

Since the Gulf War ended in 1991, some veterans of Operation Desert Shield/Desert Storm (ODS/DS) have reported a range of health symptoms and problems. Many of these veterans attribute their poor health to deployment to the Persian Gulf. In response, the Department of Defense (DoD) and the Veterans Administration (VA) have established clinical evaluation programs to diagnose and treat these ailments. As of April 1997, more than 100,000 Gulf War veterans have registered with the VA or the DoD reporting health concerns. Of approximately 75,000 veterans who have been medically examined, about 15,000 have undiagnosed symptoms, which commonly include fatigue, muscle and joint pains, headaches, memory loss, skin rash, diarrhea, and sleep disturbances.¹

To date, little conclusive evidence has been found to link many hypothesized possible causal agents—including depleted uranium, oil well fire smoke, and stress—to Gulf War illnesses.² Among the agents still being investigated are pyridostigmine bromide (PB) pills and pesticides. PB pills were given to personnel in ODS/DS to protect against the nerve agent soman. Overexposure to pesticides can cause symptoms similar to those reported by some Gulf War veterans, but little is known about the use (or misuse) of pesticides by the general in-theater military population during ODS/DS.

Before this survey, logistical information quantifying the amount of military-issue pesticides ordered from the theater of operations and interviews with military preventive medicine personnel and entomologists provided the best available data on pesticides used in ODS/DS. However, that information failed to account for pesticides acquired on the local market in theater, or those used by local contractors hired to apply them. It also fails to account for personal-

¹<http://www.va.gov/health/environ/faq.htm>.

²See, for example, Harley et al. (1999); Spektor (1998); and, Marshall et al. (1999).

use pesticides shipped from home to individual soldiers, or pesticides acquired from allied troops.

This survey was commissioned to quantify pesticide use by the average soldier during the Gulf War: Which pesticides were used, who used them, and in what quantities. The purpose of the survey was to augment available information about the extent of pesticide use by the troops, the level of multiple pesticide use, and the duration and frequency of use. We designed the survey to elicit data from veterans about their personal use of pesticides and use they observed by others. The survey was a telephone interview of just over 2,000 veterans, randomly selected to be statistically representative of the entire Gulf War population *on the ground* in the Kuwaiti theater of operations (KTO). This population—referred to in this report as the in-theater Gulf War population—consists of:

- All Army and Marine Corps personnel located in Saudi Arabia, Kuwait, and Bahrain;
- All Air Force personnel located in Saudi Arabia, Kuwait, Bahrain, Qatar, the United Arab Emirates, and Oman; and
- Navy personnel in units that were identified as being ashore in Saudi Arabia, Kuwait, and Bahrain.

The survey solicited specific information about the identification and frequency of use of many possible pesticides, including common personal-use pesticides, unusual personal-use pesticides (such as pet flea collars), and various common and rare field-use pesticides (such as those used in aerial spraying). The pesticide information was elicited in the context of the veterans' living, working, and eating conditions.

BACKGROUND ON THE GULF WAR

On August 2, 1990, Iraqi troops invaded Kuwait. By August 8, the first units of the XVIII Airborne Corps of the U.S. Army began deploying to Saudi Arabia (Schubert and Kraus, 1994). Over the course of the next six months, approximately 697,000 U.S. troops deployed to the Persian Gulf region, including almost 500,000 personnel located on the ground in theater.

Enormous effort was involved in moving, housing, feeding, and caring for this many people. For example, by January 1991, the Army was providing almost 40 million meals per month to feed military personnel in theater. It has been estimated that during the early part of the Desert Shield buildup, 4,000 U.S. soldiers arrived in Saudi Arabia each day (Scales, 1997). Such a rapid force buildup required the equally rapid deployment of a logistical infrastructure to acquire and

distribute everything from food, water, and fuel, to ammunition and repair parts, to tents and other living accommodations. Part of that effort involved controlling vermin and insect pests indigenous to the region and pests that were attracted by the influx of a large, temporary military population.

Living conditions in KTO varied greatly. The most basic accommodations were tents and rudimentary shelters typically used by the front-line combat troops; variations with increasing comfort were tent cities with additional amenities, air-conditioned tents with floors, and more urban quarters in Saudi Arabian cities. Similarly, eating, working, and sanitary facilities varied greatly (Schubert and Kraus, 1995).

PESTICIDE USE

In every war and military conflict, combat effectiveness has been significantly reduced by disease, and a large number of diseases can be directly linked to disease-carrying vermin.³ Not only can these vermin transmit disease, but their bites can result in distracting and demoralizing conditions in addition to serious secondary infections and allergic reactions. For these reasons, pest control is of significant military importance, affecting not only troop morale and welfare but also overall unit combat effectiveness and strength.

Insects and rodents were of particular concern during ODS/DS as potential disease vectors. Pest management in ODS/DS was focused primarily on ground troops.⁴ As we mentioned, with roughly one-half million personnel deployed to the region in a very short span of time, under widely varying living, working, and threat conditions, the logistical challenge was large.

During the course of ODS/DS, the military procured and used various pesticides. The authority on pesticides in the U.S. military is the Armed Forces Pest Management Board (AFPMB), which recommends pesticides and pesticide policies for all the services. All military-issue pesticides available during ODS/DS were approved by the U.S. Environmental Protection Agency (EPA). However, it is possible that pesticides other than those recommended by the AFPMB may have been used, since the only pesticides that are considered “unauthorized” are those not approved for use by the EPA (unless otherwise specifically approved by the military). For example, soldiers often supplement military-issue pesticides with commercial products.

³AFPMB (1996).

⁴Indigenous pests were not considered a significant threat to personnel remaining on naval vessels. It was expected that their exposure was no different than if the personnel had been at sea in any other part of the world; therefore, no special studies of that group were performed.

Pests of concern in theater and the vicinity included arthropods such as sand flies, “filth flies,” black flies, mosquitoes, cockroaches, lice, ticks, scorpions, spiders, and centipedes. These vermin can transmit major diseases such as viral encephalitis, sand fly fever, and leishmaniasis, and can become an extreme nuisance because of their overabundance.⁵ Rodents such as rats, mice, and voles were also of concern as disease vectors and contaminants of food supplies. Table 1.1 lists the pesticides used or potentially used by military units during ODS/DS.

More than 35 types of pesticides and pesticide products were used by military personnel during ODS/DS. None was unique to the military—all are, or were at the time, legally available for civilian use in the United States and other countries. The actual total usage of pesticides by U.S. forces during ODS/DS is unknown, but estimates for pesticides acquired within the military supply system have been made by calculating the amount ordered minus the amount returned. Estimates do not include any pesticides in the possession of units at the outset of ODS/DS or pesticides acquired outside the military supply system. Thus, they do not include any pesticides acquired from the local economy or obtained by individual soldiers on their own. For example, there is anecdotal information that some troops obtained such products as citronella candles from private sources to combat pests. In addition, some units that received pesticides did not use them or shipped them home with their unit (rather than returning them to the supply system). There were also reports of pesticides being left in theater or given to coalition partners.

OSAGWI interviews with Gulf War veterans indicate that other pesticides not listed in Table 1.1 were used by or near U.S. forces during ODS/DS. Personnel with pest control responsibilities, as well as supply and logistics personnel, obtained some insecticide from the local economy in Saudi Arabia, and local firms provided pest control contract services. The extent to which other pesticides were used and the amounts used by specific units could not be determined from existing information.

RELATED WORK

Simultaneous with this survey, RAND also was commissioned to conduct a scientific literature review of the possible health effects of pesticides that OSAGWI had determined to be of potential concern in relation to Gulf War illnesses. That companion review addresses the characteristics, toxicity, and possible health effects of the pesticides deemed of most interest by OSAGWI. The review includes several pesticide classes: organophosphates (diazinon, chlorpyrifos,

⁵AFPMB (1996).

Table 1.1
Pesticides Used or Potentially Used During ODS/DS

Active Ingredient Product	Synonyms, Trade Names	Target Pests
Allethrin	d-trans-Allethrin	Insects
Aluminum phosphide	Phostoxin, Fumitoxin, AIP	Stored product pests
Azamethiphos	Snip Flykiller, Alfacron	Flies
Bacillus thurengiensis	Teknar	Mosquito larvae
Bendiocarb	Ficam W	Roaches, fleas, ticks, mosquitoes, other arthropods
Boric acid	Whitmire (PT 240) Perma-dust	Insects
Brodifacoum	Talon G	Rodents
Bromadiolone	Maki	Rodents
Carbaryl	Sevin	Ants, fleas, other insects
Chlorophacinone	Rozol	Rodents
Chlorpyrifos	Dursban	Mosquitoes, other insects, ticks, mites
Cypermethrin	Demon	Insects
Deltamethrin		Insects
Diazinon		Insects
Dichlorvos	DDVP	Insects
Diethyl-m-toluamide	DEET, 3M Insect/Arthropod and Cutter Insect Repellents	Sand flies, other insects, ticks
Diphacinone	P.C.Q., Rodent Cake, Di-Blox	Rodents
Ethyl hexanediol		Insects
Hydramethylnon (ANSI)	Combat, MaxForce	Insects
Lindane		Lice
Malathion		Insects
Methomyl	Flytek	Flies
Pentachlorophenol		Fungi
Permethrin	Permanone	Insects
Pet flea and tick collars	Amitraz, carbaryl, chlorpyrifos, methoprene, permethrin, phosmet, propoxur, tetrachorvinphos	Insects and ticks
d-phenothrin		Insects
Pindone	Pival	Rodents
Propoxur	Baygon	Flies, roaches, other insects
Pyrethrum/pyrethrins	Pyrenone	Mosquitoes, flies
Resmethrin		Insects
Sulfur	Chigg-Away	Chiggers (mites)
Valone	Tracking powder	Rodents
Warfarin	O-R-500, Rodex, Final, Erase	Rodents

SOURCE: Modified from the Office of the Special Assistant for Gulf War Illnesses (OSAGWI).

dichlorvos, malathion, and azamethiphos), carbamates (methomyl and propoxur), pyrethroids (permethrin and d-phenothrin), organochlorine (lindane), and DEET. The results of that companion review will be published as part of the RAND publication series: *A Review of the Scientific Literature As It Pertains to Gulf War Illnesses. Volume 8: Pesticides* (Cecchine et al., forthcoming).

ORGANIZATION OF THE REPORT

This report is organized into five main chapters and four appendices. In Chapter Two, we discuss the population we surveyed and the survey instrument in detail. In that chapter we also address the methods we used to aid respondents' recall and describe the second, smaller follow-up survey we fielded to assess recall bias. Chapter Three presents our main finding in multiple tabulations of the survey data. In particular, it presents tabulations of personal-use pesticides by form and active ingredient and tabulations of field-use pesticides by form. In Chapter Four we examine and discuss variations in pesticide use and, finally, in Chapter Five we examine the question of whether pesticides may have been overused or misused. Four appendices then present the details of the survey instrument, the sampling methodology, our analytic methods, and the details of our recall bias analysis.