

TITLE PAGE

Title: The impact of health workers' strikes on health outcomes and health service utilization in low- and middle-income countries: a systematic review

Authors: Michael L. Scanlon; Lauren Y. Maldonado; Laura J. Ruhl; Lukoye Atwoli

Affiliations: Department of Health Systems Design and Global Health, Icahn School of Medicine at Mount Sinai, NY, NY, USA (ML Scanlon, MPH); Keck School of Medicine of USC, Los Angeles, CA, USA (LY Maldonado, MPH); Department of Medicine, Indiana University School of Medicine, Indianapolis, IN, USA (LJ Ruhl, MD); Department of Psychiatry, School of Medicine, College of Health Sciences, Moi University, Eldoret, Kenya (L Atwoli, PhD)

Correspondence to: Michael L. Scanlon
Arnhold Institute for Global Health, Icahn School of Medicine at Mount Sinai, One Gustave L. Levy Place, Box 1199, New York, NY 10029, USA, Tel: 212-824-7950
Email address: Michael.Scanlon@mssm.edu

This is the author's manuscript of the article published in final edited form as:

Scanlon, M., Maldonado, L. Y., Ruhl, L. J., & Atwoli, L. (2019). The Impact of Health Workers' Strikes on Health Outcomes and Health Service Utilization in Low- and Middle-Income Countries: A Systematic Review (SSRN Scholarly Paper ID 3422985). Social Science Research Network. <https://doi.org/10.2139/ssrn.3422985>

ABSTRACT

Background

The impact of strikes by health workers in low- and middle-income countries (LMIC) is not well described. We systematically reviewed articles on the impact of health workers' strikes on health outcomes or health service utilization in LMIC.

Methods

We searched PubMed, SCOPUS, Web of Science, and Google Scholar databases on May 27, 2019. To be included for review, articles met the following criteria: (1) reported on a strike that involved at least one cadre of health worker; (2) reported on a strike in a LMIC; (3) included at least one outcome related to patient or population health or health service utilization; and, (4) included a reference group or time period. There were no date or language restrictions. We modified the Newcastle-Ottawa Tool to appraise study quality. The review is registered with PROSPERO (CRD42019124989).

Findings

Among 5,123 articles, eleven articles met inclusion criteria. Studies examined 20 strikes in LMIC from 1991 to 2017 (average strike length of 32.9 days), with five studies from Kenya, two each from India and Nigeria, and one each from Malawi and South Africa. The majority of studies reported hospital admissions or inpatient mortality. Generally, health service utilization decreased during strike periods, but changes in patient mortality and other health outcomes varied. Study quality was heterogenous with most studies reporting from a single facility or medical department.

Interpretation

Compared to high-income settings, our study suggests a more complex picture of the effect of strikes by health workers on health and health service utilization outcomes in LMIC.

MANUSCRIPT

Introduction

Strikes by health workers that involve the removal or curtailing of health services raise questions about potential harm to patients. Evidence on the impact of strikes on health outcomes, however, is mixed and mostly from high-income countries (HIC). A systematic review on the impact of doctors' strikes on mortality identified seven articles that reported on five different doctors' strikes between 1976 and 2003, and found doctors' strikes were associated with either no change or a decrease in mortality.¹ The authors attributed this to the relatively short duration of strikes, availability of emergency services during strikes, postponement of elective surgeries, and sufficient staff coverage and re-assignment. In addition, all strikes occurred in HIC (Croatia, Israel, Spain, and US). Another study found that rates of in-hospital mortality and readmissions were 18.3% and 5.7% higher, respectively, during 50 different nurses' strikes at 43 facilities between 1984 and 2004 in New York State compared to non-strike periods.² A study of a 36-day municipal workers' strike in Toronto, which included employees of the Toronto Public Health Department and led to the closure of all eleven sexual and reproductive health clinics, found a small but significant increase in chlamydia cases immediately after the strike.³

In low and middle-income countries (LMIC) with different disease burdens and access to and quality of health services, it is possible that strikes by health workers pose different risks to patients compared to HIC.⁴⁻⁶ A recent review of the characteristics and frequency of health workers' strikes between 2009 and 2018 in 31 low-income countries identified 70 strikes across 23 countries that totaled 875 lost working days, with a median number of 77.5 working days lost per year.⁷ Put more starkly, the authors state, "on every third working day on average, there was a strike taking place in the health sector in a low-income country during this period."⁷ Several recent strikes by health workers in Kenya garnered global attention, including a nationwide 100-day strike by doctors in 2016 and 150-day strike by nurses in 2017, during which many public health facilities and hospitals were closed or operating at significantly reduced capacity.^{8,9} Yet, there are few data on the impact of health workers' strikes in LMIC. In this article, we describe the results of a systematic review of published studies that report patient health outcomes or health service utilization during health workers' strikes in LMIC.

Methods

Search strategy and selection criteria

We searched for studies published in any language up to May 27, 2019 using electronic literature databases PubMed/MEDLINE, Web of Science, and Scopus. We also searched Google Scholar for relevant grey literature. There were no date or language restrictions. Reporting guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement were followed.¹⁰ A detailed description of our search strategy and selection criteria are registered and published with PROSPERO (CRD42019124989).

One author (MLS) implemented our search strategy to retrieve the initial list of titles from each database. Our search strategy combined relevant terms using Boolean operators to search titles, abstracts, keywords, and subject headings as follows: ("strike" OR "industrial action" OR "slow down" OR "go slow" OR "walkout" OR "lockout" OR "labor action") AND ("health worker" OR "health personnel" OR "health professional" OR "doctor" OR "physician" OR "clinician" OR "nurse" OR "midwife" OR "health provider" OR "registrar" OR "resident" OR "medical worker"). We also used the following Medical Subject Headings to search PubMed: Strikes, Employee (N03.540.571.608 and N04.452.677.842) and Health personnel (M01.526.485 and N02.360). We categorized titles into EndNote X9 (Clarivate Analytics) libraries and removed duplicates. Two authors (MLS and LYM) independently reviewed titles and abstracts. We

compared the list of articles selected by each author and discussed discrepancies. A third author (LJR) resolved disagreements. We repeated the same process following full text review.

To be included, articles met the following criteria. First, an article had to report on a health workers' strike, defined as any collective withdrawal of services or stoppage of work by a group of individuals who are directly involved in patient care. Second, an article had to include data on at least one health or health service utilization outcome. A health outcome was defined as a patient or population-level health indicator, such as disease status, morbidity, or mortality. A health service utilization outcome was defined as any "quantification or description of the use of [health] services by persons."¹¹ Health service utilization outcomes included, but were not limited to, inpatient or outpatient visits or admissions, family planning appointments, immunizations, and disease surveillance reporting. Third, an article had to report data from an LMIC defined by the World Bank Country and Lending Groups classification.¹² Fourth, an article had to include a method to interpret strike-related outcomes such as a comparison group or time period. In cases where articles did not include sufficient information about the strike (e.g., participants, duration, reasons for strike, etc.), we searched Nexis Uni® for news articles that reported on the strike.

Data analysis

Two authors (MLS and LYM) extracted data on the study design, strike characteristics, health- or service utilization-related outcomes measured, method of control or comparison, major findings, and limitations in a Microsoft Excel database. Additional information on the strike's context such as the extent of participation by health workers in the strike action, the number and type of facilities and services affected, any contingency actions taken to reduce strike impact, and the availability of emergency services during the strike was extracted from the article itself or relevant news articles. We used narrative and descriptive analyses to interpret the impact of health workers' strike on health outcomes and health service utilization.

To evaluate study quality we adapted the Newcastle-Ottawa Scale (NOS) – a commonly used tool to evaluate case-control and cohort studies.¹³ The adapted NOS employed a "star system" along three domains: (1) selection and representativeness of the study population, (2) comparability, and (3) assessment of outcome(s). Under selection and representativeness, studies scored higher if the authors described the study population's exposure to a strike (e.g., what health services were curtailed or stopped and to what degree) and the representativeness of the study population to the broader community or population. Under comparability, studies scored higher if the authors explained and justified their use of an appropriate control group or time period to compare outcomes during the strike to a non-strike period. Finally, under assessment of outcome(s), studies scored higher if the authors justified the selection of outcome(s) and included sub-group or sensitivity analyses. We scored studies on a nine-star scale (each domain worth a maximum of three stars) with more stars indicating higher quality. The adapted NOS tool is available from the authors upon request. Two authors (MLS and LYM) independently appraised studies using the NOS and a third author (LJR) resolved disagreements.

Role of the funding source

There was no funding source for this study.

Results

Our search resulted in 5,123 unique titles. We reviewed 110 full-text articles and 11 articles met inclusion criteria (**Figure 1**). Eleven studies reported on 20 different strikes in LMIC from 1991 to 2017 with 659 total strike days (average strike length was 32.9 days). We found no studies

published before 1999 on the impact of health workers' strikes in LMIC. Eleven strikes were by doctors alone (including six by resident doctors), five by nurses alone, and four by more than one cadre of health worker. The most commonly reported outcomes were mortality (five studies) and hospital admissions (seven studies). Most studies used single-facility hospital data (seven studies), and four studies pooled data from multiple health facilities or used health surveillance databases. Five studies were from Kenya, two from Nigeria, two from India, one from Malawi, and one from South Africa. Additional information on study design and findings are summarized in **Table 1**.

In Kenya, *Ong'ayo et al. (2019)* used population-level data from the Kilifi Health and Demographic Surveillance System to examine the impact of six public sector doctors' and nurses' strikes lasting between 9 to 42 days on all-cause and cause-specific mortality. Among a total of 6,396 recorded deaths during the study period (2010 to 2016), the authors found no significant change in all-cause mortality on strike versus non-strike days (adjusted rate ratio [RR] 0.93, 95% CI 0.81-1.08, $p=0.34$). The authors also found no difference in cause-specific mortality. In age-group analyses, being aged 1-11 months was non-significantly associated with lower mortality risk during strike days (RR 0.58, 95% CI 0.33-1.03, $p=0.06$) while being aged 12-59 months was associated with higher mortality risk (RR 1.75, 95%CI 1.11-2.76, $p=0.01$). The authors did not comment as to why these age groups may have been impacted differently.

In another study from Kenya, *Adam et al. (2018)* examined hospital admissions and mortality at AIC-Kijabe Hospital, a not-for-profit hospital that remained open during a 100-day nationwide doctors' strike.¹⁴ Monthly admissions and mortality across four departments (newborn nursery, pediatric, pediatric surgery, and obstetrics) were compared during the strike (December 2016 to March 2017) to a pre-strike and post-strike period. During the strike, admissions increased in all departments except pediatric surgery, although only newborn nursery admissions increased significantly ($p=0.0003$). In the newborn nursery unit, the odds of mortality were 4.1 times higher (95% CI 2.4-7.1, $p<0.0001$), in the pediatric ward 3.9 times higher (95% CI 2.3-6.4, $p<0.0001$), and in the pediatric surgical ward 7.9 times higher (95%CI 3.2-20.0, $p<0.0001$) during the strike compared to pre-strike period.

Njuguna (2015) used facility data on attendance and inpatient deaths at the Mombasa County Referral Hospital in Kenya during a two-week public health workers' strike in 2014. Admissions declined between 41-79% across six hospital departments, and inpatient mortality declined 37% compared to a pre-strike period. No significance testing was reported. Another study by *Njuguna et al. (2018)* reported the number of fully immunized children at 18 county referral hospitals, 12 faith-based hospitals, and two health centers during the nationwide 150-day nurses' strike in 2017.¹⁵ Compared to a similar period in 2016, the percentage of fully immunized children during the strike was on average 57% lower in county referral hospitals ($p<0.001$) and 363% higher in faith-based facilities ($p<0.001$). Immunization varied significantly across facilities with one county hospital reporting a 25% increase in fully immunized children while others reported a decrease between 9-93%. Potential reasons for variability across facilities were not discussed.

In the last study from Kenya, *Irimu et al. (2018)* reported hospital admissions at 13 public county hospitals during two nationwide strikes in Kenya – a 100-day doctors' strike that was followed shortly after by a 150-day nurses' strike.¹⁶ The authors used two-year pooled data on monthly admissions to four different wards (pediatric, maternal, adult, and surgical). Admissions across all wards decreased dramatically during strike months. By the authors' estimation, 183,170 individuals were not admitted to these hospitals that would have been expected in the absence

of strikes. The authors, however, did not provide specific figures on admissions by facility or significance testing results.

Two studies examined health workers' strikes in Nigeria. *Fiebai et al. (2005)* reported no significant change in the number of deliveries, caesarean sections, perineal trauma related to delivery, or birth asphyxia during a one-month nurses' strike at a public teaching hospital in Port Harcourt.¹⁷ Using a public health database, *Daniel et al. (2017)* examined quarterly TB case reporting from 134 facilities during two public sector health workers' strikes – a 55-day strike by doctors followed by a 50-day strike by nurses and other allied health professionals in 2014.¹⁸ The authors reported a 14.7% decline in TB cases reported from public facilities in 2014 compared to 2013; when compared to equivalent non-strike periods, strike-affected quarters had significantly fewer TB cases from public facilities and significantly more cases in private facilities ($p < 0.001$). The nurses and allied health workers' strike in 2014 was also associated with a significant decrease in the proportion of presumptive TB patients tested for HIV ($p < 0.001$).

In India, two studies reported data during resident doctors' strikes. *Aggarwal et al. (2012)* reported that admissions decreased 51% across outpatient departments at a single hospital in New Delhi during five resident doctors' strikes that lasted between 2 and 8 days.¹⁹ The authors did not report to what extent outpatient services were affected by the resident doctors' strikes. *Daga and Shende (1999)* reported no change in neonatal mortality, birth asphyxia, high risk deliveries, or Caesarean sections at a special care unit at a hospital in Mumbai during a 69-day resident doctors' strike.²⁰ During the resident doctors' strike, the authors reported that medical officers from the government were seconded and trained to support special care unit services, which likely helped maintain services.

In South Africa, *Bhuiyan and Machowski (2012)* reported facility data on admissions and mortality at a tertiary hospital during a 20-day doctors' strike.²¹ The authors categorized admissions and mortality data into total hospital versus surgical or emergency-related. During the strike, general hospital and surgical admissions decreased by 63% and 68%, respectively, but emergency-related surgeries increased by 48%. Similarly, while overall hospital mortality decreased by 18%, mortality among emergency surgical patients increased by 67% ($p < 0.001$).

Finally, *Muula and Phiri (2003)* reported on a 14-day general health workers' strike at a tertiary hospital in Blantyre, Malawi. The authors noted an overall decrease in bed occupancy and inpatient deaths "compared to normal" attributed to the transfer of critically ill patients to other facilities during the strike.²² While the 1500-bed hospital normally operated at full capacity with all beds occupied, only 196 inpatient beds were occupied during the strike.

Overall quality assessment scores for each study are presented in **Table 1**. One study scored nine stars, four studies scored eight stars, three studies scored between five to seven stars, and three studies scored four stars or fewer. Generally, studies scored weakest in the comparability category and strongest in the assessment of outcomes. A minority of studies justified their selection of an appropriate control group or comparison period and addressed any limitations of their approach, and few studies noted any potential seasonality in hospital admissions in discussion the selection of comparison time periods. In addition, a minority of studies discussed the potential for delayed effects of strikes on services or outcomes. An exception, for example, was *Ong'ayo et al. (2019)* who examined mortality in the first and second weeks immediately after strikes compared to other non-strike periods. Most outcomes were assessed using hospital or public health databases providing a high degree of validity, however, few studies measured multiple outcomes or included sub-group or sensitivity analyses. Studies were also weakened

by a lack of discussion about exposure assessment – e.g., authors rarely provided information on what and how specific facilities or services were affected by health workers' strikes.

Discussion

Despite a paucity of data, our review suggests health workers' strikes in LMIC have more varied impacts on health outcomes and services compared to HIC. Studies in our review mostly reported on doctors' or nurses' strikes in sub-Saharan Africa and there were no discernable patterns about differential impacts of strikes by health worker cadre. Most studies employed only a few indicators, mostly inpatient mortality and admissions, from single facilities. Moreover, few studies described in detail the context of the strike under study, including contingency measures put in place during the strike. In many cases, this made it difficult to interpret and compare findings across studies to generalize on impact of strikes on patient outcomes and health services.

Several studies reported a decline or no change in inpatient mortality at public health facilities during strikes, which may be due to fewer patients being admitted or treated at these facilities.²⁰⁻²⁴ Including data from facilities that remained open during strikes can help assess the broader impact of strikes in the public sector where most strikes in LMIC seem to take place.⁷ At a private, faith-based facility that remained open during the 2016-17 nationwide public sector doctors' strike in Kenya, mortality increased significantly across several different departments, which the authors attributed to a triage-type admissions protocol that prioritized sicker patients during the strike.¹⁴ Studies that included data from both public and private facilities suggest that the private health sector is likely unable to cope with increased demand to provide services during regional or national-level public sector strikes.^{15,18}

Disaggregating cause-specific from all-cause mortality can also provide more insight into how patients and services are affected by strikes.²⁴ In a study from a tertiary hospital in South Africa, for example, while overall mortality decreased, emergency surgical patient deaths increased significantly during a doctors' strike.²¹ This finding suggests that, perhaps unsurprisingly, patients in need of urgent care may be particularly vulnerable during health workers' strikes if adequate provisions are not in place to provide emergency services, but few studies included a discussion of the availability of these services.

Assessing the impact of strikes by health workers on mortality and health services at a community or population level is challenging. Several studies used population-level data or clinical databases with data from multiple facilities.^{15,16,18,24} For example, population-level data from the Kilifi Health and Demographic Surveillance System that includes routine data on pregnancies, births, migrations, and deaths were used to show no change in mortality during several strikes in a Kenyan County.²⁵ Elsewhere, studies used death certificates and national death statistics during health workers' strikes to examine population-level mortality in Israel²⁶ and Croatia²⁷, respectively. However, access to reliable vital statistics at a population level are limited in many LMIC.²⁸ Outside of mortality, studies using public health surveillance tools such as the TB reporting database in Nigeria represent novel strategies to better understand the potential long-term impacts of strikes on public health activities and outcomes.

Strikes by health workers are complex and difficult events to study. This is partly because their impact on patients and services hinges so heavily on individual strike characteristics and contexts such as the accessibility and quality of the health system and its capacity to respond to service disruptions. Future research should undertake the more difficult task of evaluating the particular conditions in which strikes lead to specific outcomes related to patients and services. More rigorous investigations into these causal mechanisms may inform health workers,

governments, and other health system stakeholders in mitigating the most harmful effects of strikes. These data could, for instance, support the implementation of mandatory minimum services agreements to keep emergency and essential health services functioning while upholding the rights of health workers to strike.

Studies on the impact of strikes typically take a relatively narrow, short-term perspective. While this might be appropriate for studying acute and emergency-related outcomes, the consequences of missed childhood immunizations or other maternal and early childhood interventions likely have longer-term consequences.²⁹ In addition to their impact on patients, strikes by health workers raise questions about pay and working conditions in the health sector as well as health system governance and financing that have important implications for policy initiatives like universal health coverage.³⁰ In a recent commentary, JK Muma Nyagetuba and Mary Adam challenged researchers and policymakers to think more critically about what strikes by health workers reveal about trust between different actors in the health system,³¹ with trust being an area of increasing interest among health systems and policy scholars.³²⁻³⁵ While these questions lie outside of the scope of this review, there is clearly a need for additional research on how health workers' strikes impact both short- and long-term health outcomes and services as well as their connection to broader health system-level political, economic, and policy factors.

ADDITIONAL INFORMATION

Contributors

MLS and LYM were responsible for leading the overall conceptualization of the article, building and implementing the search strategy, reviewing articles for inclusion, and drafting the first version of the manuscript. LJR and LA assisted in conceptualization of the article, review of the search strategy, and editing all versions of the manuscript. LJR served as a third reviewer to resolve any discrepancies between the primary reviewers MLS and LYM. All authors have seen and approved the final version of the manuscript.

Funding

The study was unfunded. All authors had full access to the data and approved this version of the manuscript to submit for publication.

Declaration of interests

We declare no competing interests.

Acknowledgments

None.

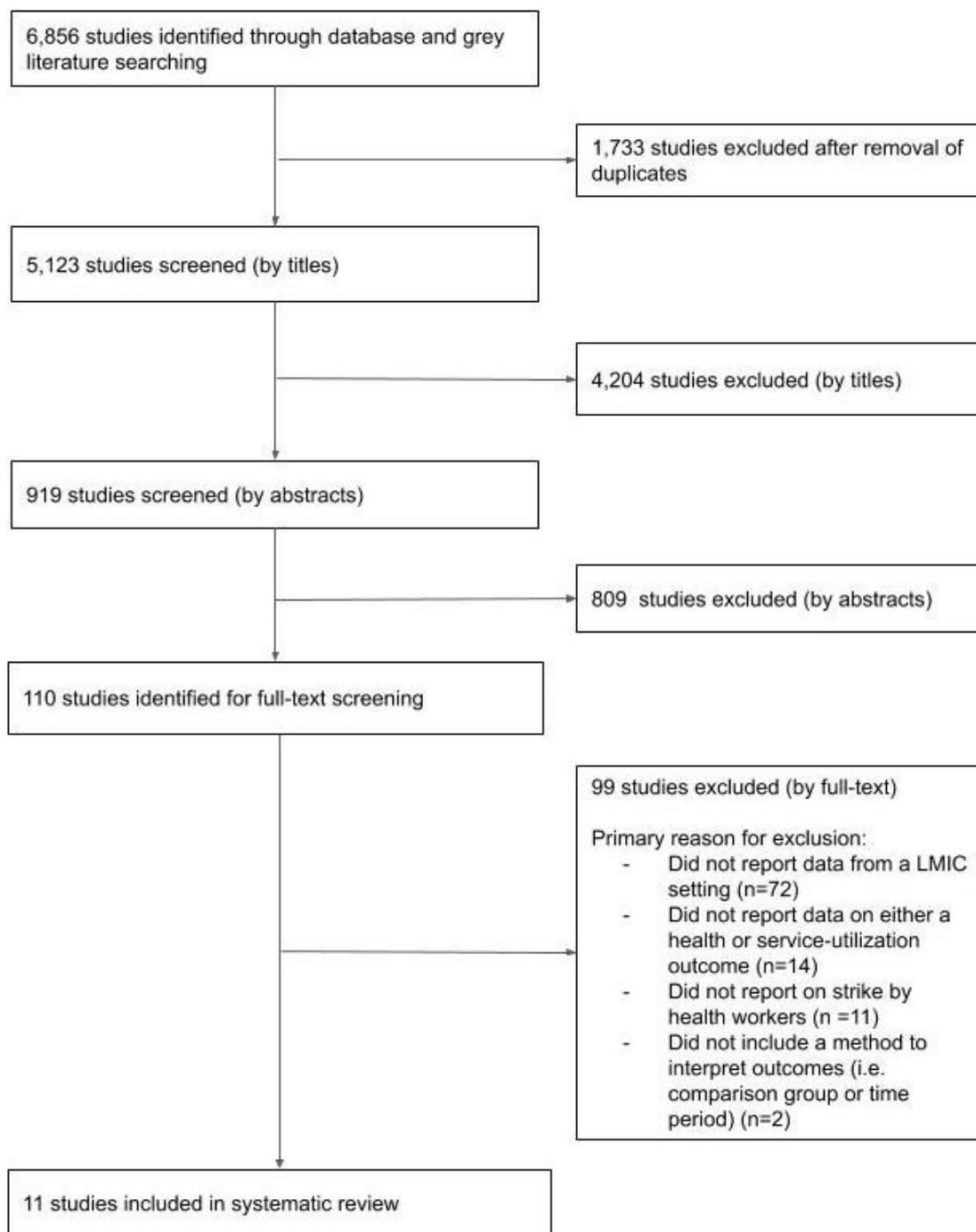
REFERENCES

1. Cunningham SA, Mitchell K, Narayan KM, Yusuf S. Doctors' strikes and mortality: a review. *Soc Sci Med*. 2008;67(11):1784-1788.
2. Gruber J, Kleiner S. Do strikes kill? Evidence from New York State. *American Economic Journal*. 2012;4(1):127-157.
3. Pinto AD, Gournis E, Al-Bargash D, Shahin R. Impact of a labour disruption affecting local public health on the incidence of chlamydia infections in Toronto. *PLoS One*. 2013;8(11):e79375.
4. Chima SC. Global medicine: is it ethical or morally justifiable for doctors and other healthcare workers to go on strike? *BMC Med Ethics*. 2013;14 Suppl 1:S5.
5. Metcalfe D, Chowdhury R, Salim A. What are the consequences when doctors strike? *Bmj*. 2015;351:h6231.
6. Kruk ME, Gage AD, Joseph NT, Danaei G, Garcia-Saiso S, Salomon JA. Mortality due to low-quality health systems in the universal health coverage era: a systematic analysis of amenable deaths in 137 countries. *Lancet*. 2018;392(10160):2203-2212.
7. Russo G, Xu L, Mclsaac M, et al. Health workers' strikes in low-income countries: the available evidence. *Bull World Health Organ*. 2019;97(7):460-467H.
8. The L. Kenya's nurses strike takes its toll on health-care system. *Lancet*. 2017;389(10087):2350.
9. Williams PCM. The reality of the mortality statistics of the nurses' strike in Kenya. *Lancet*. 2017;390(10094):551.
10. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Bmj*. 2009;339:b2535.
11. Carrasquillo O. Health care utilization. In: Gellman MD, Turner JR, eds. *Encyclopedia of Behavioral Medicine*. New York, NY: Springer; 2013.
12. The World Bank Group. World Bank Country and Lending Groups. The World Bank. <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>. Published 2019. Accessed May 25, 2019.
13. GA Wells BS, D O'Connell, J Peterson, V Welch, M Losos, P Tugwell, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Ottawa Hospital Research Institute. http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp. Published 2019. Accessed May 25, 2019.
14. Adam MB, Muma S, Modi JA, et al. Paediatric and obstetric outcomes at a faith-based hospital during the 100-day public sector physician strike in Kenya. *BMJ global health*. 2018;3(2):e000665.
15. Njuguna J. Impact of Nurses' Strike in Kenya on Number of Fully Immunized Infants in 18 County Referral Hospitals. *J Health Care Poor Underserved*. 2018;29(4):1281-1287.
16. Irimu G, Ogero M, Mbevi G, et al. Tackling health professionals' strikes: an essential part of health system strengthening in Kenya. *BMJ global health*. 2018;3(6):e001136.
17. Fiebai PO, Anya SE, Nyengidiki TK, John CT. Deliveries during a nurses' strike in Port Harcourt. *Nigerian journal of medicine: journal of the National Association of Resident Doctors of Nigeria*. 2005;14(4):454-455.
18. Daniel O, O. Adejurno, F. Soyinka, et al. The effect of health sector industrial actions on TB and TB/HIV case finding in Ogun State, Nigeria: Is public-private mix a viable solution? *Annals of Health Research*. 2017;3(2):126-131.
19. Aggarwal S, Yadav R, Singh H, Sharma A, Sharma V. Analysis of physicians' strikes and their impact. *Indian J Med Ethics*. 2012;9(3):217-218.

20. Daga SR, Shende SR. Neonatal care during a residents' strike. *Tropical doctor*. 1999;29(2):73-75.
21. Bhuiyan MM, Machowski A. Impact of 20-day strike in Polokwane Hospital (18 August - 6 September 2010). *South African medical journal*. 2012;102(9):755-756.
22. Muula AS, Phiri A. Reflections on the health workers' strike at Malawi's major tertiary hospital, QECH, Blantyre, 2001: a case study. *Nursing ethics*. 2003;10(2):208-214.
23. Njuguna J. Impact of Health Workers' Strike in August 2014 on Health Services in Mombasa County Referral Hospital, Kenya. *J Health Care Poor Underserved*. 2015;26(4):1200-1206.
24. Ong'ayo G, M. Ooko, R. Wang'ondu, C. Bottomley, A. Nyaguara, BK Tsofa, et al. Effect of strikes by health workers on mortality between 2010 and 2016 in Kilifi, Kenya: a population-based cohort analysis. *Lancet Glob Health*. 2019;7:e961-67.
25. Ndila C, Bauni E, Mochamah G, et al. Causes of death among persons of all ages within the Kilifi Health and Demographic Surveillance System, Kenya, determined from verbal autopsies interpreted using the InterVA-4 model. *Glob Health Action*. 2014;7:25593.
26. Slater PE, Ever-Hadani P. Mortality in Jerusalem during the 1983 doctor's strike. *Lancet*. 1983;2(8362):1306.
27. Erceg M, Kujundzic-Tiljak M, Babic-Erceg A, Coric T, Lang S. Physicians' strike and general mortality: Croatia's experience of 2003. *Coll Antropol*. 2007;31(3):891-895.
28. Mikkelsen L, Phillips DE, AbouZahr C, et al. A global assessment of civil registration and vital statistics systems: monitoring data quality and progress. *Lancet*. 2015;386(10001):1395-1406.
29. Kronborg H, Sievertsen HH, Wust M. Care around birth, infant and mother health and maternal health investments - Evidence from a nurse strike. *Soc Sci Med*. 2016;150:201-211.
30. Salama P, Mclsaac M, Campbell J. Health workers' strikes: a plea for multisectoral action. *Bull World Health Organ*. 2019;97(7):443-443A.
31. Muma Nyagetuba JK, Adam MB. Health worker strikes: are we asking the right questions? *Lancet Glob Health*. 2019;7(7):e831-e832.
32. Lee PV, Berwick D, Sinsky CA. Building Trust Between the Government and Clinicians: Person to Person and Organization to Organization. *JAMA*. 2019;321(18):1763-4.
33. Lee TH, McGlynn EA, Safran DG. A Framework for Increasing Trust Between Patients and the Organizations That Care for Them. *JAMA*. 2019;321(6):539-540.
34. Ozawa S, Sripad P. How do you measure trust in the health system? A systematic review of the literature. *Soc Sci Med*. 2013;91:10-14.
35. Sandy LG, Pham HH, Levine S. Building Trust Between Physicians, Hospitals, and Payers: A Renewed Opportunity for Transforming US Health Care. *JAMA*. 2019;321(10):933-4.

FIGURES

Figure 1. Study selection



TABLES

Table 1. Study characteristics

Article	Study Design and Data Source(s)	Outcome(s)	Comparison group	Findings	Quality score
Adam et al. (2018)	Single facility study at AIC-Kijabe Hospital, Kijabe, Kenya using facility records during a 100-day doctors' strike in 2016-2017	Hospital admissions and mortality data from four departments: newborn, pediatric, pediatric surgery, and obstetric	Data from pre- and post-period immediately preceding and following strike period	Generally, no change in admissions but increase in mortality across four departments	8 stars
Aggarwal et al. (2012)	Single facility study at Guru Teg Bahadur Hospital, New Delhi, India using facility records during five short resident doctors' strikes (2-8 days) between 2007-2011	Outpatient department admissions	Data from strike period compared to average daily admissions in month prior to strike	Outpatient admissions decreased but no significance test reported	5 stars
Bhuiyan & Machowski (2012)	Single facility study at Polokwane Hospital, Limpopo Province, South Africa using facility records during a 20-day doctors' strike in 2010	Admissions, surgical operations, and mortality data	Data from strike period compared with randomly selected 20-day period in same year	Overall admissions, surgical operations, and mortality decreased during strike; however, emergency operations and deaths increased significantly	5 stars
Daga & Shende (1999)	Single facility study at J. J. Hospital, Mumbai, India using facility records during a 69-day resident doctors' strike in 1991-1992	Admissions, high-risk deliveries, and deaths in neonatal unit	Data from strike period compared with pre- and post-strike data using Chi-square tests but comparison period not defined	No significant difference in admissions, high-risk deliveries, or deaths	5 stars
Daniel et	Population-based study using the	New TB cases, TB patients tested for	Quarterly data 2013-2014	Significant decrease in TB	8 stars

al. (2017)	Ogun State TB and Leprosy Control Programme database in Nigeria during two strikes: a 55-day strike by doctors and 50-day strike by allied health workers in 2014	HIV and uptake of HIV treatment	compared quarters impacted by strike with quarters from previous year using Chi Square tests	cases reported in both doctors and allied health workers strike, as well as decrease in those tested for HIV during allied health workers' strike	
Fiebai et al. (2005)	Single facility study at University of Port Harcourt Teaching Hospital, Port Harcourt, Nigeria using facility records during a 1-month nurses' strike in 2001	Number of deliveries, mode of delivery, perineal trauma	Data from strike period (July 2001) compared with pre-strike period (April 2001) using Chi Square tests	No significant difference in in any outcomes	4 stars
Irimu et al. (2018)	Multiple facility study at 13 County public hospitals in Kenya using facility records during two strikes: a 100-day doctors' strike and 150-day nurses' strike in 2016-2017	Hospital admissions in four departments: obstetrics, pediatrics, surgical, adult medicine	Two-year pooled data from all facilities January 2016 – December 2017 (and January 2014 – December 2015 for pediatric and maternity wards). No significance testing.	Decline in admissions across all departments during doctors' and nurses' strikes; estimate that 183,170 did not receive care in 13 facilities	8 stars
Muula & Phiri (2003)	Single facility study at Queen Elizabeth Central Hospital, Blantyre, Malawi using facility records during a 14-day general health workers' strike in 2001	Inpatient bed occupancy and mortality	Unclear	Of 1,500 beds, only 196 patients served during the strike and mortality decreased ("compared to normal")	2 stars
Njuguna	Single facility study at	Attendance at six clinics: inpatient,	Mean monthly attendance	Decline in admissions across	6 stars

(2015)	Mombasa County Referral Hospital, Mombasa, Kenya using the Kenya Health Information System database and facility records during a 14-day strike by public health workers in 2014	outpatient, special clinic (ENT, STI, etc.), radiology, dental, maternal and child health/family planning, and delivery; inpatient mortality	and inpatient deaths in strike-affected month (August 2014) compared to non-strike months (January – July 2014). No significance testing.	all clinics (41% - 79%) and inpatient deaths (37%) during strike month	
Njuguna (2018)	Multiple facility study at 18 County referral hospitals, 12 faith-based hospitals, and 2 health centers using the Kenya Health Information System database during a 150-day nurses' strike in 2017	Facility reported number of fully immunized infants	Number of fully immunized infants reported from facilities July – September 2017 (strike) compared to July – September 2016 (non-strike) using Mann – Whitney U Tests	Number of fully immunized infants declined 57% at public facilities ($p < 0.001$) and increased 252% at faith-based facilities ($p < 0.001$) in strike compared to non-strike period	8 stars
Ong'ayo et al. (2019)	Population-based study using the Kilifi Health and Demographic Surveillance System in Kenya during six health workers' strikes (9-42 days) between 2011-2013	Inpatient mortality classified into six causes (maternal, medical, surgical, medical or surgical, trauma associated, other causes)	Strike days (128 strikes days) compared to non-strike days (2,397 non-strike days) from January 1, 2010 to November 30, 2016 using adjusted rate ratios	No significant change in all-cause mortality or cause-specific mortality during strike periods; some evidence that all-cause mortality increased in one age group (12-59 months, $p = 0.016$)	9 stars

PANELS

Panel 1. Research in Context

Evidence before this study

Strikes by health workers are global phenomena with potentially significant consequences for patient outcomes and health services, yet there are few empirical data on the impact of health workers' strikes. We could find only one published systematic review on this topic by *Cunningham et al. (2008)* that was restricted to studies on the impact of doctors' strikes on mortality. The authors identified seven articles that reported on mortality outcomes from five different doctors' strikes between 1976 and 2003 in Croatia, Israel, Spain, and the US, and they found that all studies reported no increase or a decline in mortality during doctors' strikes. There are fewer data from low and middle-income countries (LMIC) where health systems may be more vulnerable to the impact of strikes. To address this gap in the literature, we searched PubMed, SCOPUS, Web of Science, and Google Scholar databases on May 27, 2019 for peer-reviewed articles that examined the impact of health workers' strikes on a health outcomes or health service utilization outcome in LMIC.

Added value of this study

Our systematic review contributes important insights into the impact of strikes by health workers in LMIC. Compared to literature from high-income settings, our review shows that the impact of strikes by health workers likely have more variable impacts on health outcomes and services, with several studies suggesting that both health outcomes and health services are significantly and negatively impacted by health workers' strikes. Study quality was also variable, which suggests a need for more rigorous and population-level studies to better understand both the impact of strikes as well as the particular aspects of strike characteristics that are most harmful for patients. While context of a particular strike is likely critical to its impact on patients and services, few studies attempt to tease out these different factors and their impact on outcomes and services.

Implications of all the available evidence

While the freedom to organize and strike are basic rights, strikes by health workers raise a number of complex issues including the potential impact of strikes on patient safety and population health. Our review of the literature from LMIC suggests that the impact of strikes by health workers on health outcomes and services varies significantly. Perhaps, then, asking whether or not strikes by health workers negatively impact health outcomes and services is the wrong question to ask. Rather, future research studies should undertake the more difficult task of assessing under what conditions and contexts do strikes negatively impact health outcomes and services? This information could help inform future industrial action by health workers to pursue collective action while minimizing risks to patient safety and population health.