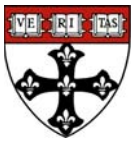


PROGRAM ON THE GLOBAL DEMOGRAPHY OF AGING

Working Paper Series

Financial incentives for return of service in underserved areas: a systematic review

Till Bärnighausen, David E. Bloom

June 2009

PGDA Working Paper No. 43
http://www.hsph.harvard.edu/pgda/working.htm

 The Program on the Global Demography of Aging receives funding from the National Institute on Aging, Grant No. 1 P30 AG024409-06.

Financial incentives for return of service in underserved areas: a systematic review

Till Bärnighausen[1, 2*], David E. Bloom[2*§]

[1]Africa Centre for Health and Population Studies, University of KwaZulu-Natal, 3935 Mtubatuba, South Africa

[2]Harvard School of Public Health, Harvard University, 665 Huntington Avenue, Boston, USA

*These authors contributed equally to this work.

[§]Corresponding author

Email addresses:

TB: tbarnighausen@africacentre.ac.za

DEB: dbloom@hsph.harvard.edu

Abstract

Background

In many geographic regions, both in developing and in developed countries, the number of health workers is insufficient to achieve population health goals. Financial incentives for return of service are intended to alleviate health worker shortages: A (future) health worker enters into a contract to work for a number of years in an underserved area in exchange for a financial pay-off.

Methods

We carried out systematic literature searches of PubMed, the Excerpta Medica database, the Cumulative Index to Nursing and Allied Health Literature, and the National Health Services Economic Evaluation Database for studies evaluating outcomes of financial-incentive programs published up to February 2009. To identify articles for review, we combined three search themes (health workers or students, underserved areas, and financial incentives). In the initial search, we identified 10,495 unique articles, 10,302 of which were excluded based on their titles or abstracts. We conducted full-text reviews of the remaining 193 articles and of 25 additional articles identified in reference lists or by colleagues. Forty-two articles were included in the final review. We extracted from these articles information on the financial-incentive programs (names, locations, periods of operation, objectives, target groups, definitions of underserved area, financial incentives and conditions) and information on the individual studies (authors, publication dates, study outcomes, study designs, samples and sample sizes, data sources, outcome measures and effect sizes, conclusions, and methodological limitations). We reviewed

program results (descriptions of recruitment, retention, and satisfaction among program participants), program effects (analyses of program effectiveness at the individual level regarding provision of care, retention, and participant satisfaction), and program impacts (analyses of program effectiveness at the population level regarding health systems and health).

Results

Of the 42 reviewed studies 33 investigated financial-incentive programs in the US. The remaining studies evaluated programs in Japan (five studies), Canada (two), New Zealand (one) and South Africa (one). The programs started between 1930 and 1998. We identified five different types of programs (service-requiring scholarships, educational loans with service requirements, service-option educational loans, loan repayment programs, and direct financial incentives). Financial incentives ranged from year-2000 United States dollars 1,358 to 28,470. All reviewed studies were observational. The random-effects estimate of the pooled proportion of all eligible program participants who had either fulfilled their obligation or were fulfilling it at the time of the study was 71% (95% confidence interval 60-80%). Seven studies compared retention in the *same* underserved area between program participants and non-participants. Six studies found that participants were less likely to remain in the same underserved area (five studies reported the difference to be statistically significant, while one study did not report a significance level); one study did not find a significant difference in retention in the same area. Twelve studies compared provision of care/retention in *any* underserved area between participants and non-participants. Ten studies found that participants were more likely to continue to practice in any

underserved area (eight studies reported the difference to be statistically significant, while two studies did not provide the results of significance tests); two studies found that program participants were significantly less likely than non-participants to remain in any underserved area. Seven studies investigated the satisfaction of participants with aspects of their enrolment in financial-incentive programs; three studies examined the satisfaction of members of participants' families with their lives in the undeserved area.

Conclusions

Financial-incentive programs for return of service are one of the few health policy interventions to improve the distribution of human resources for health on which substantial evidence exists. However, the majority of studies are from the US, and only one study reports findings from a developing country, limiting generalizability. The existing studies show that financial-incentive programs have placed substantial numbers of health workers in underserved areas and that program participants are more likely than non-participants to work in underserved areas in the long run, even though they are less likely to remain at the site of original placement. As all existing studies were observational and participants self-selected into the programs, the evidence to date does not allow the inference that financial-incentive programs have caused increases in health worker supply to underserved areas.

Background

In many geographic regions, both in developing and in developed countries, the number of health workers is insufficient to achieve population health goals. The 2004 Joint Learning Initiative (JLI) report *Human Resources for Health* estimated that "Sub-Saharan countries must nearly triple their current numbers of workers by adding the equivalent of one million workers through retention, recruitment, and training if they are to come close to approaching the MDGs [Millennium Development Goals] for health" [1]; the 2006 *World Health Report* concluded that "[t]he severity of the health workforce crisis in some of the world's poorest countries is illustrated by WHO estimates that 57 of them (36 of which are in Africa) have a deficit of 2.4 million doctors, nurses and midwives" [2]. In developed countries, certain areas, such as rural or poor communities, are commonly underserved with health workers, leaving substantial proportions of the population without access to complete primary health care [3-5].[1]

Interventions intended to alleviate health worker shortages include selective recruitment and training for practice in underserved areas, improvements in working conditions or living conditions, and compulsion or incentives [6]. In this article, we systematically review the evidence on one specific set of policy interventions: financial incentives for return of service. These interventions work as follows. A health worker in training or a fully trained health worker enters into a contract to work for a number of years in an

[1] In this article, unless otherwise specified, we use the term underserved area to encompass underserved communities, regions, and populations within countries, as well as countries where by some standards even the best-served geographic regions are underserved. The precise definition of an underserved area differs across the financial incentive programs evaluated in the studies reviewed in this article. The different definitions are reported in Table 1.

underserved area in exchange for a financial pay-off. Financial incentives can increase the numbers of health workers in underserved areas by a number of mechanisms. First, they can redirect the flow of those health workers who would have been educated without any financial incentive from well-served to underserved areas, for instance by decreasing the net emigration flow of nurses and physicians from developing to developed countries [7-9] or by increasing the net flow of physicians from urban tertiary care to rural primary care in developed countries [10, 11]. This first mechanism can take hold if there are (future) health workers who normally would not work in an underserved area, but who are willing to do so in return for a financial incentive. Second, financial-incentive programs can add health workers to the pool of workers who would have been educated in the absence of such programs and place them in underserved areas. The second mechanism can take hold if, on the one hand, there are qualified candidates who would not have the means to finance a health care education without a financial incentive and, on the other hand, a country's health care education system can absorb additional students. Third, financial-incentive programs can decrease the outflow of health workers from underserved areas, if they prolong the retention times in underserved areas of those health workers who would have worked in an underserved area even without any financial incentive but who participate in a financial-incentive program. Improved retention in this group of health workers can be a direct result of the contractual obligation to remain for a certain number of years in an underserved area or can be caused by a program's additional efforts to increase retention (e.g., by increasing health workers' satisfaction with their work environment and career progression, or by increasing the satisfaction of health workers' families with their integration into the

community) [12]. Fourth, the programs can decrease the outflow of participating and non-participating health workers from underserved areas by increasing the number of health workers in those areas through any of the three mechanisms described above. Such positive feedback may occur because increasing the number of health workers can diminish reasons for non-retention in rural and remote areas, such as high workload [13-15], lack of contact with colleagues [14], lack of support from medical specialists [16], or social isolation [15].

We have recently shown that a specific type of financial-incentive program, scholarships in return for a commitment to deliver antiretroviral treatment in Sub-Saharan Africa, is highly cost-beneficial under a wide range of assumptions [17]. In the following, we will first systematically review studies on financial incentives for return of service. Then, we will critically summarize the findings from existing studies and draw implications for policy and future research. One previous study has systematically reviewed the evidence on financial-incentive programs for return of service. Sempowski (2004) reviewed 10 studies of financial-incentive programs published between January 1966 and July 2002 [18]. The author concluded that "ROS [return-of-service] programs to rural and underserviced areas have achieved their primary goal of short-term recruitment but have had less success with long-term retention" [18]. Prima facie, an update of this systematic review is useful because more than six years have passed since the end of the period of publication of articles considered therein. In addition to the update of evidence, our review differs from the previous one in two aspects. First, the previous review was restricted to studies of physicians, while we consider studies of all types of health

workers. Second, the previous review focused on program results (i.e., descriptions of outcomes among program participants without comparison to outcomes in non-participants) [18], while our review includes program results, program effects (i.e., analysis of program effectiveness at the individual-level through comparison of outcomes among participants and non-participants), and program impacts (i.e., analysis of program effectiveness at the population level, such as changes in physicians density or population mortality) (Table 1).

Methods

Data sources and search strategies

We carried out a systematic literature search in four electronic databases: PubMed [19] in order to cover articles on financial-incentive programs published in the medical literature; the Excerpta Medica database (EMBASE) [20] in order to cover articles in medical journals that are not included in PubMed, in particular European journals [21]; the Cumulative Index to Nursing and Allied Health Literature (CINAHL) [22] in order to cover articles published in the literature on nursing and allied health professions; and National Health Services Economic Evaluation Database (NHS EED) [23] in order to cover health economics studies. We used the Cochrane Library to search in NHS EED [23]. Because MEDLINE records were included in the m search, we excluded MEDLINE records in both the EMBASE and the CINAHL search. No search option to exclude MEDLINE records was available in NHS EED. In order to detect any early financial-incentive program, we searched the literature from the earliest date at which records were available in each of the four databases given our search strategies (see

below). We searched all four databases on 31 January 2009 and included all relevant articles available in the databases up to the search date. In addition, we searched the reference lists of all publications included in the final review as well as of all articles that were excluded from the review because they were review articles, editorials, or commentaries. Finally, we asked colleagues with a research interest in human resources for health to identify articles on financial incentives for return of service.

To identify articles for review, we combined three search themes using the Boolean operator "and": health workers or students, underserved areas, and financial incentives. We combined several search terms with the Boolean operator "or" in order to operationalize the search themes. We drew the search terms from the controlled vocabularies used for subject indexing in PubMed (i.e., Medical Subject Headings (MeSH) [24]), EMBASE (i.e., EMTREE [25]), and CINAHL (i.e., CINAHL Subject Headings [26]). We used all search terms from the controlled vocabularies in their "exploded" versions. That is, in addition to the selected terms, all narrower terms that are categorized below it in the vocabulary hierarchies were included in the searches. While MeSH are available in NHS EED when searched through the Cochrane Library, we entered the search terms in all searchable, subject-specific fields (title, keyword, and abstract), because such a search strategy has been found to be superior to MeSH-based strategies in NHS EED [27]. The Appendix shows the four search algorithms.

Selection criteria

Articles were considered for inclusion in the systematic review if they reported data from a quantitative study of results, effects, or impacts of at least one financial-incentive

program for return of service. We considered articles published in any language. We excluded studies that evaluate programs that attempt to increase the number of health workers in underserved areas primarily through non-financial means [28-32]. For instance, studies evaluating the Physician Shortage Area Program (PSAP) of Jefferson Medical College were excluded because the program strives to increase the number of rural family physicians primarily through selective admission of candidates to medical school and through intensive exposure of the program participants to rural family practice, while offering only "a small amount of additional financial aid […] almost entirely in the form of repayable loans", which "represents only a small portion of each student's entire tuition and expenses" (Rabinowitz et al. 2005). Reviews, commentaries, editorials, news and policy briefs were excluded. Studies of financial incentives for return of service within the military (e.g., [33]) were excluded because experiences with return-of-service programs in the military are likely to be very different from civilian experiences, as the military can exert more control over its members than most civilian institutions over citizens. Studies of financial incentives for research positions (e.g., [34]) were excluded because health workers who conduct medical research are commonly motivated by very different factors than health workers in patient care [35], and this article's objective is to examine the evidence on financial incentives for return of patient care in underserved areas. We further excluded studies of financial incentives to enroll in a specific residency program [36] unless they were explicitly linked to work in underserved areas, and studies investigating the attractiveness of hypothetical financial-incentive programs [37]. After exclusion of 131 duplicate records, our searches identified a total of 10,495 articles, 10,302 of which were excluded based on their titles or

abstracts. We conducted full-text reviews of the remaining 193 articles and of 25 additional articles identified in reference lists or by colleagues. Forty-two articles were included in the final review. We did not apply any language restrictions in our search. However, all reviewed titles and abstracts were available in English (some as translations of original-language versions) and all articles included in the final review were published in English.

< Figure 1 >

Statistical analysis

We used DerSimonian and Laird meta-analysis [38] to compute both fixed- and random-effects estimates of the pooled recruitment proportion (and its 95% confidence interval (CI)). We defined the recruitment proportion as the proportion of program participants who had ever been eligible to fulfill their service obligation who had either fulfilled it or were fulfilling it at the time of the study. Participants were eligible for service if they had completed the required minimum medical training and were not ineligible, e.g., because of disease or because they had temporarily deferred the service. For the meta-analysis, both the recruitment proportion of a program and the total number of eligible program enrollees is required. The meta-analysis assumes that the measure to be pooled across studies is normally distributed. We used the arcsine-transformation to normalize the distribution of the recruitment proportions [39]. After meta-analysis of the transformed variable, we retransformed the pooled mean and its 95% CI back to proportions. Heterogeneity of the recruitment proportion across studies was diagnosed with the Q test

[40]. When significant heterogeneity was present, we selected the random-effects estimates.

Results

Table 1 describes the outcomes that were investigated by the 42 studies included in the review and the number of studies investigating each outcome (in parentheses). Twenty-four studies investigated 1 outcome; nine studies investigated 2 outcomes; seven studies investigated 3 outcomes; and one study investigated 4 outcomes. Two published articles report outcomes from the same study [41, 42].

< Table 1 >

Table 2 shows descriptions of each of the programs that were evaluated in at least one of the included studies. When information on some program characteristics was not available in the reviewed study itself, we extracted the information from other sources (shown in the column "Other sources" in Table 2). All monetary values in the column "Financial incentives and conditions" in Table 2 are shown both as they are provided in the reviewed study and – for ease of comparison – in year-2000 United States dollars (USD). We used the purchasing power parity index from the World Bank Development Indicators [43] in order to translate the values of a non-US currency into US dollars and the consumer price index from the US Department of Labor Bureau of Labor Statistics [44] to adjust for differences in the real value of one USD over time.

The programs evaluated in the studies included in this review started between 1930 and 1998. With the exception of five programs that accepted a range of health professionals (the North Carolina Rural Loan Program, the National Health Service Corps (NHSC), the West Virginia Recruitment and Retention Community Project, the West Virginia State Loan Repayment Program in the US, and the Friends of Mosvold Program in South Africa), the financial incentives of the evaluated programs were targeted only at future or current physicians (Table 2).

With the exception of three programs that cover, respectively, "tuition, entrance and equipment fees and living expenses" [45], university tuition, fees and "other reasonable educational expenses, such as books, supplies, and equipment" [46], and "funds for university tuition, books, residence fees and food" [47], precise monetary values of the financial incentives of the different programs were given in the reviewed studies. The financial incentives per year of service ranged from year-2000 USD 1,358 to 28,470 (Table 2). One study compared the average award amount across five types of programs (scholarship programs, loan programs with service option, loan repayment programs, direct financial-incentive programs, and resident support) and did not find significant differences [48].

< Table 2 >

We identified 42 studies that met all our inclusion and exclusion criteria. The previous systematic review of the financial-incentive programs for return of service by Sempowski [18] identified only 10 articles, three of which were not included in our review. Two

articles were not included because they evaluated a program that "tried to increase the number of health workers in underserved areas primarily through non-financial means" [49, 50] (Figure 1); one study was not included because it did not report "data from a quantitative study of results, effects, or impacts of financial incentives for return of service" [51] (see "Selection criteria" above). Of the 32 articles covered in our study but not included in the previous review, 17 were not included in the previous review because they were published after the end of its review period (i.e., after 2002) [11, 48, 52-65]; the remaining 10 studies were not included because of differences in inclusion and exclusion criteria. In particular, our review considers programmatic outcomes and health worker types that were not covered in the previous review (see "Introduction" above).

Of the 42 reviewed studies, 33 investigated financial-incentive programs in the US, 23 of which evaluated the NHSC; 8 evaluated programs in specific US states or communities; 1 evaluated both the NHSC and state-based programs; and 1 evaluated the national Commonwealth Fund Medical Undergraduate Scholarship Program. Five studies investigated the Jichi Medical University (JMU) program in Japan, two assessed the Ontario Under-serviced Area Program (UAP) in Canada, and one study each evaluated the New South Wales Department of Health Rural Resident Medical Officer Program (Cadetship Program) in New Zealand and the Friends of Mosvold Scholarship Scheme (FOMSS) in South Africa.[2] Table 3 describes the study outcomes, study designs, sample criteria, sample sizes, data sources, outcome measures, effect sizes, conclusions, and methodological limitations of all studies included in the review. Sample sizes across the

[2] One study evaluated jointly the NHSC and US state programs (see Table 2). It is included in the count of both studies evaluating the NHSC and studies evaluating US state programs.

thirty-seven studies in which individuals were the unit of observation ranged from 24 to 493,142 (Table 3). Seventeen studies had sample sizes greater than 1,000, and four had sample sizes greater than 50,000.

< Table 3 >

Types of financial-incentive programs for return of service

In our review, we identified five different types of financial-incentive programs for return of service, viz.: service-requiring scholarships (or "conditional scholarships") (e.g., [57, 66]), educational loans with service requirements (e.g., [67]), service-option educational loans (e.g., [68]), loan repayment programs (e.g., [48]), and direct financial incentives (e.g., [69]) (see Table 2). These program types differ according to the following criteria: time of commitment and time of money receipt, spending restrictions, and type of commitment. First, in the case of service-requiring scholarships, educational loans with service requirements, and service-option loans, people commit to participation in a program before or early in the course of their health care education and receive money during the education. In the case of loan repayment programs and direct financial incentives, people commit to participation after completion of their health care education. Direct financial incentives are commonly paid at the beginning of service in an underserved area while loan repayments are commonly made after each period of service in an underserved area (e.g., every three or six months). Second, while direct financial incentives can be used for any purpose, the money from any of the other four programs must be spent on health care education either during the education (in the case of service-requiring scholarships, educational loans with service requirements, and service-option

educational loans) or after the education to repay educational debt (in the case of loan repayment programs). Finally, people who participate in service-requiring scholarships, loan repayment, or direct financial-incentive programs commit to work in an underserved area, while those receiving educational loans with service requirements commit to service and financial repayment. Individuals who receive service-option educational loans commit to either service or financial repayment. While all service-option educational loans offer a choice between service and repayment of the financial incentive, some of the programs belonging to the other four types offer a buy-out option. The difference between service-option loans and service-requiring scholarships with a buy-out option is that the managers of the former will normally consider repayment and service equally desirable outcomes, whereas the managers of the latter will prefer service over buy-out. Given equal financial incentives a buy-out is thus commonly more expensive than the financial repayment of a service-option educational loan [70]. Note that many loan repayment programs do not require a buy-out option because the programs pay participants after each period they have served in an underserved area.

Program result: recruitment

The recruitment proportion varied between 33% and 100% across programs (Table 3). Fourteen studies reported, for 25 individual financial-incentive programs, both the recruitment proportion and the total number of participants who had ever been eligible to serve their obligation (or values from which these two variables could be calculated) [45,

56-58, 66, 68, 71-73].[3] The random-effects pooled recruitment proportion across these 25 programs was 71% (95% CI 60-80%, heterogeneity $p < 0.001$).

Program participants who were available for practice but did not fulfill their commitment to work in an underserved area either defaulted on their obligation or bought out of it. Of the 25 programs included in the meta-analysis, only four did not offer a buy-out option [57, 66, 67, 72]. Some programs allowed participants to repay half [74] or all [71, 75] of the principal without interest in lieu of service repayment. Other programs set the buy-out price at the principal plus interest (the "prevailing rate of interest", or a fixed rate of interest varying between 2% and 10% [68]), while yet other programs charged a buy-out price of the principal plus a penalty ("principal plus penalty up to 100%", or "triple the loan amount plus interest" [56]). The random-effects pooled recruitment proportion across those programs that did not offer a buy-out option (84%, 95% CI 73-92%, heterogeneity $p < 0.001$) was not significantly higher (overall test of heterogeneity between subgroups, $p = 0.652$) than the pooled recruitment proportion across those programs that did allow buy-out (67%, 95% CI 55-79%, heterogeneity $p < 0.001$).

Program result: retention

The proportion of program participants who remained in underserved areas after completing their obligation ranged from 12% to 90% across the eighteen articles that reported retention results [41, 42, 45, 56, 57, 61-63, 67, 68, 71, 74-80]. The reported proportions, however, could not be meaningfully compared to each other, because the

[3] Three studies reported recruitment proportions in the same program, using highly overlapping samples of participants [45, 59, 62]. Of the three studies we only included the one with the largest sample size in the meta-analysis [45].

definition of retention, the length of time during which participants were included in the sample (enrolment period), and the length of time between the end of the enrolment period and the time when retention results are observed (lag time) varied widely across studies. The studies measured retention in any underserved area [45, 57, 61, 63, 75, 77-80], in any underserved area in a specific state [68, 74], in any area in a specific state or prefecture [45, 56, 61, 62], in the underserved area of original program placement [41, 42, 56, 67, 71, 77, 78], or in a practice entered during a specific period of time [76]. Three articles reported the retention *intentions* of program participants who were fulfilling their obligations at the time rather than actual retention [41, 42, 79]. All of the other 15 articles described outcomes of retrospective cohort studies. One of the fifteen studies did not report an enrolment period or lag time [68]. Enrolment periods in the remaining 14 studies were four [76, 77], five [71], nine [78], ten [57], eleven [58], fourteen [75], eighteen [63, 67, 80], twenty [62], twenty-three [74], twenty-four [45], twenty-five [56], and twenty-six [61] years. There was no lag between enrolment and observation in five studies [45, 56, 67, 71, 74]; lag times in the other studies were 1 [58, 63, 76, 80], 6 [57], 8 [78], 11 [77], and 29[75] years; two studies assessed retention results after three different lag times (3, 7 and 9 years [61] and 9, 13, and 15 years [62])

Program effects: retention and care

In all 16 studies of program effects, program participation was defined as having received a financial incentive and having served the obligation; i.e., people who received a financial incentive but could not be recruited to serve in an underserved area were excluded from the cohorts of program participants. Table 4 shows four categories of effect studies by outcome and sample. Three categories of studies investigated retention

(in the same area, in the same underserved area, or in any underserved area), and one category investigated provision of care in any underserved area.

< Table 4 >

Five of the seven studies that compared retention in the *same* (underserved) areas between program participants and non-participants found that participants were significantly less likely to remain in the same (underserved) area [12, 48, 53, 81, 82], while one of the studies did not report a significance level but found a substantially higher retention in non-NHSC physicians than in NHSC physicians [83], and another did not find a significant difference [58]. In contrast, 10 of the 12 studies that compared differences in retention or provision of care in *any* underserved area between participants and non-participants found that participants were more likely to continue to practice in any underserved area [53, 84] or to provide care to underserved populations [11, 52, 59, 60, 65, 84-87]. These differences were shown to be statistically significant in eight of the ten studies [11, 52, 53, 65, 84-87]. Two studies did not provide the results of significance tests [59, 60]. Two of the twelve studies reported a converse finding: program participants were significantly less likely than non-participants to remain in any underserved area [60, 81],

The studies of program effects reported either hazard ratios [48, 81], odds ratios [12, 52, 65, 85, 87], relative risks (or two proportions) [11, 58-60, 82, 84], or beta-coefficients [53, 86] to compare retention or care provision among program participants and non-

participants. Except for the two studies that reported hazard ratios, which took into account the duration of retention of each individual in the sample [48, 81], and one study that used the proportion of underserved patients as its dependent variable [86], these studies used a binary concept of retention or care provision measured at different time intervals after an initial observation (at least 1 year [58], 1-28 years [65], or 3 years and 1 month and 5 years and 1 month [12]) or after graduation from medical school (0-16 [59], 0-26 [60], 7-9 [53], 7 and 11 [84], 9-10 [85, 87], 10-11 [86], 10-20 [82] or up to 29 [52] years, or an unknown time interval [11]).

Program results and effects: participant satisfaction and family satisfaction

Seven studies investigated the satisfaction of participants with aspects of their enrolment in financial-incentive programs [12, 41, 58, 67, 76, 77], viz. satisfaction with the overall experience in the program [48, 58, 67, 77], satisfaction with work [12, 41, 48, 58, 76] or personal life [12, 41, 76] in the underserved areas, or satisfaction with aspects of program administration [58, 67]. Three studies examined the satisfaction of members of participants' families with their lives in the undeserved area [41, 48, 76]. Four of the seven studies investigated satisfaction outcomes in the NHSC [12, 41, 76, 77]; the three other studies examined satisfaction outcomes in US state programs [48, 58, 67].

While the studies on participant and family satisfaction were too few to draw any strong generalized inferences, a contrast emerged between the NHSC and the US state programs. Three studies measured overall satisfaction with financial-incentive programs in US states by asking participants whether they would enroll again in the same program

[48, 58, 67]. They found a high (counterfactual) willingness to enroll again: 71% of interviewed participants in the North Carolina Rural Loan Program answered "yes" to the re-enrolment question [67]; 73% of interviewed participants in four programs in West Virginia answered either "definitely yes" or "probably yes" to the re-enrolment question [58]; and 90% of interviewed participants in US state programs indicated that they would "definitely" or "likely" enroll again [48]. In contrast, a study analyzing 183 unstructured written accounts of time in the NHSC found that only 20% of participants rated their experience as "positive", while 80% rated it either "negative", "mixed or ambivalent", or "neutral" [77]. A similar contrast emerged in the comparison of NHSC and US state-based programs across different aspects of participant work and personal-life satisfaction (see Table 3). For instance, in a study of state-based programs, Pathman and colleagues found that more than 80% of program participants were "satisfied with practice", more than 90% found their "work rewarding", and more than 70% felt "a sense of belonging to the community," while a comparison group of non-obligated physicians scored significantly lower on all three dimensions of satisfaction [12]. Conversely, in a study of the NHSC, Pathman and colleagues found that participants rated their satisfaction level between "dissatisfied" and "neutral" for 7 of 15 "work issues" and "personal-life" issues, while participants' satisfaction level exceeded "satisfied" for only one issue ("[c]aring for needy patients"), while non-obligated physicians rated their satisfaction significantly higher for 9 of 15 issues for which a comparison was made and significantly lower for only one issue [48].

Program impacts: health system and health

Six articles examined whether financial-incentive programs have led to changes in the number or density (i.e., number per population) of certain types of health workers [55, 64, 69, 71, 74, 88]. One of the five studies described the medical student density in Arizona over time and concluded that a scholarship aiming to increase student density was not effective [74]. Two studies compared changes over time – in physician numbers (from 1966 to 1972 [71]) and in physician densities (from 1956 to 1986 [69]) – in northern Ontario to changes in the same measures in Ontario as a whole, in order to investigate the impact of a financial-incentive program on the supply of physicians in underserved areas in northern Ontario. The first study concluded that an observed increase in the absolute number of physicians in northern Ontario was likely caused by the program (because the speed of increase rose substantially after introduction of the program in northern Ontario, while there was no change in the speed of increase in Ontario overall) [71]. The second study concluded that an increase in physician density in northern Ontario was not due to the program but due to the overall increase of physicians in the province (because a measure of inequality between physician density in northern Ontario and Ontario as a whole did not improve) [69]. It is possible that an initial effect of the program in the first three years after its introduction (from 1969 to 1972) – as reported in the first study [71] – ceased to exist in the longer run (until 1986) – as reported in the second study [69]. A fourth study used data from the American Medical Association Masterfile to model the practice location choices of US physicians in sequential multinomial logit regression. The parameter estimates of NHSC participation from the regression equation were then used to predict the supply of physicians in underserved areas, assuming the NHSC had not existed. Through

comparison of this counterfactual to the status quo, the study concluded that elimination of the NHSC would lead to a 10-11% decrease in the supply of physicians in underserved areas [64].

Two further studies of health system impacts of financial-incentive programs used communities as units of observation. One of the studies investigated whether underserved areas that succeed in attracting obligated physicians were different from communities that failed to do so. It found that communities that were economically worse-off and had worse population health were less likely to receive an obligated physician than communities that were economically better-off and had better population health [88]. The second study investigated whether the presence of an obligated physician in a community changed the supply of non-obligated physicians in that community and found that, when controlling for a range of demographic, economic, and health systems factors, counties staffed by NHSC clinicians experienced a larger increase in non-NHSC primary care physicians per population than counties without NHSC clinicians [55]. Only one study analyzed the effect of a financial-incentive program on a health outcome [54]. The study compared age-adjusted all-cause mortality rates in two periods, 15 years apart, in underserved communities with different levels of staffing by obligated physicians. It found no clear relationship between the level of staffing and changes in mortality.

Causal inferences

Causal inferences from studies reporting program results were necessarily weak, because the studies merely described outcomes in individuals who were enrolled in financial-

incentive programs and did not allow comparison to individuals who did not receive financial incentives. Analyses of program effects, on the other hand, were based on comparisons of cohorts of program participants and non-participants. Causal inferences from comparisons of outcomes in the two cohorts, however, can be invalid if there are no controls for differences between participants and non-participants.

Of the 16 studies of program effects, 10 controlled for additional variables in the comparison of retention and provision of care between people who did and did not participate in a financial-incentive program [12, 52, 53, 65, 81, 84-87, 89]. Seven of these studies controlled for sex of the health worker [52, 53, 65, 85-87, 89], five controlled for ethnicity [52, 53, 85-87], three for medical specialty [52, 81, 89], three for age [53, 87, 89], two for growing up in an underserved area [86, 87], one for marital status [89], one for the type of medical school a participant had attended (private vs. public, receiving vs. not receiving Title VII-funding [65][4]), and one for debt, medical school experience in an underserved area, and residency experience in an underserved area [87]. One study assessed and then controlled for measures of community-physician match and physician and family satisfaction with working and living in the placement community [12]. Another study did not show the particular control variables used, but reported that its effect measures remained significant "while controlling for selected characteristics of physicians" [84].

[4] In the US, "Title VII grants are intended to strengthen the primary care educational infrastructure at medical schools and residency programs and to encourage physicians-in-training to pursue careers working with underserved populations" [65].

While a number of studies controlled for differences in observed characteristics between participants and non-participants, only one study of program effects attempted to control for unobserved heterogeneity in program participation. The study used a bivariate probit selection model to control for the potential bias due to selective participation [53]. In order to identify the program effect, the study used four medical school characteristics, viz. the "historical proportion of graduates specializing in primary care", the "quality of the school", a "tuition index", and a "public school indicator", assuming that these variables affected selection into financial-incentive programs but did not affect provision of care or retention in underserved areas other than through their effect on program participation. One study of program impact (by the same author) used the same medical school characteristics as identifying variables in a joint model of program participation and practice location decisions [64].

Four of the six other studies of program impacts observed changes over time in the availability of a financial-incentive program and an outcome (number or density of health workers [69, 71, 74] or mortality [69]), but did not control for changes over time of any other variable. Thus, in these studies it could not be ruled out that an observed relationship or the apparent lack of a relationship between program participation and outcome was due to a confounding variable. In addition, three of the six studies [69, 71, 88] may have suffered from ecological bias [90] because they observed variables at a level of aggregation that was higher than the level at which inferences were made. For instance, Anderson and Rosenberg (1990) [69] observed changes in physicians density in *counties* in order to evaluate the impact of the Ontario Underserviced Area Program in

attracting physicians to underserved *communities* within those counties. Thus, the observed average change in physician density in any one county could have been caused by an infinite number of combinations of changes of different directions and effect sizes in the different underserviced and sufficiently serviced communities in the county.

Discussion

Of the 42 studies included in the review, 33 evaluated financial-incentive programs located in the US. The remainder examined programs in other developed countries (Japan, Canada, New Zealand), with but one exception that described a program in South Africa. The US financial-incentive programs have placed substantial numbers of health workers in underserved areas. For instance, between 1972 and 2008, the NHSC – the largest financial-incentive program in the US – placed 27,000 primary care clinicians in underserved areas [91]. At the same time, the US programs have met only a small proportion of national unmet health care need. In February 2008, 4,600 NHSC clinicians were serving 5 million people in underserved areas, while the NHSC estimated that 53 million people "still lack access to quality health care in the United States" [91].

While most of the evaluated programs were located in the US, the US market for health care education is unusual in comparison to many other countries in that students pay high tuition for their education. Countries where students of health care do not usually incur large debt (such as many Western and Eastern European countries, Cuba, Malaysia, and Saudi Arabia) may not be as successful as the US in recruiting students and health professionals into programs that provide scholarships or repayment of educational loans

in return for service in underserved areas. In many developing countries, by contrast, education for a health profession can be quite costly because of tuition and school fees as well as costs of housing and living. Some of the experiences from the US may thus be more applicable to health care education markets in developing countries than to other developed countries. On the other hand, (future) health workers in the US have many options for funding their education, while funding opportunities for education may be few in developing countries. Thus, the generalizability of US findings to other countries where students have substantial financing need for health care education may be limited because the selection into financial-incentive programs for underserved service may depend on the availability of funding alternatives. Numerous other differences, such as in the capacity to enforce and monitor obligated service (compare [92]), may limit the generalizability of the studies included in this review to other settings. One study from South Africa suggests that scholarship programs for health care education can be a successful instrument to recruit health workers for practice in rural Africa [66]. Future studies should evaluate outcomes of financial-incentive programs from other developing countries where such programs have been offered in the past or are currently offered, such as Swaziland [93], Ghana [94], and Mexico [95].

Notwithstanding the above caveats about generalizability, it is useful to summarize some of the key findings from our review. First, most of the financial-incentive programs experienced substantial losses to recruitment before the start of the service obligation. Across the 25 programs included in the meta-analysis in our review, on average about 3 in 10 participants did not fulfill their commitment to work in an underserved area.

However, there was wide variation in loss to recruitment. As reported previously by Pathman and colleagues [48] and Jackson and colleagues [58], state programs in the US that committed students to service (service-requiring scholarships and educational loans with service requirements) had significantly lower recruitment proportions than state programs that committed health workers after their training (direct financial incentives and loan repayment programs). This finding is not surprising, because preferences change over time. For instance, students who found careers in primary care appealing at entry into medical school may develop a strong interest in highly specialized health care during their training, which depends on technology that is usually not available in underserved areas.

Furthermore, we find that the recruitment proportion did not differ significantly between programs that offered a buy-out option and those that did not. While this result suggests that participants who have decided not to serve their obligation will do so independent of the conditions of the program they are enrolled in, it is important to note that the proportion of participants who would have taken up work in underserved areas had they not enrolled in a specific financial-incentive program is unknown. Thus, it is impossible to infer the relative recruitment effectiveness of different types of programs from such comparisons.

Second, participants in financial-incentive programs were significantly more likely to leave their first site of practice after completion of their obligation than non-obligated health workers in comparable sites of first practice after similar lengths of service. There

may be several reasons for this finding. For one, those health workers who find practice in any underserved area less attractive than practice in sites that are not underserved, but who nevertheless decide to complete their obligation, are likely to leave the underserved area once they have completed their obligated service. On the other hand, even among those health workers who find practice in an underserved area to be the most attractive career path in general, the obligated health workers may be more likely to leave the site of initial practice than their non-obligated colleagues in underserved areas. Obligated health workers have less choice over the particular underserved area in which they first practice than their non-obligated peers and are thus less likely to be satisfied with their work and life in the underserved area of first practice than their non-obligated peers. For instance, one study of the NHSC concludes that NHSC enrollees "placed in rural sites in the late 1980s experienced a site-matching process that they felt offered few acceptable sites" and "offered little opportunity to locate the best-suited site among those offered" [12]. Financial-incentive programs aiming to achieve high retention of obligated health workers in the site of first practice should attempt to accommodate health workers' wishes to practice in a particular underserved area to the greatest extent possible.

Third, while participants in financial-incentive programs for return of service in underserved areas were less likely to remain in their site of first practice than non-participants, the reviewed studies suggest that participants were more likely to practice in some underserved area or to work with an underserved population than their peers who did not participate in a financial-incentive program. This summary finding from our systematic review is in contrast to the conclusion of the one previous review of financial

incentives for return of service, which concluded that incentive programs "have achieved their primary goal of short-term recruitment but have had less success with long-term retention" [18].

Many of the analyses of retention in studies in this review compared the behavior of participants in financial-incentive programs to that of non-participants, controlling for a few observed characteristics of health workers, such as sex, age, ethnicity, or marital status. However, since participants self-selected into programs, it is difficult to identify whether any difference in behavior between participants and non-participants was due to unobserved characteristics distinguishing participants from non-participants or due to program effects. It is possible that those health workers with the strongest preferences to serve underserved populations chose to participate in financial-incentive programs and that these unobserved preferences fully explain the different work and retention patterns in participants and non-participants, i.e., participants would have worked for exactly the same (or longer) lengths of time in underserved areas without the program incentives they received.

An ideal strategy to identify causal effects of financial-incentive programs is randomized controlled trials. However, since program participation is an individual choice, it will be impossible to randomize individuals into program participation and control arms. While it would theoretically be possible to randomize cohorts of medical students (e.g., by year of graduation or by medical school) to financial-incentive offers of different sizes, such a randomization strategy may not be politically or administratively feasible. An alternative

strategy to identify causal effects involves the use of statistical models that control for selection into financial-incentive programs on unobserved individual characteristics. Two studies in this review (one of program effect [53] and one of program impact, which starts with program effect estimation [64]) implemented selection models of program participation. The two studies used medical school characteristics to identify program effect. However, the type of medical school students attend is likely to be related not only to the decision to enroll in financial-incentive programs, but also – independent of program participation – to the decision to work in underserved areas. For instance, students with strong preferences to work in underserved areas may be more likely than their peers with weaker preferences for such care to select medical schools with a high "historical proportion" of graduates pursuing careers in primary care, because such schools are likely to focus on medical education relevant for underserved areas. This selection may determine work location decisions, independent of any effect the medical school characteristic may have on participation in financial-incentive programs. Thus the characteristic may not be a valid variable to identify program effects. Despite the difficulty in finding variables to identify program effects in selection models, future studies using already-existing data should emphasize control of biases due to selection on unobserved variables in the analyses. Policy makers who are planning new programs should consider adopting experimental designs, such as cluster randomizing financial-incentive programs to classes of medical students, in order to strengthen the evidence on program effectiveness.

Fourth, financial-incentive programs varied substantially in the level of participant satisfaction. Participants in some programs were more satisfied than non-participants with their work and personal life in underserved areas, while the converse was true for other programs. Health workers' satisfaction with work and personal life in underserved areas is important for several reasons. For one, health worker satisfaction influences retention, as has been shown in several studies [96-98], including in studies of financial-incentive programs for return of service [12, 41, 63]. Moreover, health worker satisfaction is associated with patient satisfaction [99] and quality of care [100, 101]. Health workers are also likely to share their experiences with colleagues and may thus influence the supply of health workers to underserved areas as well as participation in financial-incentive programs. The reviewed studies offer some insight into the mechanism through which individual programs affect participant satisfaction. This evidence, based on case reports and participants' accounts, suggests that programs that achieved high participant satisfaction successfully interacted with participants during different stages of program enrolment, viz. participant selection, the matching of underserved areas to the preferences of individual participants, preparation of the participants and their family before the start of the obligated service, as well as career guidance, mentoring, monitoring of problems, and ongoing support during the service [12, 48, 58, 66, 70, 77]. Detailed case studies of relatively successful and unsuccessful programs could further improve our understanding of management skills, organizational processes, and program features that increase participant satisfaction and retention in underserved areas.

Fifth, there is no clear evidence that financial-incentive programs had any impact on the supply of health workers to underserved areas. The results of three studies suggest that certain programs led to an increase in health worker numbers or densities, while two other studies did not find such program impacts. This discrepancy could be due to actual differences in impact between programs or over time; or they could be caused by methodological limitations of the studies. Program impact on health worker numbers and densities is not only a function of the scale of financial-incentive programs as well as recruitment and retention of individual obligated health workers, but also of the effect of obligated health workers on the supply of non-obligated health workers in underserved communities. It is plausible that obligated health workers will deter non-obligated workers from practice in underserved communities because the former will compete with the latter for patients and practice personnel. Conversely, it also seems plausible that the inflow of obligated health workers into underserved communities attracts non-obligated workers to the same communities because the former decrease the overall work load per health worker and increase opportunities for referral and exchange among colleagues. A study by Pathman and colleagues is thus significant insofar as it suggests "that the NHSC contributed positively to the non-NHSC primary care physician workforce in the rural underserved counties where its clinicians worked during the 1980s and 1990s" [55].

In the above discussion of summary findings from our review, we caution that the existing evidence regarding program results, effects, and impacts does not allow (strong) causal inferences. It is further important to keep in mind that the summaries are across 5 countries, 5 types of programs, programs of different geographic reach ranging from community to country, 7 types of health workers, and study publication dates ranging

from 1963 to 2008. Program recruitment, retention, and satisfaction outcomes differed widely, even within some of the strata defined by program location, type, geographical reach, health worker type, and time period. Health planners can use our review to gain an overview of the existing evidence. In designing future programs, however, they need to carefully consider the specific health worker group they want to target with a program and the underserved areas to be covered.

Conclusion

Financial-incentive programs for return of service are one of the few health policy interventions to improve the distribution of human resources for health on which substantial evidence exists. However, the majority of studies to date are from the US and only one study reports findings from a developing country. The existing studies show that financial-incentive programs placed substantial numbers of health workers in underserved areas and that program participants were more likely than non-participants to work in underserved areas in the long run, even though they were less likely to remain at their site of original placement. As all existing studies were observational and participants self-selected into programs, the existing evidence does not allow the inference that financial-incentive programs can cause increases in health worker supply to underserved areas. In order to improve the scope of evidence on financial-incentive programs for return of service in underserved areas, future studies should evaluate programs from a more diverse set of countries, in particular in the developing world. In these studies, researchers should attempt to control selection biases as rigorously as

possible, using selection models in observational studies and randomized controlled trials where funders and policy makers are willing to support such experiments.

Competing interests

The authors declare no competing interests.

Authors' contributions

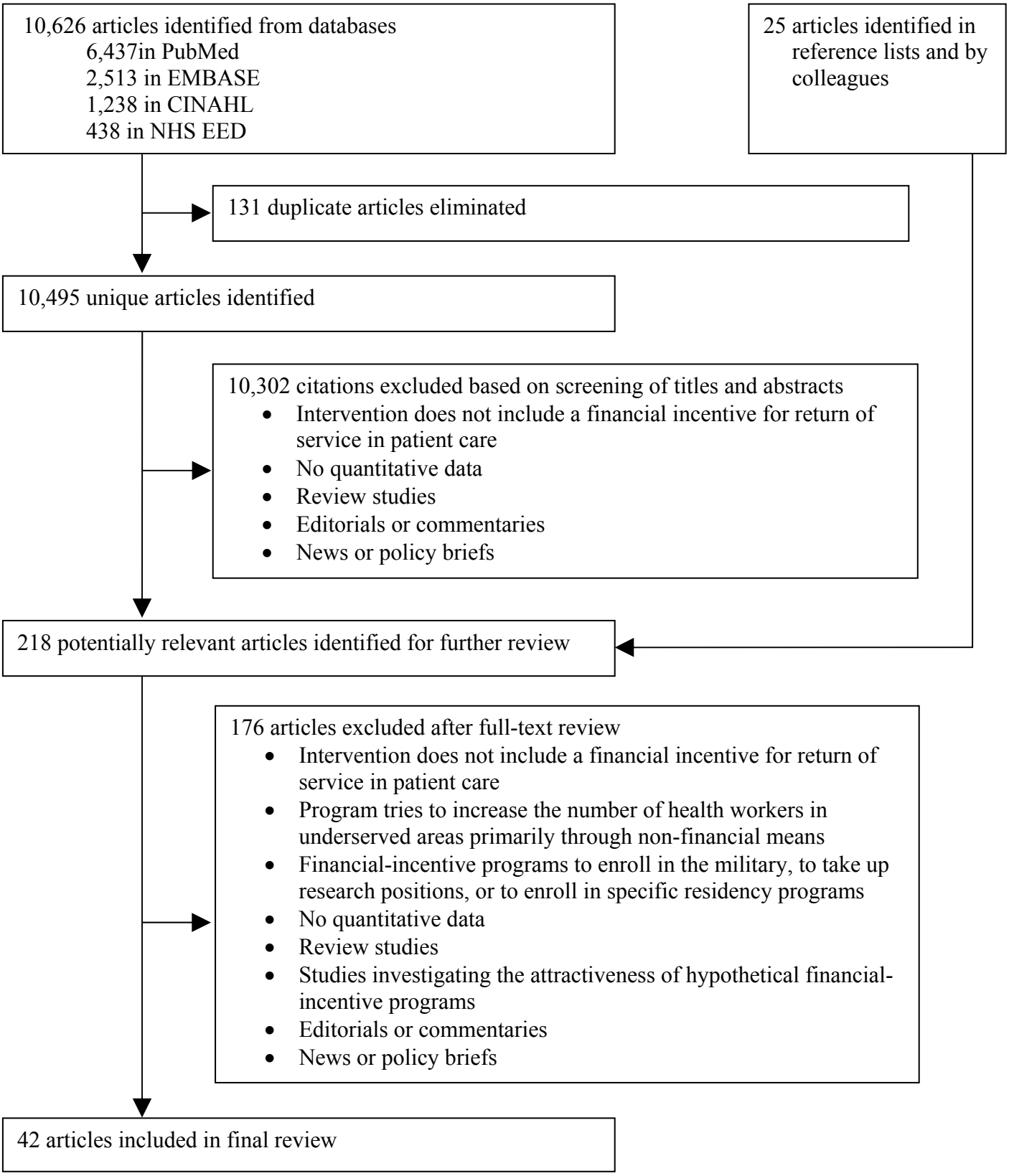
Till Bärnighausen and David Bloom jointly formulated the study design, obtained and analyzed the data, interpreted the findings, and wrote the article.

Acknowledgements

We thank Larry Rosenberg for his valuable comments and Abigail Friedman, Om Lala, Zacharias Rosner, and Natsayi Chimbindi for research support.

Figures

Figure 1 - Flowchart of the systematic review



Tables

Table 1 - Study outcomes

Program results (Program outcomes among participants)	**Program effects** (Program effectiveness at the individual level)	**Program impacts** (Program effectiveness at the population level)
• *Recruitment* What proportion of program participants take up practice in an underserved area? (13) • *Retention* What proportion of program participants continue to practice in an underserved area at some period of time after completing their obligation? (18) • *Participant satisfaction* What proportion of program participants are satisfied with - work in the underserved area - life in the underserved area - other aspects of the financial-incentive program? (7)	• *Provision of care* Does program participation influence the likelihood of individual health workers to provide care in an underserved area? (10) • *Retention* Does program participation influence the likelihood of individual health workers to continue to provide care in an underserved area after a certain period of time? (7) • *Participant satisfaction* Does program participation influence a health worker's satisfaction with - work in the underserved area - life in the underserved areas? (2)	• *Health system* Does the program lead to significant improvements in health system structures (such as physician density)? (6) • *Health* Does the program lead to significant improvements in health outcomes (such as mortality)? (1)

Program results (Program outcomes among participants)	**Program effects** (Program effectiveness at the individual level)	**Program impacts** (Program effectiveness at the population level)
• *Family satisfaction* What proportion of relatives of program participants are satisfied with - work in the underserved area - life in the underserved area - other aspects of the financial-incentive program? (3)		

The term underserved area in the table encompasses a specific underserved area, any underserved area, and underserved populations. The number of studies investigating a topic is shown in parentheses. The numbers in parentheses add up to 75 rather than 42 (i.e., the number of studies included in this review) because seven studies investigate more than one of the included outcomes (five studies investigate two topics and two studies investigate three topics).

Table 2 - Evaluated financial-incentive programs

Program name	Location	Period	Objective	Target group	Definition of underserved area	Financial incentives and conditions	Evaluation studies	Other references
Common-wealth Fund Medical Under-graduate Scholarship Program	Massachusetts, Mississippi, Tennessee, US	1930-1944	"[T]o alleviate medical shortages in rural areas"	Undergraduate medical students attending medical school at Tufts, Tulane, or Vanderbilt University	Rural communities with a population of 5,000 or less (subsequently raised to 10,000 or less)	*Scholarships for medical students:* Total of USD 1,300 per year over 4 years (between 1930 and 1944; amount equivalent to year-2000 USD 13,405 in 1930 and 12,719 in 1944). In return, the students agree to spend not less than 3 years in practice in an underserved area in their state of origin.	Fitz et al. 1977 [75]	N/A
11 US state scholarship and educational loan programs	Arkansas, Georgia, Illinois, Iowa, Kentucky, Minnesota, North Carolina, North Dakota, South Carolina, Virginia, West Virginia, US	Pro-grams started between 1942 and 1968	To increase the number of physicians practicing in underserved areas	Medical students in the respective US state	Different definitions of underserved area (town with population size below a certain threshold, rural community, rural county, rural area, "area of critical need", anywhere in the state)	*Scholarships and loans with service option for medical students:* Between USD 1,000 and USD 2,775 per year for 2-4 years (in 1970; lower amount equivalent to year-2000 USD 4,438, higher amount equivalent to year-2000 USD 10,097).	Mason 1971 [68]	N/A

Program name	Location	Period	Objective	Target group	Definition of underserved area	Financial incentives and conditions	Evaluation studies	Other references
Carolina Rural Loan Program	North Carolina, US	Since 1945	"[T]o help smaller communities to obtain professional services"	Students of medicine, dentistry, pharmacy and nursing	"[A]ny town or village having less than 2,500 population according to the last decennial census, or area outside such towns or villages, or area approved by the Medical Care Commission that is considered to meet the spirit and intent of the student loan program"	*Loans for students:* USD 1,600 per year for unmarried students (in 1963; amount equivalent to year-2000 USD 9,000) and USD 1,900 for married students (in 1963; amount equivalent to year-2000 USD 10,687). For each year the loan is received, the students agree to practice in an underserved area for one year. The loans bear an interest rate of 2%, beginning at the time the loan is advanced. The loans are repaid in monthly installments of 2% of the total amount borrowed, commencing six months after start of practice.	Bradbury 1963 [67]	N/A
Arizona Medical Student Exchange Program	Arizona, US	Since 1953	"[T]o increase the number of graduating physicians who will return to practice in Arizona"	Arizona medical students	Any area in Arizona	*Payments to medical schools to reduce students' tuition:* USD 2,000 (in 1953; amount equivalent to year-2000 USD 12,899), raised to USD 6,000 (by 1977; amount equivalent to year-2000 USD 17,050). For each year the scholarship is received, the students agree to practice 2 years (1953-1957) or 1 year (after 1957) in Arizona.	Navin and Nichols 1977 [74]	N/A

Program name	Location	Period	Objective	Target group	Definition of underserved area	Financial incentives and conditions	Evaluation studies	Other references
Ontario Under-serviced Area Program (UAP)	Ontario, Canada	Since 1969	To increase the number of physicians per population in underserved areas in Ontario	Canadian physicians and medical students	Designation of an area as underserved area decided by a committee composed of members of the MoH, based on multiple factors: "[n]umber of doctors in the area" and "their age and health", "type and amount of practice", demographic profile of the population, "[s]ocioeco-nomic status of the area", "[l]ocal demand for medical services", "[a]vailability of adequate housing and office facilities for physicians", and "[h]ealth needs and resources" (Bass and Copeman 1975)	*Scholarships for medical students:* CAD 5,000 per year (in 1987; amount equivalent to year-2000 USD 5,921). For each year the scholarship is received, the students agree to spend one calendar year in general practice in an underserved area after completion of internship. *Direct financial incentives for physicians:* CAD 10,000 per year served in an underserved area for a maximum of four years (between 1980 and 1988; amount equivalent to year-2000 USD 17,591 in 1980 and year-2000 USD 11,279 in 1988).	Bass and Copeman 1975 [71]; Anderson and Rosenberg 1990 [69]	[102]

Program name	Location	Period	Objective	Target group	Definition of underserved area	Financial incentives and conditions	Evaluation studies	Other references
Jichi Medical University (JMU)	Japan nationwide	Since 1972	"[T]o produce rural doctors and distribute them nationwide" [61]	All physicians enrolled in JMU	Rural areas of Japan. The rural areas to which JMU graduates are sent are determined by each of Japan's 47 prefectures, "considering the demand-supply balance of physicians" [61].	*Scholarships for medical students:* Full scholarships cover "tuition, entrance and equipment fees and living expenses for the 6 years of study at JMS" [45]. In return, participants "are committed to working for medical institutions in their home prefecture for 9 years after graduation. … The 9-year obligation usually includes 3 years of post-graduate training and 6 years of rural dispatch (i.e., duty" [60].	Inoue et al. 1997 [45]; Inoue et al. 2007 [59]; Matsumoto et al. 2008a [60]; Matsumoto et al. 2008b [61]; Matsumoto et al. 2008c [62]	N/A

Program name	Location	Period	Objective	Target group	Definition of underserved area	Financial incentives and conditions	Evaluation studies	Other references
National Health Service Corps (NHSC)	US nationwide	Since 1972 (scholar-ships) Since 1987 (loan repay-ments)	To increase the number of physicians and other health professionals in federally designated Health Professional Shortage Areas (HPSA)	Students enrolled in allopathic or osteopathic medical school, family nurse practitioners, nurses, midwives, physician assistants, dentists	HPSA status can be assigned to areas, population groups, and facilities. HPSA status is assigned taking into account the practitioner-to-population ratio, availability and accessibility of clinicians in adjacent areas, indicators of need (such as infant mortality) and capacity (such as poverty levels) [46]	*Scholarships for students:* Full scholarships covering tuition, fees, and "other reasonable educational expenses, such as books, supplies, and equipment" [46]. For each year the scholarship is received, the students agree to serve one year at a location designated as HPSA, with a minimum commitment of 2 years. *Loan repayments for physicians:* Maximum repayment of USD 25,000 per year for a required initial 2-year contract (in 2007; amount equivalent to year-2000 USD 20,336). One year amendments for a maximum of USD 35,000 per year (in 2008; amount equivalent to year-2000 USD 28,470).	Woolf et al. 1981 [88]; Stamps and Kuriger 1983 [79]; Brown et al. 1990 [42]; Stone et al. 1991 [41]; Pathman et al. 1992 [81]; Pathman et al. 1994a [82]; Pathman et al. 1994b [12]; Pathman and Konrad 1996 [76]; Rosenblatt et al. 1996 [77]; Cullen et al. 1997 [78]; Xu et al. 1997a [87]; Xu et al. 1997b [86]; Singer et al. 1998 [83]; Rabinowitz et al. 2000 [85]; Mofidi et al. 2002 [80];	[46, 103]

Program name	Location	Period	Objective	Target group	Definition of underserved area	Financial incentives and conditions	Evaluation studies	Other references
							Brooks et al. 2003 [11]; Porterfield et al. 2003 [63]; Probst et al. 2003 [52]; Holmes 2004 [53]; Holmes 2005 [64]; Pathman et al. 2005 [54]; Pathman et al. 2006 [55]; Rittenhouse et al. 2008 [65]	

Program name	Location	Period	Objective	Target group	Definition of underserved area	Financial incentives and conditions	Evaluation studies	Other references
Scholarship for Indian students in health sciences	Arizona, Utah, Colorado, New Mexico, US	Since 1972	To supply health manpower to the Navajo Indian Reservations and immediately adjacent communities	Indian medical students	Navajo Indian Reservations and immediately adjacent communities	*Scholarships for medical students:* Ranging from USD 650 to 11,000 per year (in 1980; lower amount equivalent to year-2000 USD 1,358 and higher amount equivalent to year-2000 USD 22,988).	Weiss et al. 1980 [72]	N/A
Oklahoma Rural Medical Education Scholarship Loan	Oklahoma, US	Since 1975	"[T]o increase the number of practicing physicians in underserved and rural areas" (Holmes and Miller 1985)	Osteopathic and allopathic medical students	Rural communities in Oklahoma	*Scholarships for medical students:* USD 15,500 per year over 4 years (in 2008; amount equivalent to year-2000 USD 12,202). For each year the scholarship is received, the students agree to practice one year in a rural community in Oklahoma (after residency in a primary care specialty).	Holmes and Miller 1985 [73]; Lapolla et al. 2004 [56]	[104]

Program name	Location	Period	Objective	Target group	Definition of underserved area	Financial incentives and conditions	Evaluation studies	Other references
NHSC Indian Health Service Corps State scholarships State loan repayment programs Practice and hospital-sponsored financial incentives	US nationwide	Programs operating in the 1980s and 1990s	To increase the number of physicians in underserved areas	Medical students, medical residents, and physicians	Different definitions of underserved area	*NHSC:* See above. *Indian Health Service Corps:* Up to USD 20,000 per year (in 2006; amount equivalent to year-2000 USD 17,083). For each year the scholarship is received, the students agree to serve one year in an Indian health program, with a minimum commitment of 2 years (Indian Health Service 2006). *State scholarships:* See above and below. *State loan repayment programs* See above and below. *Practice and hospital-sponsored financial incentives:* Not provided.	Pathman et al. 2000 [84]	[105]

Program name	Location	Period	Objective	Target group	Definition of underserved area	Financial incentives and conditions	Evaluation studies	Other references
New South Wales Department of Health Rural Resident Medical Officer Program (Cadetship Program)	New South Wales (NSW), Australia	Since 1989	"[T]o help overcome a junior doctor workforce shortage in rural hospitals" in New South Wales "[T]o increase recruitment to the rural medical workforce" (Dunabin et al. 2006)	Australian and New Zealand medical students	Rural hospitals in the NSW Rural Hospital Network	*Scholarships for medical students:* AUD 15,000 per year over the two final years of medical school (in 2007; amount equivalent to year-2000 USD 12,458). In return, the students agree to serve 2 of their first 3 postgraduate years in a rural hospital belonging to the NSW Rural Hospital Network.	Dunbabin et al. 2006 [57]	[106]

Program name	Location	Period	Objective	Target group	Definition of underserved area	Financial incentives and conditions	Evaluation studies	Other references
Community Scholarship Program (CSP) Health Sciences Scholarship Program (HSSP) Recruitment and Retention Community Program (RRCP) State Loan Repayment Program (SLRP)	West Virginia, US	CSP: 1991-1997 HSSP: Since 1996	"[T]o attract medical students, residents, and physicians to practice in rural and underserved areas" of West Virginia	CSP: medical students from HPSA HSSP: fourth year medical students RRCP: medical residents, physicians and other qualified health professionals SLRP: physicians and other qualified health professionals	HPSA	*CSP: scholarships for medical students:* Amount determined by HPSA community who co-sponsors the scholarship (with additional funding from federal and state funds). For each year the scholarship is received, the students agree to serve one year in the HPSA where their home is located *HSSP: scholarships for medical students:* USD 10,000 (in 2001; amount equivalent to year-2000 USD 9,725) For the award, the students agree to serve 2 years in an underserved area. *RRCP: direct financial incentives to medical residents, physicians, and other qualified health personnel:* Maximum of USD 20,000 per year for up to 6 years (in 2001; amount equivalent to year-2000 USD 19,450) For each year the award is received, the recipients agree to serve 1 year in an underserved area. *SLRP: direct financial incentives to physicians and other qualified health professionals:* Maximum of USD 40,000 (in 2001; amount equivalent to year-2000 USD 38,901) for a commitment to serve 2 years at a non-profit site in a HPSA. The award can be received twice.	Jackson et al. 2003 [58]	N/A

Program name	Location	Period	Objective	Target group	Definition of underserved area	Financial incentives and conditions	Evaluation studies	Other references
20 US state scholarship programs 12 state loan programs with service option 24 state loan repayment programs 6 state direct financial-incentive programs for medial residents 7 state direct financial-incentive programs for fully trained health professionals	40 US states	All US state pro-grams opera-ting in 1996	"[T]o entice young generalist physicians into rural and medically underserved areas"	Medical students, medical residents, and physicians	Different definitions of underserved area	Across all programs on average USD 14,000 per year of service (in 1996; amount equivalent to year-2000 USD 15,365) (differences between award means of the 5 program types not significant, $p = 0.55$). *Scholarship programs:* For each year the scholarship is received, the students agree to serve 1 year in an underserved area. *Loan programs with service option:* The medical students can either repay the loan at standard interest rates or repay the loan by serving 1 year in an underserved area per year of receipt of loan. *Loan repayment programs:* Medical residents commit to service in an underserved area in exchange for loan repayment (commitment usually near the end of residency training). *Direct financial-incentive programs for medical residents:* Medical residents commit to service in an underserved area in exchange for monetary reward (commitment usually at the beginning of the residency). *Direct financial-incentive programs for fully trained health professionals:* Medical residents commit to service in an underserved area in exchange for a monetary reward (commitment usually near the end of residency training).	Pathman et al. 2004 [48]	N/A

Program name	Location	Period	Objective	Target group	Definition of underserved area	Financial incentives and conditions	Evaluation studies	Other references
Friends of Mosvold Scholarship Scheme (FOMSS)	Umkhan-yakude district, KwaZulu-Natal, South Africa	Since 1998	To "help integrate graduates into the workforce in the district"	Students from Umkhan-yakude district who have been admitted to a tertiary health care education institution, complete at least 2 weeks of work experience at one of the hospitals in the district, and are selected by committee of local residents	District of Umkhanyakude	*Scholarships for students admitted to a tertiary health care education institution:* "Funds for university tuition, books, residence fees and food" [47]. For each year the scholarship is received, the students agree to work one year as health professionals in Umkhanyakude district.	Ross 2007 [66]	[47]

USD = United States dollar, CAD = Canadian dollar, AUD = Australian dollar, MoH = Ministry of Health, N/A = not applicable.

Table 3: Reviewed studies

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
Common-wealth Fund Medical Under-graduate Scholarship Program	Fitz et al. 1977 [75]	*Program results:* Recruitment Retention (in small communities)	Description of program outcomes	All individuals who ever took part in the program (N = 144)	Common-wealth Fund records	*Proportion of participants who had completed their practice obligation by 1973:* Of 144 participants, 11 (8%) did not complete medical school or died. Of 133 participants available for practice, 74 (54%) completed the practice obligation and 5 (4%) repaid the financial incentive, while the remainder defaulted. *Proportion of participants who practiced in small communities in 1973 (43 years after program start and 29 years after program cessation):* Of 99 former recipients still in practice in 1973, 50 (51%) practiced in communities of less than 25,000 population.	Almost half of all participants did not fulfill their obligation to practice in an underserved area. However, it is difficult to evaluate the program because of WWII. Most of the non-completers (52) requested and obtained release after WWII. Nevertheless, about half of the participants practiced in small communities for most of their working lives.	Descriptive study No control group Duration of individual retention not taken into account WWII created an exceptional situation during program operation

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
11 US state scholarship and educational loan programs	Mason 1971 [68]	*Program results:* Recruitment Retention (in any rural community in the state)	Description of program outcomes	All individuals who ever participated in one of the state programs and were available for practice in 1970 (N = 1,089)	Records of the individual state programs	*Proportion of participants who had completed or were completing their practice obligation in 1970:* Of 1,089 participants available for practice, 658 (60%) completed or were completing their obligation and 406 (37%) repaid the financial incentive, while the remainder defaulted. *Proportion of participants who remained in any rural community in their state after completion of their practice obligation (neither date of measurement nor duration information provided):* Georgia: 50% Kentucky: 90% North Carolina: 65%	Two fifths of participants did not fulfill their obligation to practice in an underserved area. The proportion of participants recruited to rural areas varied widely across programs. Between 50% and 90% of participants remained in rural communities after completion of their obligation.	Descriptive study No control group Duration of individual retention not taken into account

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
North Carolina Rural Loan Program	Bradbury 1963 [67]	*Program results:* Recruitment Retention(in underserved area of original placement) Participant satisfaction	Description of program outcomes	All students who were ever enrolled in the program between 1945 and 1963 (N = 320)	Records of the North Carolina Medical Care Commission	*Proportion of participants who had completed or were completing their practice obligation in 1963:* Of 320 participants, 120 (38%) were still in school, post-graduate training or served in the military, 46 (14%) withdrew from school or failed academically, and 13 (4%) withdrew their application or had died. Of 141 participants available for practice, 106 (75%) had completed or were completing their practice obligation and 35 (25%) defaulted on their obligation. *Proportion of participants who intend to leave practice location after completion of their practice obligation:* Of 36 respondents 29 (81%) stated that they intended to remain in their community, while 6 (17%) planned further training and one planned a move to an urban area. *Proportion of participants who found the loan amount sufficient:* Of 38 respondents who provided a valid answer to the question "Did you find the amount of the loan sufficient together with your resources to alleviate any undue concern over financial problems during the time you were in school?" 29 (76%) answered "yes", while the remainder answered "no".	A quarter of participants did not fulfill their obligation to practice in an underserved area. 71% of participants in the financial-incentive program were satisfied with their overall experience.	Descriptive study No control group Study of retention investigates only the intention to leave the practice location and not the actual location decision.

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
						Proportion of participants who would participate again in the same program: Of 38 respondents who provided a valid answer to the question whether they would participate again in the financial-incentive program 27 (71%) answered "yes", while 11 (29%) answered "no". .		

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
Arizona Medical Student Exchange Program	Navin and Nichols 1977 [74]	*Program results:* Recruitment Retention (in any rural community in the state) *Program impact:* Health system	Description of program outcomes Time series	All students who ever participated in the program between 1953 and 1977 and who had completed their medical training in 1975 (N = 149)	Records of the Western Interstate Commission for Higher Education	*Proportion of participants who had completed or were completing their practice obligation in 1975:* Of 149 participants, 67 (45%) served their obligation in a metropolitan area within Arizona, 21 (14%) served their obligation in a non-metropolitan area in Arizona and 55 (37%) repaid the financial incentive, while the remainder defaulted. *Proportion of participants who remained in rural communities of their state after completion of their practice obligation:* >85% *Time series of medical student density in Arizona:* The per-capita number of medical students did not increase from 1953 to 1967 (consistently 20% below national average), but increased steeply from 1968 onwards.	About two-fifths of participants did not fulfill their obligation to practice in an underserved area. 85% of participants who completed their obligation remained in Arizona. The program did not succeed in increasing the medical student population density in Arizona. The steep increase in per-capita medical students in 1968 is attributed to the opening of the first medical school in Arizona in that year.	*Program outcome:* Descriptive study No control group Duration of individual retention not taken into account *Program impact:* No analysis of time series undertaken except for visual impression No control for confounding by other variables that changed over time

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
UAP	Bass and Copeman 1975 [71]	*Program results:* Recruitment Retention (in underserved area of original placement) *Program impact:* Health system	Description of program outcomes Time series	All participating students who had completed their internship in 1974 (N = 104) 7 annual values (1966-1972) of the number of physicians in each of three geographical areas (all Ontario, northern Ontario, communities in northern Ontario with population of les than 15,000)	Canadian Medical Directory	*Proportion of participating medical students who had completed or were completing their practice obligation in 1974:* Of 104 students, 55 (53%) completed or were completing their obligation and 49 (47%) repaid the financial incentive. *Proportion of students who in 1974 had remained in the original placement location after completion of their practice obligation:* 74% *Time series of total number of physicians (expressed relative to their 1966 baseline value):* From 1966 to 1972 monotonic increase in the relative number of physicians in all Ontario (from 1.0 to over 1.3) and in northern Ontario (from 1.0 to almost 1.2). From 1966 to 1969 slight decline in the relative number of physicians in communities in northern Ontario with population of less than 15,000 (i.e., before the program was introduced) and steep increase from 1970 (after introduction of the program) to 1972 (from 1.0 to almost 1.25).	About half of participants did not fulfill their obligation to practice in an underserved area. About three quarters of participants who completed their obligation remained at the original placement location. The time series suggests that the program was effective in increasing the number of physicians practicing in small communities in northern Ontario.	*Program outcome:* Descriptive study No control group Duration of individual retention not taken into account *Program impact:* No analysis of time series undertaken except for visual impression No control for confounding by other variables that changed over time Ecological bias possible (because units of observation are groups of communities)

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
UAP	Anderson and Rosenberg 1990 [69]	*Program impact:* Health system	Before-after comparison of physician density in northern counties of Ontario (where most underserved areas are located) vs. in Ontario overall over a 30- year period (1956-1986, i.e., covering time before and after introduction of UAP in 1969)	Panel of all 10 counties in northern Ontario observed at seven points in time	Canadian Medical Directory Census Canada	*Physician population density in 1986 relative to physician population density in 1956:* 1.86-4.88 across the 10 northern counties Location quotient (physician density in the counties of northern Ontario relative to the physician population density in Ontario as a whole) in 1986 relative to location quotient in 1956: 0.88-1.33 across the northern 10 counties	The fact that the location quotient improved little over the 30-year observation period suggests that the increase in physician population density in northern Ontario (where most of the underserved areas in Ontario are located) was caused by an overall increase in physicians in the state rather than by UAP.	Observational study No control for confounding by other variables that changed over time Ecological bias possible (because not all communities in one county are underserved)

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
JMU	Inoue et al. 1997 [45]	*Program results:* Recruitment Retention (in prefecture of original placement) Retention (in any rural area)	Description of program outcomes	All physicians who graduated from JMU in one of first eighteen graduation cohorts of the university (N = 1,871)	Mail survey of JMU graduates in 1995	*Proportion of participants who had "observed the contract in compliance with the conditions for receiving financial aid" by 1995:* Of 1871 participants 1796 (96%), had observed the contract, while 75 (4%) had "repaid the loans to dissolve the contract requiring them to complete 9 years of medical employment in a rural area". *Proportion of participants who in 1995 were still practicing in the prefecture of original placement after completion of their practice obligation:* Of 924 participants who had completed their obligation in 1995 620 (67%) were still practicing in the prefecture of original placement. *Proportion of participants who in 1995 were still practicing in a rural area after completion of their practice obligation:* Of 924 participants who had completed their obligation in 1995 305 (33%) were still practicing in a rural area.	96% of all participants fulfilled their obligation to practice in an underserved area. About two thirds of participants remained in the prefecture of original placement after having fulfilled their obligation. A substantial proportion of participants left rural practice after having completed their obligation.	Descriptive study No control group Duration of individual retention not taken into account

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
JMU	Inoue et al. 2007 [59]	*Program result:* Recruitment *Program effect:* Provision of care (in any underserved area)	Description of program outcomes	All JMU participants (N = 1,661)	Japanese National Physician Census	*Proportion of participants who had completed or were completing their rural practice obligation in 1994:* "Only 2% of JMS [Jichi Medical School] did not observe the rural practice obligation" [59]. *Proportion of participants of all physicians in Japan vs. proportion of participants in rural areas:* Participants "accounted for only 0.7% of all the physicians in Japan. However, they accounted for 4.2%, 1.5%, 1.8%, and 3.0% of the physicians in small population, remote, mountain, and medically underserved municipalities, respectively" [59].	98% of participants fulfilled their obligation to practice in an underserved area. Participants were more likely than non-participants to practice in a rural area.	Descriptive study Observational sub-study without primary data extraction Selection bias due to selective participation in the JMU not controlled for
JMU	Matsumoto et al. 2008a [60]	*Program effect:* Provision of care (in any rural area)	Retrospective cohort study	All JMU graduates in 1994 (N = 1,635) and 2004 (N = 2,641) All non-JMU physicians in 1994 (N = 228,825) and 2004 (N = 260,041)	Mail surveys of JMU graduates. The mail surveys were, followed by telephone surveys of those participants who did not respond to the mail survey. Japanese National Physician Census	*Proportion of physicians who practice in any rural area: all JMU graduates vs. JMU graduates after completion of their practice obligation vs. non-JMU graduates:* 21.3% vs. 12.8% vs. 3.3% (in 1994) 15.1% vs. 10.7% vs. 2.6% (in 2004)	After having completed their obligation to practice in an underserved area JMU graduates were about four times more likely to work in rural areas than non-JMU graduates.	Observational study Selection bias due to selective participation in the JMU not controlled for

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
JMU	Matsumoto et al. 2008b [61]	*Program results:* Retention (in prefecture of original placement) Retention (in any rural area)	Retrospective cohort study	All JMU graduates who matriculated since 1972 and had completed their 9-year practice obligation by 2006 (N = 1,929)	Mail surveys in 2000, 2004, and 2006. The mail surveys were, followed by telephone surveys of those participants who did not respond to the mail survey.	*Proportion of JMU graduates who practice in the prefecture of original placement after completion of their practice obligation: graduates of rural background vs. graduates of urban background:* 73.8% vs. 74.7% ($p<0.76$) *Proportion of JMU graduates who practice in any rural area after completion of their practice obligation: graduates of rural background vs. graduates of urban background:* 21.1% vs. 12.0% ($p<0.001$) *Odds ratio of retention in the prefecture of original placement: at first practice site: graduates of rural background vs. graduates of urban background:* aOR = 0.77 ($p = 0.16$), when controlling for sex, age at entrance into JMU, years after graduation, type of high school, parental academic background, and change of academic standing throughout undergraduate medical training	Retention in the prefecture of original placement was high and did not differ significantly by the geographical background of participants. Large proportions of participants left rural practice after completion. Retention in rural areas was about twice as high in participants of rural background than in participants of urban background.	Observational study

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
						Odds ratio of retention in any rural area: graduates of rural background vs. graduates of urban background: aOR = 1.98 (p = 0.001), when controlling for sex, age at entrance into JMU, years after graduation, type of high school, parental academic background, and change of academic standing throughout undergraduate medical training		
JMU	Matsumoto et al. 2008c [62]	*Program results:* Recruitment Retention (in prefecture of original placement)	Description of program outcomes	All participants who had graduated from JMU by 1991 (N = 1,477)	Mail surveys in 2000, 2004, and 2006. The mail surveys were, followed by telephone surveys of those participants who did not respond to the mail survey.	*Proportion of participants who had completed the rural practice obligation by 2000:* Of 1,477 participants, 1,255 (85%) had completed the obligation, 127 (9%) were still under contract due to contract extension, 69 (4.7%) dissolved the contract, and 26 (2%) could not be contacted. *Proportion of participants who had completed their practice obligation by 2000 and had thereafter remained in the prefecture of original placement for at least 6 years:* 69.8%	95% of participants fulfilled their obligation to practice in an underserved area. Retention in the prefecture of original placement was high.	Descriptive study No control group

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Woolf et al. 1981 [88]	*Program impact:* Health system	Univariate comparison of means of demographic, economic, health, and education variables between the two types of sites Discriminant analysis	All communities that were eligible to receive a NHSC physician and were continuously staffed from October 1975 to October 1976 (N = 76) All communities that were eligible to receive a NHSC physician before August 1975 and had never been staffed up to August 1977 (N = 78)	NHSC records Health Resources and Services Administration Area Resource File	*Means comparison:* Staffed communities had significantly higher median family income, lower poverty prevalence, higher income growth, lower infant mortality, lower unemployment, and higher median educational attainment. *Discriminant analysis:* Seven variables contribute significantly and substantially to separation given the other variables in the discriminant function (sign of coefficient in parentheses): income growth (-), poverty prevalence (-), physician population density (-), employment ratio (+), infant mortality rate (-), median family income (+), proportion of people 65 years of age or older (-).	Underserved communities that were economically worse-off and had worse population health were less likely to receive a program participant than underserved communities that were economically better-off and had better population health.	Observational study Study covers only the first few years of the NHSC program Ecological bias possible (because community characteristics are measured at the level of the county)
NHSC	Stamps and Kuriger 1983 [79]	*Program result:* Retention (in any rural area)	Descriptive study	All NHSC physicians practicing in New England states, New York, Pennsylvania, Maryland and Virginia at the time of the survey (N = 100)	Mail survey	*Proportion of NHSC physicians who intend to practice in a rural area after completion of their practice obligation:* Of 100 physicians 56 (56%) expressed intention to practice in a rural area, 15 (15%) were uncertain, and the remainder did not intend to practice in a rural area.	More than half of participants who were currently fulfilling their obligation intended to practice in a rural area after completing their obligation.	Descriptive study Study of retention investigates only the intention to practice in a rural area and not the actual location decision.

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Stone et al. 1991 [41] and Brown et al. 1990 [42]	*Program results:* Retention (in underserved area of original placement) Participant satisfaction Family satisfaction	Descriptive study	All NHSC physicians completing their practice obligation in 1989 (N = 401)	Mail survey	*Proportion of participants who intended to leave NHSC practice location after completion of their practice obligation:* Of 397 respondents who provided valid information on their intention to leave their NHSC practice location, 265 (67%) stated that they intended to leave. *Proportion of participants who intended to leave their NHSC practice location who provided the following reasons for leaving:* "The most commonly cited reasons for leaving (each respondent could give two primary reasons) were: 1) the site was geographically isolated or was unpleasant in some other way (61 percent); 2) salary at the NHSC site was insufficient (31.5 percent); 3) on-call and clinical responsibilities associated with the NHSC position were excessive (28.5%); and 4) children's needs or spouse's career or other needs were unmet (26.2%)" [41].	Only about one third of participants who were currently fulfilling their practice obligation intended to remain in their placement practice after completing their obligation. The major reasons for intending to leave the placement site were dissatisfaction with the community, the salary, and the workload, as well as unmet needs of family members.	Descriptive study No control group Study of retention investigates only the intention to leave the practice location and not the actual location decision.

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Pathman et al. 1992 [81]	*Program effects:* Retention (in the same underserved area) Retention (in any underserved area)	Retrospective cohort study	Primary care physicians practicing in a rural county who were selected in a national stratified sample in 1981, were still alive in 1990, could be contacted and responded to a mail survey in 1990 (N = 304)	Mail survey conducted by the Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill	*Hazard ratio of non-retention in the same practice as in 1981: NHSC vs. non-NHSC physicians:* 2.11 ($p < 0.0001$) 1.98 ($p = 0.0002$), when controlling for training in internal medicine and stated importance of small community living *Hazard ratio of non-retention in any rural practice: NHSC vs. non-NHSC physicians:* 1.74 ($p < 0.004$) 1.56 ($p = 0.02$), when controlling for training in internal medicine and stated importance of small community living)	Participants were about twice as likely to leave their practice of original placement and about 50% more likely to leave rural practice than non-participants.	Observational study Selection bias due to selective participation in the NHSC not controlled for

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Pathman et al. 1994a [82]	*Program effects:* Retention (in any non-metropolitan county) Retention (in the same practice in a non-metropolitan county)	Retrospective cohort study	Physicians who responded to a mail survey in 1990 and who had worked during any part of 1981 in one of 192 practices that had been included in a stratified random sample of non-metropolitan practices receiving external subsidies (N = 202)	Mail survey in 1990	*Proportion of physicians who still worked in a non-metropolitan county in 1990: NHSC vs. non-NHSC physicians:* 24% vs. 52% ($p < 0.001$) *Proportion of physicians who still worked in the same practice in a non-metropolitan county in 1990: NHSC vs. non-NHSC physicians:* 13% vs. 44% ($p < 0.001$)	From 1981 through 1990, participants were about half as likely to remain in a non-metropolitan area and about three times less likely to remain in the same practice than non-participants.	Observational study No control of confounding cofounders Selection bias due to selective participation in the NHSC not controlled for

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Pathman et al. 1994b [12]	*Program result:* Participant satisfaction *Program effects:* Retention (in the same underserved area) Participant satisfaction	Retrospective cohort study	All primary care NHSC physicians who started their practice obligation in a rural HPSA from 1987 to 1990 (N = 417) Stratified random sample of non-NHSC physicians comparable in age and career stage who began working in a rural HPSA from 1987 to 1990 (N = 206)	Mail survey in 1991	*Proportion of physicians who remained at first practice site: NHSC vs. non-NHSC physicians:* 57% vs. 70% (OR = 0.56, p = 0.004) after 3 years and 1 month 21% vs. 52% (OR = 0.25, p < 0.001) after 5 years and 1 month aOR = 0.41 (p = 0.01) after 5 years and 1 month, when controlling for measures of community-physician match and physician and family satisfaction *Mean satisfaction score: NHSC physicians:* Across 18 dimensions of satisfaction, 9 mean satisfaction scores were between "dissatisfied" and "neutral", 8 were between "neutral" and "satisfied", and one ("Caring for needy patients") was between "satisfied" and "very satisfied".	Five years after starting work at a practice site, participants were less than half as likely as non-participants to have remained at the site. Across a number of dimensions, participants reported lower satisfaction with their stay in an underserved area than non-participants.	Observational study Selection bias due to selective participation in the NHSC not controlled for

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
						Mean satisfaction score: NHSC vs. non-NHSC physicians: Across 15 dimensions of satisfaction, NHSC physicians reported significantly lower satisfaction than non-NHSC physicians for "Referral Access to Consultants", "Freedom from Bureaucratic Interference", "Clinical Autonomy", "Opportunities to Achieve Professional Goals", "Earnings From Practice", "Quality Physician-Patient Relationships", "Life in a Small Community", "Climate or Geography", "Access to Cultural Activities", "Having Amenities of City Living" (all $p \leq 0.006$), and reported higher satisfaction only for "Caring for Needy Patients" ($p = 0.003$).		

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Pathman and Konrad 1996 [76]	*Program results:* Retention (in practice entered in a specific period of time) Participant satisfaction Family satisfaction	Retrospective cohort study	All primary care physicians placed through NHSC in a HPSA between 1987 and 1990 (N = 398)	Mail survey in 1991	*Proportion of physicians who remained in practice entered between 1987 and 1990: minority vs. non-minority NHSC physicians:* 15% vs. 21% (RR = 0.71, p = 0.24), one year after having completed the practice obligation *Mean satisfaction score: minority vs. non-minority NHSC physicians:* Across 17 dimensions of satisfaction, all mean satisfaction scores for both minority and non-minority physicians were between "dissatisfied" and "satisfied", with the exception of the score for "Caring for needy patients" which was between "satisfied" and "very satisfied" for both groups. Minority physicians had significantly lower mean scores than their non-minority peers for "Clinical autonomy", "Opportunities to achieve professional goals", "Earnings from practice", "Opportunities for outdoor sports", "Life in a rural community", "Climate or geography", and "Ability to find compatible friends" (all $p \leq 0.04$).	Minority and non-minority participants did not differ in their retention in the practice of original placement after completion of the practice obligation. Across a number of dimensions, minority physicians reported lower satisfaction with the stay in an underserved area (for themselves and their families) than non-minority physicians.	Observational study No control of confounding

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
						Proportion of minority vs. non-minority NHSC physicians who disagreed with statement on family satisfaction: "spouses knew what to expect when they came to their community": 38% vs. 24% (p = 0.02) "spouses were employed happily in the community": 51% vs. 32% (p = 0.004). *Proportion of minority vs. non-minority NHSC physicians who agreed with statement on family satisfaction:* "spouses were unhappy in the community": 45% vs. 34% (p = 0.07) "children were happy in the community": 59% vs. 74% (p = 0.02)		

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Rosenblatt et al. 1996 [77]	*Program results:* Retention (in the rural county of original placement) Retention (in any rural county) Participant satisfaction	Description of program outcomes	All physicians who graduated from medical school between 1980 and 1983, had received NHSC scholarships, completed family medicine residencies, completed their practice obligation in a rural area, and responded to the survey (N = 258)	Mail survey in 1994 Health Resources and Services Administration Area Resource File Public Health Service records American Medical Association Physician Masterfile NHSC participant roster	*Proportion of NHSC physicians who remain in the country of original placement (an average of 6.1 years after the end of their practice obligation):* 25% *Proportion of NHSC physicians who have left the county of original placement to practice in a rural county:* 27% *Proportions of NHSC physicians whose written accounts of their experience with the NHSC were characterized by an independent investigator as indicating a positive, neutral, ambivalent, or negative appraisal:* Of 183 written comments, 41% were "either mixed or ambivalent"; 33% were "positive"; 20% were "negative"; and 6% were "neutral"	About six years after completing their practice obligation a quarter of participants continued to practice in the county of original placement, while about another quarter had left the original placement site to practice in a rural county. Only 33% of participants rated their NHSC experience "positive".	Descriptive study No control group Duration of average retention reported but duration of individual retention not taken into account

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Cullen et al. 1997 [78]	*Program results:* Retention (in rural county of original placement) Retention (in any rural county)	Description of program outcomes	All NHSC scholarship recipients who graduated from medical school between 1975 and 1983 and were placed in a rural county (N = 6249)	American Medical Association Physician Masterfile NHSC participant roster	*Proportion of NHSC physicians who remained in their rural county of original NHSC placement in December 1991:* 13% (among those graduated from medical school in 1975-1977) 17% (1978-1980) 20% (1981-1983) *Proportion NHSC physicians who remained in any rural county:* 35% (1975-1977) 36% (1978-1980) 40% (1981-1983)	8-10 years after graduating from medical school, one fifth of participants remained in the county of their original placement, while two fifths remain in a rural county. 14-16 years after graduation, these proportions had fallen to 13% and 35% respectively.	Descriptive study No control group

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Xu et al. 1997a [87]	*Program effect:* Provision of care (in any underserved area)	Retrospective cohort study	Random sample physicians who one of 126 graduated from allopathic or osteopathic medical schools in 1983 or 1984 and whose self-identified specialty was family practice, general practice, general internal medicine, or general pediatrics (N = 1,588)	Mail survey in 1994	*Odds ratio of physicians' practice in underserved areas: NHSC vs. non-NHSC physicians:* aOR = 3.7 ($p < 0.0001$) when controlling for age, sex, race/ethnicity, growing up in an underserved areas, family income as a child, interest in working in underserved area prior to medical school, debt, medical school experience in an underserved area, and residency experience in an underserved area	Participants were significantly more likely to practice in an underserved area ten years after graduating from medical school than non-participants.	Observational study Selection bias due to selective participation in the NHSC not controlled for
NHSC	Xu et al. 1997b [86]	*Program effect:* Provision of care (of poor patients)	Retrospective cohort study	Random sample of physicians who graduated from medical school in 1983 or 1984 and whose self-reported specialty was family practice, general internal medicine, or general pediatrics (N = 1,581)	Mail survey in 1993	*Percentage of underserved patients: NHSC vs. non-NHSC physicians:* 30% vs. 19% *NHSC enrollment coefficient in ordinary least squares regression with the percentage of a physician's patients who the physician considered to be poor or whose primary insurance was Medicaid:* 7.46 ($p = 0.0001$) when controlling for sex, race/ethnicity, family income as a child, and growing up in an underserved area.	Participants had about one third more underserved patients than non-participants.	Observational study Selection bias due to selective participation in the NHSC not controlled for

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Singer et al. 1998 [83]	*Program effect:* Retention (in the same community health center)	Retrospective cohort study	All physicians working in a community health center during the period January 1, 1990 through September 30, 1992 (N = 2,654)	Administrative dataset at the Bureau of Primary Health Care	*Proportion of physicians who were still working at the same community health center five years after starting their contracts: NHSC vs. non-NHSC physicians* 17% vs. 36%	After five years of work in a community health center, participants were less than half as likely as non-participants to still work in the same centre.	Observational study No control of confounding Selection bias due to selective participation in the NHSC not controlled for
NHSC	Rabinowitz et al. 2000 [85]	*Program effect:* Provision of care (in any underserved area)	Retrospective cohort study	Stratified random sample of all allopathic and osteopathic physicians with a primary care specialty who graduated from a US medical school in 1983 or 1984 (N = 2,955)	American Medical Association Physician Masterfile NHSC participant roster Mail survey in 1993	*Odds ratio of "providing substantial care to the underserved": NHSC vs. non-NHSC physicians:* aOR = 2.2 (95% CI 1.6-3.0), when controlling for sex, ethnicity, family income when growing up, childhood in inner-city/rural area, strong interest in underserved practice prior to medical school, clinical experience with the underserved during medical school	"Participation in the NHSC is the only experiential factor related to caring for the underserved".	Observational study
NHSC	Mofidi et al. 2002 [80]	*Program result:* Retention (providing care to an underserved population)	Description of program outcomes	Stratified random sample of all NHSC dentists who had completed their practice obligation between 1980 and 1997 (N = 249)	Mail survey in 1998	*Proportion of NHSC dentists in 1998 who provided care to an underserved population after completion of their practice obligation:* 47%	A substantial proportion of participants continued to provide care to the underserved after their obligated service.	Descriptive study No control group Duration of individual retention not taken into account

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Brooks et al. 2003 [11]	*Program effect:* Provision of care (in any rural area)	Retrospective cohort study	All of Florida's rural primary care physicians (N = 399) and random sample of 10% of Florida's urban and suburban primary care physicians (N = 1,236)	Mail survey in 2001	*Proportion of survey respondents who ever served in the NHSC:* 12.6% of rural primary care physicians, 3.3% of suburban primary care physicians, and 3.4% of urban primary care physicians had ever served in the NHSC ($p < 0.01$).	The proportion of primary care doctors who had ever served in NHSC is almost four times as high in rural areas as in either urban or suburban areas.	Observational study No control of confounding Selection bias due to selective participation in the NHSC not controlled for
NHSC	Porterfield et al. 2003 [63]	*Program result:* Retention (in any underserved area)	Descriptive study	Stratified random sample of all NHSC health professionals who began fulfilling their practice obligation between 1980 and 1997 (N = 1,250)	Mail survey	*Proportion of NHSC participants who worked in any underserved area in 1998:* 52.5% *Proportion of NHSC participants who worked in any underserved area in 1998 by NHSC enrolment cohort:* 45.6% (1980-84 cohort) 54.8% (1985-90 cohort) 67.8% (1991-97 cohort)	7 to 17 years after starting to fulfill their practice obligation, about half of the participants still worked in an underserved area.	Descriptive study No control group Selection bias due to selective participation in the NHSC not controlled for

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Probst et al. 2003 [52]	*Program effect:* Provision of care (in any underserved area)	Retrospective cohort study	All allopathic and osteopathic physicians practicing in South Carolina during 1998 who were not enrolled in residency training, had graduated from medical school in 1969 or later and were not currently fulfilling a NHSC practice obligation (N = 3,608)	Physician licensure and inpatient discharge files from the Office of Research and Statistics of the South Carolina Budget and Control Board NHSC participant roster	*Proportion of Medicaid patients of all discharges attended: NHSC alumni vs. other physicians* 28% vs. 19% *Odds ratio of being highly engaged in Medicaid inpatient practice (i.e., ≥29.95% of their discharges were Medicaid funded) in 1998: NHSC alumni vs. non-NHSC alumni physicians:* aOR = 1.93 (95% CI 1.18-3.13), when controlling for physician's sex, ethnicity, medical specialty, period of graduation from medical school, medical education in South Carolina, graduation from a non-US medical school	Participants saw about a third more Medicaid patients than non-participants.	Observational study Selection bias due to selective participation in the NHSC not controlled for Duration of individual inpatient practice not taken into account

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Holmes 2004 [53]	*Program effects:* Provision of care (in any underserved area) Retention (in the same area)	Retrospective cohort study	All US physicians who graduated from medical school in 1977-1979 (N = 19,253), 1982-1984 (N = 20,757), 1987-1989 (N = 19,500) First observation of practice location in 1981, 1986, and 1991 for the 1977-1979, 1982-1984, and 1987-1989 cohorts, respectively (i.e., 2-4 years after graduation from medical school).	American Medical Association Physician Masterfile NHSC participant roster HPSA designation from the Bureau of Primary Health Care in the Health Resources and Services Administration	*NHSC enrollment coefficients in multiple probit regression with location in community of first practice (five years after first observation of practice location) as outcome variable:* Between -0.248 and -0.272 across the three graduation cohorts (all $p < 0.01$), when controlling for age, sex, ethnicity -0.466 (not sig.), -0.866 ($p < 0.01$), and -1.748 ($p < 0.01$) in the 1977-1979, 1982-1984, and 1987-1989 cohort, respectively, when controlling for age, sex, ethnicity, and the effect of self-selection into the NHSC *NHSC enrollment coefficients in multiple probit regression with practice in any HPSA as outcome variable:* Between 0.528 and 0.745 across the three graduation cohorts (all $p < 0.01$), when controlling for age, sex, ethnicity 0.482 (not sig.), 0.745 ($p < 0.01$), 0.161 (not sig.) in the 1977-1979, 1982-1984, and 1987-1989 cohort, respectively, when controlling for age, sex, ethnicity, and the effect of self-selection into the NHSC	Participants were less likely to remain in their first practice location than non-participants, even after the effect of self-selection into the program was controlled for. Participants were more likely to serve in any underserved area than non-participants physicians. However, this effect remained significant in one of the three graduation cohorts, once the effect of self-selection into program participation was controlled for.	Observational study Duration of individual retention not taken into account Exclusion restrictions (medical school characteristics) used in selection models to control for selective participation in the NHSC may not be valid

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Pathman et al. 2005 [54]	*Program impact:* Health	Pre-post comparison	Non-HPSA counties (N = 772) HPSA counties that received various levels of NHSC staffing between 1984 and 1988: 0 years of staffing (N = 172) 1-7 years of staffing (N = 293) 8-11 years of staffing (N = 84) 12-15 years of staffing (N = 71)	Health Resources and Services Administration Area Resource File NHSC participation roster	*Age-adjusted all-cause mortality rates (standardized to the 1981-1983 rate for non-HPSA counties) in 1981-1983/1996-1998:* Non-HPSA: 1.000/0.947 HPSA, 0 years staffing: 1.022/0.982 HPSA, 1-7 years staffing: 1.027/0.992 HPSA, 8-11 years staffing: 1.092/1.055 HPSA, 12-15 years staffing: 1.089/1.027	There were improvements in age-adjusted mortality rates in all 5 types of counties, suggesting that changes other than the program staffing were responsible for the improvements. Greater relative improvements in age-adjusted mortality were seen in non-underserved counties than in all types of underserved counties with the exception of counties staffed with program participants for 12-15 years.	Observational study No control of confounding by other variables that changed over time

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Holmes 2005 [64]	*Program impact:* Health system (supply of physicians in underserved areas)	Retrospective cohort study	All US physicians who graduated from medical school in 1976-1978, 1981-1983, 1986-1988 (N = 80,184) Observation of practice location in 1981 and 1986 for the 1976-1978 cohort, in 1986 and 1991 for the 1981-1983 cohort, and in 1991 and 1996 for the 1986-1988 cohort (i.e., 3-5 years after graduation from medical school).	American Medical Association Masterfile NHSC participation roster	*Predicted supply of physicians in underserved areas using parameter estimates from a sequential multinomial logit model of physicians' location decisions, which controls for the effect of self-selection into the NHSC: under the status quo vs. assuming that the NHSC were eliminated:* Elimination of the NHSC would lead to a 10-11% decrease in the supply of physicians in underserved areas.	The NHSC contributed about one tenth to the existing US physician workforce in underserved areas.	Observational study Duration of individual retention not taken into account Exclusion restrictions (medical school characteristics) used in selection models to control for selective participation in the NHSC may not be valid

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC	Pathman et al. 2006 [55]	*Program impact:* Health system	Retrospective cohort study	All rural HPSA staffed by NHSC physicians, nurses, and/or physician assistants in 1984 and at least 3 of the preceding 5 years (N = 141) All rural HPSA that had no NHSC clinician assigned from the above disciplines between 1979 and 2001 (N = 142)	American Medical Association Physician Masterfile NHSC participation roster Health Resources and Services Administration Area Resource File	*NHSC staffing coefficients in multiple linear regression with ratio change in non-NHSC primary care physician density from 1981 to 2001 as outcome variable:* 1.06 ($p < 0.01$), when controlling for population size, ethnic composition, per-capita income, poverty prevalence, youth unemployment rate, education, presence of a hospital, presence of a community or migrant health center, non-NHSC primary care physician population density at baseline, presence of at least one non-NHSC primary care physician at baseline	Presence of a program participant increased the supply of non-participating physicians in an underserved area by 6 percent.	Observational study
NHSC	Rittenhouse et al. 2008 [65]	*Program effect:* Provision of care (in any community health center)	Retrospective cohort study	All physicians active in direct patient care (in 2001-2003) who graduated from allopathic US medical schools and completed residency training in 1970 or later (N = 412,012)	American Medical Association Physician Masterfile NHSC participation roster	*Odds ratio of work in a community health center (in 2001-2003): participants in the NHSC loan repayment program vs. non-participants:* aOR = 6.99 ($p < 0.001$) when controlling for sex, year of residency completion, private vs. public medical school, attendance of a medical school receiving Title VII funding	Participants were significantly more likely to work in a community health center than non-participating physicians.	Observational study Selection bias due to selective participation in the NHSC not controlled for

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
Scholarship for Indian students in health sciences	Weiss et al. 1980 [72]	*Program result:* Recruitment	Description of program outcomes	All students who were supported by the scholarship between 1973 and 1977 and had graduated in 1980 (N = 124)	Navajo Health Agency Office of Student Affairs records	*Proportion of participants who practiced in the Navajo Indian reservation or immediately adjacent communities after graduation:* Of 124 participants, 34 (27%) continued their education, 9 (7%) were lost to follow-up or died, 5 (4%) were unemployed and 76 (62%) were employed Of the 76 participants available for practice, 56 (74%) worked in the Navajo Indian reservation or immediately adjacent communities, while the remainder did not serve in those areas.	In a program without obligation, but encouragement, to serve in an underserved area, three quarters of participants decided to practice in an underserved area.	Descriptive study No control group

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
Oklahoma Rural Medical Education Scholarship Loan	Holmes and Miller 1985 [73]	*Program result:* Recruitment	Description of program outcomes	All scholarship recipients from 1976 to 1985 (N = 138)	Oklahoma Physician Manpower Training Commission records	*Proportion of participants who fulfilled their practice obligation:* Of 138 students, 94 (68%) fulfilled their practice obligation, while 44 (32%) repaid the financial incentive.	About two thirds of participants fulfilled their obligation to practice in an underserved area.	Descriptive study No control group
Oklahoma Rural Medical Education Scholarship Loan	Lapolla et al. 2004 [56]	*Program results:* Recruitment Retention (in underserved area of original placement)	Description of program outcomes	All physicians who fulfilled their practice obligation (N = 313)	Oklahoma Physician Manpower Training Commission records	*Proportion of participants who fulfilled their practice obligation:* Of 544 participants available for practice, 407 (75%) had completed or were completing their practice obligation and 138 (25%) repaid the financial incentive.[5] *Proportion of participants who remained in the original placement community upon completion of their practice obligation:* Of 313 students, 167 (53%) remained in the original placement community, 91 (29%) relocated to another community in Oklahoma, and 55 (18%) relocated to another state.	One quarter of participants fulfilled their obligation to practice in an underserved area. About half of participants remained in the placement community upon completion of their obligation.	Descriptive study No control group Duration of individual retention not taken into account

[5] The true absolute numbers may be slightly different, because they were derived from percentages that are shown rounded to the first integer in the source study [56].

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
NHSC Indian Health Service Corps State scholarships State loan repayment programs Practice and hospital-sponsored financial incentives	Pathman et al. 2000 [84]	*Program effect:* Provision of care (in any underserved area)	Retrospective cohort study	Stratified random sample of all physicians who graduated from US medical schools in either 1988 or 1992 and were listed four years after graduation with a principal specialty of family practice, general internal medicine or general pediatrics (N = 468)	American Medical Association Physician Masterfile	*Proportions of financial-incentive program participants vs. non-participants who practiced in any rural area in 1999:* 33.3 vs. 6.5% ($p < 0.001$) *Average proportion of Medicaid and uninsured patients of all patients who are cared for by participants vs. non-participants in 1999:* 54.1 vs. 29.4% ($p < 0.001$) The positive association of participation with practice in rural areas and with the proportion of Medicaid and uninsured patients remained significant "while controlling for selected characteristics of physicians".	In comparison to non-participants, participants in financial-incentive programs were about five times more likely to practice in rural areas and 85% more likely to care for underserved populations.	Observational study Selection bias due to selective participation in a financial-incentive program not controlled for

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
New South Wales Department of Health Rural Resident Medical Officer Program (Cadetship Program)	Dunbabin et al. 2006 [57]	*Program results:* Recruitment Retention (in any rural community)	Description of program outcomes	All medical students who accepted the scholarship between 1989 and 2004 and should have graduated from medical school by 2004 (N = 157) All medical students who accepted the scholarship between 1989 and 1998, had graduated from medical school, and had completed their rural service (N = 82)	New South Wales Rural Doctors Network records Medical Directory of Australia Mail survey in 2004	*Proportion of participants (1989-2004 cohort) who had completed or were completing their practice obligation in 2004:* Of 157 participants, 4 (3%) did not graduate from medical school. Of the 153 participants who graduated from medical school, 133 (87%) had completed or were completing their practice obligation and 20 (13%) withdrew from the program. *Proportion of participants (1989-1998 cohort) who had completed their rural service and (in 2004) were practicing in a rural community:* Of 82 former cadets, 35 (43%) were working in a rural area (compared to 21% of all medical practitioners nationally).	About nine tenths of participants fulfilled their obligation to practice in a rural area. Retention in rural communities after completion of obligation was substantial.	Descriptive study No control group Duration of individual retention not taken into account

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
Community Scholarship Program (CSP) Health Sciences Scholarship Program (HSSP) Recruitment and Retention Community Program (RRCP) State Loan Repayment Program (SLRP)	Jackson et al. 2003 [58]	*Program results:* Recruitment Participant satisfaction *Program effects:* Retention (in the same underserved area) Participant satisfaction	Retrospective cohort study	All participants in at least 1 of the 4 incentive programs who had completed at least 1 year of their obligation (N = 105 for study of program result, N = 44 for study of program effect) All primary care physicians who graduated from US medical schools and were practicing in West Virginia counties defined as "rural" by both the federal Office of Management and Budget and the West Virginia Rural Health Education Partnership (N = 107)	West Virginia Board of Medicine licensure files West Virginia School of Osteopathic Medicine Mail survey in 2002	*Proportion of participants who had completed or were completing their practice obligation in 2002:* Of 105 participants available for practice, 82 (78%) had completed or were completing their practice obligation and 23 (22%) repaid the financial incentive. *Comparison of the proportion of participants vs. the proportion of all other primary care physicians who were still practicing at their first practice site in 2002:* "Obligated physicians were less likely to leave their service sites during the first 4 years of practice than were nonobligated physicians. After obligations were completed and physicians were free to leave, retention dropped into the range seen among nonobligated physicians." After 4 years, 32% of all participants were no longer at their first practice site, compared with 38% of all other primary care physicians (RR = 0.84, p = 0.475).[6]	More than three quarters of participants fulfilled their obligation to practice in an underserved area. Retention in the first practice site was not significantly different between program participants and non-participants. The majority of participants in one of the four evaluated financial-incentive programs were satisfied with their experience.	Observational study No control of confounding Selection bias due to selective participation in a financial-incentive program not controlled for

[6] Calculated using information available in the article [58].

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
						Proportion of financial-incentive program participants vs. non-participants who "agreed that clinical work was personally rewarding" 98% vs. 85% (p = 0.02) *Proportions of participants who were dissatisfied with program personnel* Across the different evaluated programs "one third to half of recipients of all programs felt they had too little contact, assistance, and responsiveness" from program personnel. *Proportion of participants who would participate again in the same program* Of 41 program participants who provided a valid answer when asked whether "they would sign up for their financial incentive program again" 30 (73%) answered "definitely yes" or "probably yes", while the remainder answered "definitely not" or "probably not".		

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
20 US state scholarship programs 12 state loan programs with service option 24 state loan repayment programs 6 state direct financial-incentive programs for residents 7 state direct financial-incentive programs for fully trained health professionals	Pathman et al. 2004 [48]	*Program results:* Participant satisfaction Family satisfaction *Program effect:* Retention (in the same area)	Description of program outcomes Retrospective cohort study	All primary care physicians serving or having served their obligation in 1991 or 1996 (N = 330) Stratified random sample of all graduates of US allopathic and osteopathic medical schools in 1988 and 1992 who 4 years after graduation were in primary care practice in the US and were not obligated to serve in a specific location (N = 468)	American Medical Association Physician Masterfile Records of the individual state programs 1999 US census Health Resources and Services Administration Area Resource File Mail survey in 1998 and 1999	*Proportion of program participants who had completed their practice obligation by 2004:* 44.7% (average of service-option loan programs) 66.5% (average of scholarship programs) 93.0% (average of all other programs) *Proportion of program participants who had repaid the financial incentive by 2004:* 49.2% (average of service-option loan programs) 27.2% (average of scholarship programs) 2.3% (average of all other programs) *Hazard ratio of retention at first practice site: program participants vs. program non-participants:* 0.70 (p = 0.029) 0.75 (p = 0.080), when controlling for ages, sex, medical specialty, marital status	Programs that enrolled physicians achieved higher obligation completion ratios than programs that enrolled students during medical school. Participants were about 25% less likely to remain at their site of first practice than non-participants. The majority of participants in one of the evaluated financial-incentive programs were satisfied with their experience; their spouses were significantly less satisfied.	*Program outcome:* Descriptive study *Program effect:* Observational study Selection bias due to selective participation in a financial-incentive program not controlled for

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
						Proportion of participants who were satisfied with their program placement More than 70% of obligated physicians felt "a sense of belonging to the community"; more than 80% were "satisfied with practice"; and more than 90% found their "work rewarding". All three proportions were lower among nonobligated physicians (all $p \leq 0.05$). *Proportion of family members who were satisfied with program placement* The spouses of obligated physicians did not differ significantly in their satisfaction with the community (more than 50%) or with their work (more than 70%) from the spouses of nonobligated physicians. The children of obligated physicians did not differ significantly in their satisfaction with the community (more than 80%) from children of nonobligated physicians. *Proportion of participants who would participate again in the same program* 90.2% of obligated physicians would "likely" or "definitely" participate again in their financial-incentive program.		

Program name	Study	Study outcomes	Study design	Sample criteria and sample size	Data sources	Outcome measures and effect sizes	Conclusions	Methodological limitations
Friends of Mosvold Scholarship Scheme (FOMSS)	Ross 2007 [66]	*Program result:* Recruitment	Description of program outcomes	All individuals who participated in the program between 1999 and 2002 and who graduated from a health care education program before 2006 (N = 24)	FOMSS records	*Proportion of participants who practiced in Umkhanyakude district after graduation:* Of 24 participants who graduated, 1 (0.4%) died and 3 (1%) pursued further education or training. Of 20 participants available for service, 20 (100%) had completed or were completing their practice obligation.	All participants fulfilled their obligation to practice in an underserved area.	Descriptive study

OR = odds ratio, aOR = adjusted odds ratio, RR = risk ratio. The term underserved area in the table encompasses a specific underserved area, any underserved area, and underserved populations. The sample size N refers to the largest number of people included in an analysis of program outcomes reported in a study. Some outcome analyses in the same study may use samples that are smaller than N, for instance, because data on a particular outcome were not available for all individuals. WWII = Second World War, HPSA = Health Professional Shortage Area, not sig. = not significant at the 5% level.

Table 4: Studies of program effect on provision of care or retention

		Outcome	
		Same area as at baseline	Any underserved area
Sample	All physicians	*Retention in the same area:* Holmes 2004 [53] Pathman et al. 2004 [48]	*Provision of care in any underserved area:* Brooks et al. 2003 [11] Holmes 2004 [53] Inoue et al. 2007 [59] Matsumoto et al. 2008a [60] Pathman et al. 2000 [84] Probst et al. 2003 [52] Rabinowitz et. al. 2000 [85] Rittenhouse et al. 2008 [65] Xu et al. 1997a [87] Xu et al. 1997b [86]
	Physicians who work in an underserved area at baseline	*Retention in the same underserved area:* Jackson et al. 2003 [58] Pathman et al. 1992 [81] Pathman et al. 1994a [82] Pathman et al. 1994b [12] Singer et al. 1998 [83]	*Retention in any underserved area:* Pathman et al. 1992 [81] Pathman et al. 1994a [82]

Appendix: Search algorithms

PubMed search

("Health Manpower"[MeSH Term] OR "Health Personnel"[MeSH Term] OR "Students"[MeSH Term] OR “Internship and Residency"[MeSH Term] OR “Education, Medical"[MeSH Term]) AND (“Medically Underserved Area”[MeSH Term] OR "Professional Practice Location"[MeSH Term] OR “Rural Health”[MeSH Term] OR “Rural Health Services”[MeSH Term] OR "Primary Health Care"[MeSH Term] OR “Family Practice”[MeSH Term] OR “Career Choice”[MeSH Term]) AND (“Financial Support"[MeSH Term] OR "Training Support"[MeSH Term] OR "Physician Incentive Plans"[MeSH Term] OR “Health Planning"[MeSH Term])

EMBASE search

('health care manpower'/exp OR 'health care personnel'/exp OR 'student'/exp OR 'medical education'/exp) AND ('rural health care'/exp OR 'professional practice'/exp OR 'primary health care'/exp OR 'general practice'/exp) AND ('student assistance program'/exp OR 'finance'/exp OR 'health care personnel management'/exp OR 'health care planning'/exp) AND [embase]/lim NOT [31-01-2009]/sd AND [<1950-2009]/py

CINAHL search

((MH "Health Manpower+") or (MH "Nursing Manpower+") or (MH "Health Personnel+") or (MH "Students+") or (MH "Internship and Residency") or (MH "Education+")) and ((MH "Medically Underserved Area") or (MH "Rural Health") or (MH "Rural Health Services") or (MH "Primary Health Care") or (MH "Family Practice") or (MH "Career Planning and Development")) and ((MH "Financial Support+") or (MH "Employee Incentive Programs") or (MH "Health and Welfare Planning+"))

NHS EED search

((Health Manpower) OR (Health Personnel) OR (Students) OR (Internship and Residency) OR (Medical Education)) AND ((Medically Underserved Area) OR (Professional Practice Location) OR (Rural Health) OR (Rural Health Services) OR (Primary Health Care) OR (Family Practice)) AND ((Career Choice) OR (Financial Support) OR (Training Support) OR (Physician Incentive Plans) OR (Health Planning)) in NHS Economic Evaluation Database

References

1. JLI: *Human resources for health: overcoming the crisis*. Boston: Harvard University Press; 2004.
2. World Health Organization: *Working together for health: the World Health Report 2006*. Geneva: World Health Organization; 2006.
3. Brooks RG, Walsh M, Mardon RE, Lewis M, Clawson A: **The roles of nature and nurture in the recruitment and retention of primary care physicians in rural areas: a review of the literature**. *Acad Med* 2002, **77**(8):790-798.
4. Council on Graduate Medical Education: *Physician distribution and health care challenges in rural and inner-city areas*. Rockville, MD: CBME; 1998.
5. Calman N, Hauser D: *Physician distribution in health professional shortage areas: supplement report to the bureau of health professions*. New York: The Institute for Urban Family Health; 2005.
6. Lehmann U, Dieleman M, Martineau T: **Staffing remote rural areas in middle- and low-income countries: a literature review of attraction and retention**. *BMC Health Serv Res* 2008, **8**:19.
7. Bärnighausen T, Bloom DE, Humair S: **Human Resources for Treating HIV/AIDS: Needs, Capacities, and Gaps**. *AIDS Patient Care and STDs* 2007, **21**(11):799-812.
8. Stilwell B, Diallo K, Zurn P, Vujicic M, Adams O, Dal Poz M: **Migration of health-care workers from developing countries: strategic approaches to its management**. *Bull World Health Organ* 2004, **82**(8):595-600.
9. Dovlo D: **Migration of nurses from sub-Saharan Africa: a review of issues and challenges**. *Health Serv Res* 2007, **42**(3 Pt 2):1373-1388.

10. Mullan F: **The muscular Samaritan: the National Health Service Corps in the new century**. *Health Aff (Millwood)* 1999, **18**(2):168-175.

11. Brooks RG, Mardon R, Clawson A: **The rural physician workforce in Florida: a survey of US- and foreign-born primary care physicians**. *J Rural Health* 2003, **19**(4):484-491.

12. Pathman DE, Konrad TR, Ricketts TC, 3rd: **The National Health Service Corps experience for rural physicians in the late 1980s**. *JAMA* 1994b, **272**(17):1341-1348.

13. Perkins D, Larsen K, Lyle D, Burns P: **Securing and retaining a mental health workforce in Far Western New South Wales**. *Aust J Rural Health* 2007, **15**(2):94-98.

14. Richards HM, Farmer J, Selvaraj S: **Sustaining the rural primary healthcare workforce: survey of healthcare professionals in the Scottish Highlands**. *Rural Remote Health* 2005, **5**(1):365.

15. Charles DM, Ward AM, Lopez DG: **Experiences of female general practice registrars: are rural attachments encouraging them to stay?** *Aust J Rural Health* 2005, **13**(6):331-336.

16. Kotzee TJ, Couper ID: **What interventions do South African qualified doctors think will retain them in rural hospitals of the Limpopo province of South Africa?** *Rural Remote Health* 2006, **6**(3):581.

17. Bärnighausen T, Bloom D: **"Conditional scholarships" for HIV/AIDS health workers: educating and retaining the workforce to provide antiretroviral treatment in sub-Saharan Africa**. *Soc Sci Med* 2009, **68**:544-551.

18. Sempowski IP: **Effectiveness of financial incentives in exchange for rural and underserviced area return-of-service commitments: systematic review of the literature**. *Can J Rural Med* 2004, **9**(2):82-88.

19. **PubMed** [http://www.ncbi.nlm.nih.gov/pubmed/]

20. **EMBASE** [http://www.embase.com/]

21. Wilkins T, Gillies RA, Davies K: **EMBASE versus MEDLINE for family medicine searches**. *Canadian Family Physician* 2005, **51**(6):848-849.

22. **Cumulative index to nursing and allied health literature (CINAHL)** [http://www.ebscohost.com/cinahl/]

23. **National Health Service Economic Evaluation Database (NHS EED)** [http://mrw.interscience.wiley.com/cochrane/cochrane_cleed_articles_fs.html]

24. **Medical subject headings** [http://www.nlm.nih.gov/mesh/]

25. **EMTREE** [http://www.elsevier.com/wps/find/bibliographicdatabasedescription.cws_home/707574/description#description]

26. **Subject headings and subject coverage** [http://www.ebscohost.com/cinahl/default.php?id=8]

27. Alton V, Eckerlund I, Norlund A: **Health economic evaluations: how to find them**. *Int J Technol Assess Health Care* 2006, **22**(4):512-517.

28. Verby JE: **The Minnesota rural physician associate program for medical students**. *Journal of Medical Education* 1988, **63**(6):427-437.

29. Rabinowitz HK, Diamond JJ, Markham FW, Rabinowitz C: **Long-term retention of graduates from a program to increase the supply of rural family physicians**. *Acad Med* 2005, **80**(8):728-732.

30. Foley AE: **A strategy to increase the number of urban family practice resident physicians who enter rural practice**. *J Rural Health* 1994, **10**(2):119-121.

31. Rackley BP, Wheat JR, Moore CE, Garner RG, Harrell BW: **The Southern Rural Access Program and Alabama's Rural Health Leaders Pipeline: a partnership to develop needed minority health care professionals**. *J Rural Health* 2003, **19 Suppl**:354-360.

32. Thomson WA, Ferry PG, King JE, Martinez-Wedig C, Michael LH: **Increasing access to medical education for students from medically underserved communities: one program's success**. *Acad Med* 2003, **78**(5):454-459.

33. Hsu RH, Roberts MW, Tulloch JF, Trotman CA: **A study of military recruitment strategies for dentists: possible implications for academia**. *J Dent Educ* 2007, **71**(4):501-510.

34. Solomon SS, Tom SC, Pichert J, Wasserman D, Powers AC: **Impact of medical student research in the development of physician-scientists**. *J Investig Med* 2003, **51**(3):149-156.

35. Watt CD, Greeley SA, Shea JA, Ahn J: **Educational views and attitudes, and career goals of MD-PhD students at the University of Pennsylvania School of Medicine**. *Acad Med* 2005, **80**(2):193-198.

36. Boex JR, Kirson SM, Keyes-Welch M, Evans A: **Financial incentives in residency recruiting for primary care: Scope, characteristics, and students' perceptions**. *Acad Med* 1994, **69**(11):903-906.

37. Sibbald B, Slater J, Gosden T, Williams A, Parke S, Philpin S: **Solving inequities in provider distribution: loan repayment**. *Health Soc Care Community* 2002, **10**(3):162-167.

38. DerSimonian R, Laird N: **Meta-analysis in clinical trials**. *Control Clin Trials* 1986, **7**(3):177-188.

39. Helmes E, Jackson DN: **A comparison of methods of normalizing a discrete distribution**. *J Clin Psychol* 1982, **38**(3):581-587.

40. Cochran WG: **The combination of estimates from different experiments**. *Biometrics* 1954, **1954**(10):101-129.

41. Stone VE, Brown J, Sidel VW: **Decreasing the field strength of the National Health Service Corps: will access to care suffer?** *J Health Care Poor Underserved* 1991, **2**(3):347-358.

42. Brown J, Stone V, Sidel VW: **Decline in NHSC physicians threatens patient care**. *Am J Public Health* 1990, **80**(11):1395-1396.

43. World Bank: *World development indicators*. Washington: World Bank; 2007.

44. **Consumer Price Indices** [http://www.bls.gov/cpi/home.htm]

45. Inoue K, Hirayama Y, Igarashi M: **A medical school for rural areas**. *Med Educ* 1997, **31**(6):430-434.

46. **Abouth NHSC** [http://nhsc.bhpr.hrsa.gov/about/]

47. Ross AJ, Couper ID: **Rural scholarship schemes: a solution to the human resource crisis in rural district hospitals?** *South African Family Practice* 2004, **46**(1):5-6.

48. Pathman DE, Konrad TR, King TS, Taylor DH, Jr., Koch GG: **Outcomes of states' scholarship, loan repayment, and related programs for physicians**. *Med Care* 2004, **42**(6):560-568.

49. Rabinowitz HK, Diamond JJ, Markham FW, Hazelwood CE: **A program to increase the number of family physicians in rural and underserved areas: impact after 22 years**. *JAMA* 1999, **281**(3):255-260.

50. Wilson DR, Woodhead-Lyons SC, Moores DG: **Alberta's Rural Physician Action Plan: an integrated approach to education, recruitment and retention**. *CMAJ* 1998, **158**(3):351-355.

51. Strosberg MA, Mullan F, Winsberg GR: **Service-conditional medical student aid programs: The experience of the states**. *J Med Educ* 1982, **57**(8):586-592.

52. Probst JC, Samuels ME, Shaw TV, Hart GL, Daly C: **The National Health Service Corps and Medicaid inpatient care: experience in a southern state**. *South Med J* 2003, **96**(8):775-783.

53. Holmes GM: **Does the National Health Service Corps improve physician supply in underserved locations?** *Eastern Economic Journal* 2004, **30**(4):563-581.

54. Pathman DE, Fryer GE, Green LA, Phillips RL: **Changes in age-adjusted mortality rates and disparities for rural physician shortage areas staffed by the National Health Service Corps: 1984-1998**. *J Rural Health* 2005, **21**(3):214-220.

55. Pathman DE, Fryer GE, Jr., Phillips RL, Smucny J, Miyoshi T, Green LA: **National Health Service Corps staffing and the growth of the local rural non-NHSC primary care physician workforce**. *J Rural Health* 2006, **22**(4):285-293.

56. Lapolla M, Brandt EN, Jr., Barker A, Ryan L: **State public policy: the impacts of Oklahoma's physician incentive programs**. *J Okla State Med Assoc* 2004, **97**(5):190-194.

57. Dunbabin JS, McEwin K, Cameron I: **Postgraduate medical placements in rural areas: their impact on the rural medical workforce**. *Rural Remote Health* 2006, **6**(2):481.

58. Jackson J, Shannon CK, Pathman DE, Mason E, Nemitz JW: **A comparative assessment of West Virginia's financial incentive programs for rural physicians**. *J Rural Health* 2003, **19 Suppl**:329-339.

59. Inoue K, Matsumoto M, Sawada T: **Evaluation of a medical school for rural doctors**. *J Rural Health* 2007, **23**(2):183-187.

60. Matsumoto M, Inoue K, Kajii E: **A contract-based training system for rural physicians: follow-up of Jichi Medical University graduates (1978-2006)**. *J Rural Health* 2008a, **24**(4):360-368.

61. Matsumoto M, Inoue K, Kajii E: **Characteristics of medical students with rural origin: implications for selective admission policies**. *Health Policy* 2008b, **87**(2):194-202.

62. Matsumoto M, Inoue K, Kajii E: **Long-term effect of the home prefecture recruiting scheme of Jichi Medical University, Japan**. *Rural Remote Health* 2008c, **8**(3):930.

63. Porterfield DS, Konrad TR, Porter CQ, Leysieffer K, Martinez RM, Niska R, Wells B, Potter F: **Caring for the underserved: current practice of alumni of the National Health Service Corps**. *J Health Care Poor Underserved* 2003, **14**(2):256-271.

64. Holmes GM: **Increasing physician supply in medically underserved areas**. *Labour Economics* 2005, **12**:697-725.

65. Rittenhouse DR, Fryer GE, Jr., Phillips RL, Jr., Miyoshi T, Nielsen C, Goodman DC, Grumbach K: **Impact of Title VII training programs on community health center staffing and National Health Service Corps participation**. *Ann Fam Med* 2008, **6**(5):397-405.

66. Ross AJ: **Success of a scholarship scheme for rural students**. *S Afr Med J* 2007, **97**(11):1087-1090.

67. Bradbury SF: **The North Carolina Medical Care Commission. Evaluation of the Rural Loan Program by Recipients of Medical and Dental Loans**. *N C Med J* 1963, **24**:489-491.

68. Mason HR: **Effectiveness of student aid programs tied to a service commitment**. *J Med Educ* 1971, **46**(7):575-583.

69. Anderson M, Rosenberg MW: **Ontario's underserviced area program revisited: an indirect analysis**. *Soc Sci Med* 1990, **30**(1):35-44.

70. Bärnighausen T, Bloom D: *Designing financial-incentive programmes for return of medical service in underserved areas of sub-Saharan Africa*: Program on the Global Demography of Aging (PGDA), Harvard School of Public Health, Working Paper No. 3708; 2008.

71. Bass M, Copeman WJ: **An Ontario solution to medically underserviced areas: evaluation of an ongoing program**. *Canadian Medical Journal* 1975, **113**:403-407.

72. Weiss LD, Wiese WH, Goodman AB: **Scholarship support for Indian students in the health sciences: an alternative method to address shortages in the underserved area**. *Public Health Rep* 1980, **95**(3):243-246.

73. Holmes JE, Miller DA: **A study of 138 return service scholarship applications awarded by the Oklahoma Physician Manpower Training Commission**. *J Okla State Med Assoc* 1985, **78**(10):384-388.

74. Navin TR, Nichols AW: **Evaluation of the Arizona Medical Student Exchange Program**. *J Med Educ* 1977, **52**(10):817-823.

75. Fitz RH, Mawardi BH, Wilber J: **Scholarships for rural medicine. The Commonwealth Fund experience with a pre-World War II indenture program**. *Trans Am Clin Climatol Assoc* 1977, **88**:191-196.

76. Pathman DE, Konrad TR: **Minority physicians serving in rural National Health Service Corps sites**. *Med Care* 1996, **34**(5):439-454.

77. Rosenblatt RA, Saunders G, Shreffler J, Pirani MJ, Larson EH, Hart LG: **Beyond retention: National Health Service Corps participation and subsequent practice locations of a cohort of rural family physicians**. *J Am Board Fam Pract* 1996, **9**(1):23-30.

78. Cullen TJ, Hart LG, Whitcomb ME, Rosenblatt RA: **The National Health Service Corps: rural physician service and retention**. *J Am Board Fam Pract* 1997, **10**(4):272-279.

79. Stamps PL, Kuriger FH: **Location decisions of National Health Service Corps physicians**. *Am J Public Health* 1983, **73**(8):906-908.

80. Mofidi M, Konrad TR, Porterfield DS, Niska R, Wells B: **Provision of care to the underserved populations by National Health Service Corps alumni dentists**. *J Public Health Dent* 2002, **62**(2):102-108.

81. Pathman DE, Konrad TR, Ricketts TC, 3rd: **The comparative retention of National Health Service Corps and other rural physicians. Results of a 9-year follow-up study**. *JAMA* 1992, **268**(12):1552-1558.

82. Pathman DE, Konrad TR, Ricketts TC, 3rd: **Medical education and the retention of rural physicians**. *Health Serv Res* 1994a, **29**(1):39-58.

83. Singer JD, Davidson SM, Graham S, Davidson HS: **Physician retention in community and migrant health centers: who stays and for how long?** *Med Care* 1998, **36**(8):1198-1213.

84. Pathman DE, Konrad TR, King TS, Spaulding C, Taylor DH: **Medical training debt and service commitments: the rural consequences**. *J Rural Health* 2000, **16**(3):264-272.

85. Rabinowitz HK, Diamond JJ, Veloski JJ, Gayle JA: **The impact of multiple predictors on generalist physicians' care of underserved populations**. *Am J Public Health* 2000, **90**(8):1225-1228.

86. Xu G, Fields SK, Laine C, Veloski JJ, Barzansky B, Martini CJ: **The relationship between the race/ethnicity of generalist physicians and their care for underserved populations**. *Am J Public Health* 1997b, **87**(5):817-822.

87. Xu G, Veloski JJ, Hojat M, Politzer RM, Rabinowitz HK, Rattner S: **Factors influencing physicians' choices to practice in inner-city or rural areas**. *Acad Med* 1997a, **72**(12):1026.

88. Woolf MA, Uchill VL, Jacoby I: **Demographic factors associated with physician staffing in rural areas: the experience of the National Health Service Corps**. *Med Care* 1981, **19**(4):444-451.

89. Pathman DE, Konrad TR, Dann R, Koch G: **Retention of primary care physicians in rural health professional shortage areas**. *Am J Public Health* 2004, **94**(10):1723-1729.

90. Greenland S, Morgenstern H: **Ecological bias, confounding, and effect modification**. *Int J Epidemiol* 1989, **18**(1):269-274.

91. **35 years of excellence: access today for healthier communities tomorrow** [http://nhsc.bhpr.hrsa.gov/about/history.asp]

92. Woodhall M: **Student loans: potential, problems, and lessons from international experience**. *JHEA/RESA* 2004, **2**(2):37-51.

93. Kober K, Van Damme W: **Public sector nurses in Swaziland: can the downturn be reversed?** *Hum Resour Health* 2006, **4**:13.

94. Dovlo D, Nyonator F: **Migration by graduates of the University of Ghana Medical School: a preliminary rapid appraisal**. *Human Resources for Health Development Journal* 1999, **3**(1):40-51.

95. Nigenda G: **The regional distribution of doctors in Mexico, 1930-1990: a policy assessment**. *Health Policy* 1997, **39**:107-122.

96. Kelley ML, Kuluski K, Brownlee K, Snow S: **Physician satisfaction and practice intentions in Northwestern Ontario**. *Can J Rural Med* 2008, **13**(3):129-135.

97. Pathman DE, Williams ES, Konrad TR: **Rural physician satisfaction: its sources and relationship to retention**. *J Rural Health* 1996, **12**(5):366-377.

98. Pathman DE, Konrad TR, Williams ES, Scheckler WE, Linzer M, Douglas J: **Physician job satisfaction, dissatisfaction, and turnover**. *J Fam Pract* 2002, **51**(7):593.

99. Haas JS, Cook EF, Puopolo AL, Burstin HR, Cleary PD, Brennan TA: **Is the professional satisfaction of general internists associated with patient satisfaction?** *J Gen Intern Med* 2000, **15**(2):122-128.

100. Crane M: **Why burned-out doctors get sued more often**. *Med Econ* 1998, **75**(10):210-212, 215-218.

101. Mello MM, Studdert DM, DesRoches CM, Peugh J, Zapert K, Brennan TA, Sage WM: **Caring for patients in a malpractice crisis: physician satisfaction and quality of care**. *Health Aff (Millwood)* 2004, **23**(4):42-53.

102. Copeman WJ: **The underserviced area program of the Ministry of Health of Ontario**. *Canadian Family Physician* 1987, **33**:1683-1685.

103. Politzer RM, Trible LQ, Robinson TD, Heard D, Weaver DL, Reig SM, Gaston M: **The National Health Service Corps for the 21st century**. *J Ambul Care Manage* 2000, **23**(3):70-85.

104. **Rural medical education scholarship loan program** [http://www.pmtc.state.ok.us/ruraled.htm]

105. Indian Health Service: *Loan repayment program*. Rockville, MD: Indian Health Service; 2006.

106. **NSW rural resident medical officer cadetship** [http://www.nswrdn.com.au/site/index.cfm?module=RDNSCHOLARSHIPS&leca=82&pagemode=indiv&page_id=1839]