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Sustaining Operational Readiness by Microbial Resilience: A New Paradigm for Predictive and Preventive Disease in Austere Military Operating Environments

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Abstract

Background: Military personnel face extreme physical and psychological stressors that disrupt the human microbiome, leading to dysbiosis. This imbalance is increasingly linked to serious health issues—including infectious diseases, skin and soft tissue infections (SSTIs), and mental health disorders—that directly compromise operational readiness.

Aim: This review synthesizes evidence from 2014 to 2024 on the role of the gut and skin microbiomes in soldier health. It further aims to outline a collaborative framework where nursing, laboratory, and radiological medicine are integral to the predictive and preventive application of microbiome science.

Methods: We conducted a narrative review of the scientific literature, examining foundational research on dysbiosis and evaluating intervention studies in military and comparable high-stress populations.

Results: Pre-deployment gut and skin microbiome profiles can predict vulnerability to diarrheal disease, SSTIs, and stress-induced mental health changes. Probiotic, prebiotic, and synbiotic interventions show promise in maintaining microbial homeostasis. The successful implementation of these strategies hinges on a multidisciplinary team: nursing for patient-centered monitoring and education, laboratory medicine for robust field and in-garrison diagnostics, and radiology for advanced imaging to rule out non-microbiome-related pathologies and assess systemic inflammation.

Conclusion: The integration of microbiome analysis into Force Health Protection represents a paradigm shift toward anticipatory, individualized medicine. Nursing, laboratory, and radiological medicine are not supportive but central to executing this vision, ensuring that microbiome science translates into tangible health benefits for warfighters in austere operating environments.

Keywords: military medicine, gut-brain axis, dysbiosis, probiotics, operational readiness, nursing, laboratory medicine, radiology.

1. Introduction

Military operations subject troops to a spectrum of stressors encountered infrequently in civilian life. These include extreme physical stress, sleep deprivation, psychological disturbance, dietary change, and introduction to novel pathogens in diverse geographic settings (Na-Na et al., 2021). These can significantly disrupt the precarious ecological balance of human microbiota, a state termed dysbiosis. This dysbiosis is more and more engaged not only in the classical infectious diseases but also in a wide range of non-infectious conditions, like psychiatric illnesses, having a direct impact on readiness of the military (Molina-Torres et al., 2019).

Force Health Protection (FHP) is the idea that attempts to preserve the physical as well as mental health of the service members by preventive medicine. Traditional practices of FHP are vaccination, physical fitness training, and providing food. However, the newly evolving science of the microbiome offers unparalleled potential to enhance and refashion these practices (Brenner et al., 2018). By understanding the

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baseline microbial "topography" of a warfighter, we might be able to identify those at greatest risk for certain diseases before deployment. Furthermore, by developing personalized interventions to fortify this microbial topography, we can enhance resilience against the unavoidable stressors of deployment (Integrative et al., 2019).

This review will cover the gut and skin microbiomes, two of the most significant interfaces between the soldier and his environment. The gut microbiome, through its activities of nutrient metabolism, barrier function, immune modulation, and neuroendocrine communication, is a master controller of host physiology (Cryan et al., 2019). The skin microbiome, being the body's initial line of defense against external injury, is critical in preventing infection and maintaining tissue integrity (Byrd et al., 2018). We will consider the evidence linking dysbiosis in such communities to three general categories of morbidity linked with deployment: gastrointestinal disease, SSTIs, and neuropsychiatric dysfunction. Second, we will critically review the current status of microbiome-derived interventions, including probiotics, prebiotics, and synbiotics, in terms of efficacy and application in military operational environments. Finally, we will outline future directions and challenges for the application of microbiome analysis as a foundation stone of 21st-century military medicine.

The Gut Microbiome as a Predictor of Susceptibility

Diarrheal Disease

Acute diarrheal disease remains one of the leading causes of morbidity and lost duty days in military operations, with norovirus and enterotoxigenic *Escherichia coli* (ETEC) being frequent culprits (Hoy et al., 2015). While hygiene and sanitation are primary controls, personal risk varies widely, and increasing evidence indicates the pre-exposure gut microbiota as a primary determinant.

The protective role of a healthy and diverse gut microbiota is well established. High microbial diversity is associated with "processed colonization resistance," a mechanism whereby the native microbiota competes with the entering pathogen for niches and resources (Sorbara & Pamer, 2019). Several studies have identified that individuals with decreased gut microbiome alpha-diversity are at increased risk for infection with pathogens like *Clostridioides difficile* and *Salmonella* (Hill, 2021). In the context of a military setting, the study of travelers' diarrhea is a valid model. A classic study found that travelers who acquired travelers' diarrhea had distinctive pre-travel gut microbiomes that had higher richness of Bacteroidetes and lower richness of *Prevotella* and *Ruminococcaceae* compared with healthy travelers (Yoon et al., 2022). This suggests some microbial community structures are more resilient to perturbation and invasion by pathogens.

In addition to overall community measures, some taxonomic signatures have been correlated with susceptibility. For instance, a high relative abundance of Bacteroides fragilis has been associated with protection from ETEC, potentially through immune-specific responses (Pop et al., 2014). In contrast, blooms of *Enterobacteriaceae*, which is a genus with many pathogenic members, are a normal feature of dysbiosis and often precede overt gastrointestinal disease (Vonaesch et al., 2018). The functional potential of the microbiome is also crucial. Metagenomic sequencing revealed that resistant individuals have a greater abundance of genes involved in SCFA biosynthesis, like butyrate, which strengthens the gut barrier and has anti-inflammatory effects (Zhao et al., 2017). Such a pre-deployment screening that integrates diversity metrics, key taxonomic markers, and functional gene profiles may stratify soldiers according to diarrheal disease risk categories and facilitate goal-directed pre-emptive interventions. Figure 1 shows how microbiome profiling predicts health outcomes in soldiers.

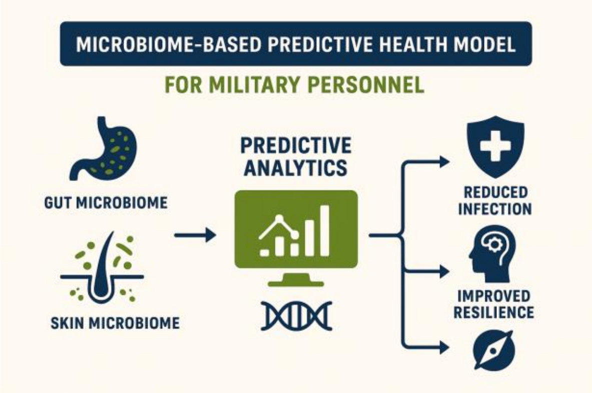

Figure 1: Microbiome-Based Predictive Health Model for Military Personnel

Psychological Resilience and Mental Health

The gut-brain axis is a bidirectional communication network between the enteric and central nervous systems. One of the most important pathways through which the gut microbiome influences this axis is through the production of neuroactive metabolites like SCFAs, gamma-aminobutyric acid (GABA), and serotonin (Cryan et al., 2019). The effect of this signaling is interrupted by dysbiosis and leads to the etiology of stress-related disorders like anxiety, depression, and Post-Traumatic Stress Disorder (PTSD)—morbidity highly prevalent among military personnel (Kessler et al., 2014).

Preclinical models provide robust evidence. Germ-free mice, lacking a microbiome, exhibit increased stress responses and abnormal behavior that can be normalized by colonization with specific bacteria (Luczynski et al., 2016). Microbial signatures of psychological states are starting to be identified in humans. For example, individuals suffering from major depressive disorder have reduced microbial richness and lowered abundances of SCFA-producing bacteria like Faecalibacterium and Coprococcus, along with increased levels of pro-inflammatory taxa (Valles-Colomer et al., 2019). In a study in a high-stress military occupational group, lower gut microbiome diversity correlated with higher perceived stress and worse sleep quality (Karl et al., 2017).

Pre-deployment microbiome interaction and subsequent development of PTSD is a highly active field of research. A prospective marine study identified that participants who developed post-deployment symptoms of PTSD were distinguished by differences in pre-deployment gut microbiome communities, such as the presence of distorted Actinobacteria, Lentisphaerae, and Verrucomicrobia, compared with resistant counterparts (Bremner et al., 2020). This suggests the potential that the gut microbiome may serve as a biological risk factor for trauma-related psychopathology. The mechanisms are thought to be mediated by systemic inflammation and kynurenine pathway metabolism alterations, both of which are microbiota-controlled and form part of PTSD pathophysiology (Ogyu et al., 2018). Gut microbiome profiling could thus identify individuals at higher risk of psychological breakdown in challenging stress so that pre-emptive psychological treatment or microbial therapy could be applied.

The Skin Microbiome as a Susceptibility Predictor Skin and Soft Tissue Infections (SSTIs)

SSTIs account for a high morbidity rate in the military training and combat setting. *Staphylococcus aureus*, including MRSA, is a top pathogen (Ellis et al., 2004). The skin microbiome plays a critical role in the defense against such colonization and invasion by pathogens via competitive exclusion and the secretion of antimicrobial peptides (Byrd et al., 2018).

The health of *S. aureus* and other commensal bacteria, *Staphylococcus epidermidis* in particular. Certain *S. epidermidis* strains produce lantibiotics (such as bacteriocins) that selectively inhibit the growth of *S. aureus* (Janek et al., 2016). In return, individuals whose skin microbiome is dominated by such protective commensals are less likely to be colonized with *S. aureus* and consequently infected. Longitudinal studies of military recruits have shown that shifts in the skin microbiome precede SSTI outbreaks. For instance, decreases in the overall diversity of skin microbiota and loss of barrier Corynebacterium species were observed in soldiers who went on to develop secondary MRSA infection (Aamot et al., 2018).

The warm occluded foot is a particular infection site in soldiers. Fungal infection and trench foot are common in austere contexts. Preconditioning of foot microbiota can predict susceptibility to these infections. A study found that greater fungal diversity and the number of non-pathogenic Malassezia species were more resistant to the development of symptomatic tinea pedis (athlete's foot) (Jo et al., 2017). Therefore, a pre-deployment screening of the skin microbiome for significant areas like the nares, axillae, and feet would be capable of identifying soldiers with high pathogenic S. abundance. aureus and defense commensal depletion, drawing them into heightened hygiene practices or pre-emptive decolonization therapeutic protocols.

Force Health Protection through Microbiome-Targeted Interventions

Prediction is excellent, but prevention must always be the desired outcome. Modulation of the microbiome through dietary and biotherapeutic intervention is a promising means to enhance warfighter resilience (Table 1).

Probiotic Approaches

Probiotics are live microorganisms, present in adequate numbers, that confer a health benefit on the host. They are used primarily in the military to avoid diarrheal disease and alleviate stress. There is robust evidence for the efficacy of using probiotics to prevent traveler's diarrhea. A meta-analysis revealed that specific strains, such as *Lactobacillus rhamnosus* GG and *Saccharomyces boulardii*, significantly reduce the risk for diarrhea among travelers (Bae, 2018). For troops deploying to areas of high risk, daily probiotic supplementation might be an effective prophylactic. Beyond that, certain probiotic strains have been shown to reduce the frequency and duration of recurring viral infections, such as upper respiratory tract infections, which are also prevalent in high-density military settings (King et al., 2014).

The use of psychobiotics—probiotics that possess mental health attributes—is a more recent but highly promising frontier. Several randomized controlled trials (RCTs) have established that some probiotic products reduce perceived stress, improve mood, and attenuate physiological indices of stress like cortisol in healthy and clinic-anxious populations (Messaoudi et al., 2021; Schmidt et al., 2015). For example, a combination of *Lactobacillus helveticus* and *Bifidobacterium longum* reduced anxiety and improved cognitive performance under academic stress (Messaoudi et al., 2021). While extensive RCTs in active-duty military continue to be needed, these findings suggest that targeted psychobiotic regimens can be introduced to enhance psychological resilience during high-stress training cycles and pre-deployment.

Prebiotic and Synbiotic Strategies

Prebiotics are selectively fermented foodstuffs that allow for certain modification of the composition and/or activity of the microbiota in the gastrointestinal tract, thus providing benefits. Synbiotics refer to probiotic-prebiotic mixtures. A significant advantage of prebiotics lies in their stability and ease of addition to military rations.

The best described prebiotics are dietary fibers, including galacto-oligosaccharides (GOS), fructo-oligosaccharides (FOS), and resistant starch. They are fermented by gut bacteria to produce SCFAs, which, as emphasized, are critical for gut barrier function and immune homeostasis (Holscher, 2017).

Prebiotic supplementation has been shown to enhance beneficial Bifidobacterium and Lactobacillus numbers and enteric pathogen resistance in animal models (So et al., 2018).

In human studies, prebiotic supplementation in the form of a GOS prebiotic was found to modulate the stress response. An RCT in healthy adults concluded that a GOS prebiotic substantially reduced the waking cortisol response and attentional vigilance to negative stimuli, a cognitive marker of anxiety (Schmidt et al., 2015). It seems that it might be possible to produce psychobiotic-like effects by supplementing with specific fibers in the diet and thus promoting a resilient indigenous microbiota. Synbiotics, providing the desirable bacteria as well as the energy they need to become established, may offer a synergistic advantage. Synbiotic supplementation was shown in experimental models of hostile environments, such as in astronauts and under simulated combat stress, to preserve gut microbiota diversity and reduce markers of inflammation (Banik et al., 2022). Figure 2 summarizes the practical applications of microbiome interventions in military health.

Table 1: Summary of Key Microbiome-Based Interventions for Military Health

Intervention Type	Examples	Proposed Mechanism of Action	Potential Military Application
Probiotics	*Lactobacillus rhamnosus GG, Saccharomyces boulardii*	Competitive exclusion of pathogens, enhancement of gut barrier, and modulation of local immunity.	Prophylaxis against travelers' diarrhea during deployment.
Psychobiotics	*Lactobacillus helveticus, Bifidobacterium longum*	Production of neuroactive metabolites (GABA, serotonin); reduction of systemic inflammation; regulation of HPA axis.	Enhancing psychological resilience and cognitive performance during high-stress operations.
Prebiotics	Galacto-oligosaccharides (GOS), Fructo-oligosaccharides (FOS), Resistant Starch	Selective stimulation of growth of beneficial endogenous bacteria (e.g., *Bifidobacterium*); increased production of SCFAs.	Incorporation into field rations to universally support gut health and stress resilience.
Synbiotics	*Bifidobacterium* + FOS, *Lactobacillus* + GOS	The combined effect of introducing beneficial strains and providing them with a competitive growth advantage.	Optimizing the survival and efficacy of probiotic strains in the stressed gastrointestinal tract.
Topical Probiotics	*Staphylococcus epidermidis* strains producing lantibiotics.	Competitive exclusion of *S. aureus*; production of specific antimicrobial peptides.	Pre-emptive application to nares and skin to prevent MRSA colonization and SSTIs.

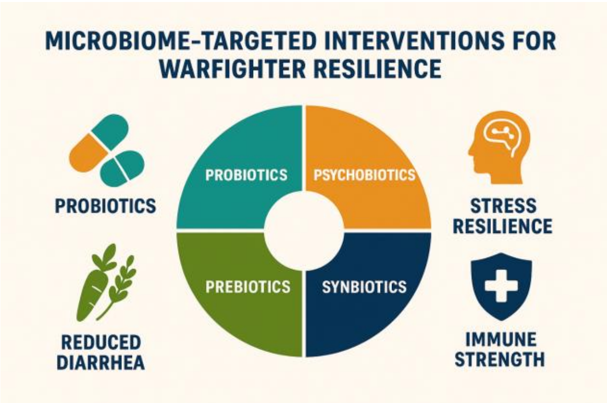

Figure 2: Microbiome-Targeted Interventions for Warfighter Resilience

Laboratory Methods and Diagnostics for Military Microbiome Analysis

Ultimately, the maturation of microbiome science from research concept to component of Force Health Protection hinges upon the advancement of robust, scalable, and operationally suitable laboratory methods. The analytical pipeline, from sample collection to data interpretation, must be established to provide actionable information to military medical operators (Table 2).

Sample Collection and Stabilization in Austere Environments

The first logistical difficulty in deployment settings is sampling and the preservation of samples without interfering with microbial integrity. For gut microbiome research, this is typically via fecal sampling, while skin sampling involves swabbing specific sites like the nares, axillae, and feet. One of the most important advancements for field use is the development of collection kits with chemical stabilizers that immediately inactivate microbial activity and stabilize nucleic acids at room temperature for extended periods (Costea et al., 2017). This eliminates the immediate need for freezing, a significant limitation in forward operating bases. For skin sampling, standardized, pre-moistened swabs and pressure protocols must be used to obtain reproducible and comparable data between time points and among different personnel (Byrd et al., 2018).

Nucleic Acid Extraction and Sequencing Technologies

In the laboratory, the initial step is the extraction of total DNA (or RNA for analysis of functional activity) from samples. This must be both efficient and unbiased so that the resulting genetic data is representative of the in-vivo microbial population. Automated high-throughput extraction platforms with kits specifically optimized for difficult sample matrices (e.g., fecal) are required to process the large cohorts that need to be analyzed for military studies (Costea et al., 2017).

High-throughput sequencing is the cornerstone of modern microbiome research. The 16S ribosomal RNA (rRNA) gene amplicon sequencing remains a common, cost-effective method for profiling bacterial diversity and composition. It enables amplifying and sequencing hypervariable regions of the 16S gene to allow taxonomic assignment to the genus level (Creasy et al., 2020). For a more resolved and functional understanding, however, shotgun metagenomic sequencing is better. This approach sequences all the genetic content in a sample, enabling species- or even strain-level identification, but more significantly, reconstruction of metabolic pathways and estimation of functional potential, for example, the abundance of genes for SCFA production or antibiotic resistance (Zhao et al., 2017). The evolution of portable, real-time sequencing devices, such as those from Oxford Nanopore Technologies, holds promise for field-deployable microbiome analysis in the future, though current throughput and cost limitations are such that they are largely restricted to the detection of pathogens and not yet to in-depth community profiling (Ho et al., 2021).

Bioinformatic Analysis and Data Integration

The raw sequencing data generate millions of reads that require sophisticated computational processing. The bioinformatic pipeline involves some key steps: quality filtering and trimming of reads, clustering into OTUs or ASVs for 16S data or assembly and binning for metagenomic data, followed by taxonomic assignment against reference databases (Integrative et al., 2019). Downstream analyses involve calculating diversity metrics (alpha and beta diversity), identifying differentially abundant taxa, and predicting metagenomic function. The ultimate goal for military medicine is to integrate this complex microbiome information with host metadata—medical records, diet diaries, and physiological stress markers—to generate predictive models. Machine learning and multivariate statistical approaches must be used to this end to sift out unique microbial signatures, or "biomarkers," for disease risk (Zmora et al., 2018). For instance, a model might be trained on pre-deployment microbiome data and subsequent health outcomes in order to generate a "risk score" for SSTI or diarrheal disease in a particular soldier.

Diagnostic Assays for Monitoring and Intervention

While sequencing is powerful for discovery, turnaround time and cost may be prohibitive for routine monitoring. Targeted diagnostic assays are therefore needed. Quantitative Polymerase Chain Reaction (qPCR) panels can be developed to rapidly quantify key predictive taxa (e.g., ratio of protective S. epidermidis to pathogenic S. aureus on skin) or functional genes (Li et al., 2019). Such assays are faster, cheaper, and could be put into larger military medical laboratories. For interventional trials, the laboratory also performs probiotic quality control and intervention efficacy testing. This entails verification of probiotic strain identity and viability and utilization of the aforementioned techniques to monitor microbiome changes as a result of prebiotic or probiotic supplementation and thereby provide objective clinical trial endpoints (Messaoudi et al., 2021).

Table 2: Laboratory Workflow for Military Microbiome Analysis

Stage	Key Activities	Military-Specific Considerations
Sample Collection	Fecal sample collection with stabilizer; standardized skin swabbing.	Use of ambient-temperature stabilization tubes; rugged, lightweight collection kits for field use.
Nucleic Acid Extraction	High-throughput, automated DNA/RNA extraction from complex samples.	Protocols optimized for samples potentially contaminated with environmental debris; rapid extraction kits for forward-deployed labs.
Sequencing & Profiling	- **16S rRNA Sequencing:** For community structure. - **Shotgun Metagenomics:** For species-level ID and functional insight.	Balancing cost vs. information depth for large cohorts; exploring portable sequencers for rapid pathogen detection in outbreak scenarios.
Data Analysis	Bioinformatic processing, taxonomic assignment, diversity analysis, and machine learning.	Development of standardized analysis pipelines and secure data storage; building classified predictive models for specific deployment-related health risks.
Targeted Diagnostics	qPCR/Multiplex PCR for specific biomarkers of health or disease risk.	Development of rapid, point-of-care molecular tests for key pathogens or resilience markers; monitoring compliance and efficacy of probiotic interventions.

The Essential Contribution of Nursing in Microbiome-Based Health Care

As the first contact for patients, the nursing corps is essential in the implementation of microbiome-based Force Health Protection (FHP) strategies over the full range of continuity of care (Brenner et al., 2018). Nurses have the primary responsibility for patient education to assist soldiers in understanding the underlying health of the microbiome, the rationale of introduced probiotics or prebiotics, and hygiene protocols to maintain a healthy skin microbiome (Byrd et al., 2018). This aspect of patient education to promote adherence is essential for the efficacy of the implementation (Zmora et al., 2018). In addition to education, nurses sit uniquely as a source of ongoing assessments during training and deployment. Their clinical judgment in screening and determining whether an early symptom develops into gastrointestinal distress, skin and soft tissue infections (SSTI), or is stress-related can trigger the use of rapid diagnostics or escalation of care which provides a critical link between the first sign or symptom of development of any dysbiosis-related illness and intervention (Karl et al., 2017); this is of particular importance within the combat context and given the military health-care urgency.

Lastly, nurses would be trained to collect standardized feces and skin swabs, which is essential for proper collection to ensure biospecimen integrity for laboratory analysis and to move forward with any future enumerable or qualitative analyses of health care delivery intentions and protocols through implementation investigation (Costea et al., 2017). Within the field of mental health, nurses who are involved in administering psychobiotics deliver comprehensive support by monitoring for side effects, determining subjective perception of well-being, and providing critical psychosocial support, all contribute to creating a comprehensive therapeutic milieu necessary for warfighter resilience (Messaoudi et al., 2011; Schmidt et al., 2015).

The Radiologist's Role in a Holistic Approach to Microbiome Health

While the microbiome analyses provide prediction and prevention, radiology supplies the critical diagnostic arm to contextualize findings and determine the total system effect attributable to dysbiosis. A primary role is differential diagnosis; when a soldier presents with abdominal discomfort and diarrhea, one must obtain abdominal imaging with either ultrasound or CT to rule out surgical emergencies, including appendicitis or obstruction (all of which would require treatment well beyond modulation of the microbiome). Radiology can also determine systemic inflammation stemming from alterations in gut dysbiosis. As an example, MRI enterography could be utilized for evaluating inflammatory bowel disease, and newly developed research is investigating new applications with PET imaging to visualize neuroinflammation attributable to the brain axis and potential relationship to PTSD (Bremner et al., 2020; Cryan et al., 2019).

Ultrasound thus becomes an indispensable part of the management of SSTIs in defining the extent of the infection; in focusing attention on abscesses which need drainage, and in helping guide the intervention, while supplementing microbiological data from skin swabs (Aamot et al., 2018). Since the gut microbiome has effects on systemic inflammation and recovery rate, radiological assessments of common military injuries, such as stress fractures, might be analyzed in relation to microbiome profiling to identify individuals at greater risk for impaired healing, creating an even more personalized approach to soldier health (Karl et al., 2017). Figure 3 shows the multidisciplinary role of nurses, laboratory technicians, and radiologists.

Figure 3: The multidisciplinary role of nurses, laboratory technicians, and radiologists.

Challenges and Future Directions

Despite the firm promise, integration of microbiome analysis into routine FHP is faced with a variety of significant challenges (Table 3).

The human microbiome is highly personalized and is subject to genetics, diet, and life history. A one-size-fits-all probiotic is not good for all. The future is personalized microbiome medicine, where interventions are tailored based on an individual's baseline microbiota (Zmora et al., 2018). But this requires high-end decision structures and analytics that are not currently feasible on a large scale. In addition, the field does not have standardization of sampling strategy, DNA extraction process, and bioinformatic analyses, so it is difficult to make inter-study comparisons and build generalizable prediction models (Costea et al., 2017).

It is logistically difficult to implement microbiome solutions in lean environments. Probiotics must be refrigerated to retain their viability, which is something which may not be available in forward operating bases. Prebiotics included in rations should remain stable at elevated temperatures and be palatable. Cost-effectiveness of field microbiome sampling and analysis is another constraint, though there has recently been a breakthrough in miniaturized sequencing technologies that should overcome this limitation in the future (Ho et al., 2021).

Most of the current evidence demonstrates correlation, not causation. Animal models are highly amenable to an inference of a causal role of the microbiome in health outcomes, and human intervention studies, particularly among military populations, are needed. Large prospective longitudinal cohort studies tracking service members from basic training to deployments are needed to validate predictive biomarkers and demonstrate the efficacy of interventions under naturalistic conditions (Creasy et al., 2020).

Table 3: Leeway Research Questions and Implications for Future Research

Research Gap	Recommended Future Study
Lack of large-scale military cohort data.	Initiate a longitudinal study (e.g., "The Military Microbiome Project") profiling 10,000+ service members over 5 years, linking microbiome data to health records.
Causality in the gut-brain axis in humans.	Conduct RCTs of specific psychobiotics in military cohorts undergoing high-stress training (e.g., Special Forces selection), using fMRI and biochemical markers as endpoints.
Operational feasibility of interventions.	Perform field trials to test the stability and efficacy of novel, shelf-stable probiotic formulations and prebiotic-fortified rations during extended training exercises.
Mechanisms of skin microbiome protection.	Use culture-based and metagenomic approaches to identify specific antimicrobial molecules produced by protective skin commensals and develop them as topical therapeutics.
Personalized vs. general interventions.	Conduct a randomized trial comparing the efficacy of a generic probiotic versus a personalized synbiotic regimen (selected based on pre-deployment microbiome analysis) in preventing diarrheal disease.

Conclusion

The study of the human microbiome is expected to radically alter military medicine; however, execution of this change relies on a fully integrated and interprofessional strategy. There is overwhelming evidence that a soldier's microbial ecology plays a critical role in their risk for diarrheal disease, SSTIs, and stress-related mental illness. As we leverage this knowledge for effective Force Health Protection, the entire medical team will need to work together.

Nursing can deliver this science to the individual warfighter through education, monitoring, and compassionate care to promote compliance and early detection. Laboratory Medicine is a core component of diagnostics through field-stable collection kits, advanced sequencing, and rapid qPCR assays, turning complex microbial data into meaningful health intelligence. Radiology rounds out the clinical picture by providing diagnostic clarity, excluding differential diagnoses, and visualizing the systemic impact of dysbiosis.

Investing in microbiome research is not just a theoretical exercise; it is the cornerstone of a military strategy. Providing our nursing, laboratory, and radiology practices the tools and protocols to leverage microbiome science provides our operational leadership a healthier, more resilient and effective fighting force. The future of military medicine will be in winning the internal war related to the microbiome, and winning that war takes a force united.

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