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Force health surveillance in the North Atlantic Treaty Organization (NATO) does not meet the needs of its users: A structured evaluation of EpiNATO-2

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Abstract

Introduction: Disease and non-battle injuries (DNBIs) cause substantial losses among military personnel. NATO has monitored DNBIs among its personnel since 1996 using multiple versions of a tool now called EpiNATO-2, but the surveillance system has never been systematically evaluated. Following a request from NATO to the CDC, the objective of this study was to assess surveillance system attributes of EpiNATO-2 using CDC's updated guidelines for evaluating public health surveillance systems.

Materials and Methods: Between June and October 2022, a literature review and key informant interviews were conducted to assess the following attributes: usefulness, simplicity, flexibility, data quality, acceptability, sensitivity, positive predictive value, representativeness, timeliness, stability, informatics system quality, informatics service quality, and informatics interoperability. Key informant interviews were conducted in Kosovo, Germany, and remotely with EpiNATO-2 users spanning three levels: clinical and data entry personnel (tactical level); regional medical and public health officers (operational level); and senior commanders and other governmental entities (strategic level).

Results: Fourteen EpiNATO-2 users participated in interviews, representing 3 of the 5 major NATO missions, 3 partner entities, and 7 nationalities. All users (100%) reported that the system

AUTHOR CONTRIBUTIONS

AR: study design, data collection, manuscript writing, corresponding author. RL: study design, manuscript revision. JG: study design, manuscript revision.

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There are no previous public presentations.

INSTITUTIONAL CLEARANCE

Approved for publication.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *Military Medicine* online.

did not meet their needs, with most users noting the following challenges: lack of clearly defined system objectives; poor data quality due to ambiguous case definitions and frequently unsubmitted reports (37% missing during January to June 2022); long delay between the occurrence of health events and the availability of corresponding data (≥2 weeks); and an antiquated and inflexible data management system. Overall, performance was deemed unsatisfactory on 11 of the 13 attributes.

Conclusions: This multinational sample of EpiNATO-2 users at all military levels reported that the system is currently not useful with respect to its stated objectives. Opportunities exist to improve the performance and usefulness of EpiNATO-2: improve case definitions, modernize data infrastructure, and regularly evaluate the surveillance system.

INTRODUCTION

Disease and non-battle injuries (DNBIs) are health events experienced by deployed troops not directly related to combat or enemy action. Historically, DNBI have caused substantial military losses—up to 83% of casualties and 30% of air medical evacuations among the few countries reporting DNBI outcomes.[1–4] DNBI surveillance is considered an essential component of military medicine.[5] However, unique characteristics of the military environment, such as a geographically dispersed population with inconsistent access to medical diagnostics, present obstacles to DNBI surveillance.

Syndromic surveillance is the identification of health events based on a constellation of symptoms (a syndrome) instead of diagnostic testing.[6] Its widespread use began in 2001 in the United States following biological and chemical weapons attacks[7] and has since increased globally since.[8,9] Syndromic surveillance can provide early warning of rare, novel, or unpredictable health events; identify and monitor trends; and provide timely information to facilitate rapid public health action.[10] Although syndromic surveillance has been implemented in military environments,[11–13] more information is needed on its effectiveness for DNBI surveillance.

The North Atlantic Treaty Organization (NATO) is a military-political alliance of 31 member nations. It operates in several major long-term missions (e.g., Kosovo peacekeeping, Mediterranean security, Iraq training mission, African Union support) as well as other activities associated with the Permanent Joint Headquarters, each of which consists of bases and maritime vessels with varying levels of medical support. NATO doctrine mandates the use of a force health surveillance system to monitor DNBI;[14] these surveillance operations began in 1996.[15] Since NATO initiated DNBI surveillance, the only evaluation of the NATO surveillance system was conducted by the Canadian Military in 2003.[16] The system was revised and reimplemented in 2013 as EpiNATO-2, which is operated by the NATO Center for Excellence in Military Medicine (MilMed CoE). The current version of EpiNATO-2 has not been evaluated. Therefore, the purpose of this study was to use the updated CDC guidelines for evaluating public health surveillance systems[17] to (1) identify the objectives of NATO force health surveillance, (2) describe the operation of EpiNATO-2, (3) assess the system's performance, and (4) identify opportunities for improvement.

METHODS

An evaluation of EpiNATO-2 was conducted between June and October 2022 using CDC's guidelines for public health surveillance system evaluation.[17] A literature review was conducted to provide context on single-nation military public health surveillance systems,[11–13,18–22] trends in military epidemiology,[1,12,15,18,23,24] and surveillance system evaluation.[6,17,25–28] NATO organizational documents, EpiNATO-2 user guides, and other unpublished and internal documentation of EpiNATO-2 processes were also reviewed. The results of the literature review informed the adaptation of CDC guidelines to the NATO context and supported the development of questions for semi-structured key informant interviews (Supplementary Table 1). This work was determined by CDC not to be human subjects research; further ethics approval was not required.

Key informant interviews were conducted in English (an official NATO language) in Kosovo, Germany, and remotely to assess the system attributes. All interviewees were fluent in English. EpiNATO-2 users spanning three levels were interviewed: medical providers and data entry personnel (tactical level); supervising regional medical and public health officers (operational level); and senior military commanders and other governmental entities (strategic level). This stratified convenience sample was selected to ensure inclusion of users directly involved with EpiNATO-2 operations representing all stages of data flow. All interviews were transcribed and annotated on the same day they were conducted.

Manual thematic analysis of the transcripts was conducted to identify patterns. To evaluate data completeness (i.e., the number of weekly reports submitted compared to the number expected), EpiNATO-2 submissions between January 1 and June 30, 2022 were analyzed. Descriptive statistics were calculated and visualized using R Statistical Software.

RESULTS

Fourteen EpiNATO-2 users were approached for interviews; all participated. By the 14th user, the sample achieved the desired diversity of user roles and geographic assignments, and operational availability of users limited further recruitment. The sample represented all 3 user levels (tactical [$n = 5$], operational [$n = 5$], strategic [$n = 4$]), 3 of the 5 major NATO missions (Kosovo [$n = 6$], Mediterranean Maritime [$n = 1$], and Joint Forces Command [$n = 5$]), 4 partner entities (European Union [$n = 1$], Belgian military intelligence [$n = 1$], United States Defense Health Agency [$n = 1$], medical services contractors [$n = 3$]), and 7 nationalities (Belgium [$n = 2$], France [$n = 1$], Great Britain [$n = 2$], Germany [$n = 2$], Italy [$n = 1$], Switzerland [$n = 1$], and the United States [$n = 5$]).

System Objectives

EpiNATO-2 documentation did not consistently define the system's objectives, despite the system's use being mandated by NATO policy.[14] Conceptual priorities were identified in publicly available[14] and internal NATO documents and corroborated by users' perceptions captured during interviews. These included: (1) early warning of disease outbreaks; (2) detection of biological weapons attacks; (3) monitoring for disease and injury clusters; (4)

following trends in health care activity; and (5) assessment of public health policy and programs.

System Design

Each medical treatment facility (MTF) is operated by a member nation or contractor using its own format for documenting medical care. Each MTF performs a weekly manual data extraction by assigning each patient encounter into one of EpiNATO-2's categories. The EpiNATO-2 data entry tool consists of 23 categories, each with a military letter designation and a title (Fig. 1). These categories function as case definitions and are the units of measure in EpiNATO-2. Every initial presentation for medical attention is assigned to one category and thus defined as a unique type of DNBI. Internal NATO documents provided a text description of each category but did not refer to standardized medical terminology (e.g., International Classification of Diseases [ICD] or Systematized Nomenclature of Medicine [SNOMED]).

Weekly totals in each category are recorded on a spreadsheet (Fig. 1). This spreadsheet is submitted as an email attachment to the medical officer supervising the mission, who aggregates the data from all MTF's in their mission into another spreadsheet representing the mission's weekly totals. The combined data are submitted as another email attachment to MilMed CoE, where data from all of NATO's operations are received and analyzed. The results of the analysis are disseminated back to each mission's supervising medical officer as well as other end users, such as NATO command entities and other member nation entities (Fig. 2).

Data in EpiNATO-2 are stored and transmitted in several formats. Source data (host nation medical records) are maintained by the individual member nations in various formats including paper. Upon capturing into EpiNATO-2, case counts are recorded in a Microsoft Excel spreadsheet. At MilMed CoE, data are stored in Excel spreadsheets and analyzed in PowerBI (Microsoft, 2023). The analysis is distributed by MilMed CoE epidemiologists in Portable Document Format (PDF). Each mission's medical officer receives the weekly report for their mission; reports are also available to strategic-level consumers, such as NATO commanders.

Performance on Key Attributes

Usefulness—Users reported that EpiNATO-2 does not provide useful information for decision-making, despite being the only source of NATO DNBI surveillance information. All users at the tactical and operational levels and one of 3 users at the strategic level did not identify any value in participating in the EpiNATO-2 system. The remaining 2 strategic-level users deemed it not useful overall.

The following key challenges were noted: the weekly reporting period, the design of the health event categories, and the dissemination products. First, users described the weekly reporting period as too long to provide early warning of disease outbreaks, because the duration between health events and the availability of analysis was usually ≥2 weeks. For all but the largest epidemics (e.g., COVID-19), this precluded the ability to use

surveillance data to inform public health interventions within a meaningful response time or to provide for detailed retrospective analysis. Second, all users reported that event categories were confusing and vague, resulting in misclassification error and ambiguous findings. Third, users did not find added value in dissemination products because they consisted of a synopsis of the data without contextual information (e.g., from nearby units). The distribution plan for EpiNATO-2 data was also weighted toward the operational level, where it was considered least useful because of its inflexible design and siloed communications flow. The data were available to other potential consumers, but there was no established distribution process at the strategic level, despite those users' wide-ranging interest in public health surveillance information. Data sharing and other innovative applications of the data were considered infeasible due to the system's infrastructure and administrative obstacles.

Simplicity—All users reported that passive data collection was not possible because the source data (host nation medical records) exist in incompatible formats including paper. Data entry users reported that the mechanics of using the tool were simple but reported challenges assigning DNBI into ambiguously defined categories (e.g., the classification of a non-battle musculoskeletal injury as "Musculoskeletal Disorders" or "Non-Battle Injuries").

In addition to the DNBI categories, which are mostly defined as syndromes (e.g., "Musculoskeletal Disorders"), a second diagnosis-based section of the data entry tool exists with 59 individual "Notifiable Infectious Diseases" (e.g., smallpox). Users considered this section to be an unnecessary component because of its impracticality; MTFs lack the diagnostic testing required to identify cases of many of these diseases, and these diseases are covered by other reporting systems outside of EpiNATO-2.

Flexibility—Data were transmitted via email attachment, and several data processing steps involved manual transcription. Users noted that archived data were not available to be queried and that custom analysis required manual recombination of Excel files by MilMed CoE personnel. Users reported frustration with the static PDF format of presentation, which has no option for modifying visualization parameters (e.g., time interval). Innovative applications, such as secondary analysis or data sharing among neighboring units, were described as difficult because of the rigidity of the data management platform.

Acceptability—All tactical-level users reported that 10 to 30 minutes per week were required to record and submit EpiNATO-2 data, resulting in high acceptability. Regional medical personnel reported spending 1 hour per week transcribing and transmitting data from their area of responsibility to MilMed CoE. These officers reported the greatest desire for public health surveillance data among all users, a frustration that was not ameliorated by the low burden of participation.

All strategic personnel and other end users reported that their workflow was rarely impacted by participation in EpiNATO-2; in the absence of useful information from EpiNATO-2, most reported substituting public health information from open-source non-military resources such as CDC, the World Health Organization, and Bluedot.

Data quality—High-quality data are both complete (i.e., individual records have low rates of blank, “unknown,” or invalid data points) and valid (i.e., low rates of errors). Due to the simplicity of the tool—each patient encounter is represented as a tally, without associated data points—EpiNATO-2 is not subject to incomplete or otherwise defective capture of individual patient encounters. At the level of the weekly aggregated report, however, incomplete recording could occur in the form of unrecorded patient encounters. Data entry personnel reported high confidence in their ability to report every patient in their weekly census to EpiNATO-2, but there was no mechanism for data quality audits, and this was not being objectively evaluated.

Furthermore, all tactical- and operational-level users reported that the system’s case definitions (event categories) produced frequent misclassification, an error type that can compromise data quality. For example, tactical-level users reported routine difficulty classifying encounters for respiratory infections among Bravo through Echo (Fig. 1), categories with overlapping and ambiguous definitions. The EpiNATO-2 data dictionary did not provide sufficient guidance for data entry personnel to confidently assign events among these categories. NATO policy prescribed a SNOMED mapping tool to accompany EpiNATO-2,[14] but no such tool was available.

Sensitivity and positive predictive value—To the extent that it occurs, misclassification could compromise the sensitivity and positive predictive value of EpiNATO-2. However, quantitative evaluation of these attributes was not possible due to the lack of interoperable data standards such as SNOMED or International Classification of Diseases. Users reported that data seem to reflect true health care utilization based on informal observations of large-scale patterns (e.g., seasonal variation), but these have not been quantitatively evaluated.

Representativeness—Representativeness is the fidelity with which surveillance data reflects the true condition of the total NATO force. During the first 6 months of 2022, 943 MTF reports were expected (1 per MTF per week); 792 were submitted (84%). Of the 130 mission reports submitted to MilMed CoE (1 per mission per week), 82 (63%) contained complete data from all MTFs in the mission. There were zero weeks in which complete data were received from all MTFs in all 5 missions. This MTF-level missingness (Fig. 3) was neither constant over time nor equally distributed among missions ($P < 0.05$, Fisher’s exact test). Users attributed this missingness to apathy about EpiNATO-2, which, combined with personnel rotations, produced the observed nonrandom patterns of incomplete data. Users also reported that communications blackouts occasionally interfered with reporting, but that this was infrequent and accounted for a small minority of missing data.

Timeliness—All operational- and strategic-level users reported that the value of EpiNATO-2 surveillance information, already limited by the above concerns, was largely nullified by the lack of timeliness. Because of the weekly reporting period, surveillance data do not provide early warning of disease outbreaks or other acute events such as a potential bioweapon attack. Users also reported that EpiNATO-2 data could not provide useful retrospective health event information such as an epidemic curve. Weekly aggregate data were only deemed useful for describing seasonal or other long-term trends.

Stability—All users reported that personnel turnover was the major source of system interruptions. Frequent duty rotations disrupted communication (e.g., the use of an obsolete email address), introduced delay in reporting, and produced inconsistency during handovers. Occasionally, military operational needs also disrupted the flow of data (e.g., security-related communications quarantines affecting maritime medical facilities).

Informatics system quality—All users reported that communications interruptions were common, owing to the large number of users and the frequency of their turnover. Since data flow relied on sequential individual-to-individual email messages, submissions were frequently delayed. Users also reported that informal handovers (e.g., recording key contact information on a scrap of paper that was physically passed to one's replacement) tended to produce and perpetuate incorrect operational procedures. In addition, users reported that the lack of clear data definitions and technical resources contributed to error in the absence of modern informatics standards.

Informatics service quality—All users (except those in MilMed CoE) reported rarely having contact with other users of the system. MilMed CoE did not conduct routine site visits. MTF personnel reported little understanding of what happened to their submissions and did not receive feedback on their participation. All consumers of surveillance data reported that MilMed CoE was responsive, but all MilMed CoE staff reported feeling under-resourced with respect to the demands of operating a robust surveillance system. All users reported difficulty identifying appropriate points of contact across the multinational force, resulting in difficulty addressing potentially avoidable data quality issues. All tactical-level users reported obtaining technical support through channels other than MilMed CoE, specifically relying on their own nation's general technical support resources for problems with EpiNATO-2.

Informatics interoperability—EpiNATO-2 was interoperable among NATO nations. However, the EpiNATO-2 data format lacked interoperability with external partners and alternative software platforms. Data were not managed in any standardized format and were not indexed or searchable by any commonly accepted vocabulary. Custom analysis products could be requested from MilMed CoE, but raw data were not stored in a shareable format for reanalysis even by the contributing member nations who generated the data.

CONCLUSIONS

This is the first surveillance evaluation of EpiNATO-2, following on other reports that evaluated a version no longer in use[16] or provided a more narrative description.[29] Our findings highlight the unique difficulties of monitoring DNBI in the NATO environment. While users reported perceived shortcomings for nearly every system attribute, 3 key themes emerged. First, data quality was deemed poor. Case definitions (event categories) were ambiguous and confusing, leading to multiple types of error and poor data quality. As a result, surveillance data were nearly uninterpretable upon collection, and subsequent steps of the analysis process could not produce an interpretable or actionable final product. Second, the system was considered inflexible. EpiNATO-2 data were managed in fixed file formats and email attachments, which did not permit dynamic querying, custom analysis, or

interoperability. The constraints of predefined algorithms inhibited innovation, collaboration, and evolution of the system. Third, the process was not considered timely. The weekly reporting period of EpiNATO-2 did not enable meaningful public health response. Together, these major findings substantiated the widespread perception that EpiNATO-2 is currently not useful.

This evaluation identified 3 concrete actions that could improve the flexibility, data quality, and timeliness of EpiNATO-2, and thus, its overall usefulness. First, EpiNATO-2 could be enhanced by well-defined, clinically distinguishable, and operationally relevant case definitions that reflect the epidemiology of DNBI as well as the public health priorities of its users.[10,30] Second, modernizing the data infrastructure of EpiNATO-2 could address current technical challenges and expand the usefulness of the data.[28] Examples include transitioning to a web-based data entry tool rather than emailed spreadsheets, a cloud-based data management platform, and a web-hosted dashboard for disseminating data. Third, whereas gains achieved through the above changes could improve responsiveness to external factors and data needs, ongoing evaluation of the system could help identify further opportunities for improvement.[26] Surveillance system management could incorporate mechanisms for obtaining and addressing user feedback as well as scheduled evaluations involving supervisory authorities and users at all levels. Past research has suggested military-specific modifications when evaluating military surveillance systems,[25] which could aid in evaluating the effectiveness of the proposed changes.

The findings in this study are subject to at least two potential limitations. First, although sensitivity and positive predictive value are key determinants of a surveillance system's usefulness, quantitative assessments of these attributes were not possible due to the lack of interoperable data standards. Second, the austere and geographically dispersed nature of military operations did not allow for inclusion of users from all of NATO's missions. However, our sample of users represented the complete EpiNATO-2 process from data collection to final reporting.

Users throughout NATO understand the potential value of EpiNATO-2 data to inform DNBI surveillance. The longstanding NATO structure of multilateral collaborative effort could support implementation of the recommendations outlined in this study, achieving modernization of EpiNATO-2 and enhanced military health surveillance.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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CONFLICT OF INTEREST STATEMENT

All authors have completed the ICMJE uniform disclosure form at http://www.icmje.org/disclosure-of-interest/ and declare no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

DATA AVAILABILITY

The data that support the findings of this study are not openly available due to reasons of sensitivity. They may be available from the corresponding author upon reasonable request. Data are located in controlled access data storage at the NATO Military Medicine Center for Excellence.

LIST OF ABBREVIATIONS

DNBI	Disease and non-battle injury
MilMed CoE	Military Medicine Center for Excellence
PDF	Portable document format

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	Item code	Event to report	Number of new cases by event
V	Alpha	Gastrointestinal Infection	
	Bravo	Respiratory tract and ENT infections without pulmonary or systemic complica	
	Charlie	Asthma or reactive airways symptoms or signs	
	Delta	Flu symptoms and pneumonia	
	Echo	Non-specific febrile illness	
	Foxtrot	Systemic haemorrhagic illness	
	Golf	Musculoskeletal disorders	
	Hotel	Acute neurological symptoms or signs	
	India	Mental health symptoms or signs	
	Juliet	Dermatological disorders	
	Kilo	Sexual exposure	
	Lima	Dental disorders	
	Mike	Bites and stings	
	November	Battle injuries	
	Oscar	Non-Battle Injuries	
	Papa	Reserved - DO NOT USE	
	Quebec	Disorders caused by climate or altitude.	
	Romeo	Reserved - DO NOT USE	
	Sierra	Reserved - DO NOT USE	
	Tango	Urgent surgical condition NEC	
	Uniform	Urgent medical condition NEC	
	Victor	Routine clinical care	
	Whiskey	Preventive care	
VI	Comments:		

FIGURE 1.
The EpiNATO-2 data collection tool and case definitions.

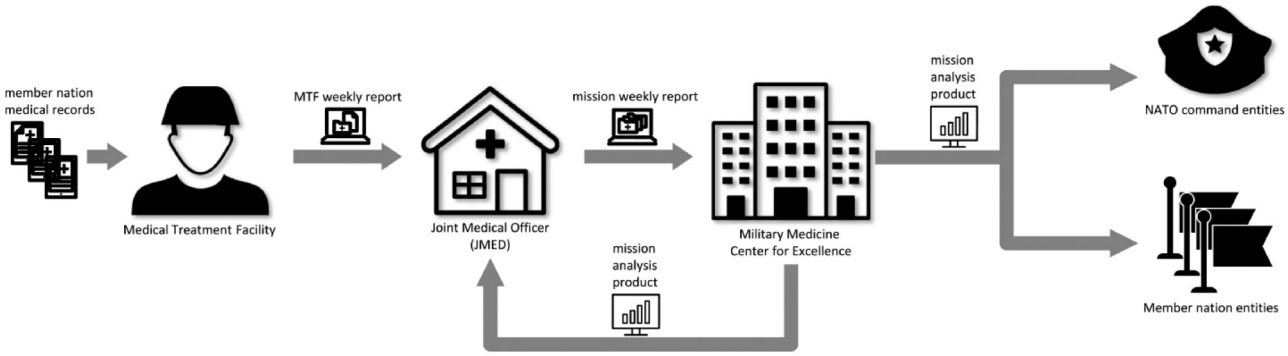

FIGURE 2.

Schematic of information flow in EpiNATO-2. Data flowed linearly from member nation medical records at individual MTFs, to the mission's Joint Medical Officer, and then to the Military Medicine Center for Excellence. After analysis, information from each mission was made available to its corresponding Joint Medical Officer, and NATO-wide information was made available to strategic command entities.

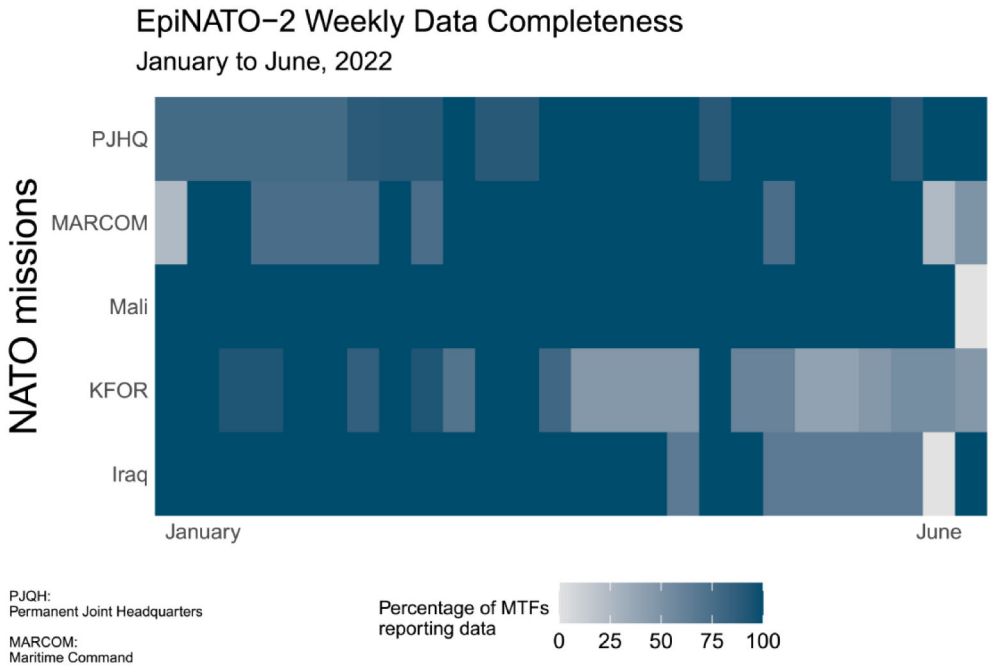

FIGURE 3.

Completeness of EpiNATO-2 data submissions. Missing data submissions were neither constant over time nor equally distributed among missions ($P < 0.05$, Fisher's exact test).