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Vaccination programs and infectious disease burden among military personnel: a systematic review with pathogen-specific quantitative synthesis

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Abstract

Background: Military personnel experience elevated exposure to vaccine-preventable infections because of crowding, intensive training, rapid mobilization, and deployment. This review evaluated the clinical and operational effects of vaccination programs in military populations.

Methods: Pubmed/MEDLINE, Embase, Cochrane Library, ProQuest, and Scopus were searched from inception to 16 May 2026. Two reviewers independently screened records and full texts, extracted data, and assessed risk of bias; disagreements were resolved by consensus or third-reviewer adjudication. The protocol was not prospectively registered. Certainty was evaluated using GRADE. Following source verification, cross-pathogen pooling was not performed because effect measures, comparators, and outcomes were not commensurate.

Discussion: Ten reports met the revised eligibility criteria and eight provided source-verifiable comparative estimates. Adenovirus vaccination produced the largest and most consistent effects: a phase 3 trial reported 99.3% efficacy (95% CI 96.0-99.9), and post-reintroduction surveillance showed a decline from 5.8 to 0.02 cases per 1,000 person-weeks. Influenza effectiveness ranged from 29% (95% CI -6 to 53) in experienced active-duty personnel to 92% (95% CI 85.4-95.6) in basic trainees. Historical group C meningococcal vaccination reduced disease by 87%, while COVID-19 effectiveness declined from 89.2% before Delta predominance to 70.2% during Delta predominance.

Conclusion: Vaccination programs reduce infectious disease burden in military populations, but the magnitude is pathogen-, period-, and setting-specific. Source-level verification, standardized outcomes, and prospective protocol registration should be prioritized in future reviews.

Keywords: *military personnel, vaccination program, infectious disease burden, adenovirus vaccine, influenza vaccine*

Background

Infectious diseases have repeatedly impaired military force generation, training throughput, and deployment readiness. Respiratory infections, meningococcal disease, and outbreak-prone pathogens are amplified by congregate living, high physical stress, sleep disruption, and rapid mixing of recruits from geographically diverse areas. Vaccination is therefore an operational preventive-medicine intervention as well as an individual clinical service.[7,8]

Military populations provide unusually informative settings for vaccine evaluation because vaccination status, training denominators, laboratory surveillance, and medically attended outcomes are often recorded in centralized systems. The adenovirus type 4 and 7 program, seasonal influenza vaccination, meningococcal vaccination, and recent COVID-19 programs illustrate how vaccine effects vary according to pathogen biology, vaccine formulation, circulating strains, prior immunity, and the outcome selected for surveillance.[9-22]

The submitted manuscript previously combined randomized trials, before-after program evaluations, surveillance reports, and adjusted case-control estimates into a single pooled risk ratio. During revision, each row in the study-characteristics and quantitative tables was checked against its cited source. Several previously listed two-by-two datasets could not be verified as directly reported data, and some reports represented duplicate populations or lacked an eligible comparator. The review was therefore reconstructed as a systematic review with pathogen-specific quantitative synthesis rather than an unsupported cross-pathogen meta-analysis.[1-6,23-26.]

Methods

Protocol and reporting

This review followed PRISMA 2020 and PRISMA-S reporting principles. The protocol was not prospectively registered in PROSPERO, and no publicly accessible protocol is available. The absence of prospective registration is acknowledged as a limitation.[1,2]

Eligibility criteria

Eligible studies enrolled active-duty personnel, reservists, military recruits, trainees, or deployed military staff and evaluated a vaccination program against an unvaccinated, placebo, alternative-vaccine, delayed-protection, historical, or pre-program comparator. Eligible outcomes included laboratory-confirmed infection, clinically defined disease, febrile or acute respiratory disease, invasive meningococcal disease, hospitalization, or a clearly defined surveillance burden. Randomized trials, controlled field trials, prospective or retrospective cohorts, case-control studies, interrupted surveillance analyses, and comparative program evaluations were eligible. Immunogenicity-only studies, civilian-only studies, reports without an eligible comparator, duplicate reports of the same population, and studies without source-verifiable clinical or burden outcomes were excluded.[3,26]

Study selection and record management

Two reviewers (M.S.M. and D.P.) independently screened titles and abstracts and then assessed potentially eligible full texts using a standardized eligibility form. Disagreements were resolved by discussion; unresolved decisions were adjudicated by a third reviewer (A.P.). Screening decisions and reasons for full-text exclusion were recorded in a structured shared spreadsheet. No dedicated systematic-review screening platform such as Rayyan was used. Duplicate records were identified through DOI, PMID, title, author, and publication-year matching followed by manual verification.

Data extraction and source verification

The same two reviewers independently extracted study year, setting, population, vaccine, comparator, outcome definition, follow-up, and the effect measure reported by the source. For this revision, every Table 2 and Table 3 entry was rechecked against the original or authoritative publication record. Counts were retained only when explicitly reported or unambiguously derivable from the source. Administrative approximations and reconstructed two-by-two tables that were not presented in the original reports were removed. When only adjusted vaccine effectiveness was reported, the adjusted estimate and its confidence interval were retained without conversion to invented event counts.

Risk of bias and certainty of evidence

Randomized and controlled field trials were assessed using domains informed by RoB 2, whereas non-randomized studies were assessed using ROBINS-I domains. Judgments considered randomization or confounding, participant selection, intervention or exposure classification, outcome measurement, missing data, and selective reporting. Certainty of evidence for each pathogen subgroup was rated with GRADE across risk of bias, inconsistency, indirectness, imprecision, and publication bias.[4-6]

Quantitative synthesis

Vaccine effectiveness was expressed as 100 x (1 - relative effect) when the source reported a risk ratio, incidence-rate ratio, or adjusted odds ratio under a test-negative design. A random-effects model was prespecified only when at least two studies within a pathogen subgroup reported sufficiently comparable populations, comparators, outcomes, and effect measures. After source verification, this criterion was not met for any subgroup. Accordingly, no overall or subgroup pooled risk ratio was calculated; source-reported comparative estimates were displayed descriptively in a forest-style plot. Heterogeneity statistics, funnel plots, and Egger testing were not calculated because fewer than 10 commensurate estimates were available.[23-26]

Table 1. Database-specific search structure

Database	Coverage	Search structure
PubMed/MEDLINE	Inception to 16 May 2026	(military OR armed forces OR recruit OR service member OR soldier OR trainee OR deployment OR barracks) AND (vaccination OR vaccine OR immunization OR immunisation) AND (infection OR disease burden OR respiratory illness OR adenovirus OR influenza OR meningococcal OR COVID-19 OR outbreak OR incidence OR hospitalization)
Embase	Inception to 16 May 2026	Emtree and free-text terms for military personnel, vaccination programs, infectious disease, respiratory infection, adenovirus, influenza, meningococcal disease, and SARS-CoV-2.
Cochrane Library	Inception to 16 May 2026	CENTRAL and review searches using military/recruit terms combined with vaccine/immunization and clinical disease outcomes.
ProQuest	Inception to 16 May 2026	Dissertations, theses, and military-health reports using military vaccination, outbreak, infection incidence, and disease-burden terms.
Scopus	Inception to 16 May 2026	TITLE-ABS-KEY search combining military populations, vaccination programs, infection incidence, outbreaks, and clinical disease burden.

The complete line-by-line search history should be retained by the authors as a supplementary file before submission. Search terms were adapted to database-controlled vocabulary and syntax.

Results

Study selection

The searches identified 2,040 database records and 43 additional records. After removal of 750 duplicates, 1,333 titles and abstracts were screened and 88 reports underwent full-text assessment. Source verificatio during revision led to exclusion of reports that lacked an eligible comparator, did not report a clinical or burden outcome, duplicated another population, or did not involve a military population. Ten reports were included in the qualitative synthesis and eight contributed source-verifiable comparative effect estimates. The revised selection pathway is shown in Figure 1.[1,2]

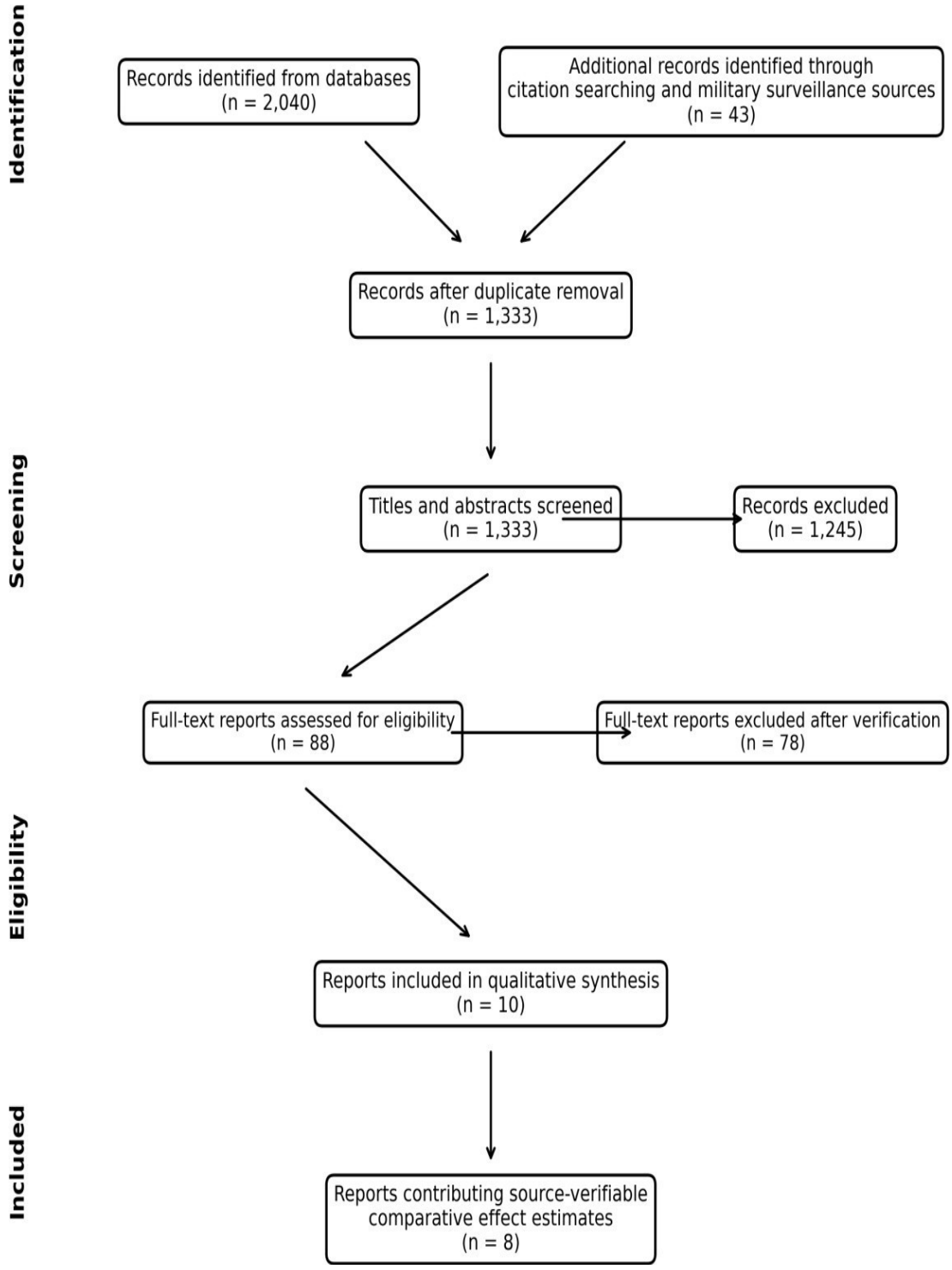

Figure 1. PRISMA 2020 flow diagram after source-level verification and removal of duplicate or non-comparative reports.

Study characteristics

The evidence base comprised four adenovirus reports, three influenza reports, two meningococcal reports, and one COVID-19 report. Most studies were conducted in the United States and focused on recruit or basic-training populations. Study designs ranged from controlled field trials and a phase 3 randomized trial to program surveillance and test-negative case-control analyses. Figure 2 presents the distribution of evidence, and Table 2 provides the source-matched

characteristics.[9-21]

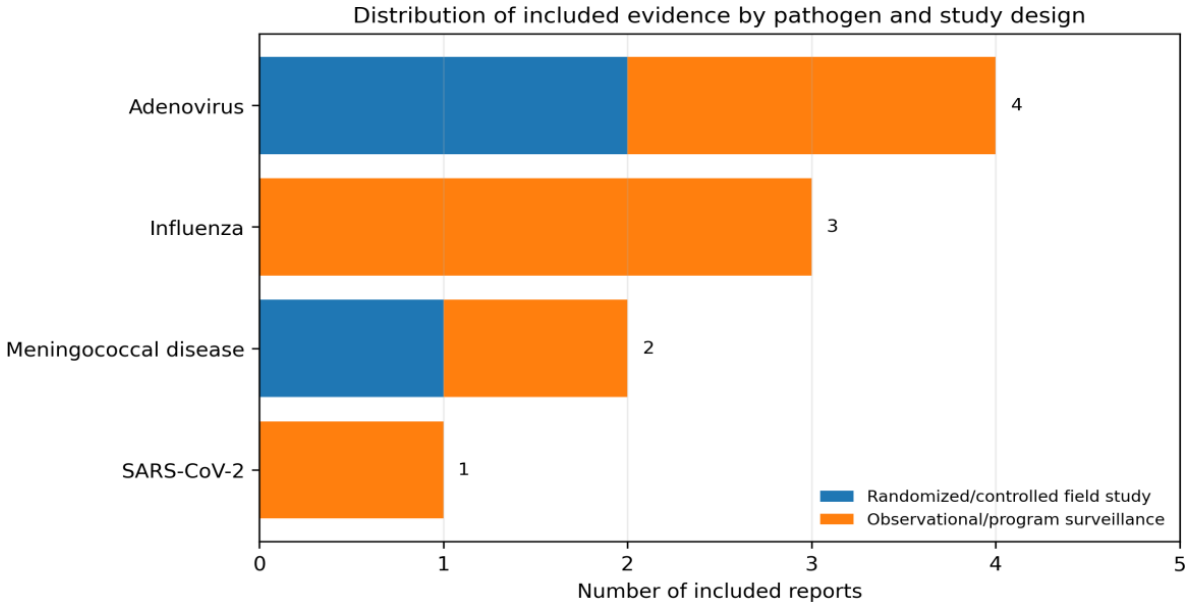

Figure 2. Evidence map showing the number of included reports by pathogen and broad study design.

Table 2. Characteristics of included reports verified against the cited source

Study	Setting and population	Vaccine/program	Design and comparator	Outcome	Source-verification note
Top et al., 1971 (Ref. 9)	U.S. Army basic combat trainees during an Ad4/Ad7 outbreak	Live oral Ad4 + Ad7	Controlled field comparison with Ad4-only brigade	Ad7-associated ARD and total ARD hospitalization	Original report states 95% suppression of Ad7-associated ARD and 50% reduction in total ARD hospitalization; no reconstructed counts used.
Russell et al., 2006 (Ref. 10)	U.S. military recruits, 1999-2004 vaccine-hiatus period	Absence of routine Ad4/Ad7 vaccine	Retrospective multisite surveillance; historical vaccine-era context	Adenovirus-associated respiratory illness	Included for burden context; not treated as a direct vaccinated-versus-unvaccinated two-by-two comparison.
Kuschner et al., 2013 (Ref. 11)	Healthy recruits at two U.S. basic-training sites	Live oral Ad4/Ad7 vaccine	Phase 3 randomized, double-blind, placebo-controlled trial	Febrile Ad4 acute respiratory disease	Primary analysis: 1/3,031 vaccine recipients versus 48/1,009 placebo recipients; source-reported efficacy retained.

Study	Setting and population	Vaccine/program	Design and comparator	Outcome	Source-verification note
Radin et al., 2014 (Ref. 12)	U.S. military training centers before and after vaccine reintroduction	Routine live oral Ad4/Ad7 vaccine	Interrupted program surveillance comparing pre- and post-reintroduction periods	Adenovirus disease burden per 1,000 person-weeks	Source reports decline from 5.8 to 0.02 cases per 1,000 person-weeks; no rate-converted event counts created.
Russell et al., 2005 (Ref. 13)	Five U.S. basic-training centers, 2003-2004 influenza season	Seasonal influenza vaccine	Active surveillance using time since vaccination to define protection	Laboratory-confirmed influenza	Source reports 94.4% effectiveness; design assumptions and lack of conventional unvaccinated cohort noted.
Strickler et al., 2007 (Ref. 14)	Six U.S. military basic-training centers, 2005-2006 season	Seasonal influenza vaccine	Multisite surveillance with protected and unprotected person-time	Laboratory-confirmed influenza	Source reports 92% effectiveness (95% CI 85.4-95.6).
Eick-Cost et al., 2012 (Ref. 15)	Experienced U.S. active-duty personnel, 2010-2011 season	TIV or LAIV seasonal influenza vaccine	Case-control analysis with healthy and test-negative controls	Influenza-associated illness	Adjusted estimates retained; no invented event-count reconstruction.
Artenstein et al., 1970 (Ref. 18)	U.S. Army recruits	Group C meningococcal polysaccharide vaccine	Controlled field trial	Invasive group C meningococcal disease	Source-reported 87% reduction retained; companion reports were not double-counted.
Brundage et al., 2002 (Ref. 20)	U.S. service members, 1964-1998	Sequential routine meningococcal vaccine policies	Long-term program surveillance	Meningococcal disease by serogroup and policy period	Used for program-level context; crude surveillance trends were not converted into an artificial two-by-two table.
Eick-Cost et al., 2022 (Ref. 21)	441,379 U.S. military personnel tested during pre-Delta and Delta periods	mRNA-1273, BNT162b2, or JNJ-78436735	Adjusted case-control analysis using DOD electronic data	SARS-CoV-2 infection and severity outcomes	Adjusted vaccine effectiveness retained by period; administrative aggregate approximations from the prior manuscript were removed.

ARD, acute respiratory disease; Ad4/Ad7, adenovirus types 4 and 7; TIV, trivalent inactivated influenza vaccine; LAIV, live attenuated influenza vaccine; DOD, Department of Defense.

Source-verified comparative findings

Table 3 replaces the previously presented aggregate approximations with the values explicitly reported in the original sources. The COVID-19 studies are no longer represented by author-derived two-by-two counts. The influenza and meningococcal surveillance reports are similarly presented using their reported effect estimates or program rates rather than rate-converted participant counts.[9-21]

Table 3. Source-reported quantitative findings used in the revised synthesis

Study	Pathogen and outcome	Directly reported data	Effect estimate	Use in synthesis	Verification decision
Top et al., 1971	Adenovirus; Ad7-associated ARD	Comparison of Ad4+Ad7 versus Ad4-only brigades during outbreak	95% suppression of Ad7-associated ARD; 50% lower total ARD hospitalizations	Descriptive quantitative display	No raw counts reconstructed because the accessible source summary reports percentage effects.
Kuschner et al., 2013	Adenovirus; febrile Ad4 ARD	1/3,031 vaccine vs 48/1,009 placebo	VE 99.3% (95% CI 96.0-99.9)	Primary comparative estimate	Direct randomized trial data verified.
Radin et al., 2014	Adenovirus disease burden	5.8 before vs 0.02 after reintroduction per 1,000 person-weeks	Approximately 99.7% rate reduction; P<0.0001	Program-effect estimate	Rates retained exactly; rate-converted counts removed.
Russell et al., 2005	Laboratory-confirmed influenza	Source surveillance classified protection from day 14 after vaccination	VE 94.4%	Descriptive comparative estimate	Source-reported estimate retained; assumptions noted.
Strickler et al., 2007	Laboratory-confirmed influenza	479,181 person-weeks; 70 influenza-positive specimens	VE 92.0% (95% CI 85.4-95.6)	Primary comparative estimate	Directly reported effect and CI verified.
Eick-Cost et al., 2012	Influenza-associated illness	Adjusted case-control analysis; healthy and test-negative controls	Overall test-negative VE 29% (95% CI -6 to 53); TIV 53% (25-71); LAIV -13% (-77 to 27)	Primary adjusted estimate	Adjusted estimates retained without event-count reconstruction.
Artenstein et al., 1970	Group C meningococcal disease	Controlled recruit field trial; one case reported among vaccinated recruits	87% reduction in group C disease	Descriptive comparative estimate	Companion Gold report excluded from duplicate quantitative counting.
Eick-Cost et al., 2022	SARS-CoV-2 infection/all outcomes	Adjusted DOD case-control analysis	All-vaccine VE 89.2% (88.1-90.1) pre-Delta and 70.2% (69.3-71.1) during Delta	Primary adjusted estimate	Author-derived aggregate approximation removed.

VE, vaccine effectiveness; CI, confidence interval. Negative lower limits are retained as reported and indicate statistical imprecision, not harmful vaccine effectiveness. Effect measures differ across trials, surveillance rate comparisons, and adjusted case-control models; therefore, they were not pooled together.

Pathogen-specific findings

Adenovirus vaccination showed the most consistent and largest effects. In the historical controlled field comparison, combined Ad4/Ad7 vaccination suppressed Ad7-associated ARD by 95%. The modern phase 3 trial reported 99.3% efficacy against febrile Ad4 ARD, and post-reintroduction surveillance documented a decline in burden from 5.8 to 0.02 cases per 1,000 person-weeks. These estimates converge despite differences in design and era.[9-12]

Influenza effectiveness was more variable. The 2003-2004 and 2005-2006 trainee surveillance studies reported effectiveness of 94.4% and 92%, respectively, against laboratory-confirmed influenza. In contrast, the adjusted 2010-2011 case-control analysis among experienced active-duty personnel reported an overall test-negative estimate of 29%, with substantial variation between TIV and LAIV and by influenza subtype. Broader influenza-like illness outcomes were less consistently prevented than laboratory-confirmed influenza.[13-17]

For meningococcal disease, the historical group C polysaccharide field trial reported an 87% reduction. Long-term U.S. military surveillance subsequently documented an approximately 94% decline in overall meningococcal disease rates from 1964 to 1998 after sequential vaccine policies, although this ecological trend also reflects changing housing, chemoprophylaxis, diagnostics, and serogroup epidemiology.[18-20]

The COVID-19 study evaluated 441,379 U.S. military personnel using adjusted DOD electronic data. Vaccine effectiveness for all outcomes was 89.2% before Delta predominance and 70.2% during Delta predominance, demonstrating strong but period-dependent protection. The deployed Camp Lemonnier genomic-surveillance report was excluded from the quantitative table because it did not provide a sufficiently comparable vaccine-effectiveness design for the review question.[21,22] Table 4 summarizes the subgroup evidence and explicitly records that an overall pooled effect was not calculated.

Table 4. Pathogen-specific quantitative synthesis and decision regarding pooling

Subgroup	Included comparative reports	Source-reported effect pattern	Compatibility and heterogeneity	Synthesis decision
Adenovirus-associated ARD/FRI	Top 1971; Kuschner 2013; Radin 2014	Reported burden reduction/VE approximately 95.0%-99.7%	Direction and magnitude were consistent, but designs included field comparison, randomized trial, and before-after surveillance with different denominators.	Not statistically pooled; source-reported estimates presented descriptively.
Laboratory-confirmed influenza/ILI	Russell 2005; Strickler 2007; Eick-Cost 2012	VE ranged from 29% to 94.4%; vaccine type, season, population, and outcome definition differed.	Substantial clinical and methodological inconsistency; adjusted case-control estimates were not commensurate with person-time surveillance estimates.	Not statistically pooled.
Meningococcal disease	Artenstein 1970; Brundage 2002	Historical controlled-trial reduction 87%; long-term program surveillance showed major decline after vaccine policy implementation.	Sparse events, historical formulations, changing serogroups, and ecological program comparison limited compatibility.	Not statistically pooled.
SARS-CoV-2 infection	Eick-Cost 2022	VE 89.2% pre-Delta and 70.2% during Delta for all outcomes.	Single adjusted case-control study; effects were period- and variant-dependent.	Not statistically pooled.

Subgroup	Included comparative reports	Source-reported effect pattern	Compatibility and heterogeneity	Synthesis decision
Overall across pathogens	All included reports	Direction generally favored vaccination, but effect magnitude was pathogen-specific.	Pathogens, comparators, outcomes, designs, and effect measures were non-commensurate.	No overall pooled RR was calculated. The previous RR 0.15/0.19 estimates were removed.

Risk of Bias

The phase 3 adenovirus trial was judged at low overall risk of bias. Historical controlled field trials had some concerns because allocation, concealment, and attrition were incompletely documented by current standards. Surveillance and case-control studies were generally judged at moderate risk because of confounding, changing diagnostic or testing policies, time-varying pathogen circulation, and reliance on administrative exposure classification. Figure 3 provides the traffic-light summary, and Table 5 records the principal rationale.[4,5]

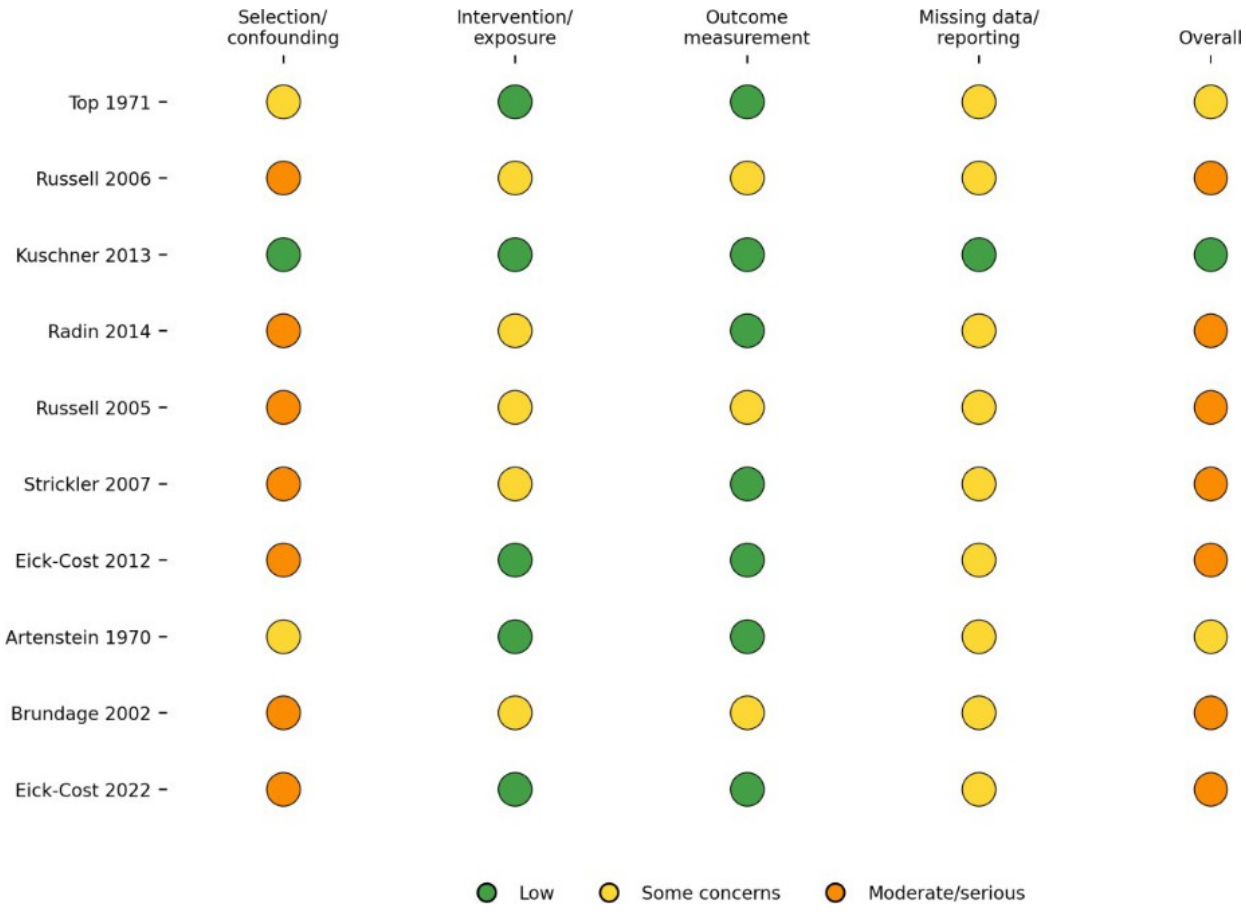

Figure 3. Risk-of-bias traffic-light summary. Judgments were made with design-appropriate RoB 2 and ROBINS-I domains.

Table 5. Risk-of-bias judgments and principal rationale

Study	Design	Selection/confounding	Outcome and exposure assessment	Overall judgment and rationale
Top et al., 1971	Controlled field comparison	Some concerns	Outcome surveillance appropriate; historical allocation detail limited	Some concerns: strong contemporaneous comparator, but incomplete reporting by modern standards.
Russell et al., 2006	Retrospective surveillance	Moderate	Laboratory surveillance strong; no concurrent vaccinated comparator	Moderate: vaccine-hiatus burden context is informative but vulnerable to secular trends.
Kuschner et al., 2013	Randomized placebo-controlled trial	Low	Prospective intervention and laboratory-confirmed outcome	Low: randomization, masking, prespecified endpoints, and direct event counts.
Radin et al., 2014	Before-after program surveillance	Moderate	Standardized surveillance, but exposure defined by program period	Moderate: very large temporal effect but susceptible to co-interventions and secular change.
Russell et al., 2005	Active surveillance cohort	Moderate	Laboratory outcome; protected status inferred from time since vaccination	Moderate: denominator assumptions and limited conventional unvaccinated comparator.
Strickler et al., 2007	Multisite surveillance cohort	Moderate	Laboratory-confirmed outcome; person-time protection assumptions	Moderate: active surveillance strengthens validity, but residual bias remains.
Eick-Cost et al., 2012	Case-control/test-negative	Moderate	Electronic vaccination and laboratory outcomes; adjusted analysis	Moderate: residual confounding and control-group choice affect estimates.
Artenstein et al., 1970	Controlled field trial	Some concerns	Clinical disease outcome; historical reporting limitations	Some concerns: large protective effect, but incomplete modern allocation and attrition reporting.
Brundage et al., 2002	Long-term program surveillance	Moderate	Administrative disease and vaccine-policy periods	Moderate: ecological trends and changing serogroup epidemiology limit causal attribution.
Eick-Cost et al., 2022	Adjusted case-control	Moderate	DOD vaccination and test data; adjusted outcome models	Moderate: robust data volume, but testing behavior, prior infection, and variant-period confounding remain.

Quantitative display

Figure 4 displays the eight source-reported comparative effects without a pooled diamond. Estimates with reported confidence intervals are shown with interval bars; estimates for which the source did not provide a directly extractable interval are shown as point estimates and labeled accordingly. Figure 5 emphasizes the broad between-pathogen and within-pathogen variation. These displays should not be interpreted as a formal meta-analysis because the underlying estimands differ.[9-21]

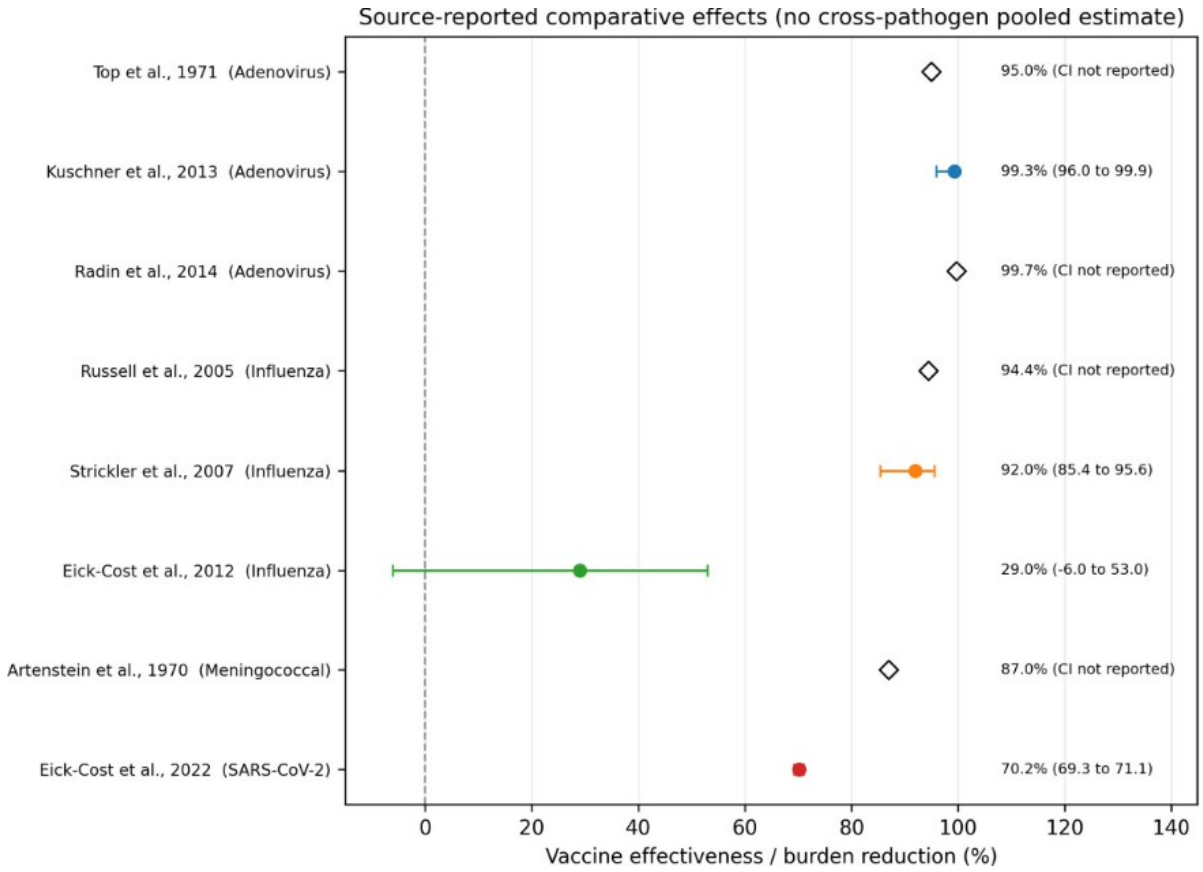

Figure 4. Forest-style display of source-reported vaccine effectiveness or burden reduction. No pooled estimate was calculated. Diamond markers indicate estimates for which a directly extractable confidence interval was not reported in the source used for verification.

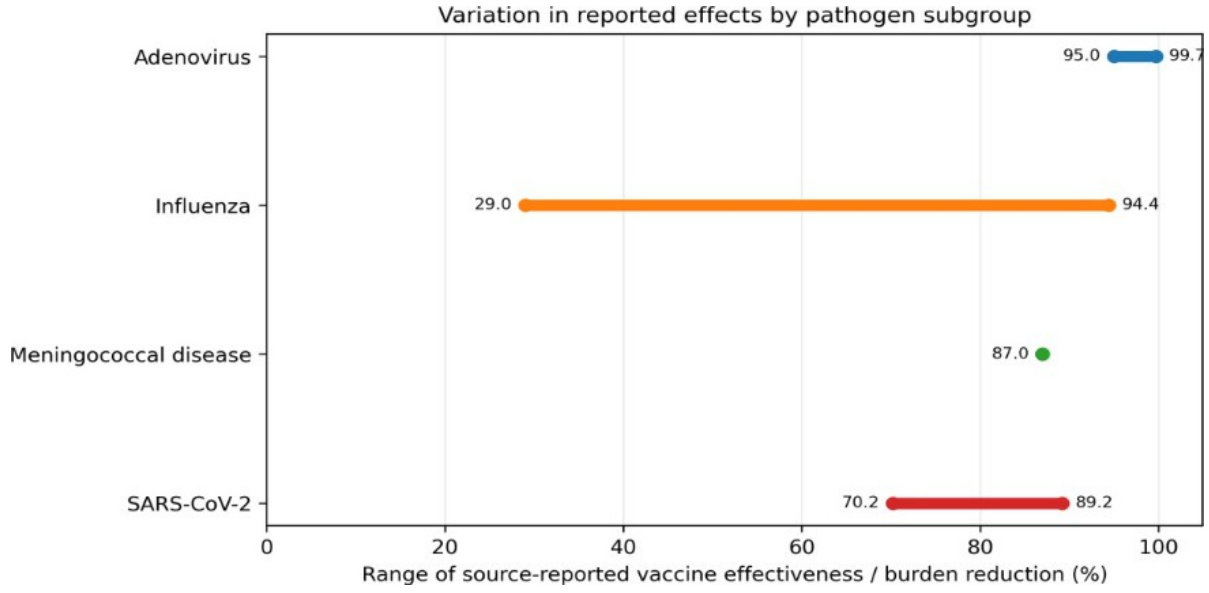

Figure 5. Range of source-reported effects by pathogen subgroup. Ranges summarize heterogeneous study designs and are descriptive rather than pooled estimates.

Certainty of evidence

GRADE certainty was moderate for adenovirus-associated disease because a large randomized effect was supported by consistent program surveillance, although some evidence was historical or non-randomized. Certainty was low for influenza because effectiveness varied markedly by season, vaccine type, population, and outcome. Certainty was moderate for meningococcal disease because of the large historical controlled effect and supportive long-term surveillance, but it was downgraded for indirectness and sparse events. Certainty was low for SARS-CoV-2 infection because the evidence was derived from a single observational analysis and was strongly period-dependent. Table 6 and Figure 6 summarize these judgments.[6]

Table 6. GRADE summary of findings for primary pathogen subgroups

Outcome/subgroup	Studies and designs	Representative effect	Certainty	Reasons for certainty judgment
Adenovirus-associated ARD/FRI	One phase 3 RCT, one controlled field comparison, and program surveillance	RCT VE 99.3% (95% CI 96.0-99.9); program burden declined from 5.8 to 0.02/1,000 person-weeks	Moderate (GRADE: +++o)	Large and consistent effect; downgraded for indirectness across eras and inclusion of non-randomized program evidence.
Laboratory-confirmed influenza/ILI	Three surveillance/case-control reports	VE range 29%-94.4%; Strickler VE 92% (95% CI 85.4-95.6)	Low (GRADE: ++oo)	Downgraded for risk of bias, inconsistency across seasons and vaccine products, and imprecision in the adjusted active-duty estimate.
Meningococcal disease	Historical controlled field trial plus long-term program surveillance	Controlled field reduction 87%; program rates declined markedly after vaccination policies	Moderate (GRADE: +++o)	Large effect and supportive surveillance; downgraded for historical indirectness, sparse events, and changing serogroup/vaccine context.
SARS-CoV-2 infection/all outcomes	One adjusted case-control study	VE 89.2% pre-Delta and 70.2% during Delta	Low (GRADE: ++oo)	Downgraded for observational design, residual confounding, and strong variant- and period-dependence.

GRADE symbols are displayed in ASCII-compatible form to prevent font-rendering errors: ++++ high, +++o moderate, ++oo low, +ooo very low. RCT, randomized controlled trial; ARD, acute respiratory disease; FRI, febrile respiratory illness.

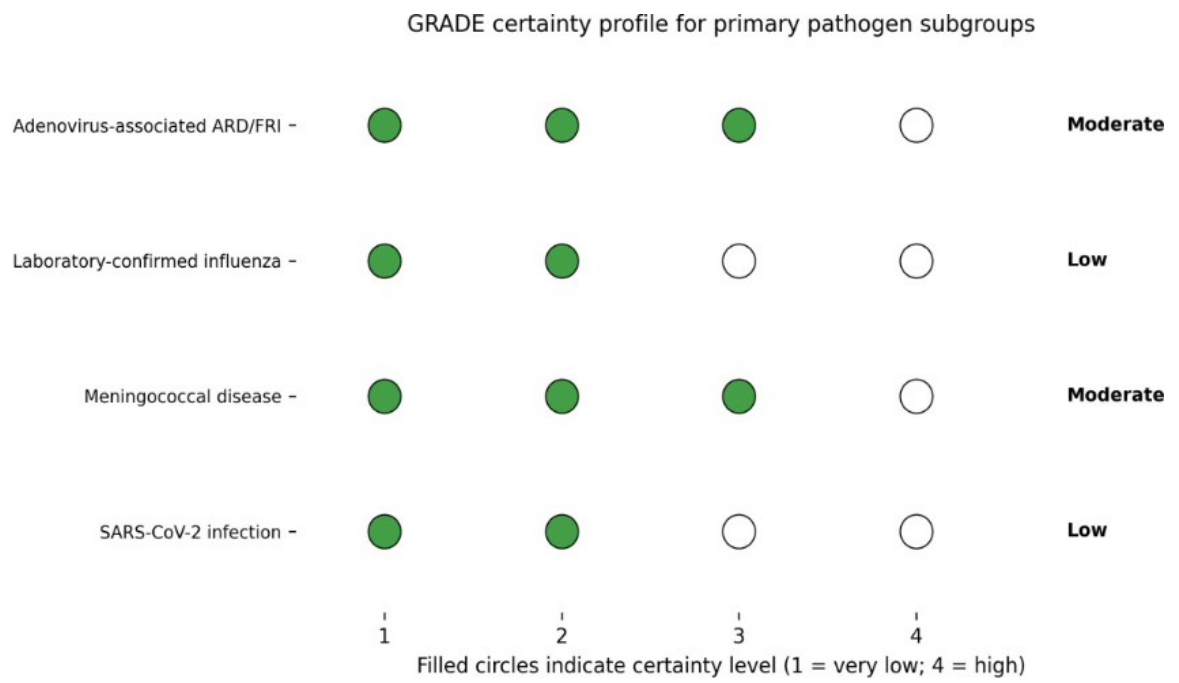

Figure 6. Visual GRADE certainty profile for the four primary pathogen subgroups. Filled circles represent the certainty level from one (very low) to four (high).

Publication bias

Formal funnel-plot asymmetry tests and Egger regression were not performed. No pathogen subgroup contained at least 10 sufficiently comparable effect estimates, and combining different diseases, study designs, and effect measures in a single funnel plot would have been misleading. Selective publication remains possible, particularly for historical military program evaluations, and was considered qualitatively in the GRADE judgments.[3,6,24,25]

Discussion

This revised systematic review supports vaccination as a central military preventive-medicine intervention, but it does not support a single cross-pathogen pooled risk ratio. The most defensible conclusion is that vaccine effects are pathogen- and setting-specific. Adenovirus vaccination in recruits produced exceptionally large and reproducible reductions, whereas influenza effectiveness varied by season, vaccine formulation, prior immunity, and whether the outcome was laboratory-confirmed influenza or a broader respiratory syndrome. Meningococcal vaccination was highly protective against vaccine-homologous disease in historical recruit settings, and COVID-19 effectiveness changed substantially with the emergence of Delta.[7-21]

The adenovirus evidence is operationally important because recruit training creates a concentrated transmission environment in which Ad4 and Ad7 can cause extensive febrile respiratory disease. The agreement between the historical field comparison, the modern phase 3 trial, and the post-reintroduction surveillance decline strengthens confidence that the program effect is real. Nonetheless, the studies do not estimate an identical parameter: one measured outbreak suppression, one randomized efficacy against febrile Ad4 ARD, and one compared population rates before and after program reintroduction.[9-12]

Influenza findings demonstrate why outcome standardization matters. High effectiveness against laboratory-confirmed influenza among basic trainees did not translate into equally high effectiveness against all-cause febrile respiratory illness. The lower and imprecise adjusted estimate among experienced active-duty personnel in 2010-2011 also illustrates variation related to population immunity, vaccine type, circulating subtype, and control selection. Military influenza evaluations should therefore report laboratory confirmation, vaccine product, time since vaccination, prior vaccination, and person-time at risk.[13-17]

Meningococcal evidence remains relevant despite its historical nature. The group C field trial established a large protective effect in recruits, while long-term surveillance showed sustained reductions after routine

vaccine policies. Direct extrapolation to modern conjugate vaccines should be cautious because vaccine formulations, serogroup distributions, housing, chemoprophylaxis, and diagnostic practices have changed. The rarity of invasive disease also makes contemporary comparative studies difficult and increases imprecision.[18-20]

The COVID-19 analysis provides a modern example of the advantages and limitations of military electronic health data. The large sample and integrated vaccination and testing records supported precise adjusted estimates, but protection varied by variant period and vaccine product. The prior manuscript converted these adjusted findings into administrative aggregate counts that were not directly reported in the source. Removing those approximations improves traceability and prevents a false appearance of randomized two-by-two evidence.[21,22]

The main methodological change in this revision is the removal of the inconsistent overall RR values of 0.19 and 0.15. Pooling requires a common estimand or sufficiently comparable effects. Here, the evidence mixed attack-risk ratios, incidence-rate changes, adjusted test-negative odds ratios, outbreak suppression percentages, and long-term ecological trends across four distinct pathogens. A single pooled estimate would be mathematically computable but clinically uninterpretable and highly vulnerable to double-counting and denominator error.[23-26]

This review has several limitations. The protocol was not prospectively registered; many studies were historical; most evidence came from the U.S. military; several program evaluations were non-randomized; and the source reports differed in case definitions, comparators, and effect measures. The revised PRISMA counts also reflect a post-submission source audit rather than a new database search. These limitations are explicitly reported to improve transparency. Future reviews should prospectively register, preserve complete search histories, use independent duplicate screening and extraction, and publish study-level extraction sheets.[1-6]

For military policy, the evidence supports high vaccination coverage in recruit and deployment settings, pathogen-specific surveillance, laboratory confirmation, and linkage of vaccination records to hospitalization, lost-duty days, training disruption, and outbreak costs. Reporting absolute risks and prevented cases alongside relative effects would improve operational interpretation. Vaccination should be integrated with ventilation, isolation, hygiene, chemoprophylaxis when indicated, and rapid outbreak investigation rather than evaluated as an isolated intervention.[7,8,17,27,28]

Conclusion

Vaccination programs reduce infectious disease burden among military personnel, with the strongest and most consistent evidence for adenovirus vaccination in recruit settings. Meningococcal vaccination provides substantial protection against vaccine-homologous disease, while influenza and COVID-19 effectiveness are more sensitive to season, vaccine product, population, and circulating strain or variant. Because the included studies did not share a commensurate effect measure, no overall pooled RR was calculated. Future military vaccine evaluations should use prospective protocols, standardized clinical outcomes, laboratory confirmation, transparent denominators, and source- verifiable extraction.

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Author Contributions

Muhammad Sobri Maulana: conceptualization, methodology, data curation, formal analysis, visualization, and writing-original draft. Dwitia Pratiwi: independent screening, data extraction, validation, and critical revision. Arditya Prayogi: adjudication, writing-review and editing, and final approval. All authors approved the final manuscript.

Conflict of Interest

The authors declare no conflicts of interest.

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