Health & Performance Research for Military Women:
The 1994 Defense Women's Health Research Program (DWHRP94)

A special appropriation in fiscal year 1994 ($40M) provided an opportunity to leap ahead in closing the gap between men and women in military operational medicine research. Results of this research and other efforts promoted through this initiative have had far-reaching effects on policies and products that will provide health and performance benefits to service women comparable to those developed for men through previous decades of biomedical research.

Background

Women in the U.S. military now exceed 200,000 active duty members, or about 14% of the force. Until recently, most operational medicine research was conducted on young males, with research findings applied to both sexes. Much of this could be generalized to men and women, but in some areas applicability was uncertain (e.g., performance-enhancing drugs), while in other areas there was clear evidence for gender differences (e.g., susceptibility to heat injury), and other issues were specific to women (e.g., occupational hazards during pregnancy). Recognizing these deficiencies, Congress appropriated $40 M in 1994 to reduce the research backlog in issues of importance to the health and performance of military women. Funding was distributed to 100 intramural projects and to complementary research in 27 extramural grants. Funds were also used to develop an innovative knowledge management system for the Defense Women's Health Information Clearinghouse, and for several conferences (traumatic stress; hypoxia; social psychology) and Institute of Medicine reviews (research gaps; readiness standards; stress fracture; iron status; protein requirements).

Accomplishments

Strategies to Overcome Strength Limitations: There is almost no overlap between the weakest male and strongest female soldiers for upper body strength. Many military jobs require strength for pulling, lifting and carrying, but most problems caused by strength limitations can be solved by reengineering the task or equipment, improving job performance and safety for all service members. Critical equipment redesign needs were identified for emergency tasks such as manual lowering of landing gear and activation of ejection seats (most women lacked the required strength), and performing emergency damage control tasks on ships (women were slowed by ladder rung spacing). In load carriage studies, women with 75 lb backpacks performed better than predicted by published planning guidance, but another study showed that personal equipment is not well adapted to women and impaired optimal performance. Team lifting studies showed that lifting (e.g., litter bearing) is determined by the sum of individual lift capabilities, but with greater efficiency in single gender than mixed gender team lifts. Physical training may also narrow the gap between requirements and capabilities but there is little data on female strength training. Training studies demonstrated substantial improvements in strength and ability to accomplish "very heavy" strength demand tasks; muscle changes were defined for different types of training; and it was shown that only task specific tests accurately reflect improved job capabilities. Detailed biomechanical studies of push ups, used by the services for strength testing, identified modes of failure and injury.

DWHRP94 Priority Research Issues

- Upper body strength mismatched to equipment and tasks
- High rates of musculoskeletal injury, including stress fracture
- Stress of military life (pregnancy/social roles/command climate)
- Personal readiness standards to be based on female physiology
- Metabolic differences affecting military SUSOPS performance
- Efficacy and safety of strategies to enhance performance
- Personal equipment designed to female physiology/anthropometry
- Gynecological health care in military deployments
- Clinical causes of performance impairment for servicewomen
- Health risk behaviors affecting readiness
- Efficacy/safety of preventive medical materiel and alternatives
- Military occupational hazards for women of childbearing age

***Prevalence and Causes of Injuries and Illnesses*:** Sick call rates are higher in women compared to men (not simply due to gynecologic or obstetric care), as are psychiatric and stress-related hospitalizations and attrition from the military. Factors may include administrative policies, selection criteria, and a greater tendency for women to seek medical care when ill. An intensive effort organized by Navy epidemiologists continues to consolidate databases across services for medical surveillance in the Defense Medical Epidemiological Database

and research to address such questions. Development of a unique composite database (TAIHOD) linking data from diverse Army sources resulted in discoveries such as: female light-wheeled vehicle mechanics have the highest rate of musculoskeletal hospitalizations (a target for task analysis); female parachutists have a high incidence of injury attributable to their landing falls. Other epidemiologically-based studies considered approaches to behavioral interventions to prevent female smoking relapse and unintended pregnancy, and examined delivery of health care to women during the Gulf War deployment.

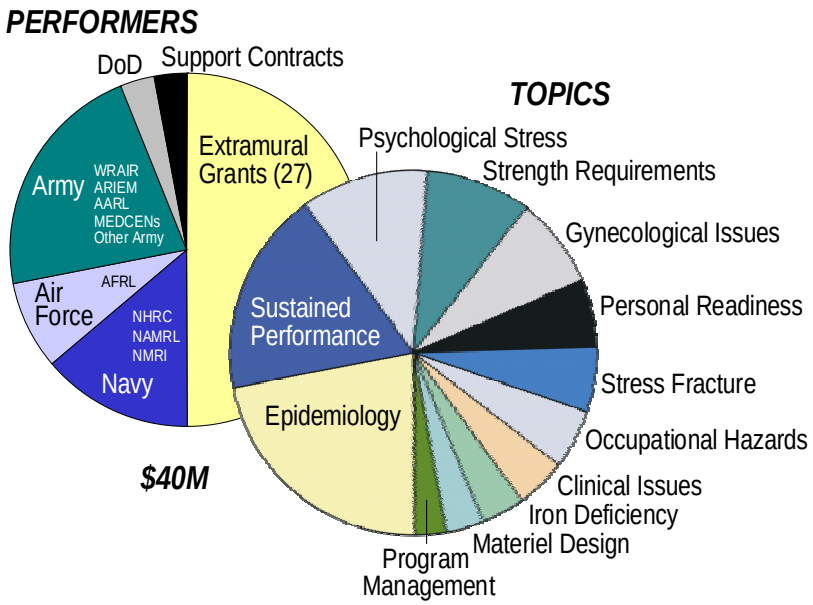
***Stress of Military Life Related to Attitudes and Social Roles*:** Identification of strategies to eliminate sexual harassment and make mixed gender units successful will also reduce the stress burden for individuals. One study found that sexual harassment rates were higher in Army units with fewer women, with lower unit readiness, and with poor scoring on acceptance of women: men and women in such units had high stress levels. Several studies examined external factors and personality characteristics that contribute to job satisfaction, mental health, and retention in the military. Nearly half of the women in each of three separate service studies reported premilitary sexually-related traumas (e.g., rape, attempted rape, unwanted sexual contact); this was the greatest risk factor for development of posttraumatic stress symptoms. Soldiers with childhood abuse histories experienced poorer health, and female soldiers who reported childhood violence were twice as likely to experience in-military physical and sexual violence. Mixed gender units were also studied to understand the effects of factors such as command climate and attitudes toward pregnancy to unit cohesion. One study found that the psychological health (e.g., absence of depression, anxiety) of pregnant active duty women was related to supportive work environments, and birth outcomes were related to maternal psychological health of the mothers. Group work was also examined to determine how mixed-gender crew configurations may influence communication and overall performance in combat control center simulations. A major conference and review of available data synthesized current knowledge on stress and military women, and these studies provided timely data for several commissions considering solutions to military gender integrations issues.

***Protection Against Reproductive and Developmental Hazards*:** Ten percent of female warfighters are pregnant at any given time. In their jobs, servicewomen may be exposed to poorly defined hazards to reproductive health or to a developing fetus, including toxic chemicals, prophylactic drugs, vibration, ionizing radiation, and electromagnetic fields. If identified, hazards can be eliminated or protected against, and women can be warned about exposure risks. Studies of birth outcomes within occupational specialties revealed no specific job associations. A study of newborns of women exposed to the antimalarial drug mefloquine during pregnancy in the Somalia deployment showed that there were no gross malformations resulting from this drug (not specifically approved for pregnant women). A pregnancy-safe antibiotic (azithromycin) was

studied for effectiveness in protection against malaria and treatment of typhus. The basis of female attractiveness to malarial mosquitoes was studied to improve protective strategies; another study discovered the basis for increased malaria susceptibility in first pregnancy women, suggesting an approach to an effective vaccine. Validation tests were conducted for a bioassay-based developmental toxicity screen. A large animal study confirmed the absence of injury to reproductive organs

following blast exposures typically encountered in field artillery. Reproductive outcomes in flight attendants continue to be studied to assess the importance of ionizing radiation exposure at high altitude. A Phase II Small Business Innovative Research project produced a novel biochemical test strip to measure progesterone and estrogen urinary metabolites for noninvasive monitoring of menstrual cycle phase, with applications to fertility evaluations as well as reproductive research.

***Bone Health and Reduction of Stress Fracture Incidence*:** Military women in initial entry training have twice the rate of men for musculoskeletal injuries, including a consistently higher rate of stress fracture. Current stress fracture incidences were prospectively obtained in large samples of Army (4.6%) and Navy (4.9%) recruits, with new information about their occurrence, risk factors (e.g., low fitness level), and possible predictive methods based on bone geometry, calcaneal bone mineral density, total bone mineral density, and gene mutations. Other studies evaluated the use of exercise to increase bone mineral density and treatment of pelvic stress fractures with electromagnetic fields. These studies gave impetus to the current research program on bone health and military medical readiness. Studies of dental bone health showed that progestogen-based contraceptives did not increase localized bone reactions (osteitis), and that estrogens did not affect healing of dental implants in maxillofacial injury patients.



Research Investment

Concepts for research studies were submitted by commanders of intramural medical research labs. These were prioritized within each service and a Tri-Service panel determined the funding threshold for each service list. Extramural projects were solicited for specific topics to augment the intramural program.

Personal Readiness Standards: Half of pregnant soldiers failed to return to their prepregnancy fitness levels 6-9 months postpartum, at least one third were overfat, and postpartum soldiers were 4 times more likely to fail the APFT at their first postpartum fitness test compared to nonpregnant female soldiers, supporting the need for a mandatory, graded postpartum PT program specifically targeting this population. One of the most detailed studies ever conducted on pregnancy-induced changes in body composition and physical fitness continues and will produce new data on postpartum return to duty readiness. The Institute of Medicine developed recommendations for readiness standards, with integration of nutrient and energy requirements of servicewomen, existing fitness standards, and special factors such as pregnancy and lactation. Several studies of menstrual cycle effects on physical and cognitive task performance documented a lack of important effects.

***Gynecological Health in the Field*:** Infections of the vaginal tract are not given priority among infectious diseases of military importance, yet these can have a significant impact on readiness, impair a woman's reproductive health and fertility, and have even been cited as reasons why women should not serve in the field. Studies of infection prevalence and better diagnostic and treatment methods included findings that 40% of patients in Army STD clinics tested positive for Mycoplasma genitalium-specific antibodies (suggesting a hidden epidemic with rates 4-5 times higher in women than men); and identified high rates of chlamydia infection (9.2%) in young female recruits (suggesting cost effectiveness of a screening program for asymptomatic female recruits). Other studies explored new drug treatments for Candida yeast infections, a prototype vaccine for toxic shock syndrome, effect of bacterial vaginosis on adverse pregnancy outcomes, and mucosal immune responses in the female genital tract which may be important in transmission of HIV.

***Prevalence and Consequences of Low Iron Status*:** Approximately 10% of U.S. women are marginally iron deficient; this was found to be equally prevalent in a large sampling of healthy military women. Even marginal iron deficiency may reduce aerobic performance and work capacity and has been associated with cognitive deficits and reduced immune function. However, no effect on physical performance could be demonstrated in a sample of iron deficient but otherwise healthy Army women, calling into question the importance of this issue. However, the appropriateness of medical attention for

at least some of these servicewomen was highlighted in a clinical study which found asymptomatic gastrointestinal lesions in six out of 20 military women with iron deficiency. Repletion of mild zinc and iron deficiencies in women was studied for potential benefits to neuropsychological performance.

***Enhancement of Performance Limits in Extreme Environments*:** Physiological limits, and interventions to extend the limits in operational environments, have been studied almost exclusively in males. Energy metabolism and disruption of reproductive hormone secretion was examined in scenarios with high energy expenditure and limited food intake. Other studies confirmed effectiveness of performance-enhancing drugs including caffeine and amphetamine for monotonous tasks and after sleep deprivation, and bright light and melatonin resynchronization of biological rhythms following deployment across time zones. Studies of the basis for reduced female metabolic response to cold and menstrual cycle effects provided new data for military thermoregulatory models. Thermal models were also improved by hot weather field studies, including women working in chemical protective gear and walking with 150 lb litters; other data showed the importance of menstrual phase in predicting thermal responses to exercise. Sex hormones had minimal effects in other studies: estrogen given to young women had no effect on heat transfer or evaporative cooling, and previously described effect of progestogens on ventilatory drive and acclimatization did not translate into an advantage for women in their luteal phase ascending to high altitude.

***Military Equipment and Materiel Design Considerations*:** Previously described gender differences in G-force endurance disappeared when the standard anti-G suit was modified for a best fit for females. Fatigue and injury criteria appropriate to the thinner female neck were developed for helmet-mounted equipment. Female vibration exposure criteria were developed to optimize aircraft and vehicle seat cushions, showing that low frequency vibrations are especially fatiguing to women. Studies of moisture vapor transmission rates for garments worn by men and women showed lower skin wettedness in women and a smaller effect on body cooling. A series of anthropometric studies will lead to modifications of female aviator clothing and improved cockpit compatibility. Two studies recommended female urine collection equipment for aviators and other field use.

***Clinical Health Issues*:** Clinical issues translate into important performance limiters for military women who may be called to action at any time. For example, most active duty debilitating headaches occur in women; one study evaluated new drugs for migraine relief. Premenstrual syndrome is a problem for some women; several studies identified aggravating factors and tested treatments including sertraline and biofeedback training. One third of female soldiers reported urinary incontinence during exercise and field training, restricting fluids to reduce these problems; urethral biofeedback and pelvic muscle exercises were shown to useful treatments. Many women developed transient anal incontinence after pregnancy; 15% still had problems 12 weeks postpartum but symptoms diminished over 6 months. Other studies included improved diagnostic algorithms for chest pain in young women, treatments for severe breast pain (mastodynia), and assessment of health care delivery to military women with endocrine deficiencies.