practic* or approach* or deliver*)) OR TI ((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (pedagog* or method* or practic* or approach* or deliver*))	Search modes - Boolean/Phrase	121,766
S11	AB ((Track* or de-track* or detrack*) N1 (school* or class or classes or classroom or classrooms or curriculum or student* or program* or intervention* or reform* or polic*)) OR TI ((Track* or de-track* or detrack*) N1 (school* or class or classes or classroom or classrooms or curriculum or student* or program* or intervention* or reform* or polic*))	Search modes - Boolean/Phrase	2,815
S10	AB ((chang* or improv* or adjust* or adapt* or strength* or wors*) N1 curriculum*) OR TI ((chang* or improv* or adjust* or adapt* or strength* or wors*) N1 curriculum*)	Search modes - Boolean/Phrase	5,142
S9	AB ((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (admin* or supervisor* or govern* or facult*)) OR TI ((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (admin* or supervisor* or govern* or facult*))	Search modes - Boolean/Phrase	59,189
S8	AB ((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (object* or guid* or target*)) OR TI ((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (object* or guid* or target*))	Search modes - Boolean/Phrase	42,593
S7	AB ((learn* or teach* or school* or educat* or class or classes or classroom or classrooms or student*) N1 (equalit* or injustic* or inequalit* or disparit* or diversit* or ethnicit*)) OR TI ((learn* or teach* or school* or educat* or class or classes or classroom or classrooms or student*) N1 (equalit* or injustic* or inequalit* or disparit* or diversit* or ethnicit*))	Search modes - Boolean/Phrase	10,827
S6	AB ((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (condition* or circumstance* or environment or environments or climate* or setting* or culture* or resourc*)) OR TI ((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (condition* or circumstance* or environment or environments or climate* or setting* or culture* or resourc*))	Search modes - Boolean/Phrase	104,432
S5	AB ((teacher* or educator* or instructor* or lecturer* or professor*) N1 (wage* or benefit* or attract* or retention or incent* or salar*)) OR TI ((teacher* or educator* or instructor* or lecturer* or professor*) N1 (wage* or benefit* or attract* or retention or incent* or salar*))	Search modes - Boolean/Phrase	5,856
S4	AB ((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (expenditure* or funding* or financ*)) OR TI ((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) N1 (expenditure* or funding* or financ*))	Search modes - Boolean/Phrase	13,724
S3	AB ((teach* or educat* or instructor* or lectur* or professor*) N1 quality) or TI ((teach* or educat* or instructor* or lectur* or professor*) N1 quality)	Search modes - Boolean/Phrase	19,476
S2	AB ((educat* or school* or teach* or learn*) N1 material*) or TI ((educat* or school* or teach* or learn*) N1 material*)	Search modes - Boolean/Phrase	18,482
S1	AB ((education* OR school*) N1 (infrastructure* OR framework*)) OR TI ((education* OR school*) N1 (infrastructure* OR framework*))	Search modes - Boolean/Phrase	2,857

Appendix 4 Detail of Search Strategy in PsychINFO

#	Query	Result
1	((education* or school*) adj1 (infrastructure* or framework*)).tw.	637
2	((educat* or school* or teach* or learn*) adj1 material*).tw.	5707
3	((teach* or educat* or instructor* or lectur* or professor*) adj1 quality).tw	3979
4	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (expenditure* or funding* or financ*)).tw	1559
5	((teacher* or educator* or instructor* or lecturer* or professor*) adj1 (wage* or benefit* or attract* or retention or incent* or salar*)).tw.	1325
6	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (condition* or circumstance* or environment or environments or climate* or setting* or culture* or resourc*)).tw.	68811
7	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms or student*) adj1 (equalit* or injustic* or inequalit* or disparit* or diversit* or ethnicit*)).tw.	4767
8	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (object* or guid* or target*)).tw.	11972
9	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (admin* or supervisor* or govern* or facult*)).tw.	15223
10	((chang* or improv* or adjust* or adapt* or strength* or wors*) adj2 curriculum*).tw.	1769
11	((track* or de-track* or detrack*) adj2 (school* or class or classes or classroom or classrooms or curriculum* or student* or program* or intervention* or reform* or polic*)).tw.	1656
12	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (pedagog* or method* or practic* or approach* or deliver*)).tw.	51879
13	((Learn* or teach* or school* or educat* or class or classroom or classrooms or course or instruction*) adj1 language*).tw.	21853
14	((class or classes or classroom or classrooms) adj1 (siz* or capacit* or proportion*)).tw.	1764
15	(Number* adj2 (student* or teacher*)).tw.	4313
16	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (outcome* or result*)).tw.	21858
17	((educat* or cognit*) adj1 (outcome* or improve* or performance*)).tw.	29024
18	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (attainment or priorit* or goal* or standard or standards or coordination)).tw.	15859
19	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (evaluation* or assessment*)).tw.	9427
20	((teach* or educat* or instructor* or lectur* or professor*) adj1 (appraisal* or prais* or judg* or feedback* or report* or evaluation* or assessment*)).tw.	16780
21	((Pre kindergarten* or Prekindergarten* or Pre-kindergarten* or Play-school* or Play school* or Playschool* or Kindergarten* or Pre-school* or Preschool* or Pre school* or day-care* or daycare* or day care* or child-care* or child care* or childcare* or early child* or early-child* or foundation year or universit* or college* or apprenticeship* or academic* or distan* learn* or advanced diploma*) adj2 (intervention* or reform* or polic* or initiative* or program*)).tw.	19738
22	((early-education* or early education* or elementary education* or secondary education* or tertiary education* or higher education* or contin* education* or further education* or company education* or middle-school* or middle school* or special education* or high school* or high-school* or adult education* or night-school* or night school* or part time education* or part-time education* or online education* or online-education* or vocational education*) adj2 (intervention* or reform* or program* or polic* or initiative*)).tw.	8102
23	Education* quality.tw.	908
24	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23	261353
25	(Physical health or health outcome* or morbid* or adult outcome* or youth outcome*).tw.	77961
26	((improv* or chang* or increase* or decreas*) adj2 health).tw.	28967
27	Hospitali?ation*.tw.	29396
28	(Death* or dead* or mortalit*).tw.	133435
29	(mental adj1 (health or ill or illness* or disorder* or disease*)).tw.	278170
30	(depression* or depressive* or depressed).tw.	316278
31	disabilit*.tw.	125721
32	25 or 26 or 27 or 28 or 29 or 30 or 31	820376
33	(clinical trials or randomized controlled trials or randomized clinical trials or placebo or random sampling).sh,id.	21293
34	trial*.ti,ab.	188569
35	(placebo* or random*).ti,ab.	231319
36	(cluster* adj2 randomi*).tw.	3175
37	((communit* adj2 intervention*) or (communit* adj2 randomi*)).tw	5343
38	group* randomi*.tw.	972
39	RCT.tw.	5243
40	quasi*.tw.	19241
41	(natural* adj3 experiment*).tw.	2837
42	(non random* or non-random* or nonrandom*).tw.	5021
43	cohort*.tw.	81977
44	exp Randomized Controlled Trials/ or exp Randomized Clinical Trials/	879
45	(before adj2 after).tw.	45884
46	(case* and control*).tw.	63237
47	case?control.tw.	42
48	case-referent.tw.	20
49	(interrupted time series or interrupted-time-series).tw.	856
50	(instrumental variable* or instrumental-variable*).tw.	1317
51	(difference in difference* or difference-in-difference* or diff-in-diff*).tw.	1234
52	(regression discont* or RDD).tw.	638
53	(panel analy* or panel data).tw.	3923
54	Experiment Controls/	927
55	Cohort Analysis/ or Cluster Analysis/ or Followup Studies/ or Retrospective Studies/ or Longitudinal Studies/ or Prospective Studies/ or Between Groups Design/	35582
56	33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55	562623
57	24 and 32 and 56	5343
58	limit 57 to english language	5046
59	(doctor* or physician* or midwif* or patient* or medical school or therapist* or nurse* or nursing).tw.	906511
60	58 not 59	3514
61	limit 60 to yr="2000 -Current"	3152
62	(animal not human).po.	366989
63	61 not 62	3121

Appendix 5 Detail of Search Strategy in HMIC

#	Query	Results
1	((education* or school*) adj1 (infrastructure* or framework*)).tw.	49
2	((educat* or school* or teach* or learn*) adj1 material*).tw.	334
3	((teach* or educat* or instructor* or lectur* or professor*) adj1 quality).tw.	74
4	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (expenditure* or funding* or financ*)).tw.	85
5	((teacher* or educator* or instructor* or lecturer* or professor*) adj1 (wage* or benefit* or attract* or retention or incent* or salar*)).tw.	2
6	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (condition* or circumstance* or environment or environments or climate* or setting* or culture* or resourc*)).tw.	1007
7	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms or student*) adj1 (equalit* or injustic* or inequalit* or disparit* or diversit* or ethnicit*)).tw.	211
8	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (object* or guid* or target*)).tw.	268
9	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (admin* or supervisor* or govern* or facult*)).tw.	182
10	((chang* or improv* or adjust* or adapt* or strength* or wors*) adj2 curriculum*).tw.	53
11	((track* or de-track* or detrack*) adj2 (school* or class or classes or classroom or classrooms or curriculum* or student* or program* or intervention* or reform* or polic*)).tw.	35
12	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (pedagog* or method* or practic* or approach* or deliver*)).tw.	1390
13	((Learn* or teach* or school* or educat* or class or classroom or classrooms or course or instruction*) adj1 language*).tw.	18
14	((class or classes or classroom or classrooms) adj1 (siz* or capacit* or proportion*)).tw.	16
15	(Number* adj2 (student* or teacher*)).tw.	134
16	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (outcome* or result*)).tw.	310
17	((educat* or cognit*) adj1 (outcome* or improve* or performance*)).tw.	314
18	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (attainment or priorit* or goal* or standard or standards or coordination)).tw.	473
19	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (evaluation* or assessment*)).tw.	117
20	((teach* or educat* or instructor* or lectur* or professor*) adj1 (appraisal* or prais* or judg* or feedback* or report* or evaluation* or assessment*)).tw.	200
21	((Pre kindergarten* or Prekindergarten* or Pre-kindergarten* or Play-school* or Play school* or Playschool* or Kindergarten* or Pre-school* or Preschool* or Pre school* or day-care* or daycare* or day care* or child-care* or child care* or childcare* or early child* or early-child* or foundation year or universit* or college* or apprenticeship* or academic* or distan* learn* or advanced diploma*) adj2 (intervention* or reform* or polic* or initiative* or program*)).tw.	461
22	((early-education* or early education* or elementary education* or secondary education* or tertiary education* or higher education* or contin* education* or further education* or company education* or middle-school* or middle school* or special education* or high school* or high-school* or adult education* or night-school* or night school* or part time education* or part-time education* or online education* or online-education* or vocational education*) adj2 (intervention* or reform* or program* or polic* or initiative*)).tw.	122
23	Education* quality.tw.	32
24	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23	5220
25	(Physical health or health outcome* or morbid* or adult outcome* or youth outcome*).tw.	8076
26	((improv* or chang* or increase* or decreas*) adj2 health).tw.	7522
27	Hospitali?ation*.tw.	1845
28	(Death* or dead* or mortalit*).tw.	17230
29	(mental adj1 (health or ill or illness* or disorder* or disease*)).tw.	20804
30	(depression* or depressive* or depressed).tw.	5111
31	disabilit*.tw.	8730
32	25 or 26 or 27 or 28 or 29 or 30 or 31	57804
33	24 and 32	881
34	limit 33 to yr="2000 -Current"	20

Appendix 6 Detail of Search Strategy in Global Health

#	Query	Results
1	((education* or school*) adj1 (infrastructure* or framework*)).tw.	152
2	((educat* or school* or teach* or learn*) adj1 material*).tw.	2382
3	((teach* or educat* or instructor* or lectur* or professor*) adj1 quality).tw.	370
4	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (expenditure* or funding* or financ*)).tw.	212
5	((teacher* or educator* or instructor* or lecturer* or professor*) adj1 (wage* or benefit* or attract* or retention or incent* or salar*)).tw.	11
6	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (condition* or circumstance* or environment or environments or climate* or setting* or culture* or resourc*)).tw.	5063
7	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms or student*) adj1 (equalit* or injustic* or inequalit* or disparit* or diversit* or ethnicit*)).tw.	1557
8	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (object* or guid* or target*)).tw.	1676
9	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (admin* or supervisor* or govern* or facult*)).tw.	1254
10	((chang* or improv* or adjust* or adapt* or strength* or wors*) adj2 curriculum*).tw.	242
11	((track* or de-track* or detrack*) adj2 (school* or class or classes or classroom or classrooms or curriculum* or student* or program* or intervention* or reform* or polic*)).tw.	331
12	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (pedagog* or method* or practic* or approach* or deliver*)).tw.	7419
13	((Learn* or teach* or school* or educat* or class or classroom or classrooms or course or instruction*) adj1 language*).tw.	155
14	((class or classes or classroom or classrooms) adj1 (siz* or capacit* or proportion*)).tw.	452
15	(Number* adj2 (student* or teacher*)).tw.	598
16	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (outcome* or result*)).tw.	3280
17	((educat* or cognit*) adj1 (outcome* or improve* or performance*)).tw.	9329
18	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (attainment or priorit* or goal* or standard or standards or coordination)).tw.	4158
19	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (evaluation* or assessment*)).tw.	429
20	((teach* or educat* or instructor* or lectur* or professor*) adj1 (appraisal* or prais* or judg* or feedback* or report* or evaluation* or assessment*)).tw.	900
21	((Pre kindergarten* or Prekindergarten* or Pre-kindergarten* or Play-school* or Play school* or Playschool* or Kindergarten* or Pre-school* or Preschool* or Pre school* or day-care* or daycare* or day care* or child-care* or child care* or childcare* or early child* or early-child* or foundation year or universit* or college* or apprenticeship* or academic* or distan* learn* or advanced diploma*) adj2 (intervention* or reform* or polic* or initiative* or program*)).tw.	2423
22	((early-education* or early education* or elementary education* or secondary education* or tertiary education* or higher education* or contin* education* or further education* or company education* or middle-school* or middle school* or special education* or high school* or high-school* or adult education* or night-school* or night school* or part time education* or part-time education* or online education* or online-education* or vocational education*) adj2 (intervention* or reform* or program* or polic* or initiative*)).tw.	772
23	Education* quality.tw.	95
24	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22	37642
25	(Physical health or health outcome* or morbid* or adult outcome* or youth outcome*).tw.	104439
26	((improv* or chang* or increase* or decreas*) adj2 health).tw.	31290
27	Hospitali?ation*.tw.	34459
28	(Death* or dead* or mortalit*).tw.	287314
29	(mental adj1 (health or ill or illness* or disorder* or disease*)).tw.	63044
30	(depression* or depressive* or depressed).tw.	48559
31	disabilit*.tw.	23379
32	25 or 26 or 27 or 28 or 29 or 30 or 31	464779
33	controlled clinical trial.tw.	3189
34	placebo.ab.	37059
35	randomly.ab.	93240
36	randomi#ed.ab.	95763
37	trial.ti.	35173
38	RCT.tw.	3448
39	(cluster* adj2 randomi*).tw.	5000
40	((communit* adj2 intervention*) or (communit* adj2 randomi*)).tw.	4452
41	group* randomi*.tw.	769
42	quasi*.tw.	7861
43	(natural* adj3 experiment*).tw.	1847
44	(non random* or non-random* or nonrandom*).tw.	4178
45	(before adj2 after).tw.	46889
46	(case* and control*).tw.	163281
47	case?control.tw.	65
48	case-referent.tw.	191
49	(interrupted time series or interrupted-time-series).tw.	1045
50	(instrumental variable* or instrumental-variable*).tw.	949
51	(difference in difference* or difference-in-difference* or diff-in-diff*).tw.	1255
52	(regression discont* or RDD).tw.	270
53	(panel analy* or panel data).tw.	1379
54	randomized controlled trials/	44256
55	case-control studies/	21202
56	experimental design/	1722
57	"controls (experimental)"/	21
58	retrospective studies/	16406
59	longitudinal studies/	8373
60	cluster analysis/	1769
61	33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60	420273
62	24 and 32 and 61	2013
63	(doctor* or physician* or midwif* or patient* or medical school or therapist* or nurse* or nursing).tw.	809261
64	62 not 63	1530
65	limit 64 to english language	1471
66	limit 65 to yr="2000 -Current"	1442

Appendix 7 Detail of Search Strategy in Social Policy and Practice

#	Query	Results
1	((education* or school*) adj1 (infrastructure* or framework*)).tw.	39
2	((educat* or school* or teach* or learn*) adj1 material*).tw.	251
3	((teach* or educat* or instructor* or lectur* or professor*) adj1 quality).tw.	136
4	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (expenditure* or funding* or financ*)).tw.	323
5	((teacher* or educator* or instructor* or lecturer* or professor*) adj1 (wage* or benefit* or attract* or retention or incent* or salar*)).tw.	13
6	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (condition* or circumstance* or environment or environments or climate* or setting* or culture* or resourc*)).tw.	2092
7	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms or student*) adj1 (equalit* or injustic* or inequalit* or disparit* or diversit* or ethnicit*)).tw.	296
8	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (object* or guid* or target*)).tw.	385
9	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (admin* or supervisor* or govern* or facult*)).tw.	468
10	((chang* or improv* or adjust* or adapt* or strength* or wors*) adj2 curriculum*).tw.	77
11	((track* or de-track* or detrack*) adj2 (school* or class or classes or classroom or classrooms or curriculum* or student* or program* or intervention* or reform* or polic*)).tw.	81
12	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (pedagog* or method* or practic* or approach* or deliver*)).tw.	2097
13	((Learn* or teach* or school* or educat* or class or classroom or classrooms or course or instruction*) adj1 language*).tw.	110
14	((class or classes or classroom or classrooms) adj1 (siz* or capacit* or proportion*)).tw.	139
15	(Number* adj2 (student* or teacher*)).tw.	153
16	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (outcome* or result*)).tw.	825
17	((educat* or cognit*) adj1 (outcome* or improve* or performance*)).tw.	1017
18	((learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (attainment or priorit* or goal* or standard or standards or coordination)).tw.	1361
19	((Learn* or teach* or school* or educat* or class or classes or classroom or classrooms) adj1 (evaluation* or assessment*)).tw.	217
20	((teach* or educat* or instructor* or lectur* or professor*) adj1 (appraisal* or prais* or judg* or feedback* or report* or evaluation* or assessment*)).tw.	368
21	((Pre kindergarten* or Prekindergarten* or Pre-kindergarten* or Play-school* or Play school* or Playschool* or Kindergarten* or Pre-school* or Preschool* or Pre school* or day-care* or daycare* or day care* or child-care* or child care* or childcare* or early child* or early-child* or foundation year or universit* or college* or apprenticeship* or academic* or distan* learn* or advanced diploma*) adj2 (intervention* or reform* or polic* or initiative* or program*)).tw.	1102
22	((early-education* or early education* or elementary education* or secondary education* or tertiary education* or higher education* or contin* education* or further education* or company education* or middle-school* or middle school* or special education* or high school* or high-school* or adult education* or night-school* ornight school* or part time education* or part-time education* or online education* or online-education* or vocational education*) adj2 (intervention* or reform* or program* or polic* or initiative*)).tw.	239
23	Education* quality.tw.	18
24	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23	10202
25	(Physical health or health outcome* or morbid* or adult outcome* or youth outcome*).tw.	4892
26	((improv* or chang* or increase* or decreas*) adj2 health).tw.	3790
27	Hospitali?ation*.tw.	778
28	(Death* or dead* or mortalit*).tw.	8053
29	(mental adj1 (health or ill or illness* or disorder* or disease*)).tw.	28556
30	(depression* or depressive* or depressed).tw.	9829
31	disabilit*.tw.	20415
32	25 or 26 or 27 or 28 or 29 or 30 or 31	64272
33	controlled clinical trial.tw.	14
34	placebo.ab.	113
35	randomly.ab.	1282
36	randomi#ed.ab.	2454
37	trial.ti.	964
38	RCT.tw.	189
39	(cluster* adj2 randomi*).tw.	175
40	((communit* adj2 intervention*) or (communit* adj2 randomi*)).tw.	457
41	group* randomi*.tw.	13
42	quasi*.tw.	751
43	(natural* adj3 experiment*).tw.	38
44	(non random* or non-random* or nonrandom*).tw.	152
45	(before adj2 after).tw.	1075
46	(case* and control*).tw.	2054
47	case?control.tw.	1
48	case-referent.tw.	0
49	(interrupted time series or interrupted-time-series).tw.	22
50	(instrumental variable* or instrumental-variable*).tw.	25
51	(difference in difference* or difference-in-difference* or diff-in-diff*).tw.	20
52	(regression discont* or RDD).tw.	10
53	(panel analy* or panel data).tw.	138
54	33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53	8068
55	24 and 32 and 54	77
56	limit 55 to yr="2000 -Current"	71

References

1. Muennig P. Can universal pre-kindergarten programs improve population health and longevity? Mechanisms, evidence, and policy implications. Soc Sci Med. 2015 Feb;127:116–23.

2. Walsemann K, Gee G, Ro A. Educational Attainment in the Context of Social Inequality New Directions for Research on Education and Health. Am Behav Sci. 2013 Aug 1;57:1082–104.

3. Kawachi I, Adler NE, Dow WH. Money, schooling, and health: Mechanisms and causal evidence. Ann N Y Acad Sci. 2010;1186(1):56–68.

4. Zajacova A, Lawrence EM. The Relationship Between Education and Health: Reducing Disparities Through a Contextual Approach. Annu Rev Public Health. 2018 Apr 1;39(1):273–89.

5. Conti G, Heckman J, Urzua S. THE EDUCATION-HEALTH GRADIENT. Am Econ Rev. 2010 May;100(2):234–8.

6. Raghupathi V, Raghupathi W. The influence of education on health: an empirical assessment of OECD countries for the period 1995–2015. Arch Public Health. 2020 Apr 6;78(1):20.

7. Mitra D. The Social and Economic Benefits of Public Education. :42.

8. Educational Attainment in the United States: 2015. :12.

9. Goldman D, Smith JP. The Increasing Value of Education to Health. Soc Sci Med 1982. 2011 May;72(10):1728–37.

10. Fedak KM, Bernal A, Capshaw ZA, Gross S. Applying the Bradford Hill criteria in the 21st century: how data integration has changed causal inference in molecular epidemiology. Emerg Themes Epidemiol [Internet]. 2015 Sep 30 [cited 2021 Jun 16];12. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4589117/

11. The Effects of Education on Health [Internet]. NBER. [cited 2021 May 12]. Available from: https://www.nber.org/digest/mar07/effects-education-health

12. Lleras-Muney A. The Relationship Between Education and Adult Mortality in the United States. Rev Econ Stud. :34.

13. History of Head Start [Internet]. [cited 2021 May 12]. Available from: https://www.decal.ga.gov/HeadStart/History.aspx

14. The Abecedarian Project | Abecedarian Project [Internet]. [cited 2021 May 12]. Available from: https://abc.fpg.unc.edu/abecedarian-project

15. Barnett-Page E, Thomas J. Methods for the synthesis of qualitative research: a critical review. BMC Med Res Methodol. 2009 Aug 11;9(1):59.

16. Campbell FA, Pungello EP, Burchinal M, Kainz K, Pan Y, Wasik BH, et al. Adult outcomes as a function of an early childhood educational program: An Abecedarian Project follow-up. Dev Psychol. 2012;48(4):1033–43.

17. Jones SM, Brown JL, Hoglund WLG, Aber JL. A school-randomized clinical trial of an integrated social-emotional learning and literacy intervention: impacts after 1 school year. J Consult Clin Psychol. 2010;78(6):829–42.

18. Sutton EE. Academic and social-emotional classroom composition and the quality of classroom interactions in New York City public elementary schools. Diss Abstr Int Sect Humanit Soc Sci. 2020;81(5):No-Specified.

19. Muennig P, Woolf SH. Health and Economic Benefits of Reducing the Number of Students per Classroom in US Primary Schools. Am J Public Health. 2007 Nov;97(11):2020–7.

20. Learn About Mental Health - Mental Health - CDC [Internet]. 2018 [cited 2021 Jun 14]. Available from: https://www.cdc.gov/mentalhealth/learn/index.htm

21. Center on Society and Health [Internet]. [cited 2021 Jun 18]. Available from: https://societyhealth.vcu.edu/work/the-projects/why-education-matters-to-health-exploring-the-causes.html

22. Problems at School | Association for Children's Mental Health [Internet]. ACMH. [cited 2021 Jun 19]. Available from: http://www.acmh-mi.org/get-help/navigating/problems-at-school/

23. Groundbreaking Follow-Up Studies | Abecedarian Project [Internet]. [cited 2021 Jun 20]. Available from: https://abc.fpg.unc.edu/groundbreaking-follow-studies

24. Stormshak EA, Fosco GM, Dishion TJ. Implementing Interventions with Families in Schools to Increase Youth School Engagement: The Family Check-Up Model. School Ment Health. 2010 Jun;2(2):82–92.

25. Connell AM, Dishion TJ, Yasui M, Kavanagh K. An adaptive approach to family intervention: linking engagement in family-centered intervention to reductions in adolescent problem behavior. J Consult Clin Psychol. 2007 Aug;75(4):568–79.

26. Spoth RL, Kavanagh KA, Dishion TJ. Family-centered preventive intervention science: toward benefits to larger populations of children, youth, and families. Prev Sci Off J Soc Prev Res. 2002 Sep;3(3):145–52.

27. Bunting L. Parenting Programmes: The Best Available Evidence. Child Care Pract. 2004 Sep 1;10:327–43.

28. Carter N, Kahn L. See How We Grow: A Report on the Status of Parenting Education in the U.S. 1996.

29. Research to Practice Briefs [Internet]. What Works Wisconsin - Effective Programs and Resources for Children, Youth and Families. [cited 2021 Jun 20]. Available from: https://fyi.extension.wisc.edu/whatworkswisconsin/research-to-pratice-briefs/

30. Wong MD, Coller KM, Dudovitz RN, Kennedy DP, Buddin R, Shapiro MF, et al. Successful schools and risky behaviors among low-income adolescents. Pediatrics. 2014;134(2):e389–96.

31. Delaruelle K, van de Werfhorst H, Bracke P, Bracke Piet; ORCID: http://orcid.org/0000-0002-9477-3236 PAI-O http://orcid.org/Bracke. Do comprehensive school reforms

impact the health of early school leavers? Results of a comparative difference-in-difference design. Soc Sci Med 1982. 2019;239:112542–112542.

32. Kaplan LE. Disrupting the school to prison pipeline: Rebt with African-American youth in a school setting. Diss Abstr Int Sect B Sci Eng. 2019;80(1):No-Specified.

33. Groot W. 4.A. What does education do to our health? 2006;9.

34. Walsemann K, Geronimous AT, Gee G. Accumulating disadvantage over the life course: evidence from a longitudinal study investigating the relationship between educational advantages in youth and health in middle-age. Res Aging. 2008 Mar 1;30:227–51.

35. Caldwell DM, Davies SR, Hetrick SE, Palmer JC, Caro P, López-López JA, et al. School-based interventions to prevent anxiety and depression in children and young people: a systematic review and network meta-analysis. Lancet Psychiatry. 2019 Dec 1;6(12):1011–20.