

A Review of Exposure Assessment Methodology in Research on Occupational and Environmental Exposures During Military Deployment

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Introduction

Studying deployment-related toxic exposures (e.g., burn pit smoke, chemical warfare agents) is uniquely challenging. Little real-time exposure data is available, so researchers must find ways to retrospectively assess exposure to toxicants. The accuracy of these assessments is foundational to the research that supports Veteran healthcare.

Materials & Methods

A literature review was conducted to identify peer-reviewed articles reporting exposure assessment data for three deployments: the Vietnam War, Gulf War, and post-9/11 operations in Iraq and Afghanistan (Table 1). Each reported toxicant and linked exposure assessment method was then recorded. The recorded exposure assessment methods included self-report, biomonitoring, historical models, occupational proxies or models, medical records, proximity to exposure area, and service-connected conditions. Use of deployment and occupation as proxy measures of exposure with no assessment of specific toxicants was also recorded.

Table 1. Deployed cohorts included in literature search

Conflict	Estimated Number of Deployed Personnel	Date of Deployment
Vietnam War	2.6 – 4.3 million	1962 – 1975
Gulf War	700,000	1990 – 1991
Post-9/11 Operations in Iraq and Afghanistan	at least 3 million	2001 – 2021

Results

The review identified 609 publications that reported or used exposure data for the cohorts of interest: 190 for Vietnam, 300 for the Gulf War, and 126 for post-9/11. 6 publications included data for multiple cohorts. The use of deployment status with no specifically assessed toxicant was the most commonly used method across all cohorts: Vietnam ($n = 74$ publications, 39%), Gulf War ($n = 156$, 52%), and post-9/11 ($n = 66$, 52%). Of these publications, 54% ($n = 158$) used deployment status as the only method of exposure assessment. Self-report was the most common method used to assess specific toxicants for both the Gulf War ($n = 132$, 44%) and post-9/11 ($n = 54$, 43%); it was less common in Vietnam research ($n = 23$, 12%). Biomonitoring data was published frequently ($n = 132$) but covered a narrow range of exposures and personnel, with 64% coming from either the Air Force Health Study ($n = 46$) or the Depleted Uranium Registry ($n = 39$).

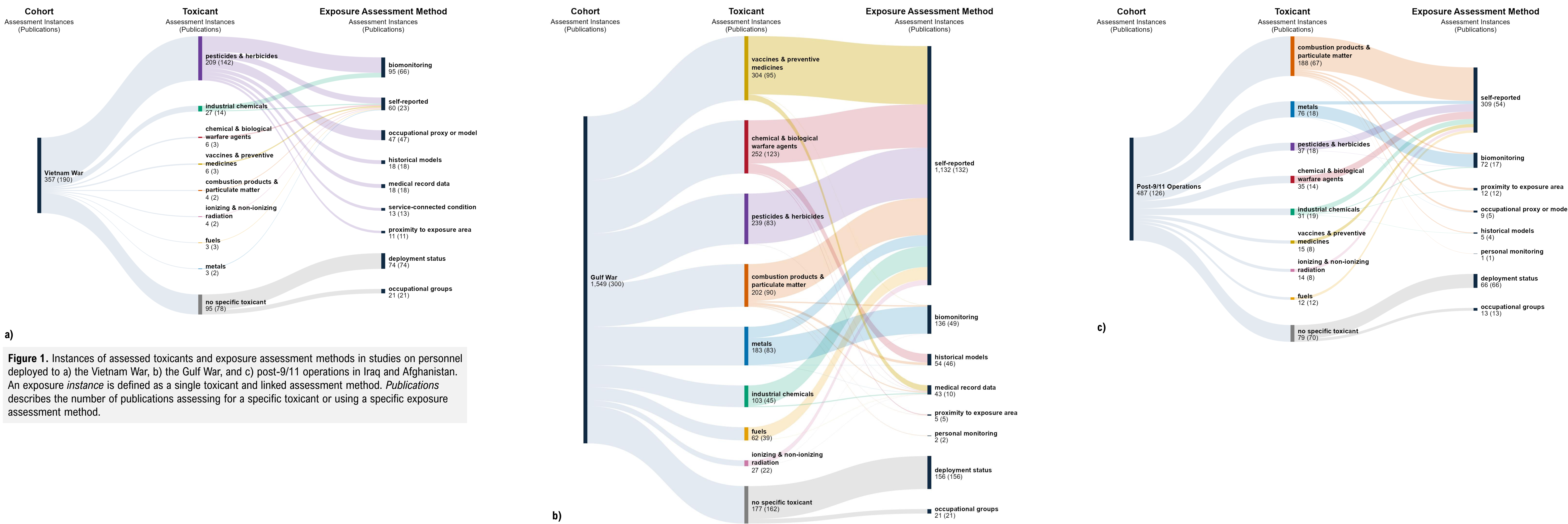


Figure 1. Instances of assessed toxicants and exposure assessment methods in studies on personnel deployed to a) the Vietnam War, b) the Gulf War, and c) post-9/11 operations in Iraq and Afghanistan. An exposure *instance* is defined as a single toxicant and linked assessment method. *Publications* describes the number of publications assessing for a specific toxicant or using a specific exposure assessment method.

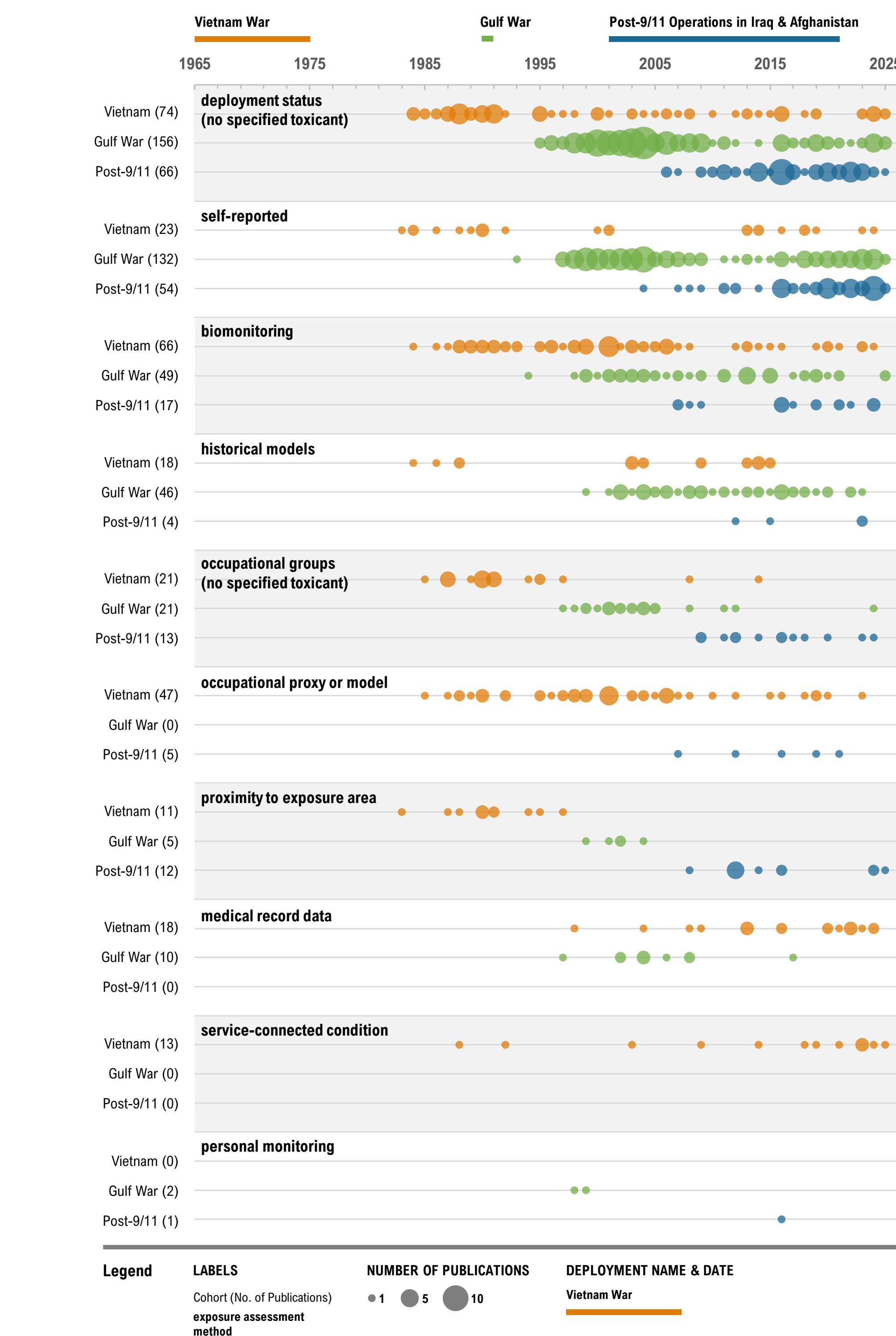


Figure 2. Use of exposure assessment methods in publications reporting or using exposure data from the Vietnam War, Gulf War, and post-9/11 operations in Iraq and Afghanistan.

Results (con.)

Personal monitoring was the least published assessment method ($n = 3$). Other recorded methods included historical models ($n = 68$), occupational groups ($n = 55$), occupational models/proxies ($n = 52$), medical records and service-connected conditions ($n = 41$), and proximity to exposure area ($n = 28$).

Toxicants and exposure assessment methods are broken down by cohort in Figures 1 and 2.

Conclusion

The majority of research on deployment-related toxic exposures relies on two assessment methods: 1) deployment as a proxy measure and 2) self-report. While biomonitoring data is published frequently, the scope of the data is limited: the majority comes from cohorts with unique exposures to dioxin (from handling Agent Orange) or embedded metals. Biomonitoring of other toxicants is limited as it is usually not possible to measure deployment-related exposures using specimens collected after the deployment ends.

Very few studies that used personal monitoring have been published. While this kind of monitoring can no longer be done for the cohorts surveyed here, the absence of such studies draws attention to the need for exposure monitoring in future conflicts. The varied use of other exposure assessment methods reflects the unique factors of each deployment and the availability of historical data (e.g., personnel location, purpose-build models) for research.

This historical analysis points to opportunities for improved exposure assessment moving forward. A key component of the successful studies reviewed here is institutional support, including provision of timely, accurate, and relevant data alongside resources for the development of targeted and more complex exposure assessment techniques. Understanding the trends discussed here can help investigators and funders produce the high-quality exposures research needed to support the health and well-being of both current and future Veterans.