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Abstract

The Effectiveness of Interventions to Increase Employment in Education and Healthcare: A Systematic Literature Review*

Both the healthcare and education sector suffer from considerable staff shortages. In the healthcare sector, shortages are particularly prominent for nurses, while the education sector experiences significant teacher shortages. In this systematic literature review, we examine the effectiveness of interventions and policies to reduce staff shortages in healthcare and education in high-income countries. We focus our analysis on studies that apply research designs that allow for causal inference to inform policymakers about the effectiveness of interventions. In total, we include 85 studies that meet our inclusion criteria. Out of these studies, 71 studies focus on teachers and 14 on nurses. Interestingly, 72 of the retrieved studies were conducted in the US. The majority of studies examine the impact of financial incentives and a large share of these studies report positive effects on teacher employment. Moreover, different types of interventions that invest in workers' human capital show predominantly positive effects on employment. Interventions that equip nurses with skills to better cope with the stressors of their profession seem to be particularly effective. The same holds for policies that increase the scope of practice for nurses. Finally, effective school leaders show to be better capable of retaining (high-quality) teachers.

JEL Classification Codes: I10; I20; J22

Keywords: Labor shortage; teachers; nurses

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Introduction

Healthcare and education sectors around the world have been experiencing considerable staff shortages (e.g., OECD, 2016; UNESCO, 2016; WHO, 2022b). These have been exacerbated by the COVID-19 pandemic as well as increasing retirement rates which have not been compensated by the inflow of new staff (OECD, 2016, 2021; WHO, 2022a). The World Health Organization (WHO) (2022b) forecasts a global need of an additional 9 million nurses and midwives by 2030 to be able to reach the United Nations' (UN) goal of “ensuring healthy lives and promoting well-being for all at all ages” (UN, 2021). Similarly, according to the UNESCO Institute for Statistics, there is a need to recruit 69 million teachers worldwide by 2030 in order to achieve broad universal coverage of primary and secondary educational needs (UNESCO Institute for Statistics, 2016).

In the healthcare sector, shortages are highest for nurses and midwives, making up for more than 50 percent of total staff shortages in healthcare (WHO, 2021, 2022a, 2022b). Nurse shortages have detrimental effects on quality of care and societal health outcomes, e.g., exacerbating patient mortality (Aiken et al., 2002), and increasing 30-day hospital readmission rates (Friedrich & Hackmann, 2021). Moreover, nurse shortages are likely to increase the workload and demand for the remaining healthcare staff and therefore, decrease incumbent staff's job satisfaction (Chan et al., 2013; El-Jardali et al., 2009), increase sickness absence rates (Rauhala et al., 2007), or increase nurses' inclination to leave the employer or even the nursing profession altogether (e.g., Barron & West, 2005; El-Jardali et al., 2009; Lu et al., 2012).

Due to an uneven distribution of teachers across subjects (mainly STEM) and regions, the European education sector faces shortages and oversupply, often co-existing in the same countries (European Commission/EACEA/Eurydice, 2019). Furthermore, high dropout rates out of initial teacher education (European Commission/EACEA/Eurydice, 2019) lead to an ageing teacher population, with only 7 percent of teachers being under 30 years old and 36 percent of teachers being 50 or older (Katsarova, 2020). Regional shortages can occur due to economic opportunities, cultural context, the school environment and student population (European Commission/EACEA/Eurydice, 2019). These aspects are reflected in a relatively high level of teacher shortages in disadvantaged, high-poverty schools in rural and urban areas, also in the US, typically employing a larger share of lower-quality teachers (Ingersoll, 2004; Monk, 2007; Sutchter et al., 2019). Research has shown that high-quality teachers often choose to work in schools with a larger share of students with high socioeconomic backgrounds (e.g., Hanushek et al., 2004). The difficulty of low-performing, high-poverty schools to compete for the limited number of high-quality teachers is often exacerbated by their inability to meet

salary standards, benefits, and resources that are offered by more upscale schools (Ingersoll, 2004). Sustaining quality of education however is crucial in order to secure the effectiveness of the education system, increase students' learning outcomes and prepare young people for their adult lives as active and productive members of society (European Commission/EACEA/Eurydice, 2019; Santiago, 2002). Failing to deliver high-quality education over time could result in gaps in relevant knowledge and skills crucial for social and economic development (UNESCO, 2016).

The wide array of determinants calls for a variety of interventions to reduce staff shortages targeting different mechanisms and levels. In this paper, we assess the effectiveness of interventions to reduce staff shortages in healthcare and education in high-income countries. We do so by means of a systematic review of available empirical evidence. Importantly, we focus our analysis on studies that apply research designs that allow for causal inference to inform policymakers about the effectiveness of interventions (Brook et al., 2019; See et al., 2020). We examine shortages in healthcare and education sectors jointly as both sectors have similar causes of shortages and working conditions, e.g., relatively low salaries (e.g., Chan et al., 2013; Gjefsen, 2020; Ingersoll, 2004; Lephala et al., 2008; Monk, 2007), and demanding workloads (e.g., Chan et al., 2013; Gjefsen, 2020; Harris, 1989; Hipwell et al., 1989; Kirkcaldy & Martin, 2000). Furthermore, both, the healthcare and education sector globally employ a relatively high share of female workers compared to other sectors (Katsarova, 2020; OECD, 2021; WHO, 2021, 2022a, 2022b), which could potentially contribute to the shortages due to a higher share of absence due to parental leave (Friedrich & Hackmann, 2021) and part-time work (Booth & van Ours, 2013). Given these similarities in worker characteristics, evidence on the effectiveness of specific types of interventions in one of the two sectors might also be insightful for the other sector.

To the best of our knowledge, there is no systematic review comparing interventions that address both nurse and teacher shortages, and compare interventions between these sectors. Existing reviews addressing nurse or teacher shortages separately, often focus on predictors of turnover or retention (e.g., Chan et al., 2013; Falatah, 2021; Wu et al., 2015) or the evaluation of one specific (type of) intervention (e.g., Anderson et al., 2012; Dawson et al., 2014; Kehoe et al., 2016). Most reviews limit their exploration to one specific target group within the respective occupations, e.g., geriatric nurses or special education teachers (e.g., Billingsley, 2004; Billingsley & Bettini, 2019; Brook et al., 2019; Chenoweth et al., 2010; Lartey et al., 2014). Other reviews examine different outcomes and focus for example on interventions' effects on working environments rather than quantitative turnover measures (e.g., Elliott et al., 2012; Schalk et al., 2010). Park and Yu's (2019) review is closely related to ours,

however, their study focuses on nurses only and they do not restrict their analysis to causal impact studies. See et al. (2020) on the other hand do restrict their systematic review to quasi-experimental studies but limit their scope to interventions for teacher shortages in hard-to-staff areas.

In contrast to existing reviews, we aim to provide a more comprehensive and holistic analysis, contributing to the literature in the following ways: First, we consider and compare interventions addressing nurse and teacher shortages. Second, we do not focus on specific subgroups within the two occupations in order to exploit additional nuances stemming from the heterogeneity within and between occupational groups of nurses and teachers. Third, we do not restrict our analysis to one particular type of intervention: We are interested in interventions at the sector-, institution- and individual level, targeting the inflow or outflow of nursing and teaching staff as well as those aimed at increasing working hours of incumbent workers. Further, we exclusively review studies with (quasi-)experimental research designs in order to infer causal effects of the introduced interventions and evaluate their effectiveness. Creating an overview of the effectiveness of different interventions further allows us to derive ways for potential transfers of measures between healthcare and education sectors.

This paper is structured as follows: Section 2 outlines the methodology by describing the systematic literature search and selection processes as well as the approach to analysis. Section 3 provides synthesized findings from the analyzed studies, distinguishing interventions into several groups related to financial incentives, human capital investments, organizational features, school accountability and other interventions. In Section 4, results as well as their comparability and generalizability are discussed, limitations identified and implications for future research and policy highlighted.

Methodology

Inclusion and exclusion criteria

Before we performed our systematic literature search, we set inclusion and exclusion criteria, i.e., a set of conditions for the records we retrieved from the searches to be eligible for inclusion in the analysis. We restricted our analysis to high-income countries according to the categorization of the World Bank (2022)¹. Further, we limit our analysis to studies measuring the impact of at least one intervention or policy addressing, or contributing to, nurse or teacher shortages. Interventions could be either targeted at decreasing the outflow or increasing the inflow of staff, or at work hours. Outcome measures for turnover and retention could either be measured as actual behavior or as reported

¹ An overview of high-income countries according to the WorldBank can be found at: <https://data.worldbank.org/country/XD>

intentions. We excluded papers that examined teacher or nurse absenteeism. Within the education sector, we limit our literature selection to primary and secondary education. Further, we exclude studies measuring the impact of interventions on the quality of healthcare and education, measured by commonly used proxies such as e.g., hospital readmission rates or student achievement.

With respect to the type of methodology, we exclude qualitative and non-causal quantitative studies and exclusively include quantitative studies that are suitable for causal inference according to Van Klaveren and De Wolf (2013). These include (clustered) randomized controlled trials (RCTs) or quasi-experimental techniques, including difference-in-differences, instrumental variable(s), regression discontinuity designs, propensity score matching, and fixed-effects regressions.

Literature Search

We conducted two systematic literature searches in January and May 2022. Initially, we performed a search in Web of Science (Core Collection) with search terms (and terms related to) “teachers” or “nurses” paired with “shortage”, “turnover”, “mobility”, “attrition”, “transition”, “retention”, “productivity” in addition to terms entailing research designs for causal inference (e.g., “experiment*”). We restricted the search terms to be run within the title, abstract and keywords of papers. After completion of the screening process, we realized that our search did not cover some of the studies that were considered as seminal papers by experts in the field. Therefore, we considered options to retrieve a more complete set of causal studies. We ran a second search, whilst continuing to include the relevant publications from our first attempt. For the second search strategy, we sought support from a medical information specialist. Together, we conducted additional systematic searches in an expanded set of bibliographic databases ERIC (Ebsco), CINAHL (Ebsco), and Web of Science (Core Collection).² The following search terms were used (including synonyms and closely related words) as index terms or free-text words: “teachers”, “nurses”, “nursing”, “shortage”, “turnover”, “retention”, “causal effect”. The full set of search terms for all databases can be found in Appendix A.

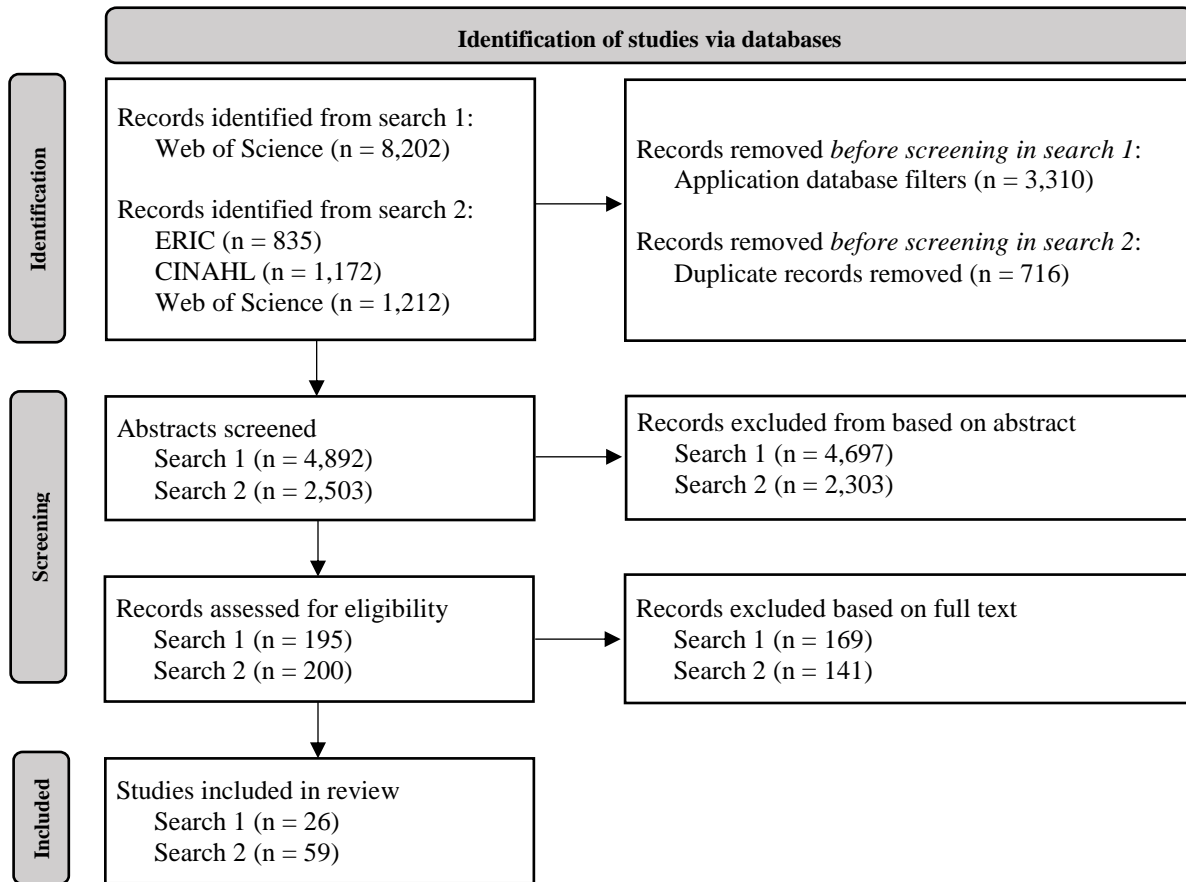
Literature Selection

Figure 1 provides a summarized overview of the literature selection processes following the initial and updated literature searches. Subsequently, the results of both selection processes are separately described in more detail.

² We choose to perform an additional search in ERIC as it is the largest index of education journals. Likewise, CINAHL indexes the nursing and health related literature.

Figure 1

Selection process following search strategy 1 (January 2022) and search strategy 2 (May 2022)



By using our initially determined search terms in the database, we retrieved 8,202 initial hits from Web of Science. After applying database filters for journal articles as document type, publication dates between 2010 and 2022, English language, and high-income countries, we obtained 4,892 abstracts to screen. We screened abstracts in a reiterative manner, where one researcher pre-screened the database retrieval and marked studies that appear to fit the selection criteria.³ After excluding irrelevant papers based on the respective abstracts, we were left with a total of 195 records to be double-checked. Three researchers then went through this narrowed selection and indicated papers' suitability by checking the respective full-text versions for the study designs and further in- and exclusion criteria.

³ To ensure reliability that the pre-selected papers meet the inclusion criteria, we picked a random sample of 100 studies from the total set of excluded studies which were then checked by two additional reviewers. For additional reviewer 1 and 2 there was a 99 and 98 percent overlap in ratings with the reviewer that pre-screened the abstracts, respectively. The conflicting abstracts – rated as “maybe” instead of “reject” – were discussed and fully rejected after group discussion based on the abstract content. As the overlap is close to complete, and the checking process did not lead to the inclusion of additional studies, we concluded that our procedure is reliable.

Each paper was checked independently by at least two researchers. To reach consensus, we together reviewed, compared, and discussed the inclusion and exclusion of studies for which decisions between two researchers were inconclusive. After this stage of screening, we were left with 26 articles for analysis from search 1.

Our second literature search generated a total of 3,219 references: 835 in ERIC, 1,172 in CINAHL and 1,212 in Web of Science. After removing duplicates that were retrieved from more than one database, a total of 2,503 records remained. The selection process was identical to the first selection process. First, one researcher pre-screened all abstracts. Next, full-texts of each of the pre-selected 200 articles were checked independently by three researchers which led to an ultimate selection of 59 papers after correcting for duplication from the first search.⁴ Overall, the first and second search lead to the inclusion and analysis of 85 papers.

Method of analysis

To analyze the retrieved studies, we extracted study characteristics and developed a coding scheme. Besides metadata such as publication title, date, and source, we extracted relevant information regarding the sector and subsector of study, the country and region, a thorough description of the intervention and its level of implementation (e.g., sector-level, district-level, institution-level). Further, we listed mechanisms that are targeted by the intervention, outcome measures, data sources and sample characteristics as well as study results and limitations. Finally, we coded whether the estimated *overall* effect for the total sample either increased (+), had no effect on (0), or decreased (-) teacher or nurse employment. In addition, we find that some papers report overall null effects, yet show that for certain subgroups – e.g. teachers with certain characteristics – the treatment did have a positive or negative effect on employment. These are indicated with dash (0/+) or (0/-) in Tables 2-5, respectively. Finally, some papers report multi-directional effects for different groups without a clear overall effect. These interventions are marked as having no effect (0) on employment.

Results

Overall, we retrieved a total of 85 studies out of which 71 focused on teachers and 14 on nurses (Table 1). Remarkably, 72 of the retrieved studies were conducted in the US, four in Norway, two each in Chile and Korea, and one each in Denmark, France, the Netherlands, Sweden and Uruguay. We grouped the studied interventions into the following main categories: Financial incentives, human capital investments, organizational features, school accountability and its consequences, and other interventions.

⁴ In addition to removing papers that did not meet our inclusion criteria, we removed 5 working papers and 1 policy brief. 7 papers were inaccessible.

Among the 85 retrieved papers, 18 describe outcomes of RCTs. The remaining studies use the following quasi-experimental methodologies: difference-in-differences, regression discontinuities, fixed-effect models, instrumental variables, and propensity score matching.

Table 1

Overview of all retrieved studies' characteristics

Characteristic	Categorization	Count
Sector	Education	71
	Healthcare	14
Country	US	72
	Norway	4
	Chile	2
	Korea	2
	Denmark	1
	France	1
	The Netherlands	1
	Sweden	1
Type of intervention	Financial incentives	30
	Human capital investments	15
	Organizational features	11
	Accountability	18
	Other interventions	11
Research Designs	Difference-in-differences	30
	Randomized control trial	18
	Regression discontinuity	18
	Fixed effects	12
	Instrumental variables	4
	Propensity score matching	3

Note. Overview of analyzed studies. Studies can fall in more than one category in regard to their research design.

Financial incentives

As listed in Table 2, a total of 30 studies – 29 in the context of education and 24 situated in the US – describe causal effects of financial incentives on entry and exit decisions of teachers and nurses. Payments that result from incentive schemes can be conditioned on the worker's choice or action – for example being employed at a hard-to-staff school or meeting some performance target – or can be independent. Moreover, payments from an incentive scheme can be a one-time occurrence in the form of a bonus or can occur continuously as a definite wage or pension increase. We classify the different financial incentives along the

aforementioned dimensions: According to the criteria on which they depend and whether the potential wealth increase is a short-lived occurrence or continuous.

Table 2*Overview of studies within the category “Financial incentives”*

Autor(s) (year)	Intervention group	Treated sample	Level	Design	Outcome
Bueno and Sass (2019)		Understaffed subjects, secondary schools in US	State	DiD	Increase in retention (+)
Cabrera and Webbink (2020)	Wage increase based on working conditions	Disadvantaged, primary schools in Uruguay	Country	RD	Increase in retention and/or entry (+)
Falch (2011)		Understaffed primary and secondary schools in Norway	County	DiD	Increase in retention (+)
Falch (2017)		Understaffed primary and secondary schools in Norway	County	DiD	Increase in entry (+)
Askildsen et al. (2003)		Half of hospitals in Norway	Country	IV	Hours worked (+)
Cook et al. (2021)	Unconditional wage increase and frontloading	Primary and secondary schools in US	District	RD	Decrease in entry (-)
Han (2020)		Primary and secondary schools in US	District	IV	No effect on retention (0/+/-)
Hendricks (2014)		Primary and secondary schools in US	State	FE	Increase in retention (+)
Tran and Buckman (2020)		Primary and secondary schools in US	District	FE	Increase in entry (+)
Brown (2013)	Greater pension conditioned on delayed retirement	Primary and secondary schools in US	State	RD	Increase in retention (+)
Kim (2023)		Primary and secondary schools in US	State	DiD	Increase in retention (+)
Koedel and Xiang (2017)		Primary and secondary schools in US	City	DiD	Increase in retention (+)
Berlinski and Ramos (2020)		Primary and secondary schools in Chile	Country	RD	No effect on retention (0)
Clotfelter et al. (2011)		Disadvantaged, primary and secondary schools in US	District	DiD	No effect on retention (0/+)
Cowan and Goldhaber (2018)		Disadvantaged, secondary schools in US	State	RD	Increase in retention (+)
Elacqua et al. (2022)	Financial bonus conditioned on working conditions and teacher quality	Primary and secondary schools in Chile	Country	RD	Increase in retention and/or entry (+)
Feng and Sass (2018)		Understaffed subjects, secondary schools in US	State	DiD	Increase in retention (+)
Glazerman et al. (2013)		Disadvantaged, primary schools in US	Country	RCT	Increase in retention (+)
Protik et al. (2015)		Disadvantaged, primary schools in US	Country	RCT	Increase in entry (+)
Springer et al. (2016)		Disadvantaged, primary and secondary schools in US	State	RD	Increase in retention (0/+)
Steele et al. (2010)		Primary and secondary schools in US	State	IV	Increase in entry (+)

Table 2*Continued*

Autor(s) (year)	Intervention group	Treated sample	Level	Design	Outcome
Chiang et al. (2015)		Disadvantaged, primary and secondary schools in US	Country	RCT	No effect on retention and/or entry (0)
Dee et al. (2021)	Financial bonus conditioned on worker performance	Disadvantaged, primary schools in US	District	RD	No effect on retention (0/-)
Dee and Wyckoff (2015)		Primary schools in US	District	RD	No effect on retention (0/-)
Jones and Hartney (2017)		Primary and secondary schools in US	District	DiD	No effect on entry (0/+)
Shifrer et al. (2017)		Disadvantaged, primary schools in US	District	RD	No effect on retention (0/+)
Fryer (2013)		Disadvantaged, primary and secondary schools in US	City	RCT	No effect on retention (0)
Goodman and Turner (2010)	Financial bonus conditioned on group performance	Disadvantaged, primary schools in US	City	RCT	No effect on retention (0)
Jones (2013)		Primary and secondary schools in US	Country	IV	Decrease in retention (-)
Ryu and Jinnai (2021)		Primary and secondary schools in US	State	FE	Decrease in retention (-)

Note. DiD = Difference-in-differences; FE = Fixed effects; IV = Instrumental variables; RCT = Randomized control trial; RD = Regression discontinuity. The level indicates the level at which the (policy) intervention was implemented. The last column shows whether the study finds an *overall* positive (+), negative (-), or no effect (0) for the full sample. In the case that a study reports an overall null effect, but a positive or negative effect for a subsample, the table reports (0/+) or (0/-). If the overall effect is zero, but different subsamples show a positive as well as a negative effect, the table reports (0/+/-).

Wage increase conditioned on working conditions

Four studies examine the impact of a wage increase conditional on teachers' willingness to work in a hard-to-staff school – i.e. due to regional shortages or disadvantaged student populations – or subject – i.e. science and languages. By increasing wages, it is hypothesized that outside job options become less attractive and more teachers are willing to remain teaching or are attracted to the profession.

All studies show results in the hypothesized direction: As wages increase, entry rates increase and exit rates decrease. Cabrera and Webbink (2020) show that more experienced workers sort into disadvantaged schools in Uruguay following a 26 percent salary increase. Moreover, tenure in these schools increases relative to schools without a wage increase, i.e. more teachers decide to stay. Falch (2011) and Falch (2017) also identify a labor supply increase after teachers in understaffed schools in the north of Norway receive a 10 percent wage increase. They find a 6.5 percentage point decrease in exit rates and a 5.7 percentage point increase in entry rates. Finally, Bueno and Sass (2019) find that an increase in wages of teachers in understaffed subjects decrease their likelihood of exiting.

Unconditional wage increase and frontloading

In contrast to conditional wage increases, an unconditional wage increase reflects what would happen if wages would increase for all workers in the profession. There is no condition that must be met; one must simply be employed in teaching or nursing.

Firstly, these estimates follow from studies that use registration data in which exogenous variation in wages is identified to estimate wage effects. Askildsen et al. (2003) use administrative nursing data that track the hours worked of half of the Norwegian registered nurses between 1993 and 1998. The authors find a labor supply elasticity of 0.2: a 1 percent increase in wages causes a 0.2 percent increase in hours worked. Hendricks (2014) uses registration data on teachers from Texas and estimates a turnover elasticity of -1.6.

Secondly, two studies focus on the effects of unconditional wage increases that result from greater union bargaining power. These studies explicitly focus on a tradeoff between higher pay and alternative allocations of education funding where total funding is presumably fixed. This implies that greater teacher salaries must be matched by a decrease in other education inputs. In line with this idea, Cook et al. (2021) show a decrease in hired teachers in districts where greater bargaining power led to higher salaries. In a similar vein, Han (2020) shows that districts with greater union bargaining power cause the increased dismissal of low-quality teachers and increased retention of high-quality teachers. Both cases show that overall teacher supply does not necessarily increase as wages rise. The way in which wage increases are financed is crucial in determining its overall effect on employment.

Finally, Tran and Buckman (2020) study the effects of salary frontloading where larger wage raises are provided earlier in the fixed rate salary schedule creating more competitive wages for early-career teachers. Again, the salary change does not depend on working conditions and its hypothesized

working mechanisms are the same as before; greater upfront earnings increase the attractiveness of the profession. Tran and Buckman (2020) study frontloading in an education context and test its implications in a competitive teacher labor market. In particular, the authors show that more high-quality teachers sort into teaching jobs with frontloading schemes. This can be taken as (indirect) evidence that greater earnings early in the career attract teachers.

Greater pension conditioned on delayed retirement

Three US studies document teachers' willingness to postpone their retirement. In all studies, the effects of a policy reform for teachers are examined where delayed retirement yields financial benefits. For example, Koedel and Xiang (2017) study a pension enhancement policy that involves greater backloading of pension compensation – i.e. more pension is generated as age increases. This generates an incentive for teachers to work longer. The other two studies have a similar policy setup.

All three studies show that the increased marginal benefit of delaying retirement translates into teachers' decision to retire later. The results range from a decrease of 4 percentage points (Brown, 2013) to 10 percentage points (Kim, 2023) for workers who are in the pension eligible age category. Surprisingly, the largest decrease in exit rates is evidenced by a policy reform that is budget neutral. The other policies generate additional pension wealth and may therefore not be cost efficient (Koedel & Xiang, 2017).

Financial bonus conditioned on working conditions and teacher quality

In this setting, teachers receive a financial bonus if they meet certain quality requirements *and* move to an understaffed school. We identified nine studies that document the effects of programs that are designed to attract talented teachers to disadvantaged, hard-to-staff schools.

Glazerman et al. (2013) and Protik et al. (2015) document the impact of the Talent Transfer Initiative (TTI) where teachers at the top of the quality distribution were targeted to fill vacancies at disadvantaged schools. In return, they received a one-time \$20,000 bonus if they stayed for 2 years. In comparison to the control group – business-as-usual filling of vacancies –, Glazerman et al. (2013) show that relatively more TTI candidates remain at disadvantaged schools, even after the obligatory 2-year period is over. Protik et al. (2015) show that the TTI program indeed attracts higher-quality workers with 22 percent of the potential candidates applying for transfer and 5 percent actually transferring to disadvantaged schools. Cowan and Goldhaber (2018) find qualitatively similar effects of programs that resemble the TTI program – where retention of high-quality teachers is increased at hard-to-staff, disadvantaged schools. Springer et al. (2016) and Clotfelter et al. (2011) find overall null effects with a positive effects depending on teacher characteristics.

Berlinski and Ramos (2020) and Elacqua et al. (2022) study the effects of the Chilean Pedagogical Excellence Assignment program (AEP) where teachers can apply for a bonus if they meet certain quality requirements. The bonus is increased if they teach at a disadvantaged school. Overall,

the Berlinski and Ramos (2020) find little effects of the program on retention decisions for all teachers to stay in the profession. Elacqua et al. (2022) do show, however, that the financial incentive to work at a disadvantaged school is effective: teachers are 6 percentage points more likely to stay. It does not attract high-quality teachers from advantages schools, however.⁵

Finally, two studies examine the effects of loan forgiveness programs on teachers' willingness to i) teach subjects with a teacher shortage (Feng & Sass, 2018), ii) seek employment at disadvantaged schools (Steele et al., 2010). Both studies find corroborating evidence that loan forgiveness programs lead to enhanced entry in disadvantaged schools and decreased exits out of hard-to-staff teaching jobs.

Financial bonus conditioned on worker performance

In this incentive system, workers receive a financial bonus if they meet some performance requirement within a certain period. The idea behind pay-for-performance is to i) motivate workers to increase effort and invest in their skills, and ii) attract and retain highly skilled workers and potentially lose and avoid the hiring of low skilled workers. The identified studies in this overview focus on the latter showing the causal changes in the overall composition of workers. Results on net entry or exit are not discussed in the identified papers.

Two studies analyze the causal effects of a pay-for-performance mechanism versus a fixed salary system. Jones and Hartney (2017) find that pay-for-performance causes the attraction of more highly skilled teachers. Chiang et al. (2015), however, find no such effect. However, it should be noted that the designs of the incentive schemes differ in terms of bonus size, evaluation criteria and period of installment. As such, it is *a priori* not surprising that the results differ.

The three remaining studies focus on the effects of receiving a bonus which is based on teachers' performance. Dee and Wyckoff (2015) and Dee et al. (2021) evaluate the IMPACT program and find that teachers who receive a poor performance evaluation – and thus no financial bonus – are more likely to leave the school district. The authors do not find that high performers are more likely to stay in the school district. Alternatively, Shifrer et al. (2017) do find evidence that high performers are more likely to be retained. Note that these studies test the mechanisms that underlie pay-for-performance schemes, yet do not provide information about what would have happened if alternative incentive schemes – e.g. fixed salary – would be in place.

Financial bonus conditioned on group performance

In this instance, a teacher receives a financial bonus if the group they belong to – e.g. school or district – meets some performance threshold within a certain period. Again, it is not clear *a priori* what the net effect on employment will be. As with individual bonuses, group pay-for-performance may

⁵ In line with this finding, Berlinski and Ramos (2020) find that between-school mobility increases which can also be due to the award's potential signaling function.

cause the attraction and retention of more highly skilled workers, and the losing and locking out of low skilled workers. Nonetheless, four studies estimate the causal effects of group bonus systems on the retention decision of all teachers involved.

The results are mixed. Jones (2013) and Ryu and Jinnai (2021) find that retention is reduced by 14.2 and 3.8 percentage points, respectively. Alternatively, Fryer (2013) and Goodman and Turner (2010) find no retention effects. It is important to note that the aforementioned studies rely on large samples and quasi-experimental identification strategies whereas the latter studies perform RCTs with relatively small samples.

In summary, we find that financial incentives are employed in many different ways and yield various outcomes. First, we find that wage increases – both dependent and independent of working conditions and teacher quality – mostly attract and retain teachers. All seven of nine studies confirm the hypothesis that an increase in wages increases the entry of workers and decreases the exit of workers. Second, three studies that document the effect of greater pension wealth contingent on delayed retirement, show affirmative results. Teachers decide to retire at a later point in time – and receive a larger pension – than they would do if they did not receive such compensation. Third, one-time or short-term financial bonuses that depend on working conditions and teacher quality show mostly affirmative results. Especially, six out of nine studies document that financial bonuses can attract and retain teachers in hard-to-staff schools and high quality teachers. Finally, pay-for-performance schemes show mixed results. For group bonuses, half of the studies show a significant and negative effect on retention rates whereas other studies document a null effect. For individual bonuses, the positive impacts concentrate on the attraction and retention of high-quality workers as opposed to teachers in general. All studies show an overall null effect. At the same time, some studies show that pay-for-performance incentives either attract high-quality teachers or repel low-quality workers. Importantly, it is difficult to assess *ex ante* whether pay-for-performance incentives will have a net positive effect on the influx of workers.

Human capital investments

Effective on-the-job training and learning increases workers firm- and occupation-specific human capital yielding greater opportunities to prosper on the job (Gibbons & Waldman, 2004; Jovanovic, 1979; Sullivan, 2010). Teachers' and nurses' efforts thereby become more valuable such that they can demand greater financial rewards and have better employment prospects in terms of primary and secondary working conditions, both in the short- and long-run. As such, their value of the job increases and they are more likely to remain in the organization and profession. More generally, investments in human capital create a bond between workers and their employers (Becker, 1994), therefore contributing to employee commitment and retention (Gross, 2015). We group together studies that examine interventions that act as human capital investments for teachers and nurses. These interventions expand teachers' and nurses' skills and/or offer them opportunities to advance their careers. Specifically, this category includes interventions such as induction programs directed at

beginning teachers, career advancement programs, and initiatives to increase employees' ability to cope with work-related stressors.

Induction programs

Teacher attrition is particularly pronounced among early-career teachers (European Commission/EACEA/Eurydice, 2019; Schaefer et al., 2012), especially in disadvantaged schools (Hanushek et al., 2004). Beginning teachers' lack of experience in navigating the demands of the profession combined with, e.g., the perceived lack of peer support, hampers the motivation to stay in the profession (Clandinin et al., 2015; Schaefer et al., 2012). Interventions designed to accompany teachers within their first years at the school are called induction programs. These entail extensive guidance for beginning teachers and thus, ease their transition into the teaching profession. This approach is supposed to enhance beginning teachers' commitment and therefore, foster their retention (Clandinin et al., 2015; Schaefer et al., 2012).

As listed in Table 3, seven studies among the analyzed papers investigate the effects of induction programs. All of these studies were conducted in the education sector, among them six in the US and one in the Netherlands. One major component of induction seems to be mentoring: two of our retrieved studies exclusively focus on this aspect (DeCesare et al., 2017; Rockoff, 2008), while the remaining five induction programs include some mentoring as a component (Glazerman et al., 2010; Helms-Lorenz et al., 2016; Jaciw et al., 2021; Ronfeldt & McQueen, 2017; Schmidt et al., 2020).

Table 3*Overview of studies within the category “Human capital investments”*

Autor(s) (year)	Intervention group	Treated sample	Level	Design	Outcome
Decesare et al. (2017)		Probationary teachers in first three years at elementary schools in Colorado, US	District	RCT	No effect on retention (0)
Glazerman et al. (2010)		Elementary schools in US	District	RCT	No effect on retention (0)
Helms-Lorenz et al. (2016)		Secondary schools in the Netherlands	School	RCT	Increase in retention (+)
Jaciw et al. (2021)	Induction programs	Final-year university students planning to teach in elementary or middle public schools in Georgia, US	State	PSM	Increase in retention (+)
Rockoff (2008)		Probationary teachers with less than one year experience in US	District	DiD	Increase in retention (+)
Ronfeldt & McQueen (2017)		First year public school teachers in US	Various	PSM	Increase in retention (+)
Schmidt et al. (2020)		Beginning teachers in disadvantaged schools in US	District	RCT	No effect on retention (0)
Dill et al. (2010)		Nursing homes in North Carolina, US	State	FE	Increase in retention (+)
Glazerman & Seifullah (2012)	Career advancement programs	Primary and secondary schools in Chicago, US	District	RCT	Increase in retention (+)
Goldhaber & Hansen (2009)		Teachers in North Carolina, US	State	RD	Decrease in retention (-)
Pierson et al. (2021)		Early childhood teachers in Oregon, US	State	RCT	No effect on retention (0)
Concilio et al. (2021)		Newly licensed graduate nurses in California and Pennsylvania, US	State	RCT	No effect on retention (0)
El Khamali et al. (2018)	Coping	Intensive care unit nurses in France	Country	RCT	Increase in retention (+)
Kang & Jeong (2019)		Nurses in university hospital in Busan, Korea	Hospital	RCT	Increase in retention (+)
Kang et al. (2017)		Nurses in university hospitals in B-City, Korea	Country	RCT	Increase in retention (+)

Note. DiD = Difference-in-differences; FE = Fixed effects; PSM = Propensity Score Matching; RCT = Randomized control trial; RD = Regression discontinuity. The level indicates the level at which the (policy) intervention was implemented. The last column shows whether the study finds an *overall* positive (+), negative (-), or no effect (0) for the full sample.

Rockoff (2008) studies the effects of a mentoring program among new teachers with less than one year of teaching experience in New York City. Compared to teachers with prior experience, beginning teachers' probability to complete their first school year increases by 4.5 percent following weekly mentoring, thereby reducing turnover (Rockoff, 2008). Similarly, DeCesare et al. (2017) examine a mentoring program in Colorado elementary schools that assigns retired teachers to probationary teachers who are working less than three years within the district. Using an RCT, they find that mentorship by retired teachers in addition to "business-as-usual" mentoring does not significantly affect turnover compared to teachers who only received "business-as-usual" mentoring.

Other studies assess the effectiveness of more comprehensive, multifaceted induction packages (Glazerman et al., 2010; Helms-Lorenz et al., 2016; Jaciw et al., 2021; Ronfeldt & McQueen, 2017; Schmidt et al., 2020). These include a bundle of interventions, such as e.g., mentoring, coaching, peer-support, classroom observations, or professional development over a longer time span of up to three years. In an RCT across secondary schools in the Netherlands, a 3-year induction program for early career support was implemented to retain beginning teachers and increase their commitment to the profession. Helms-Lorenz et al. (2016) find a small and positive significant effect of the program on 3-year retention. Slightly shorter induction programs of 1-2 years in the US show null effects on retention and turnover rates (Glazerman et al., 2010; Schmidt et al., 2020). Notably, two studies investigating the effects of induction programs with propensity score matching do find effects. Ronfeldt and McQueen (2017) find that comprehensive induction support including weekly mentoring, observations, monthly professional development and teacher study groups decrease the probability of beginning teachers moving to another school or another profession.

The CREATE residency program targets teachers in Georgia in an even earlier stage of their career: their final year at university. The three-year intervention entails one year of a pre-service teacher practicum, one year of paired teaching in a single classroom and one year of sole teaching in a single classroom, accompanied by peer-support and a supporting program team. Jaciw et al. (2021) find a positive effect of this residency program on the probability of staying in the teaching profession for at least the duration of the program.

In sum, there is no common definition of teacher induction programs. The interventions listed above mostly entail different components, target groups, durations and hence, differ in their effects. Notably, mentoring by experienced teachers seems to be a relevant component of induction programs, but the inconclusive effects across the analyzed studies complicate judging its potential to bolster the retention of beginning teachers. The absence of positive effects in some studies (e.g. DeCesare et al. (2017) might however be explained by the fact that the control group was also subjected to "business-as-usual" mentoring. The effect of the intervention might be different if compared to a control group that is not treated with any type of mentoring.

Career advancement programs

Another set of studies focus on programs that either encourage or directly affect the development of workers' skills as a means to advance in their career. These programs are diverse and range from information nudges to a bundle of potentially effective components – e.g. training and greater responsibilities. While three of the studied interventions target teachers (Glazerman & Seifullah, 2012; Goldhaber & Hansen, 2009; Pierson et al., 2021), one of the retrieved studies investigates a development program on turnover of nurses (Dill et al., 2010).

In an RCT, Pierson et al. (2021) examine the effect of promoting professional development initiatives on workplace retention of the early childhood education workforce in Oregon, US. Receiving nudges via email, the workforce was encouraged to sign up for a career lattice: a pathway system helping workers to further their education, in exchange for a monetary incentive. The study finds no effect of the email nudges on workforce retention, suggesting that participants might have not sufficiently absorbed the information given in the emails (Pierson et al., 2021).

Glazerman and Seifullah (2012) examine the teacher advancement program (TAP) in Chicago that encourages teachers to take on additional responsibilities and offers extra pay and eligibility for an annual performance bonus. Although no significant effects are found on workforce retention after two years of program implementation, in the third year after the implementation, effects become significant: The retention rate increases by 11.5 percentage points compared to the control group (Glazerman & Seifullah, 2012).

To improve nurses' work environment and decrease turnover, Dill et al. (2010) investigate the "Workforce Improvement for Nursing Assistants: Supporting Training, Education and Payment for Upgrading Performance" (WIN A STEP UP) program. Next to providing education on clinical and interpersonal topics, the program committed participants to stay in their jobs for three months and provided retention bonuses and/or raises upon completion. Nursing facilities' likelihood of having below-average turnover increased by 15 percentage points when participating in the intervention.

Finally, Goldhaber and Hansen (2009) study important side-effects of skill development when this leads to accredited certification. Due to the certificate's signaling power, certifications can enhance awardees' employment opportunities, or even incentivize earlier retirement due to a pensionable salary supplement. These may be reasons for certified teachers to leave their current profession, school district, and/or state, thereby contributing to teacher shortages. Goldhaber and Hansen (2009) examine the impact of the National Board of Professional Teaching Standards (NBPTS) certificate within a regression discontinuity framework. They find that teachers just above the eligibility cutoff for certification are more likely to leave their school, district, and state four years after certification compared to their counterparts just below the eligibility cutoff. In the case that certified teachers stay within the state, they tend to sort out of disadvantaged schools. This points towards a double-edged sword of human capital investments: As investments in skills become more general, this may induce

greater turnover as teachers' enhanced skills allow them to work in more favorable schools or professions.

Coping

Within the healthcare literature, four retrieved studies examine nurses' turnover behavior and intentions following interventions that we group under Coping. Instead of changing nurses' direct work environment, coping interventions are aimed at increasing nurses' resilience and equipping them with skills to better cope with the stressors of their profession. Therefore, the increased ability to cope with demands such as stress and workplace bullying are expected to affect nurses' turnover.

El Khamali et al. (2018) study a stress-management intervention for intensive care unit (ICU) nurses in France. This intervention entails a 5-day course recapping nursing theory and stimulating situational role-play in simulated scenarios. It aims to reduce job strain through enabling ICU nurses' to cope with various stressors. In an RCT, the intervention achieves a significant, 8 percentage points reduction of turnover in the treatment group after 6 months. Concilio et al. (2021) use a digital intervention in the form of supportive text messages to increase social support, resilience and nurses' ability to cope with stress. In an RCT, they find no significant effects on turnover intentions.

Kang and Jeong (2019) as well as Kang et al. (2017) analyze "cognitive rehearsal" interventions which are aimed to increase the ability to cope with workplace bullying and mitigate the turnover intentions of nurses. The intervention developed by Kang et al. (2017) entails 20 direct contact hours, and Kang and Jeong (2019) examine a respective smartphone application. Both interventions are associated with slightly declining turnover intentions of nurses within a small sample.

Organizational features

In this section, we discuss the results of various studies investigating how organizational features affect teachers' and nurses' employment decisions. First, we discuss how various aspects of the organizational climate, including leadership, affect teacher behavior. Second, we discuss how the work and task design of jobs can either in- or decrease the work pressure or autonomy of workers, and thereby affect behavior.

Climate and leadership

Hoy (1990) conceptualizes school climate as "a broad term that refers to teachers' perceptions of their general work environment; it is influenced by the formal organization, informal organization, personalities of participants, and the leadership of the school" (p. 151). Hypothetically, teachers would be more willing to commit to a school if it offered a pleasant school climate enabling social, emotional and physical safety (Grant et al., 2022; Kraft et al., 2016).

Table 4*Overview of studies within the category “Organizational features”*

Autor(s) (year)	Intervention group	Treated sample	Level	Design	Outcome
Grant et al. (2022)		Low-performing secondary schools across US	District	RCT	No effect on retention (0)
Grissom & Bartanen (2019)		Primary and secondary schools in US	State	FE	Increase in retention (+)
Jacob et al. (2015)	Climate and leadership	Rural schools in Northern Michigan, US	State	RCT	Increase in retention (+)
Kraft et al. (2016)		Secondary schools in New York City, US	City	FE	Increase in retention (+)
Steinberg & Yang (2022)		Public and charter schools in Pennsylvania, US	State	DiD	Increase in retention (+)
Choi et al. (1986)		Registered nurses and licensed practical nurses in hospital in the US	Hospital	RCT	No effect on retention (0)
DePriest et al. (2020)		States across the US	State	DiD	Increase in retention and entry (+)
Fuchsman et al. (2020)	Work and task design	Public Schools in Georgia, US	State	DiD	No effect on retention (0/+)
Kandrack et al. (2021)		States across the US	State	DiD	No effect on retention or entry (0)
Minor et al. (2019)		Secondary schools in Michigan, US	State	FE	Decrease of retention (-)
Xue et al. (2018)		States across the US	State	FE	Increase in retention and entry (+)

Note. DiD = Difference-in-differences; FE = Fixed effects; RCT = Randomized control trial. The level indicates the level at which the (policy) intervention was implemented. We only report effects on the full sample, unless studies only perform subsample analyses. Heterogeneous effects are discussed in the text. The last column shows whether the study finds an *overall* positive (+), negative (-), or no effect (0) for the full sample. In the case that a study reports an overall null effect, but a positive effect for a subsample, the table reports (0/+).

Of the retrieved studies, Kraft et al. (2016) examine four dimensions of school climate (leadership, expectations, relationships and safety) and their effect on teachers' exit rates. They indeed find that an improved school climate reduces teacher turnover. Notably, leadership is the strongest dimension in predicting turnover reduction (Kraft et al., 2016). Grant et al. (2022) study another intervention aimed at improving school climate: *Restorative Practices*. The intervention reforms disciplinary measures within the school community by addressing inappropriate behaviors among students in a proactive and empathetic way. They investigate the intervention in the context of another intervention called *Diplomas Now*, fostering teamwork among teachers and small learning communities, among others. While the interventions indeed have a positive effect on the school climate, they do not significantly affect teacher turnover (Grant et al., 2022).

Two studies specifically focus on the improvement of school leadership through development programs targeting school leaders. The *Balanced Leadership Program* investigated by Jacob et al. (2015) aims to increase principals' self-efficacy by teaching them 21 key leadership responsibilities that are significantly related to student achievement. Two years after the implementation of the program, treated schools witness a 5 percentage point decrease of teacher turnover. Similar yet less sizable effects were found by Steinberg and Yang (2022), who examined the *Pennsylvania Inspired Leadership Induction Program*, consisting of two courses to establish three core leadership standards within the first five years of appointment to principal. Treatment schools experience a significant decline in teacher turnover in the second and third year after program completion.

Finally, Grissom and Bartanen (2019) analyze how the effectiveness of principals influence strategic personnel management. They find that especially effective principals increased retention among the most effective teachers and increased turnover among low-scoring teachers in the state of Tennessee. They also find that more effective principals reduced teacher turnover on average.

Work and task design

Another important feature of organizations is how tasks are designed and how work is organized. Public press increasingly reports about teachers and nurses taking on tasks that they dislike and did not sign up for – e.g. administrative duties.⁶ Such duties may increase work pressure and decrease job satisfaction such that the likelihood of turnover increases. Two papers in our final literature sample study how the intensity of certain tasks influence turnover decisions. Minor et al. (2019) examine a Michigan curriculum change that increased the number of courses required for graduation, leading to increased work pressure for teachers. They find that, after the announcement of the curriculum change in 2006 as well as 4 years later in 2010, school-level teacher turnover increases significantly around 4.3

⁶ <https://www.weforum.org/agenda/2023/01/healthcare-workloads-and-staff-shortages-davos23/>
<https://nos.nl/artikel/2167480-basisschoolleraan-werkdruk-vooral-door-administratieve-rompslomp>
<https://nationalpost.com/news/canada/studies-show-teachers-buried-in-admin-work-have-less-time-for-students>

percent compared to 2004. Hence, reducing the work pressure through a curriculum change might decrease turnover. Fuchsman et al. (2020) study reduced testing in certain subjects and grades in Georgia public schools as an intervention to decrease work pressure and turnover. They find that the removal of certain testing requirements had little to no effect on the probability of overall teacher turnover. However, heterogeneity analyses reveal that early-career teachers consistently became less likely to leave their profession in response to reduced testing requirements.

For healthcare workers, a common catalyst for work pressure is related to the limited accommodation of work-life-balance due to strict time scheduling (Tausig & Fenwick, 2001). A way to modify the constraints in balancing work time with other responsibilities, is by increasing flexibility of working times. Choi et al. (1986) investigate the effect of an intervention aiming to increase flexibility in shift scheduling for nurses in an RCT. However, Choi et al. (1986) do not find significant differences in turnover intentions between the control and treatment group.

A number of studies also look at the task content of nurse practitioners' jobs. In the US, nurse practitioners have different authorizations depending on the state and the respective scope of practice (SOP) regulations. Full SOP regulated counties permit nurse practitioners to evaluate patients, pose diagnoses, initiate treatments and prescribe medications. Reduced SOP regulations limit nurse practitioners' permission in one of these areas and require collaborative agreement with an outside health discipline, while restricted SOP regulations additionally require supervision delegation and team management by an outside health discipline (DePriest et al., 2020; Kandrack et al., 2021; Xue et al., 2018). Overall, extended SOP regulations aim at reorganizing healthcare supply to reduce the inequity of nurse practitioner supply in over- and underserved areas. Simultaneously, an extended SOP enriches nurse practitioners' work by increasing task variety, hypothetically diversifying their skills use.

All three retrieved studies exploit the variation in these regulations to measure their effects on the supply of nurse practitioners. Xue et al. (2018) find that full SOP regulation is associated with a higher supply of nurse practitioners in rural and shortage areas compared to countries with reduced or restricted SOP regulations. Likewise, DePriest et al. (2020) finds that the implementation of full SOP increases the probability of nurse practitioners living near or in high shortage areas. In contrast, Kandrack et al. (2021) find null effects of adopting full SOP regulations on nurse practitioners' supply.

School accountability and its consequences

School accountability has become increasingly common around the world and implies that schools are being evaluated based on student performance. On the basis of these evaluations, schools receive explicit or implicit rewards or sanctions (Figlio & Loeb, 2011). For example, schools that meet performance expectations may receive increased resources or autonomy, as well as bonuses for educators. Underperforming schools might experience increased pressure from stakeholders to improve performance or might even be forced into a school turnaround. Accountability systems may both

increase and decrease teacher turnover in the short- and long run. The *potential* rewards or sanctions may motivate both school management and teachers to perform better. Accountability puts more emphasis on students' test performance, which can increase pressure on teachers and make their profession less attractive. Moreover, information about teacher effectiveness – together with greater accountability pressure – can induce school leaders to exert more effort into dismissing their less effective teachers, but also into keeping their most effective teachers. The *actual* receiving of rewards or sanctions – consequences of being held accountable – in turn can have severe direct effects on turnover – e.g., if a pre-defined fraction of teacher staff is laid off.

Although school accountability systems – and their consequences – do not directly address acute teacher shortages, it is important to recognize that these systems are put in place to improve educational quality. As such, incentive schemes that motivate schools to improve school and educational quality may make schools and the teaching profession more attractive (e.g., Grissom et al., 2014). It might therefore be viewed as a way to structurally reduce future shortages and might at least bring definitive consequences for the future attraction and exits of teachers.

In the next section, we first discuss 6 studies that analyze the incentive effects of accountability systems on teacher labor markets as a whole. These studies investigate what happens to teachers as a consequence of specific accountability systems. In the second part of this section we synthesize the findings of 12 studies from the US that look specifically into the explicit consequences of school accountability, such as turnarounds of persistently low-performing schools, and how these consequences affect the inflow and outflow of teachers. The findings of the studies discussed in this section are summarized in Table 5.

Incentive effects of school accountability

In the US, the passage of the “No Child Left Behind Act” (NCLB) in 2002 marked the starting point of high-stakes accountability reforms. NCLB required states to test students and, based on test outcomes, evaluate whether schools met the state's yearly improvement targets. Due to NCLB, students' parents were better informed about how their children's schools were performing. Schools that did not meet improvement targets could be labeled as “needing improvement”. NCLB only entailed explicit penalties for schools with many low-income students or specific racial/ethnic subgroups (so-called “Title I schools”) that did not meet the improvement goals set by the state. These penalties included a change of the school's leadership team or even school closure. Sun, Saultz, et al. (2017) find that NCLB increased the odds of involuntary leaves yet had no effect on voluntary mobility (transfer to other schools) and voluntary attrition (leaving the teacher profession) among teachers. Similarly, Grissom et al. (2014) find no evidence that NCLB decreased teachers' intention to remain in teaching. The intent to remain in teaching even became higher in high-poverty schools compared to low-poverty schools, despite the fact that these schools faced the threat of sanctions (Grissom et al., 2014). Shirrell (2018) also finds no effect of the subgroup-specific accountability policies on overall teacher exits. The

policy actually caused black teachers who were held accountable for the black student subgroup to leave teaching at significantly lower rates. These findings suggest that NCLB did not make the teacher profession less attractive and may even encourage teachers to stay.

Another set of our retrieved studies analyze a specific component of school accountability systems: Teacher evaluations which contain both novel, more intensive evaluation methods and policies to reduce teachers' employment protection. According to Brunner et al. (2019), "Proponents argue that [evaluations] will make it easier to identify and remove ineffective teachers and reduce administrative constraints over human capital ... [while] opponents counter that these reforms make teaching a less attractive profession, leading to an increase in attrition..." (p. 403). Brunner et al. (2019) study the effect of Michigan's teacher evaluation reform, while Robertson-Kraft and Zhang (2018) analyze the impact of a teacher evaluation system in Texas. Both studies find that the teacher evaluation systems had no effect on average teacher turnover, although the policies did increase exits among early career and low-quality teachers.

One study focuses directly on how teacher evaluations impact strategic personnel management. In response to a rigorous teacher evaluation implemented by the Houston Independent School District, Cullen et al. (2021) find that less effective teachers became more likely to exit the school or district.

To summarize, none of the studies offer convincing evidence that school accountability policies – and the underlying teacher evaluations – have a negative effect on teachers' (willingness to) leaving their school or profession. However, a few studies do find that increased accountability pressure can increase turnover among early-career teachers. In some instances, accountability measures actually increased teacher retention. Improved information about teacher performance can help schools to retain their most effective teachers. Moreover, accountability pressure might also encourage schools to improve student achievement and make their schools a more desirable workplace.

Table 5*Overview of studies within category “School accountability and its consequences”*

Autor(s) (year)	Intervention group	Treated sample	Level	Design	Outcome
Brunner et al. (2019)		Low-performing, high-poverty schools in US	State	DiD	No effect on retention (0/-)
Cullen et al. (2019)		Primary and secondary schools in US	District	DiD	No effect on retention (0/-)
Grissom et al. (2014)	Incentive effects of school accountability	Primary and secondary schools in US	Country	DiD	No effect on retention (0/+)
Robertson-Kraft and Zhang (2016)		Primary and secondary schools in US	District	DiD	No effect on retention (0/-)
Shirrell (2018)		Primary schools in US	Country	RD and DiD	No effect on retention (0/+)
Sun, Saultz et al. (2017)		Grades 3-8 in US	Country	DiD	No effect on retention (0)
Bacolod et al. (2012)		Primary and secondary school in US	State	RD	No effect on retention (0)
Carlson & Lavertu (2018)		Low-performing primary, middle, and high-schools in US	State	RD	No effect on retention (0)
Dizon-Ross (2018)		Primary and middle-schools in US	City	RD	No effect on retention (0/+)
Feng et al. (2018)		Primary and secondary schools in US	State	RD	No effect on retention (0/-)
Gjefsen & Gunnes (2020)		Lower-secondary schools in Norway	City	DiD	No effect on retention (0)
Heissel & Ladd (2018)	The effects of sanctions and rewards embedded in school accountability	Low-performing primary and middle-schools in US	State	Fuzzy RD	Decrease in retention (-)
Henry et al. (2020)		Low-performing primary and secondary schools in US	State	DiD	Increase in entry (+)
Henry & Harbatkin (2020)		Low-performing primary and secondary schools in US	State	Fuzzy RD	Decrease in retention (-)
Lee & Sartain (2020)		Under-enrolled primary schools with low accountability ratings in US	District	DiD	Decrease in retention (-)
Pham et al. (2020)		Low-performing primary, middle, and high-school schools in US	State	DiD	Decrease in retention (0/-)
Pope (2019)		Primary schools in US	District	FE	No effect on retention (0)
Sun, Penner et al. (2017)		Low-performing primary, middle, and high-schools in US	District	DiD	No effect on retention (0)*

Note. DiD = Difference-in-differences; FE = Fixed effects; RD = Regression discontinuity. The level indicates the level at which the (policy) intervention was implemented. The last column shows whether the study finds an *overall* positive (+), negative (-), or no effect (0) for the full sample. In the case that a study reports an overall null effect, but a positive or negative effect for a subsample, the table reports (0/+) or (0/-). * Sun, Penner et al. (2017) find an increase in involuntary teacher mobility, but we consider voluntary mobility as the most important outcome measure since our study aims to investigate how teachers can be incentivized to remain in teaching or enter the profession.

The Effects of Sanctions and Rewards embedded in School Accountability

The academic standards set by accountability policies in the US have increased awareness of the persistently poor performance of certain schools and have led to explicit consequences for these schools. As a response, the federal government provided more than US\$7 billion in resources to stimulate states and districts to implement federally approved turnaround reforms through School Improvement Grants (SIG) and Race to the Top (RttT) funds.

These federally mandated turnaround measures were based on the belief that incremental changes in school learning processes would be insufficient to achieve significant school performance gains and involved specific practices for disrupting the status quo (Henry et al., 2020). States that received federal turnaround funds through RttT and SIGs were required to employ one of four specific models: 1) the transformation model, 2) the turnaround model, 3) the restart model, or 4) school closure. The transformation model required schools to replace the principal, take measures to increase teachers' and principals' effectiveness, and introduce comprehensive instructional reforms, amongst other things. The turnaround model included all of the requirements of the transformation model, but additionally required schools to replace at least half of their teaching staff. Under the restart model, schools had to transfer school management responsibilities to an independent entity such as a charter management organization.

Most school districts that implemented turnaround interventions under RttT and SIG selected either the transformation or turnaround model. Six of our included studies analyze the effects of these two models and report mixed effects on teacher retention. In North-Carolina, where 85 percent of the schools opted for the transformation model, teacher turnover increased after the first full year of program implementation (Heissel & Ladd, 2018). Sun, Penner, et al. (2017) find that the transformation and turnaround models in the San Francisco Unified School District caused a weak increase in involuntary teacher mobility. Importantly, the turnaround models had no significant effect on voluntary teacher mobility. While Carlson and Lavertu (2018) report no significant effect on average teacher retention of Ohio's SIG turnaround efforts, descriptive heterogeneity analyses suggest that the transformation model increased teacher retention, while the turnaround model led to a reduction in teacher retention. Tennessee allowed its lowest-performing schools to join a so-called Innovation Zone (iZone) which implemented reforms aligned with the transformation model. While iZones were not required to replace their teachers, almost all iZone schools did replace at least 50 percent of teachers. Pham et al. (2020) find that teacher turnover was not significantly affected in the five year period after iZone schools were installed.

Tennessee also placed some of its lowest-performing schools into an Achievement School District (ASD). The ASD implemented the restart model by reopening schools under new management and required schools to replace their principal and at least 50 percent of their teachers. Pham et al. (2020) find that ASD schools experienced increased teacher turnover. After the intentional staff

replacements, turnover continued to be high in the years after the introduction of the reform. Henry et al. (2020) show that both ASD and iZone schools increase the proportion of entering teachers which is also partly explained by the initially high teacher turnover.

Two studies in our review examine the impact of turnaround initiatives that were not federally mandated. Under the Every Student Succeeds Act (ESSA) that was installed in 2015, states received more flexibility in how they reformed their lowest performing schools. The North Carolina Transformation Initiative implemented two-day visits by the Department of Public Instruction staff who collected data through classroom observations, interviews, and focus groups. After this assessment phase, schools submitted an improvement plan, which was followed by school transformation coaching with the goal of building leadership and teaching capacity. Henry and Harbatkin (2020) find that teachers in treated schools were more likely to leave the school than teachers in control schools one year after the implementation.

One study investigates the most rigorous consequence for low-performing schools. The Chicago Public Schools identified 330 under-enrolled schools, some of which were also suffering from low accountability ratings. Although all schools faced initial threat of closure, the Chicago Board of Education voted to close 47 elementary schools. Lee and Sartain (2020) find that teachers in closed schools were more likely to leave the school district compared to teachers in under-enrolled and low-performing schools that faced initial threat of closure and teachers in schools that were never at risk.

While most of the accountability studies have analyzed the impact of (in-)direct sanctions for poor performance such as school turnaround and school closures, Bacolod et al. (2012) examine the effects of financial awards for high performing schools and teachers in the California Public School system. Many of the awards were distributed as teacher bonuses. Bacolod et al. (2012) find no evidence that the financial awards increased teacher hiring. The authors argue that this finding could be explained by the fact that the financial awards were typically short-lived (2 years).

Feng et al. (2018) examine the impact of a major change in 2002 in Florida's grading system to recalibrate the acceptable student proficiency levels for the purposes of school accountability. Due to this change, half of all schools faced an accountability "shock", with some schools receiving a higher grade and other schools receiving a lower grade than they would have otherwise received. Importantly, high-performing schools receive rewards while low-performing schools receive sanctions as well as additional assistance. In most parts of the school performance distribution, grading shocks did not affect teacher mobility. Only in the lowest part of the distribution, a downward shock in the grade increased the likelihood of teachers leaving the school. To the contrary, and in a similar RD setup, Dizon-Ross (2020) documents that the assignment and publication of school grades decreases teacher turnover at the bottom end of the grade distribution. Differential grading does not affect teacher turnover at the top end of the grade distribution.

Finally, performance ratings of schools and teachers have increasingly become publicly available. Poorly performing schools or teachers can experience increased pressure to improve once

community stakeholders are informed about their performance. Two of our selected studies look at the impact of the publication of teacher ratings in Los Angeles and Oslo. None of these studies find that the publication of teacher ratings affects teachers' likelihood to leave the school district or switch to a new school or grade (Gjefsen & Gunnes, 2020; Pope, 2019).

In sum, the impact of school turnarounds and other evaluation system outcomes on teacher employment are mixed. Many schools intentionally replaced a large share of their teaching staff which caused high turnover rates. Under some turnaround models, teacher turnover continued to be high, potentially due to organizational instability. However, some turnaround initiatives also increased schools' ability to retain and recruit high performing teachers. It is difficult to explain why some schools managed to positively affect the quality of their teacher composition as the turnaround initiatives widely varied across school districts and states. Other reward or sanctioning outcomes – such as the publication of teacher grades – seem to cause little changes in teacher employment.

Other interventions

A total of 11 studies could not be distinctly grouped into one of the preceding categories and will therefore be summarized individually. Retrieved studies addressing teacher turnover cover various types of schools (Barrett et al., 2022; Hensvik, 2012; Roch & Montague, 2021), the extension of the probationary period (Goldhaber et al., 2016), a strategy for alternative teacher preparation (Curran, 2017; Hansen et al., 2016), and recruitment and retention initiatives (Guffey & Young, 2020). In the healthcare context, we retrieved isolated studies on a parental leave program (Friedrich & Hackmann, 2021), staffing requirements (Chen & Grabowski, 2015; Han et al., 2021), and insurance reimbursement policies (He et al., 2020).

Type of schools

Schools can operate in different markets and have different core features that are unmalleable. For instance, schools run by private organizations are typically free from union contracts, as well as teacher employment regulations, potentially increasing their attractiveness for high-quality teachers due to increased flexibility in contracting. Exploiting the expansion of private schools in Sweden, Hensvik (2012) identifies the effects of school competition between 1991 and 2006. They find that teachers who move from public to private schools have above average cognitive skills compared to those who remain in public schools, indicating that private schools may be more attractive for high-quality teachers. Simultaneously, private schools loosen formalities of teacher requirements and hire from other occupations within the private sector.

Barrett et al. (2022) compare schools operating in different market types. They investigate the relationship between teacher performance and the probability of teacher exits in deregulated markets versus traditional school districts in the US. An important characteristic of deregulated market-based systems is that the government holds school operators responsible for school performance. In turn,

market-based school systems are typically free from union contracts and are granted autonomy to make decisions regarding personnel hiring, dismissal, and compensation strategies. Barrett et al. (2022) find that market-based school systems are better able to retain high-quality teachers. Teachers with higher value added are less likely to exit from the current school or district in market-based school systems compared to traditional systems. Both Hensvik (2012) and Barrett et al. (2022) suggest that flexibility in personnel policies enable school to attract and retain high-quality teachers.

Another emerging school type are schools that focus on online education. Roch and Montague (2021) analyze the impact of K-12 online schools on teachers' intention to move to another school as well as their intention to leave teaching. Compared to traditional schools, online schools are characterized by larger student-teacher ratios, higher shares of low-income and minority students, management organizations (limiting teachers' school-wide influence), lower salaries, and potentially higher problems with student discipline and motivation. Roch and Montague (2021) find that teachers in online schools do not significantly differ in their intention to leave the profession or to move to a new school than teachers in traditional schools. In contrast to the authors' expectations, they actually find that online teachers are more satisfied with their jobs than teachers in traditional schools. Differences in job satisfaction could potentially be explained by higher personal autonomy in online teachers' daily lives. However, further research is needed to understand what drives teacher satisfaction in the online environment.

Probationary period

A key element of public-school teaching is to reach job protection after a given number of years in the profession, so-called tenure. Tenure, as well as its timing, determine the attractiveness of a teaching career. Goldhaber et al. (2016) investigate a policy change in North Carolina and Washington State that extended the time to tenure by one year. Untenured teachers' mobility patterns intensified exclusively in North Carolina in response to the policy change: pre-tenure teachers were 2-3 percentage points more likely to exit their school district or state. Teachers who otherwise would have received tenure in the year of the policy change were 1-2 percentage points less likely to leave their district.

Alternative teacher preparation

Compared to traditional teacher preparation, alternative routes remove barriers to enter the teaching profession. The Teach for America (TFA) program was initially introduced in high-shortage areas and prepared recent high-achieving college graduates to become full-time teachers within 5 weeks. This approach has increased in popularity and now also serves school districts that do not face shortages. Curran (2017) argues that TFA placement could potentially be perceived by fully certified teachers in non-shortage areas as threatening their jobs. Curran (2017) finds that the presence of the TFA program in a district predicts a decreasing number of 11 to 14 teacher vacancies per year in that same district. The placement of one TFA teacher in a district translates into approximately one less

vacancy. Similarly, Hansen et al. (2016) find that increased TFA density is associated with increased mobility of the overall teacher sample out of school districts. However, an increase in school-level TFA density decreases the TFA teachers' probability of switching schools. These findings suggest that the placement of TFA-teachers has adverse effects on the retention of the regular teaching workforce, but not necessarily on the overall supply of teachers.

Recruitment and retention initiatives

Attracting and retaining teachers may also improve in effectiveness if granted more funding. The STAR program explored by Guffey and Young (2020) allocated \$8,000 per year to strategic recruitment and retention initiatives for agriculture teachers. Specifically, funded recruitment initiatives entail promotion at conventions in high schools and universities, while retention initiatives include workshops, mentoring, work-life-balance and professional development. State enrollment in this program significantly increased the recruitment of alternatively-certified agriculture teachers approximating to, on average, 10 new hires compared to control states and prior to the intervention. Effects on retention as well as the placement of fewer new vacancies were insignificant.

Parental leave program

Friedrich and Hackmann (2021) analyze the unintended effect of a federally funded parental-leave program in Denmark on the nurse shortage that the country was facing at the time the policy was implemented. The policy was introduced in 1994 and allowed parents to take up one year's absence per child aged up to eight years. The program intended to give unemployed individuals the opportunity to fill the open positions and gain valuable work experience. The program also offered job security and a compensation of 80 percent of unemployment benefits. Friedrich and Hackmann (2021) find that the reform reduced the employment of hospital nurses with 15 percent, while the employment of nurses in nursing homes decreased by 10 percent. In contrast, the policy had no significant effect on the employment of nursing assistants in hospitals and nursing homes.

Staffing level (requirements)

In this section, we discuss two studies examining the impact of (minimum) staffing requirements on nursing staffing levels. One other study examines how an insurance reimbursement policy affects nurse staffing levels. While these studies are directly targeted at addressing nurse shortages, they can indirectly inform us on how hospitals can be incentivized to exert more effort to attract nurses. Chen and Grabowski (2015) analyze the impact of the California AB 1731 law that was enacted in 2000. The law required nursing homes to raise the minimum nursing staff requirement from 3.0 to 3.2 hours of direct resident care per day. Similarly, Ohio increased its minimum total direct care hours from 1.6 to 2.75 in 2002. The minimum staffing standard included all direct care workers, i.e., registered nurses (RNs), licensed practical nurses (LPNs), and certified nursing assistants (CNAs). Nursing facilities that are not in compliance with the minimum staffing level may receive a deficiency citation and receive

monetary sanctions. Compared to states that did not have a minimum staffing regulation in place, the treatment states experienced an increase of 0.175 total nursing hours per resident in all three post-intervention years. Because the minimum staffing standard included all direct care workers, the policy change led to the hiring of additional CNAs and LPNs rather than higher wage RNs.

Han et al. (2021) assess whether different legislative approaches effectively increase the nurse staffing in hospitals. They compare changes in productive hours per patient day for RNs, LPNs, and nursing assistive personnel (NAPs) in the state that mandated staffing ratios, states that legislated staffing committees (which were comprised of at least 50% RNs who are involved in developing the staffing plan), and states that legislated public reporting of staffing levels at hospitals. Compared to states with no staffing legislation, the state that legislated minimum staffing ratios had a 0.996 increase in RN hours per patient day and a 0.224 increase in NAP hours. The staffing committee approach had a negative effect on LPN hours, while the public reporting approach had a positive effect on LPN hours.

The staffing level in health organizations can also be affected by insurance reimbursement policies. He et al. (2020) focus on Medicare payments covering a large share of care provided in nursing homes. Medicare is the primary reimbursement payer to 14% of nursing home residents. He et al. (2020) exploit a 2006 change in the calculation of the hospital wage index which substantially induced a variation in payment of daily rates for a large number of facilities, regardless of specific facility or market conditions. They find that an increased Medicare payment led nursing homes to increase their nursing staff hours per resident day. Relative to facilities without patients reimbursed by Medicare, a 5 percent increase in Medicare payment raised RNs' hours per resident day by 9 percent, LPNs' hours by 10 percent. A large share of the Medicare payment increase is thus spent directly on staffing within the entire facility (He et al., 2020). Although, evidently, an increased reimbursement payment increases nurse staffing levels in nursing homes, this only is indicative of an increasing demand for nurses on the facility-level. Hence, this study does not answer the question as to whether and how the overall nurse supply can meet the increasing demand in publicly reimbursed nursing homes.

Concluding discussion

Summary and discussion of the results

This study systematically reviewed 85 studies documenting the causal effects of interventions and policies that address nurse and teacher shortages. The systematic search yielded studies that are predominantly from the US, with a majority of studies focusing on education. The most widely exercised identification strategy is the difference-in-differences approach. The retrieved studies contain a wide range of different interventions that are ultimately classified in five different intervention categories. The biggest category examines the effect of financial incentives – in different shapes and forms – on entry and exit of teachers or nurses. Other categories include human capital investments,

organizational features and accountability policies. Table 6 provides an overview of the main findings with the percentages of studies showing positive, negative or no effects on employment. Overall, we find that 44 percent of the studies document an overall positive effect on retention and entry, 46 percent show null effects and the remaining studies document negative effects on employment.

Table 6

Percentage of studies with employment effects per intervention category

	No effect on employment	Increase in employment	Decrease in employment	N
Financial incentives	37%	53%	10%	30
Wage increase conditioned on working conditions	0%	100%	0%	4
Unconditional wage increase and frontloading	20%	60%	20%	5
Greater pension conditioned on delayed retirement	0%	100%	0%	3
Financial bonus conditioned on working conditions and teacher quality	33%	67%	0%	9
Financial bonus conditioned on worker performance	100%	0%	0%	5
Financial bonus conditioned on group performance	50%	0%	50%	4
Human capital investments	33%	60%	7%	15
Induction programs	43%	57%	0%	7
Career advancement programs	25%	50%	25%	4
Coping	25%	75%	0%	4
Organizational features	36%	55%	9%	11
Climate and leadership	20%	80%	0%	5
Work and task design	50%	33%	17%	6
School accountability	78%	5%	17%	18
Incentive effects	100%	0%	0%	6
Reward or sanction effects	67%	8%	25%	12
Other	45%	45%	9%	11

Note. Summarized overview of the studies' main effects on employment per intervention category. Information on effects from subsample analyses can be found in Tables 2-5.

Financial incentives marks the largest intervention category and shows overall positive effects on teacher employment. The differences in effectiveness between incentive designs are large, however. Studies that look at wage increases – both independent and dependent of working conditions or teacher quality – largely show positive effects on employment. Only wage increases caused by union bargaining – over a fixed education budget – may yield negative employment effects. Also, pension reforms in which employees receive greater pension wealth if they delay their retirement decision cause employees to work longer. Likewise, financial bonuses that depend on working conditions or teacher quality reveal overall positive effects. According to heterogeneity analyses, the success rate increases further if studies are considered that only show positive employment effects for teachers with certain characteristics.

Finally, the implementation of pay-for-performance schemes – either based on individual or group performance – mostly do not attract or retain more employees. This is not surprising, as they a priori can both attract higher-quality workers and push away lower-quality workers. Interestingly, even studies that focus on the quality composition of the workforce do not find corroborative evidence.

Interventions that entail *Human capital investments* shows positive effects on the entry and retention of teachers and nurses in 60 percent of the studies. Studies that analyze the effects of *Coping* most often report positive impacts on employment in nursing. This category comprises of studies examining stress management and anti-bullying interventions. *Induction programs* focus on the skill enhancement, social ties and professional development of beginning teachers. Here, we see that 3 out of 7 studies provide evidence that induction programs are more likely to retain teachers. While mentoring by experienced teachers is a common element of induction programs, the analyzed interventions vary substantially in their components and intensity which might explain why the effects differ across studies. The absence of positive effects in some studies might also be explained by the fact that the control group was also treated with a type of mentoring. The *Career advancement programs* encourage the development of workers' skills to advance in their career. While two studies find a positive effect of offering training on the retention of nurses and teachers, another study also shows that the certification of skills can lead to teacher attrition as its signaling power increases the pursuit of job opportunities outside the education sector. One study found no effect

The selected studies that analyze aspects of *Organizational features* provide some evidence that interventions aiming to improve *Climate and leadership* can reduce teacher turnover. Notably, leadership seems to be an important dimension of school climate in predicting turnover reduction (Kraft et al., 2016). This is confirmed by three studies that consistently demonstrate that improved leadership translates into increased teacher retention. The studies that investigate interventions that affect *Work and task design* often report null effects, where one study shows that increased work pressure induced by a curriculum change increases turnover among teachers. It is however unclear from this study whether a reduction in work pressure would reduce turnover. Finally, our review also offers some evidence that increasing the *Scope of practice* regulations might increase the supply of nurses in shortage areas.

A substantial part of the studies focus on *Incentive effects* – i.e. reacting to the potential “carrot” or “stick” – that underlie school accountability systems which involve the process of evaluating school performance and tying consequences (e.g. school closure or extra funding) to such evaluation. We find that none of the accountability studies document positive main effects on teacher employment. It is important to note that a priori the incentive effect does not imply a greater entry or retention of teachers as structural changes to improve school quality might include smaller (e.g., retaining all staff) or larger (e.g., changing teacher composition) turnover. Moreover, studies on the effects of sanctions and rewards embedded in school accountability and a consequence of evaluation provide dispersed evidence on employment effects. Approximately 8 percent of the studies show an increase in net influx whereas a

quarter of the studies show a decrease. School turnaround as the largest set of interventions follows from a sufficiently low evaluation and contains drastic measures. In some instances, it entails the dismissal of 50 percent of staff whereas in others it may imply better management and working conditions for teachers. Unfortunately, the included studies offer little insight into whether turnaround schools create more attractive working conditions for teachers in the long run.

Finally, the *Other* category offers some interesting findings. For example, *Alternative teacher preparation* programs such as Teach for America (TFA) ease individuals' selection into the teaching profession. Although the studies included in our review show that TFA teachers might replace regular teachers in non-shortage areas, they find no effect on the overall supply of teachers. Hence, in shortage areas, programs like TFA might increase the supply of teachers. The *Other* category also contains studies that look into the unintended effects of policies. For example, one Danish study finds that the implementation of a generous parental-leave program can exacerbate the shortage of nurses.

Education and healthcare

The systematic search retrieved articles on intervention effects for both teachers and nurses. The majority of studies retrieved in this review concern education. First, some intervention categories are solely treated within the realm of education where it is perhaps questionable whether their effectiveness translates easily to the healthcare sector. On the one side, *Accountability* and *School turnaround* are only discussed in the context of education and involve the evaluation and incentivization of schools and school districts. As education and healthcare are organized fundamentally different, we posit that this type of intervention is less suitable for healthcare. On the other side, *Induction programs* are exclusively treated within education, yet may signal similar effectiveness in the healthcare sector. Young, early-career nurses show a relatively higher probability of transitioning out of the profession and union strikes are on the rise in many European countries to improve nurses working conditions. Second, *Coping* and *Scope of practice regulations* interventions are solely analyzed in the context of healthcare. Akin to the previous argument, the educational field may benefit from the insights from these studies as teachers battle with stress and burnout, and professional development is gaining more and more attention. The remaining intervention categories are treated within both education and nursing which suggests a potentially fruitful comparison between studies.

Limitations to interpretation

Intervention categories that are relatively often cited as having positive causal effects on employment might signal that they can indeed be implemented to attract and retain teachers and nurses. At the same time, it is important to discuss the limitations that underlie these results. In particular, the included studies i) employ different research designs, ii) focus on either education or healthcare, iii) consider short-term effects for a single unit – e.g. school or district, and iv) can contain multiple (in)effective components.

Research designs

This review only includes studies with research designs that aim to measure causal impacts of interventions on labor supply. The retrieved studies employ different designs as shown in Table 7. Only 22 percent of the studies employ (clustered) RCTS. Van Klaveren and De Wolf (2013) suggest that this design provides the strongest evidence for causal inference as units of observation are randomly assigned to treatment and control groups. The remaining studies use quasi-experimental designs in which the assignment to treatment or control follows from features in naturally occurring data. The validity of the assumptions underlying these models are crucial to interpret the evidence as causal. As discussed by Imbens and Wooldridge (2009), the regression discontinuity design arguably gives strong evidence of causal effects as it relies on few and easily verifiable assumptions. Other models rely much more heavily on independence assumptions that are not easily verified in the data such that the likelihood of bias increases. Table 7 shows that studies that employ RCTs, RDs, but also DiDs, least often document positive effects on employment of interventions that are (mostly) designed to do so. As described above, these studies are also arguably least susceptible to bias and therefore may reveal more accurate intervention effects. If we only consider RCTs and RDs, then *Financial incentives*, *Coping* and *Professional Development* are the intervention categories with the greatest share of employment enhancing effects. This coincides with the main results mentioned above.

Table 7

Percentage of studies with employment effects per research design

Research designs	No effect on entry or retention	Increase on entry or retention	Decrease in entry or retention	N
Difference-in-differences	50%	43%	7%	30
Fixed-effects regression	17%	66%	17%	12
Instrumental variable	25%	50%	25%	4
Propensity score matching	33%	67%	0%	3
Randomized controlled trial	56%	44%	0%	18
Regression discontinuity	22%	22%	56%	18
Total	46%	43%	11%	85

Note. Summarized overview of main effects on employment depending on the research design utilized by the studies.

Limited scope

Many of the included studies contain causal evidence with a distinct focus on one outcome measure, partial equilibria, and the short run. First, studies often focus solely on entry or exits where 80 percent of the studies focus on the latter. As many interventions aim to increase the attractiveness of a job or profession – e.g. less stress, greater income, better professional outlooks – one could expect both retention *and* entries to increase. In contrast, policy implementations may simultaneously decrease entries and exits due to the higher costs, for example. Hence, the focus on one outcome measure – exit or entry – does not signify the effect on total employment. Moreover, only one retrieved study focuses

on the number of hours worked as an outcome measure. Increasing our understanding of how workers can be stimulated to work more hours might help address shortages as both the education and healthcare sector are characterized by a large share of part-time workers.

Second, by definition of a clean design to identify causal effects, the control group must mimic what would have happened in the absence of an intervention. Therefore, teachers or nurses nested in control units – e.g. schools or hospitals – that are in the proximity of treated units are not perfect control units as they are potentially affected by the treatment due to spillovers. For example, a wage increase in hospitals in municipality A may draw nurses from hospitals in adjacent municipality B. Studies thus often analyze partial equilibria and do not consider what happens to teacher or nurse labor markets as a whole. This is, however, crucial information if the aim of policy is to reduce overall shortages. Finally, many studies document short-term effects where it is unclear how policies will affect employment in the long run. On the one hand, employment effects may be short-lived. One-time wage increases or issuing of financial bonuses may only attract more workers in the short run, for example. On the other hand, policies that implement systematic changes may yield long-term increases in employment. School turnaround policies, for example, may increase turnover in the short run, yet have positive effects on entry and retention in the long run due to better working conditions.

Third, given that we qualitatively synthesized the available evidence on potentially effective interventions, our study does not address the potential presence of publication bias. This publication bias can be addressed by means of a meta-analysis which ideally estimates the impact of comparable interventions on comparable outcome measures. In a similar vein, many of the economic studies included in our review might also have analyzed the interventions for which some source of exogenous variation was available. Hence, many other potentially effective interventions – e.g. class size reduction, increased teacher autonomy, removal of irregular work hours – might benefit from impact evaluation. Moreover, our systematic literature review is restricted to publications in the English language. This restriction might introduce language bias as studies in non-English speaking countries are more likely to be published in an international journal if significant effects are found (Egger et al., 1997; Moher et al., 1996). Nevertheless, we expect the problem of the language bias to be limited due to a shift towards publications in the English language in recent years (Galanti et al., 2006).

We posit that above-mentioned shortcomings are fruitful avenues for future research and should be addressed explicitly in the evaluation of policy effectiveness.

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Appendix A

Search 1

Web of Science (Core Collection) Session Results (17 January 2022)

Search	Query	Items found
S1	TS=(teach* OR nurs*) AND (shortage OR turnover OR mobility OR attrition OR transition OR retention OR retain* OR productivity) AND (polic* OR interven*) AND (effect* OR impact OR evaluat* OR causal OR experiment*)	8,202

After applying database filters for journal articles as document type, publication dates between 2010 and 2022, English language, and high-income countries, we obtained 4,892 abstracts to screen. After the screening process outlined in Section 2, we retrieved 26 papers with a research design that allows for causal inference, out of which only 6 studies were on nurses. Furthermore, a number of causal studies we are aware of were not in this list. To increase the number of causal studies on both teachers and nurses, we conducted an additional search in three databases (ERIC, CINAHL and WoS) with the help of a medical information specialist.

Search 2

ERIC (Ebsco) Session Results (20 May 2022)

Search	Query	Items found
S3	S1 AND S2	835
S2	TI ("random* control* trial*" OR "random* clinical trial*" OR "RCT*" OR "instrumental variable*" OR "difference-in-difference*" OR "dif-in-dif" OR "regression discontinuit*" OR "fixed effect*" OR "control group*" OR "intervention group*" OR "treatment group*" OR "propensity score*" OR "score match*" OR "panel data" OR "longitudinal data" OR "random effect*" OR "causal*" OR "experiment*" OR "quasiexperiment*") OR AB ("random* control* trial*" OR "random* clinical trial*" OR "RCT*" OR "instrumental variable*" OR "difference-in-difference*" OR "dif-in-dif" OR "regression discontinuit*" OR "fixed effect*" OR "control group*" OR "intervention group*" OR "treatment group*" OR "propensity score*" OR "score match*" OR	131,831

Search	Query	Items found
	"panel data" OR "longitudinal data" OR "random effect*" OR "causal*" OR "experiment*" OR "quasiexperiment*") OR SU ("random* control* trial*" OR "random* clinical trial*" OR "RCT*" OR "instrumental variable*" OR "difference-in-difference*" OR "dif-in-dif" OR "regression discontinuit*" OR "fixed effect*" OR "control group*" OR "intervention group*" OR "treatment group*" OR "propensity score*" OR "score match*" OR "panel data" OR "longitudinal data" OR "random effect*" OR "causal*" OR "experiment*" OR "quasiexperiment*")	
S1	((DE "Occupational Mobility" OR DE "Teacher Transfer" OR DE "Labor Turnover" OR DE "Career Change" OR DE "Career Choice" OR DE "Career Planning" OR DE "Occupational Aspiration") AND ("teacher*" OR "nurs*")) OR DE "Teacher Shortage" OR TI (("teacher*" OR "nurs*") N3 ("shortage*" OR "turnover*" OR "turn-over*" OR "mobilit*" OR "attrition*" OR "transition*" OR "retention*" OR "retain*" OR "recruit*" OR "persist*" OR "supply" OR "leave" OR "hire" OR "hiring")) OR AB (("teacher*" OR "nurs*") N3 ("shortage*" OR "turnover*" OR "turn-over*" OR "mobilit*" OR "attrition*" OR "transition*" OR "retention*" OR "retain*" OR "recruit*" OR "persist*" OR "supply" OR "leave" OR "hire" OR "hiring")) OR SU (("teacher*" OR "nurs*") N3 ("shortage*" OR "turnover*" OR "turn-over*" OR "mobilit*" OR "attrition*" OR "transition*" OR "retention*" OR "retain*" OR "recruit*" OR "persist*" OR "supply" OR "leave" OR "hire" OR "hiring"))	23,142

CINAHL (Ebsco) Session Results (20 May 2022)

Search	Query	Items found
S3	S1 AND S2	1,172
S2	TI ("random* control* trial*" OR "random* clinical trial*" OR "RCT*" OR "instrumental variable*" OR "difference-in-	549,495

Search	Query	Items found
	<p>difference*" OR "dif-in-dif" OR "regression discontinuit*" OR "fixed effect*" OR "control group*" OR "intervention group*" OR "treatment group*" OR "propensity score*" OR "score match*" OR "panel data" OR "longitudinal data" OR "random effect*" OR "causal*" OR "experiment*" OR "quasiexperiment*") OR AB ("random* control* trial*" OR "random* clinical trial*" OR "RCT*" OR "instrumental variable*" OR "difference-in-difference*" OR "dif-in-dif" OR "regression discontinuit*" OR "fixed effect*" OR "control group*" OR "intervention group*" OR "treatment group*" OR "propensity score*" OR "score match*" OR "panel data" OR "longitudinal data" OR "random effect*" OR "causal*" OR "experiment*" OR "quasiexperiment*") OR SU ("random* control* trial*" OR "random* clinical trial*" OR "RCT*" OR "instrumental variable*" OR "difference-in-difference*" OR "dif-in-dif" OR "regression discontinuit*" OR "fixed effect*" OR "control group*" OR "intervention group*" OR "treatment group*" OR "propensity score*" OR "score match*" OR "panel data" OR "longitudinal data" OR "random effect*" OR "causal*" OR "experiment*" OR "quasiexperiment*")</p>	
S1	<p>((MH "Career Mobility+") OR (MH "Career Planning and Development") OR (MH "Personnel Turnover") OR (MH "Personnel Shortage+")) AND ("teacher*" OR "nurs*") OR TI (("teacher*" OR "nurs*") N3 ("shortage*" OR "turnover*" OR "turn-over*" OR "mobilit*" OR "attrition*" OR "transition*" OR "retention*" OR "retain*" OR "recruit*" OR "persist*" OR "supply" OR "leave" OR "hire" OR "hiring")) OR AB (("teacher*" OR "nurs*") N3 ("shortage*" OR "turnover*" OR "turn-over*" OR "mobilit*" OR "attrition*" OR "transition*" OR "retention*" OR "retain*" OR "recruit*" OR "persist*" OR "supply" OR "leave" OR "hire" OR "hiring")) OR SU (("teacher*" OR "nurs*") N3 ("shortage*" OR "turnover*" OR "turn-over*" OR "mobilit*" OR "attrition*" OR "transition*" OR "retention*" OR "retain*" OR "recruit*" OR "persist*" OR "supply" OR "leave" OR "hire" OR "hiring"))</p>	42,613

Web of Science (Core Collection) Session Results (20 May 2022)

Search	Query	Items found
#3	#1 AND #2	1,212
#2	TS=("random* control* trial*" OR "random* clinical trial*" OR "RCT*" OR "instrumental variable*" OR "difference-in-difference*" OR "dif-in-dif" OR "regression discontinuit*" OR "fixed effect*" OR "control group*" OR "intervention group*" OR "treatment group*" OR "propensity score*" OR "score match*" OR "panel data" OR "longitudinal data" OR "random effect*" OR "causal*" OR "experiment*" OR "quasiexperiment*")	6,566,218
#1	TS=(("teacher*" OR "nurs*") NEAR/3 ("shortage*" OR "turnover*" OR "turn-over*" OR "mobilit*" OR "attrition*" OR "transition*" OR "retention*" OR "retain*" OR "recruit*" OR "persist*" OR "supply" OR "leave" OR "hire" OR "hiring"))	16,127