

# Occupational Medicine Model and Asthma Military Recruitment

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**ABSTRACT** Medical evidence hints that asymptomatic recruits with a history of childhood asthma, quiescent since their 13th birthday, are still at risk for adverse changes in their clinical status following unfavorable environmental exposures during military deployment or combat. Asthmatic persons, claiming none or few symptoms, may still manifest airflow obstruction and display biomarkers of airway inflammation even when they are relatively asymptomatic and experience few if any respiratory complaints. The occupational medicine model offers a credible foundation for acknowledging the importance of personal susceptibility in the pathogenesis of military-associated asthma. It is appropriate to re-explore the current military standard for recruits with asymptomatic childhood asthma ( $\geq 12$  months) not prescribed antiasthma medications. Raising the acceptance age for these recruits may be a consideration. Unfortunately, there is no effectual screening test that recognizes such susceptible soldiers at risk for future asthma attacks. Nevertheless, there is general support for evidence-based, scientifically valid medical screening that judges fitness for military service. Screening tests comprising asthma biomarkers and genetic indices may better verify vulnerable soldiers destined to suffer future asthma reactivation.

## INTRODUCTION

Asthma warrants a global health care awareness since an estimated 300 million people, about 8% of the world's adult population and around 250,000 annual deaths worldwide are related to asthma.<sup>1</sup> In the United States, the rising prevalence of asthma affects over 38 million persons at some point in their life.<sup>2,3</sup> In 1995, asthma accounted for 1.87 million Emergency Department visits, over 100 million restricted activity days, and more than 5,000 deaths.<sup>4</sup> According to the Centers for Disease Control and Prevention, asthma was linked to 3,404 deaths in the United States in 2010.<sup>5</sup>

The price tag for asthma's detection and management has risen. There was a 6% increase in asthma expenditures in the United States between 2002 and 2007.<sup>3</sup> From 2002 to 2007, asthma's annual cost was about \$3,300 per person in medical expenses, missed school and work days, and early deaths.<sup>3</sup> The individual per-person cost attributable to asthma is \$1,907 per year.<sup>6,7</sup> The lifetime cost of an asthmatic individual born in the year 2000 is roughly \$7.2 billion.<sup>8</sup>

Annually, about 11% of recruits ( $>18,000$  persons) fail to complete initial military entry training and nearly 3% are discharged with an Existed Prior to Service (EPTS) discharge.<sup>9</sup> Psychiatric conditions, orthopedic disorders, and asthma are the most common causes of EPTS discharges.<sup>10</sup> The retention of recruits in the military service is critical because of the significant cost and effort the process requires.<sup>9</sup> The military recruiting, screening, and training expenditures cost about \$75,000 per enlistee.<sup>9,11</sup> EPTS discharges can be challenged with waivers to reverse the discharge pronouncement. Between 2007 and 2012, 2.6% of all applied waivers (i.e., 3,455 EPTS applicants) were related to asthma; 1,559 waivers were subsequently approved.<sup>11</sup>

Military recruitment concentrates on the age group at which childhood asthmatics are in "remission" but, potentially, may be poised to relapse. Countless cases of childhood asthma achieve a "remission" and/or display a reduction in asthma symptoms between the ages of 10 and 20 years but suffer future exacerbations.<sup>12,13</sup> Recruitment of a soldier with earlier quiescent childhood asthma can lead to new asthma development or exacerbation during military deployment. The acute asthmatic event may require immediate treatment, subsequent military discharge, and possible future medical care through the Veteran Administration (VA) system.

This article speaks to the issue of military recruitment of soldiers with asymptomatic, suspected, or known asthma whose disease may potentially become "active" during military deployment or thereafter. The article emphasizes that recruits with any history of childhood asthma may be more susceptible to and/or are not suitable for the numerous environmental hazards associated with military deployment. Childhood asthma may be different from adult-onset asthma. Delaying the recruitment age of military services of recruits with quiescent childhood asthma identified after 12 years of age may be appropriate. One suggestion is, after 20 years of age. This article endorses potentially better screening of recruits employing biological markers of asthma. Reconsiderations of the current recruitment policy as well as utilizing improved screening methods might reduce the numbers of new cases of military-associated asthma.

## MILITARY RECRUITMENT

The 1991 Gulf War deployed almost 697,000 U.S. military personnel consisting of 581,433 active duty personnel (85.1%) and 102,046 reservists (14.9%).<sup>10</sup> There were more than 3 million deployments to Iraq and Afghanistan. In 2012, nearly 279,000 recruits were examined for medical fitness examinations compared to about 323,000 yearly examinations from 2007 to 2011.<sup>10</sup> Between 1996 and 2001, there

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were approximately 8200 active duty enlisted hospitalizations (4.6%) during the first year of service.<sup>14</sup> The wide-ranging military recruitment process comprises of criminal background checks, aptitude tests, weight-for-height standards, minimum physical fitness test, and medical examinations.<sup>10</sup>

## POLICY FOR ASTHMA RECRUITMENT

The Department of Defense's Directive, 6130.03 (April 28, 2010) restated the Physical Standards for Appointment, Enlistment or Induction in the Armed Force (6130.4) that were relaxed in 2004.<sup>15</sup> Recruits suffering from current airway hyperresponsiveness comprising asthma (493.xx), reactive airway disease, exercise-induced bronchospasm (519.11), or asthmatic bronchitis (493.90) "reliably" diagnosed and symptomatic since the age of 13 years were rejected from military service. The term "reliable" equated to a verified history of recurring cough, wheeze, chest tightness, and/or dyspnea existing for more than 12 months and persisting over the prior 3 years. Additionally, there could not be any use of controller or inhaled rescue medications; there could not be symptomatic asthma exacerbations requiring acute medical treatment and no use of oral corticosteroid medications. Also, there was a "normal" reliably performed spirometry obtained within the prior 90 days conducted in accordance with American Thoracic Society guidelines and National Heart, Lung, and Blood Institute standards.<sup>15</sup> In contrast, recruits with a history of childhood asthma since age 13 years of age but not displaying "reliable" diagnostic asthmatic-type symptoms ( $\geq 12$  months) were permitted entrance into military service.<sup>16</sup> The choice of  $\geq 12$  months of asthma inactivity seems arbitrary.<sup>17</sup>

## ASTHMA DEFINITION

Asthma, a chronic condition of the airways in which many cells and cellular elements play a role, represents a complex interaction between airflow obstruction, bronchial hyperresponsiveness, and airway inflammation.<sup>18,19</sup> The condition stems from a poorly understood relationship between genetic and environmental factors.<sup>20,21</sup>

Clinically, there is usually recurring cough, chest tightness, wheezing, shortness of breath, and a need for controller or inhaled rescue agents. More symptomatic asthmatics may require oral or parenteral corticosteroid treatment. Using a stethoscope, a health care provider will hear audible wheezing (especially with inspiration) on auscultation of the chest. Reversible bronchospasm, an essential feature of asthma, is considered present when there is  $\geq 12\%$  improvement in spirometric-measured forced expiratory volume at 1 second (FEV<sub>1</sub>) after administration of an inhaled bronchodilator medication. Increase in airway hyperactivity, another key asthma characteristic, is recognized by a methacholine challenge that is "positive" at a provocative concentration (i.e., PC<sub>20</sub>) of  $\leq 8$  mg/mL. There may also be an alternative acceptable "positive" provocative test for airway hyperresponsiveness.<sup>19,22</sup>

Evaluating the severity of asthma holds relevance to military recruitment since the decision for acceptance is often dependent on information communicated from the patient to the health practitioner/examiner. Unfortunately, some recruits find advantages in denying or minimizing their childhood asthma history, exercise-induced symptoms, or ongoing asthma complaints.<sup>23</sup>

## ADULT AND CHILDHOOD ASTHMA PHENOTYPES

Distinct adult and childhood asthma phenotypes depend upon the type of airway cellular inflammation and the airway's unique response to environmental stimuli.<sup>24–26</sup> Purportedly, the asthmatic child and adolescent are different than adults with asthma.<sup>26,27</sup> Adult asthma may be predestined in childhood asthma as early allergen exposures and viral infections intersect with genetic susceptibility.<sup>28,29</sup> Although structural and biochemical dissimilarities between children and adults change over time, the inherited tendency towards respiratory symptoms never disappears.<sup>29</sup>

Asthma's transformations over time are influenced by its clinical heterogeneity, airway structural changes, unrelenting airway inflammation, persistent airway remodeling, and fluctuating airway hyperactivity. The age when various airway changes originate or end have not been precisely defined in adult and children. More men than women experience a worsening of their asthma as adulthood approaches.<sup>30</sup> Presently, men predominate in the military services. Particular environmental stimuli, during military deployment, might institute an acute asthmatic attack or initiate a new case of asthma "de novo" in susceptible individuals.

## OCCUPATIONAL MEDICINE MODEL

In many ways, the military experience mirrors the occupational encounter typified by assorted exposures.<sup>31</sup> An occupational medicine model argues that there are only four possible mechanisms to explain newly developed asthma (i.e., occupational asthma).<sup>32</sup> Military deployment has been predicated as an inciting influence for asthma initiation. Of course, deployment, in itself, is not an exposure.<sup>33</sup>

First, there is the allergic/immunologic-type that requires a prior latency with repeated exposure to a sensitizing agent, happening over months or years.<sup>34</sup> There is very little, if any, published medical data to support allergy/immunology as a mechanistic cause of military adult-onset asthma.

A second potential explanation is acute irritant-induced asthma without latency, referred to as Reactive Airways Dysfunction Syndrome.<sup>35</sup> A soldier inhales a single massive concentration of an irritant gas, vapor or fume, and then exhibits newly developed asthma within 24 hours after the exposure. As with the first mechanism, the published medical literature does not support this manner to explain the majority of new-onset asthma cases among deployed military personnel.

A third possibility, holding merit, dictates that a uniquely susceptible soldier is repeatedly exposed to nonmassive levels of an irritant gas, vapor, fume or mixture, over a few days,

weeks, or months. Pre-existing, undiagnosed/quiescent asthma has been reported to be present in about 40% of such cases.<sup>36</sup>

Finally, work-aggravated asthma, the most common type of occupational asthma, holds value for explaining the majority of military-related asthma cases.<sup>37,38</sup> Under this scenario, there is pre-existing asthma or the predisposition to develop asthma depending upon the particular environmental exposure(s).

### ASTHMA DURING MILITARY SERVICE

Asthma was one of the most common reasons for medical evacuation during the 1991 Gulf War.<sup>39</sup> Using partial data pertaining to 1995–1997, Clark et al<sup>40</sup> estimated that approximately 1000 asthmatic recruits per year were discharged from military services with an EPTS reason. A more complete statistical investigation conducted more than a decade later reported nearly 3,000 military applicants being disqualified from military service each year because of asthma.<sup>41</sup> The appearance of acute asthma during military service may necessitate immediate treatment, subsequent military discharge, and possible future medical care through the VA system.

Perhaps, the implication of asthma in the military was highlighted after researchers from the Veterans Affairs Medical Center, Newport, New York claimed that there was an increased risk for developing new-onset asthma because of U.S. military deployment to Iraq and Afghanistan.<sup>42</sup> The concern has not yet been adequately settled.<sup>40,43</sup>

### MILITARY COST OF ASTHMA

Approximately 40% of young asthmatic recruits who wheeze subsequently became wheeze free in their late twenties.<sup>23</sup> Even so, succeeding wheezing and asthma attacks may reappear even after an asthma-free interval of up to 7 years or more.<sup>28</sup>

An investigation, comprising the years 1995–1998, recorded 3,699 EPTS discharges (13.5% of all) because of asthma.<sup>41</sup> From 1998 through 2002, approximately 17% of EPTS discharges among U.S. Army active duty enlistees was for asthma.<sup>14</sup> A 2006 study, revealed that many Navy recruits were discharged early because of asthma.<sup>41</sup>

Exercise-induced bronchospasm (i.e., airway obstruction triggered by exercise), common among military recruits, has been linked to numerous cases of undetected asthma.<sup>44–46</sup> Disappointingly, lung function testing for airways obstruction is rarely positive during extended remissions, between attacks, or among persons with exercise-induced bronchospasm. Likely, extreme physical performance and innumerable environmental stimuli are problematic for the soldier with exercise-induced bronchospasm.<sup>47</sup>

Nontraumatic military-related death because of asthma is rare with only 1 reported case detected among relatively healthy young military recruits not exercising.<sup>48</sup> However, many nontraumatic deaths are associated with exercise, especially unrecognized pre-existing cardiac disease.<sup>48</sup> Heat stress is a factor in roughly one-third (45 of 141) of exercise-related death of recruits.<sup>48</sup> There were 3 cases of asthma chronicled as exercise-related deaths.<sup>48</sup>

### VA COST FOR ASTHMA

Higher health care costs for asthma have been passed on to the U.S. VA, which provides pension benefits for more than 3.8 million Veterans and beneficiaries. As of 2011, about \$13.2 billion was directly spent on Veterans' medical care. Another \$18.1 billion was paid out in disability compensation and other benefits, signifying a \$31.3 billion total expenditure.<sup>49</sup> A 2008 estimate suggested that the long-term cost of providing medical care and paying disability compensation for Veterans of the Iraq and Afghanistan Wars may be between \$400 billion and \$700 billion.<sup>49</sup>

According to a 2014 VA report, 6% of Veterans serving in Iraq or Afghanistan received VA care between 2002 and 2011 and met one of the criteria for obstructive lung disease (i.e., asthma, bronchitis, or emphysema).<sup>43,50</sup> Individual diagnostic category was not mentioned but around 10.5% meet the criteria for chronic wheezing or coughing. Unfortunately, there have been trepidations about the adequacy of health care for asthma provided through the VA Health Care system.<sup>51</sup>

### ASTHMA REPORTS FROM OTHER COUNTRIES

Sears et al<sup>52</sup> determined that persistence or relapse of asthma among New Zealand children were associated with sensitization to house dust mite antigen, presence of airway hyper-responsiveness, current cigarette smoking and early age of asthma onset. Asthma relapses were common among "ex-asthmatics" showing persistent respiratory symptomatology.<sup>17</sup> Asymptomatic airway hyperresponsiveness may be a feature of some cases of quiescent asthma that enter the military.<sup>53</sup>

According to Taylor et al,<sup>54</sup> who followed New Zealand children over time, 35% had asthma in remission at 18 years of age but relapsed by 21 or 26 years of age. Totally, new adult asthma developed by 26 years of age in 9% of study members who reportedly had no asthma or wheezing at any time up to 18 years of age.

In a 1988 study by the British Army, 6.3% of annual medical discharges were attributed to asthma.<sup>23</sup> About 43% of 108 discharged soldiers were ultimately shown to have a history of asthma in childhood. Nearly 30% of military service persons discharged because of asthma denied having asthma in childhood.

In an Australian population, undiagnosed asthma was common and had a similar clinical spectrum as individuals with diagnosed asthma.<sup>44</sup> Service in combat units tended to unmask previously mild cases of asthma that were not disabling and induced asthma in subjects who had never suffered from the disease. It was recommended that candidates with a history of asthma should not be accepted before the age of 22 years.<sup>23</sup>

According to Katz et al,<sup>55</sup> service in an Israeli combat units was associated with more exacerbations of asthma among soldiers with previous asthma as well as the appearance of asthma de novo.

In Finland, mild or moderate asthma was not a reason for military exemption even though asthma represented the major reason for discharge from military service.<sup>56</sup> Both during military service and at 2-year follow-up, asthma was milder among the men, who had a new onset of asthma during military service. Atopy, as defined by the number of positive skin-prick tests and higher total serum IgE levels, was a significant predictor for persistent asthma at follow-up.<sup>56</sup>

## RECOMMENDATIONS

There is wide-ranging support as the military moves toward developing and using more evidence-based, scientifically valid standards to judge fitness for military service based on medical screening.<sup>57</sup> This article's contention is that recruits with any history of childhood asthma are more susceptible to and/or are not suitable for the numerous environmental hazards associated with military deployment. There may be a need for reassessing the present military policy that allows military service for recruits with childhood asthma but without recurring asthma complaints ( $\geq 12$  months) and taking no antiasthma medications. Perhaps, delaying the recruitment age of military services for recruits with quiescent childhood asthma after their 12th birthday may be appropriate. It may be appropriate to encourage such asthmatics to reapply for military service after their 20th birthday (or later), if they are free of wheezing for at least 4 years.

The article reinforces using more sensitive, evidence-based, scientifically valid medical screening procedures for asthma. Likely, the paucity of established and/or accepted predictive noninvasive markers for adults with quiescent asthma requires further testing and research. Imaging studies might be applicable in the future.<sup>58,59</sup> High-resolution computed tomography (HRCT) can gauge altered features of asthma such as airway lumen size (diameter, area), extent of airway wall widening (thickness, area), degree of airway narrowing, presence of air trapping, and ventilation inhomogeneity.<sup>60,61</sup> A single HRCT examination would not result in excessive radiation. The effective dose from an HRCT (0.98 mSv) is about 6.5 times less than the effective dose from a standard CT scan (6.5 mSv) but roughly 12 times higher than a conventional chest examination (0.085 mSv).<sup>62</sup> Analysis of eosinophil counts in induced sputum recognizes individuals with the eosinophilic-type asthma phenotype, common among persons with childhood asthma and is a useful biomarker for asthma diagnosis.<sup>63</sup> Urinary leukotriene E<sub>4</sub> (LTE<sub>4</sub>), an indirect marker of lung cysteinyl leukotriene activity, is also a possible biologic marker for asthma because increased basal levels of urinary leukotriene E<sub>4</sub> have been associated with adult-onset asthma.<sup>61</sup> Asthma is considered a genetically complex disease, with multiple genes acting additively to increase each other's effect through gene–gene and gene–environment interactions. Noteworthy advancements have been made in genetic studies of asthma using candidate gene, genome-wide association, and positional cloning studies.<sup>64</sup> Perhaps, future asthma likelihood will be based

on a prediction model that incorporates genes as well as personal and environmental risk factors.<sup>65</sup> Recent studies suggest that noninvasive surrogate marker of airway inflammation, such as exhaled breath nitric oxide, can be used to detect asthmatic individuals.<sup>66,67</sup> Measuring the concentration of nitric oxide present in exhaled breath is inexpensive, easy to perform and is applicable to using portable monitors that deliver instantaneous results that may be appropriate for military field testing. There may be other exhaled biomarkers of significance for military recruitment.<sup>68</sup> Since most childhood asthma tends to be on an allergic basis, allergy testing can be beneficial for asthma recognition. The quantity of total IgE antibodies and the presence of allergen-specific IgE antibody in serum are biomarkers for defining the phenotype of a patient who presents with asthma symptoms. Although the prick/puncture skin testing is the preferred techniques for assessing IgE-mediated hypersensitivity, serologic testing can demonstrate allergen sensitivity equivalent to prick/puncture tests.<sup>69</sup>

## CONCLUSIONS

Asthma continues to be a leader among medical conditions associated with disqualification from military service, medical waivers, and EPTS discharges. Regrettably, there remains no absolute standard for the diagnosis of asthma in remission and no objective screening test predicting the potential risk or severity of future asthma attacks. It has not yet been substantially established whether particular environmental exposures, noted during military deployment, are associated with asthma recurrence and/or new-onset asthma cases. Medical evidence hints that recruit with a history of childhood asthma quiescent since their 13th birthday might still be at risk for asthma exacerbation or new-asthma onset following adverse environments exposure accompanying military deployment. Further studies are necessary to determine whether hazardous military environments can provoke explicit immune or non-immune influences. Is there unrelenting pre-existing airway lability associated with quiescent asthma or is there *de novo* change in airway lability because of military influences? Perhaps, future investigative screening tools will better verify the status of asthmatic subjects claiming prolonged remission from childhood asthma.

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