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What is the dietary intake and nutritional status of defence members: a systematic literature review

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Abstract
Optimal diet and nutrition is vital for military readiness, performance and recovery. Previous research on military diets has primarily focused on the nutritional composition of field/combat rations and dietary intake during deployment. There is accumulating research exploring the usual free-living dietary intake and nutritional status of defence members in garrison (i.e. military bases on which personnel are stationed). However, no comprehensive review has been conducted to assess the overall dietary quality of defence members internationally. Therefore, this review assessed the diets of military populations against national nutritional guidelines and Military Dietary Reference Intakes (MDRI). A systematic literature review of original research was conducted. CINAHL, Medline (EBSCO), Scopus (Elsevier), PubMed and AMED databases were searched up to the 20/02/2023. A total of thirty-six studies met the inclusion criteria. The overall quality of included studies was high, with a low risk of bias. The diet quality scores indicate poor to fair diet quality among defence members. Defence members display low intakes of fruits, vegetables, wholegrains, seafood, plant protein and nuts and high intakes of added sugars, trans fat and processed meat. Results also indicated suboptimal intake of fibre, essential fatty acids, vitamin A, vitamin E, folate, Mg, Zn and iodine. This may lead to reduced performance, increased risk of chronic diseases and mental health disorders. More research is needed to assess the long-term consequences of poor diet quality in defence members. These results require the attention of policymakers to ensure that military education and food environment is supportive of healthy eating.

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Introduction

Diet and nutrition have long been established as a crucial component to military readiness and performance[1–3]. Adequate dietary nutrients are vital to maintain optimal health, protect against both physical and mental illness, and promote resilience and recovery[4]. The nutritional requirements of defence members vary according to their work environment (i.e. hot desert environments, tropical humid environments and cold arctic climates) and the physical requirements specific to their role (i.e. carrying provisions and gear, lifting supplies and equipment, digging, climbing, and marching)[5,6]. As a result, military dietary reference intakes (MDRI) have been developed by some defence forces to guide nutritional requirements for defence members[7]. The MDRI have been adapted from the recommended daily allowances, published by the Institute of Medicine in the USA[8]. The most recent MDRI were updated in 2017 and are based on physically active military men and non-lactating, non-pregnant women, aged 17–50 years[9]. While the MDRI for some nutrients are the same as the general population, some specific nutrients, such as Na, are required in higher quantities.

The Committee on Diet and Health of the Food and Nutrition Board recommends that Na intake should not exceed 2400 mg/d[7]. However, the Committee on Military Nutrition Research highlights that this intake is too low for military purposes due to the potential risk of Na depletion experienced under certain conditions, predominantly in hot environments without adequate periods of adaptation[10]. For most nutrients, the MDRI are set at the highest sex-specific reference value or recommended daily allowance, with the exception of Ca, P and Fe for males and Ca, P and Mg for females[7]. Recommendations for energy (kcal) intake are divided into different levels of activity (light, moderate, heavy and exceptional)[7].

Historically, military nutrition research has focussed on optimising field/combat ration pack composition[4], particularly in regard to energy intake and macronutrient balance[11–13]. Previous research has also investigated the taste, texture and palatability of field/combat rations, with a focus on improving consumption compliance among defence members deployed or on exercise[14,15]. Other studies investigate the success of healthy eating initiatives and programmes in garrison delivered at

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military dining facilities[16–18]. More recently, research has begun to focus on the usual dietary patterns, food habits and nutritional intake of defence members during non-deployment free-living[19–21]. However, to date, no comprehensive international systematic literature review has evaluated the overall dietary intake, composition and quality, or nutritional status of military personnel.

This review aimed to explore the diets of military populations internationally and assess whether their diets meet national nutritional guidelines and country-specific MDRI. The review aimed to determine which components of defence members diets require attention and highlight priority areas for policy makers, governments and defence organisations. Evaluating dietary intake is crucial in order to help influence dietary education materials and target future nutritional interventions.

Methods

Data source and search strategies

A protocol was developed according to the Preferred Reporting Items For Systematic Reviews And Meta-Analysis Protocols (PRISMA-P) 2020 statement[22] (Supplementary file 1). The review was registered with the International Prospective Register of Systematic Reviews, PROSPERO (registration ID: CRD42023402198).

The primary outcome was to synthesise the dietary intake, composition and diet quality of military populations and compare intakes relative to dietary reference values such as the MDRI for individual nutrients. Additional outcomes included identifying which dietary components require improvements, by assessing the frequency of food consumption (e.g. number of serves of vegetables consumed per day) and identifying nutrient excesses or deficiencies compared to the MDRI values.

A literature search was conducted in the following databases: CINAHL, Scopus (Elsevier), Pubmed and AMED. A combination of Medical Subject Headings (MeSH) and free terms were used with Boolean operators integrated for advanced searches. The search used a combination of two search strings: the first one using terms for diet and nutrition, the second one using terms for military personnel and veterans. The following search is an example for the search used in PubMed, with the terms were adapted for each database:

(Diet [MeSH] OR Diet, Food, and Nutrition [MeSH] OR Diet Quality OR Diet Intake OR Nutrition Assessment [MeSh] OR Nutrient Intake OR Nutritional Status OR Nutrition) AND (Military Personnel [MeSH] OR Military Health [MeSH] OR Military [Title/Abstract] OR Army [Title/Abstract] OR Airforce [Title/Abstract] OR Navy [Title/Abstract] OR Veterans [MeSH]).

Screening of grey literature such as government reports/websites and clinical practice guidelines was also performed, along with hand searching the reference list of the included articles. Studies identified through database searching were exported and stored in EndNote X9[23]. Articles were then imported into Covidence[24] where they were screened by title and abstract first, and later assessed as full text by J.B. and E.B. Covidence is a web-based collaboration software platform that streamlines the production of systematic and other literature reviews[24]. The initial database search was performed by J.B. and final articles reviewed by E.B.

Inclusion and exclusion criteria

Original research published up to 21 February 2023, which assessed usual dietary intake, quality or composition (from either free living or in garrison), or nutritional status in current/active serving military populations were included in the review. Current serving military populations refers to all full time or part time military personnel, including national guard and reservists. All research designs were deemed eligible, including observational research designs (cross-sectional, cohort, case-control) and qualitative research designs (focus groups, interviews, etc). Experimental research designs (randomised control trials (RCT) and quasi-experimental studies) were included only when data on dietary intake or nutrition status was reported at baseline or for the control group.

Articles were excluded from the review if they constituted literature reviews, duplicate studies, conference proceedings, commentaries, abstracts, short communications and letters to the editor or reported findings from animal model research, *in vivo* and in *vitro* research. Research examining the nutritional quality or effects of combat rations or field rations on military personnel were also excluded, as reviews on this topic have already been conducted. Instead, this review focuses on dietary intake from either free living or in garrison.

Quality appraisal

Each paper was critically appraised for methodological consistency using risk of bias (ROB) critical appraisal tools. The Joanna Briggs Institute (JBI) checklists[25] for cross-sectional studies and quasi-experimental studies were used and the Critical Appraisal Skills Programme (CASP) checklist for cohort studies and RCT were also used. The JBI critical appraisal tools have been developed by the JBI and collaborators and approved by the JBI scientific committee following extensive peer review[25]. The checklists ask questions which result in answers of yes/no or unclear. The checklist for cross-sectional studies includes eight questions which evaluate inclusion and exclusion criteria, study setting, measurement reliability, confounding factors and statistical analysis. A score of zero to three was considered a high ROB, a score of four to five was considered a medium ROB and a score of six to eight was considered a low ROB. The checklist for quasi-experimental studies includes nine questions which assess clarity of “cause” and “effect” variables, comparisons/control group similarity, measurement reliability, follow-up and statistical analysis. A score of one to three was considered a high risk of bias, a score of four to six was considered a medium risk of bias and a score of seven to nine was considered a low risk of bias.

The CASP checklist for cohort studies has twelve questions which evaluate measurement accuracy, confounders and follow-up. A score of zero to four was considered a high ROB, a score of five to eight was considered a medium ROB and a score of nine to twelve was considered a low ROB. The CASP checklist for RCT has eleven questions which evaluate randomisation, blinding, methodology and results. A score of zero to four was considered a high ROB, a score of five to eight was considered a medium ROB and a score of nine to eleven was considered a low ROB. ROBwas assessed by J.B. and reviewed by E.B. and disagreements were resolved through discussion. Table 1 displays the results from the critical appraisal.

Data extraction

Predetermined data extraction was registered with PROSPERO prior to commencing the review. The Cochrane Data Extraction Template for Included Studies was used to extract key information from each of the final included studies[26]. The template is designed to capture all relevant information about the included studies and their results[26]. It comprises of seven sections including: (1) General review information (title, authors, year of publication, funding sources); (2) Methods of the study (study design, number of participants, location, setting); (3) Risk of bias assessment (results from the JBI and CASP ROB assessments); (4) Study characteristics – participants (age, sex, inclusion/exclusion criteria for the study, comorbidities, military branch e.g., Army, Navy or Air Force); (5) Study characteristics – interventions and comparisons; (6) Study characteristics – outcomes; (7) Data and results (diet data, including diet quality score (DQS) if available). The extracted data from the final articles is summarised in Table 2.

Results

Identification of studies

The article selection process is outlined in Figure 1. The initial search identified 7567 papers. After the removal of 1304 duplicates, articles were screened by title and abstract. A total of 352 articles were then screened by full text. Initially, 157 studies met the full inclusion criteria; however, a large number of these were over 30 years old. In order to present a contemporary overview of the current dietary intake of military personnel, the inclusion criteria were further refined to only include articles published within the last 10 years and to exclude veteran populations. We recommend that an additional review be conducted to examine veteran dietary intake separately, as the dietary and energy needs of active serving military and veterans varies considerably. These additional refinements resulted in 36 articles which met the full inclusion criteria and are presented in this review.

Critical appraisal results

Table 1 displays the ROB score for each included article. For the cross-sectional studies (n 21), the majority had a low ROB (n 10)[21,27–35] or a medium ROB (n 9)[19,36–43], with only two studies[44,45] displaying a possible high ROB. The main issues observed included the sample inclusion criteria not being clearly defined, confounding factors not being adequately identified and a lack of reported strategies to deal with confounding factors. None of the cohort studies (n 10) had a high ROB, four had a medium ROB[46–49] and six had a low ROB[20,50–54]. The main issues observed in the cohort studies was the lack of reported techniques to correct, control or adjust for confounding factors, in addition to a lack of precision when reporting the results (e.g. lack of confidence intervals). For the two RCT, one had a medium ROB[55] and one had a low ROB[56]. For the quasi-experimental studies (n 3), one study had a medium ROB[57] and two had a low ROB[17,58]. The risk of bias analysis revealed an overall low risk of bias among the included articles in this review suggesting a high level of confidence in the reported results.

Study characteristics

Several different study designs were included in this review. The majority were cross-sectional studies (n 21) or cohort studies (n 10), with only a few using RCT (n 2) or quasi-experimental (n 3) designs. The number of participants in each study ranged from 12 participants to 27 034 participants. A total of 69 351 participants were included in this review. Fourteen studies included only male participants and one did not report participant sex[19]. The vast majority of studies were conducted in the USA; n 20)[17,20,21,27,30,31,33,36,38,39,42,46,50–53,55–58], with the remaining studies conducted in Iran (n 5)[29,32,34,35,37], England (n 3)[40,43,54], Australia (n 2)[28,49], Belgium (n 2)[44,45], Finland (n 1)[47], Poland (n 1)[41], Greece (n 1)[48] and Canada (n 1)[19]. The majority of studies were conducted in Army members (n 27), three were conducted in all services (Army, Navy and Air Force)[27,31,39], two were conducted in the Navy/Marines[48,51] and two did not report which service members were included[32,34].

Diet measurement

The majority of studies used standard FFQ (n 23), with the most common being block FFQ (n 11) which are designed based on the block dietary data systems and include a standardised format and item list designed to capture a wide range of commonly consumed foods[59]. Three studies asked general questions about food consumption as part of larger surveys[27,39,44]. One study used digital photographs to assess food intake[58] and three assessed food weight and plate waste[43,54,58]. Seven studies used food diaries or food logs to assess food intake[19,40,43,45,47,52,54], and two used blood tests to assess nutrient status[49,57]. A range of different nutrients were assessed across the included articles. The majority of studies (n 23) assessed energy (kJ) and macronutrients (protein, carbohydrates and fats). Many also assessed fibre, essential fatty acids and a number of micronutrients (vitamins and minerals). The most common micronutrients assessed included vitamin A, C, D and K, folate, Na, Ca, Mg, K, Se, Fe and Zn. Some studies also assessed caffeine, water and added sugar consumption.

Diet quality scores

Eight of the included studies calculated a diet quality score from the food FFQ results[20,28,29,34,36,42,50,58]. The most commonly used scores were the Healthy Diet Indicator[34], Healthy Eating Index[20,42,50,51,58] and Healthy Eating Score[36]. The Australian Recommended Food Score was used for one study[28]. For each of these diet quality scores, the overall diet quality is rated as:

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Table 1. Risk of bias results

Critical appraisal for cross sectional studies (JBI)									
Author/date	1	2	3	4	5	6	7	8	Total
Purvis et al. 2013	Y	N	Y	Y	N	UC	Y	Y	5/8
Ramsey et al. 2013	Y	Y	Y	Y	Y	UC	Y	Y	7/8
Smith et al. 2013	Y	Y	Y	Y	N	N	Y	Y	6/8
Taleghani et al. 2014	Y	N	Y	Y	N	N	Y	Y	5/8
Beals et al. 2015	N	N	Y	Y	N	N	Y	Y	4/8
Kullen et al. 2016	N	N	Y	Y	Y	Y	Y	Y	6/8
Mullie et al. 2016	N	Y	N	Y	UC	N	N	Y	3/8
Hruby et al. 2018	Y	Y	UC	Y	Y	N	UC	Y	5/8
Rahmani et al. 2018	Y	UC	Y	Y	Y	Y	Y	Y	7/8
Chapman et al. 2019	N	Y	Y	Y	N	N	Y	Y	5/8
Lutz et al. 2019	Y	Y	Y	Y	Y	N	Y	Y	7/8
Nakayama et al. 2019	Y	Y	Y	Y	Y	Y	Y	Y	8/8
Anyżewska et al. 2020	N	Y	Y	Y	N	N	Y	Y	5/8
De Bry et al. 2020	N	N	Y	Y	N	N	N	Y	3/8
Ghodsi et al. 2020	UC	Y	Y	Y	Y	Y	Y	Y	7/8
Rittenhouse et al. 2020	UC	Y	Y	Y	N	N	Y	Y	5/8
Daniels & Hanson 2021	N	Y	Y	Y	Y	Y	Y	Y	7/8
Parastouei et al. 2021	Y	Y	Y	Y	Y	Y	Y	Y	8/8
Edwards et al. 2022	N	Y	Y	Y	N	N	Y	Y	5/8
Ahmed et al. 2023	N	N	Y	Y	N	N	Y	Y	4/8
Salehi et al. 2023	Y	Y	Y	Y	Y	Y	Y	Y	8/8

Critical appraisal for cohort studies (CASP)												
Author/Date	1	2	3	4	5	6	7	8	9	10	11	12	Total
Carlson et al. 2013	Y	UC	Y	Y	N	Y	Y	N	Y	N	Y	N	7/12
Lutz et al. 2013	Y	UC	Y	Y	N	Y	Y	UC	Y	Y	Y	Y	9/12
Farina et al. 2017	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	10/12
Sepowitz et al. 2017	Y	UC	Y	Y	N	Y	Y	N	Y	Y	Y	Y	9/12
McAdam et al. 2018	Y	Y	Y	UC	N	UC	Y	N	Y	Y	Y	Y	9/12
Lutz et al. 2019	Y	Y	Y	Y	N	Y	Y	UC	Y	Y	N	Y	9/12
Nykänen et al. 2019	Y	UC	Y	UC	N	Y	Y	N	Y	Y	Y	Y	8/12
Chapman et al. 2020	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	10/12
Doupis et al. 2020	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y	8/12
Peoples et al. 2022	Y	UC	Y	UC	N	Y	Y	N	Y	Y	Y	Y	8/12

Critical appraisal for RCT (CASP)											
	1	2	3	4	5	6	7	8	9	10	11	Total
Gaffney-Stomberg et al. 2014	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	10/11
Frank & McCarthy 2016	Y	Y	Y	N	N	Y	UC	N	Y	Y	Y	7/11

Critical appraisal for quasi-experimental studies (JBI)									
	1	2	3	4	5	6	7	8	9	Total
Barringer et al. 2016	Y	N/A	UC	N	Y	UC	Y	Y	Y	5/9
Cole et al. 2018	Y	N	N	Y	Y	Y	Y	Y	Y	7/9
Bukhari et al. 2022	Y	Y	Y	Y	Y	Y	Y	Y	Y	9/9

Key: Y, yes; N, no; UC, unclear/cannot tell; N/A, not applicable

Joanna Briggs Institute checklist for cross sectional studies:

1. Were the criteria for inclusion in the sample clearly defined?
2. Were the study subjects and the setting described in detail?
3. Was the exposure measured in a valid and reliable way?
4. Were objective, standard criteria used for measurement of the condition?
5. Were confounding factors identified?
6. Were strategies to deal with confounding factors stated?
7. Were the outcomes measured in a valid and reliable way?
8. Was appropriate statistical analysis used?

CASP checklist for cohort studies:

1. Did the study address a clearly focused issue?
2. Was the cohort recruited in an acceptable way?
3. Was the exposure accurately measured to minimise bias?
4. Was the outcome accurately measured to minimise bias?
5. (a) Have the authors identified all important confounding factors?
(b) Have they taken account of the confounding factors in the design and/or analysis?
6. (a) Was the follow up of subjects complete enough?
(b) Was the follow up of subjects long enough?
7. What are the results of this study? Have they been reported accurately?
8. How precise are the results?

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9. Do you believe the results?
10. Can the results be applied to the local population?
11. Do the results of this study fit with other available evidence?
12. Are there implications of this study for practice?

CASP checklist for RCT:

1. Did the study address a clearly focused research question?
2. Was the assignment of participants to interventions randomised?
3. Were all participants who entered the study accounted for at its conclusion?
4. Were the participants "blind" to intervention they were given? Were the investigators "blind" to the intervention they were giving to participants? Were the people assessing/analysing outcome/s "blinded"?
5. Were the study groups similar at the start of the randomised controlled trial?
6. Apart from the experimental intervention, did each study group receive the same level of care (that is, were they treated equally)?
7. Were the effects of intervention reported comprehensively?
8. Was the precision of the estimate of the intervention or treatment effect reported?
9. Do the benefits of the experimental intervention outweigh the harms and costs?
10. Can the results be applied to your local population/in your context?
11. Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?

Joanna Briggs Institute checklist for quasi-experimental studies:

1. Is it clear in the study what is the "cause" and what is the "effect" (i.e. there is no confusion about which variable comes first)?
2. Were the participants included in any comparisons similar?
3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?
4. Was there a control group?
5. Were there multiple measurements of the outcome both pre and post the intervention/exposure?
6. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?
7. Were the outcomes of participants included in any comparisons measured in the same way?
8. Were outcomes measured in a reliable way?
9. Was appropriate statistical analysis used?

(1) poor diet quality; (2) fair diet quality – requires improvement; (3) good diet quality. In all eight studies which calculated a diet quality score, the results indicated poor to fair diet quality which indicates improvement is necessary[20,28,34,36,42,50,51,58].

Energy and macronutrients

Twenty-three of the studies assessed daily energy intake (kJ). Twenty of these studies found that defence members did not meet energy requirements according to their country's MDRI[17,19,21,29–35,38,40,43,45,47,51,52,54–56], while only three studies reported adequate intake[37,46,49]. The majority of studies which assessed carbohydrate intake reported adequate intake (*n* 12)[19,30,32,35,37,46,47,49,52,54–56] and only three reported inadequate intakes[43,45,51]. All 19 studies that assessed protein intake reported an adequate intake which exceeded the country's recommendations[19,21,29–32,35,37,38,40,43,45–47,51,52,54–56]. Fat intake was assessed by 21 studies, with only two reporting inadequate intake[29,52]. Nineteen reported an intake which exceeded recommendations[17,19,21,30–32,35,37,38,40,43,45–47,49,51,54–56]. Six studies assessed essential fatty acids with all reporting suboptimal intake[17,42,49–51,58]. Two studies also assessed trans-fat, with both indicating a high consumption which exceeded recommendations[17,49]. Eight studies assessed fibre, with six reporting inadequate intake[19,21,33,34,40,47] and only two reporting adequate intake[32,35].

Vitamins

A variety of different vitamins were assessed including; A, B1, B2, B3, B5, B12, K C, D, E and folate. Inadequate intake of vitamin A was reported in four studies[19,37,38,40], with only two reporting adequate intake[21,33]. Inadequate intake of vitamin C was reported in two studies[38,40], while five studies indicated adequate intake[19,21,33,37,55]. Inadequate intake of vitamin D was indicated in three studies[40,46,57], while adequate intake was indicated in five studies[19,30,37,55,56]. Inadequate intake of vitamin E was reported in three studies[21,37,38], with only one reporting adequate intake[33]. Inadequate intake of vitamin K was reported in two studies[38,46], while four reported adequate intake[30,37,46,55]. Six studies assessed folate, with three reporting inadequate intake[19,38,40] and three reporting adequate intake[21,30,33]. Most studies indicated adequate B vitamins, excluding one study which reported inadequate B3[19].

Minerals

A variety of minerals were assessed among the studies, including Na, Mg, Fe, Zn, Ca, K, I, Se and P. Suboptimal intake of Na was reported in six studies[21,34,42,50,51,58] and inadequate intake of Mg was reported in three studies[19,38,40]. Two studies found that iron intake among female defence members was inadequate[38,40], while four reported adequate intake[19,21,32,33]. Inadequate intake of Zn was reported in four studies[19,32,38,40] and only one reported adequate intake[37]. Inadequate intake of Ca was reported in four studies[19,38,40,56], while adequate intake was reported in seven studies[21,31–33,37,46,55]. Inadequate intake of potassium was reported in four studies[19,31,38,40], while adequate intake was reported in five studies[21,30,37,46,55]. Both studies which assessed iodine intake reported inadequate intake[38,40]. Inadequate intake of selenium was reported in one study[40], while adequate intake was reported in three studies[32,37,38]. All seven studies which assessed P intake reported adequate intake[19,30,32,38,40,46,55].

Food groups

Several studies assessed daily serves of food groups such as fruits, vegetables, wholegrains, seafood/plant protein, meat, dairy, fats, added sugars and fast food. All thirteen studies which assessed food group portions reported inadequate intakes of fruits, vegetables, seafood, plant proteins, nuts and wholegrains[27–29,31,36,39,41,42,44,48,50,51,58]. A further five studies assessed added sugars with all reporting higher than recommended intake[39,41,42,48,58]. Of the two studies that assessed processed meat intake, both reported intake that exceeded recommendations[34,41].

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Table 2. Data summary table

Author/year	Country	Design	Participants	Military branch	Diet measure or nutrient analysis method	Diet components assessed	Results	Comparison to dietary reference ranges and values
Carlson et al. 2013	USA	Longitudinal cohort study	*n* = 19 mean age, 23 years M = 63% F = 37%	Army	Block FFQ (2010)	Macro: energy, fat, CHO, protein. Micro: Ca, Mg, Na, P, vit K, vit D. Results, mean/d measured at baseline	Energy: 13518 kjs, Protein: 117 g, CHO: 409 g, fat: 120 g, Ca: 1150 mg, Mg: 427 mg, Na: 5152 mg, P: 1722 mg, vit K: 208 mcg, vit D: 4.5 µg	Army members did not meet the DRI for vit D and exceeded the DRI for energy, protein, CHO, fat, Mg, Na, P and vit K
Lutz et al. 2013	USA	Longitudinal cohort study	*n* = 135 mean age, 23 years M = 56% F = 44%	Army	110 item, semi-quantitative, block FFQ (2005)	Intake of fruit, grains, vegetables, meat and beans, milk, oils, Na, saturated fat, calories from solid fats, alcoholic beverages, and added sugars. Results converted to a HEI score (_/100)	Participant split into three tertiles based on total HEI score. Those in the lowest tertile (*n* = 45) had a mean HEI score of 47/100, those in the middle tertile (*n* = 45) had a mean score of 60/100 and those in the highest tertile (*n* = 45) scored 73/100	Army members displayed poor to fair diets (require improvement) at baseline according to the HEI scores
Purvis et al. 2013	USA	Cross-sectional study	*n* = 13 858 mean age, 28 years M = 83% F = 17%	Army	5-item Healthy Eating Score (HES-5)	Intake of fruit, vegetables, whole-grains, dairy and fish. Results are reported as number of servings and converted to a total HES-5 score (_/25)	Only 38.7% met the DRI for fruit, 22.2% met the DRI for vegetables 16.8% met the DRI for whole grains, 17.3% met the DRI for dairy and 46.6% met the DRI for fish. The mean HES-5 was 15.7/25	Army members displayed fair diets (require improvement) according to the HES-5, and display low intake of fruits, vegetables, wholegrains and dairy
Ramsey et al. 2013	USA	Cross-sectional study	*n* = 39 mean age, 36 years M = 46% F = 54%	Army	National Cancer Institute DHQ	Macro: energy, fat, CHO and protein. Micro: vit A, vit C, vit E, B12, folate, Fe, Ca, K, Na. Other: fibre, alcohol and caffeine. Results = mean/d	Energy: (M: 11042 kjs and F: 8263 kjs). Vit E: (M: 12 mg and F: 11 mg). Na: (M: 3659 mg and F: 3232 mg). Nutrient intake for all other nutrients met or exceeded the MDRI	Army members did not meet the MDRI for energy in both males and females for moderate activity levels. Intake of vit E was also lower than the MDRI. Na intake was lower than the MDRI, but still well above the DRI. Intake of fibre was also suboptimal
Smith et al. 2013	USA	Cross-sectional study	*n* = 15,747 mean age, NR M = 85% F = 15%	Navy, Marine Corps, Army and Air Force	Questions which asked frequency of food consumption – name of tool NR	Intake of fruit, vegetables, grains, dairy, protein, snack foods/sweets and fast foods. Results = frequency of consumption. Final results compared to the Healthy People 2010 guidelines for food intake	Only 29% of participants ate fruit at least once per day, and 10% ate vegetables ≥ 3 times/d. Fewer than 12% ate whole-grains ≥ 3 times/d. A total of 34% eat snack foods/sweets one or more times per day and 51% eat fast food three or more times per week	In defence members, only 3% met the Healthy People 2010 objectives for fruit, vegetable, and whole-grain intake
Gaffney-Stomberg et al. 2014	USA	RCT	*n* = 247 mean age, 21 years M = 70% F = 30%	Army	Block FFQ	Macro: energy, fat, CHO and protein. Micro: Ca and dietary vit D. Results = mean/d measured at baseline	Energy: 9481 kjs, CHO: 269 g, fat: 92 g, protein: 89 g, Ca: 975 mg, dietary vit D: 4.5 µg	In army members, energy intake was lower than the MDRI for moderate activity levels. Ca intake was also lower than the recommended MDRI and DRI

Table 2. (*Continued*)

Author/year	Country	Design	Participants	Military branch	Diet measure or nutrient analysis method	Diet components assessed	Results	Comparison to dietary reference ranges and values
Taleghani et al. 2014	Iran	Cross-sectional study	*n* = 77 mean age, 41 years M = 100% F = 0%	Army	168-item semi-quantitative FFQ	Macro: energy, fat, CHO and protein. Micro: vit A, vit B1, B2, B3, B6, B12, vit C, vit D, vit E, vit K, Se, Ca, Zn, Mg. Foods: fruit and vegetables. Results = mean/d	Energy: 13443 kjs, protein: 122g, CHO: 550 g, fat: 98 g, vit A: 593 g, vit C: 203 mg, vit E: 12 g, Ca: 1714 mg, Zn: 20 mg, Se: 168 μg, Mg: 681 mg	In army members, intake of Vit A and Vit E was lower than the MDRI and DRI. All other nutrients met or exceeded the DRI
Beals et al. 2015	USA	Cross-sectional study	*n* = 439 mean age, 28 years M = 85% F = 15%	Army	Nutrition history questionnaire and 24-h food recall	Macro: energy, fat, CHO, protein. Micro: vit A, B1, B2, B3, B5, B6, B12, C, D, E, folate, Ca, Mg, Zn, Se, I, Fe, P, K, Na. Results = mean/d	Energy: (M: 10305 kjs and F:) 8033 kjs), vit A: (M: 387 μg and F: 355 μg), vit C: (M: 85 mg and F: 82 mg), vit E: (M: 5.7 mg and F: 7.5 mg), vit K: (M: 46 μg and F: 50 μg), folate: (M: 330 μg and F: 241 μg), Ca: (M: 893 mg and F: 680), Mg: (M: 209 mg and F: 169 mg), Zn: (M: 9.5 mg and F: 7.4 mg), Fe: (M: 17 mg and F: 13 mg), I: (M: 75 μg and F: 45 μg), K: (M: 1850 mg and F: 1685)	Army members did not meet the MDRI for several nutrients, including total energy intake, vit A, vit E, Vit K, folate, Ca, Mg, Zn, I and K. Males did not meet recommendations for vit C and females did not meet recommendations for Fe
Barringer et al. 2016	USA	Quasi-experimental study design	*n* = 100 mean age 26 years, M = 100% F = 0%	Army	Blood pathology tests	Vit D (ng/mL), Ω -3 Index (EPA + DHA), EPA, DHA and AA. Results = means measured at baseline	Vit D: 28.6 ng/mL, Ω-3 index: 1.38, EPA (% total phospholipids): 0.205, DHA (% total phospholipids): 1.17, AA (% total phospholipids): 0.206	Army members displayed deficient levels of vitamin D and sub-optional Ω-3 Index, EPA and DHA levels according to blood pathology
Frank & McCarthy 2016	USA	RCT	*n* = 234 mean age, 24 years F = 94% M = 6%	Army	110 item Block FFQ	Macro: energy, protein, fat, CHO. Micro: vit C, vit D, Vit K, Ca, Na, K, P. Other: cholesterol. Results = mean/d measured at baseline	Energy: 11230 kjs, protein: 105 g, fat: 107 g, CHO: 325 g, vit C: 157 mg, vit D: 4.7 μg, vit K: 157 mg, Ca: 1121 mg, Na: 4335 mg, K: 3143 mg, P: 1721 mg	Army members did not meet the MDRI for energy or Na, but exceeded the MDRI for all over nutrients
Kullen et al. 2016	Australia	Cross-sectional study	*n* = 211 mean age, 29 years M = 100% F = 0%	Army	DQES – version 2	Intake of vegetables, fruit, grains, fish, dairy, eggs/nuts/beans/soy, meat/poultry, fats and alcohol. Results converted to a total ARFS (_/74)	ARFS results: vegetables – 16.7/22, fruit – 5.3/14, grains – 4.5/14, fish – 1.3/2, dairy – 2.2/7, eggs/nuts/beans/soy – 2.4/7, meat/poultry – 3.5/5, fats – 0.5/1, alcohol – 1.1/2. Total ARFS score – 37.6/74	Army members displayed low diet quality as measured by the ARFS, and display low intake of fruit, grains, eggs/nuts/beans/soy and dairy
Mullie et al. 2016	Belgium	Cross-sectional study	*n* = 7,252 mean age, M = 90% F = 10%	Army	Questions relating to consumption of foods/d	Intake of fruits and vegetables. Results expressed as mean portions/d. Intake of meat. Results expressed as mean g/d	Fruit: M – 1.5/d, F – 1.6/d, Vegetables: M – 1.7/d, F – 1.8/d Meat: M – 170 g/d, F – 126 g/d	Army members displayed low intakes of fruit and vegetables
Farina et al. 2017	USA	Longitudinal cohort study	*n* = 50 mean age, 33 years M = 100% F = 0%	Army	101 item block FFQ (2005)	Intake of vegetables, fruit, grains, dairy, protein, seafood/plant protein, fatty acid ratio, Na and empty calories. Results converted to a HEI score (_/100) measured at baseline	Total vegetables: 4.4/5, total fruit: 4.6/5, dairy: 6.2/10, protein: 5/5, seafood/plant protein: 4.2/5, fatty acid ratio: 6.5/10, Na: 3.2/10 and empty calories: 14.3/20. Total HEI score: 70/100	Army members displayed fair diets (require improvement) according to the HEI score, and display suboptimal fatty acid ratio and Na intake

Table 2. (*Continued*)

Author/year	Country	Design	Participants	Military branch	Diet measure or nutrient analysis method	Diet components assessed	Results	Comparison to dietary reference ranges and values
Sepowitz et al. 2017	USA	Longitudinal cohort study	*n* = 20 mean age, 25 years M = 100% F = 0%	Marines	101 item Block FFQ (2005)	Macro: energy, fat, CHO, protein. Results = mean/d. Intake of vegetables, fruit, grains, dairy, seafood/plant protein, fatty acid ratio, Na and empty calories. Results converted to a HEI score (_/100) measured at baseline	Energy: 12945 kjs, Protein: 128 g, CHO: 96 g, and fat: 120 g. HEI results: Total vegetables: 3.5/5, total fruit: 3.8/5, dairy: 6.8/10, protein: 4.6/5, Seafood/Plant Protein: 4.1/5, fatty acid ratio: 4.8/10, Na: 3.6/10 and empty calories: 14.2/20. Total HEI score: 66/100	Army members displayed fair diets (require improvement) according to the HEI score, and display suboptimal intake of fruits and vegetables, fatty acid ratio, total energy and Na intake
Cole et al. 2018	USA	Quasi-experimental study design	*n* = 688 mean age, 25 years M = 82% F = 18%	Army	Digital photographs, and plate waste	Intake of fruit, vegetables, grains, legumes, dairy, meat, seafood, fats, soy/nuts/seeds, and added sugars. Results converted to a HEI score (_/100) measured at baseline	Total vegetables: 3.5/5, total fruit: 2.8/5, dairy: 6.7/10, protein: 3.4/5, seafood/plant protein: 1.2/5, fatty acid ratio: 5.9/10, Na: 2.7/10 and empty calories: 14/20. Total HEI score: 49/100	Army members displayed fair diets (require improvement) according to the HEI score, and display suboptimal intake of fruits and vegetables, seafood/plant protein, fatty acid ratio and Na intake
Hruby et al. 2018	USA	Cross-sectional study	*n* = 27,034 mean age, 30 years M = 85% F = 15%	Navy, Marines, Coast Guards, Army and Air Force	Questions relating to frequency of food consumption	Intake of fruit, vegetables, wholegrains, dairy, lean meat, snacks, sweets, sugary drinks, caffeinated drinks and fried foods. Results expressed as mean serving/week	Fruit: 8.5, vegetables: 9.4, wholegrains: 9.4, dairy: 9.4, lean meat: 9.6, snacks: 3.8, sweets: 3.7, sugary drinks: 5.2, caffeinated drinks: 8 and fried foods: 2.9	Defence members displayed high intakes of sugary drinks and low intakes of fruits, vegetables and wholegrains
McAdam et al. 2018	USA	Longitudinal cohort study	*n* = 111 mean age, 19 years M = 100% F = 0%	Army	Meal specific diet logs collected over three days	Macro: Energy, protein, fat, CHO and cholesterol. Micro: Na. Results = mean/d at baseline	Energy: 11063 kjs, protein: 114 g, CHO: 352 g, fat: 89 g	Army members did not meet the MDRI for energy or fat
Rahmani et al. 2018	Iran	Cross-sectional study	*n* = 246 mean age, 24 years M = 100% F = 0%	Army	168 item FFQ	Macro: energy, protein, fat, CHO, Ω 3. Foods: red meat, wholegrains, fruit, vegetable and nuts/legumes. Results expressed as mean/d and converted to a AHEI score. Participants then split into 4 quartiles based on total AHEI score (Q1 = lowest, Q4 = highest)	Energy: Q1 – 8481 kjs, Q2 – 2342 kcal, Q3 – 9799 kjs, Q4 – 9686 kjs, protein: Q1 – 96 g, Q2 – 105 g, Q3 102 g, Q4 – 115 g, fat: Q1 – 74 g, Q2 – 83 g, Q3 – 73 g, Q4 – 70 g, wholegrains: Q1 – 22 g, Q2 – 27 g, Q3 – 27 g, Q4 – 30 g, fruit: Q1 – 222 g, Q2 – 243 g, Q3 – 236 g, Q4 – 265 g, vegetables: Q1 – 203 g, Q2 – 257 g, Q3 – 269 g, Q4 – 299 g, nuts and legumes: Q1 – 17 g, Q2 – 19 g, Q3 – 22 g, Q4 – 28 g	Army members did not meet the MDRI for energy or fat. The majority of soldiers consumed suboptimal quantities of wholegrains, nuts and legumes, fruits and vegetables
Chapman et al. 2019	England	Cross-sectional study	*n* = 45 mean age, 21 years M = 38% F = 62%	Army	Weighed food records and food diaries	Macro: energy, fat, CHO, protein. Micro: vit A, vB1, B2, B2, B6, B12, C and D, folate, Ca, Mg, Zn, Fe, I, P, K, Se, Cu and Na. Other: fibre. Results = mean/d	Energy: (M: 11908 kjs and F: 9234 kjs), vit A: (M: 840 μg and F: 516 μg), vit C: (M: 67 mg and F: 49 mg), vit D: (M: 2 μg and F: 1 μg), folate: (M: 231 μg and F: 140 μg), Ca: (M: 1078 mg	Both male and female army members did not meet the MDRI for energy, fibre, Na, Vit A, Vit C, Vit D, folate, Mg, Se, I, K and Zn. Female personnel

Table 2. *(Continued)*

Author/year	Country	Design	Participants	Military branch	Diet measure or nutrient analysis method	Diet components assessed	Results	Comparison to dietary reference ranges and values
							and F: 699 mg), Mg: (M: 239 mg and F: 174 mg), Zn: (M: 8 mg and F: 6 mg), I: (M: 135 μg and F: 77 μg), K: (M: 2859 mg and F: 2115), Fe: (M: 10 mg and F: 7 mg), Se: (M: 57 μg and F: 29 μg), Na: (M: 2700 mg and F: 2500 mg)	additionally do not meet the MDRI for Ca and Fe
Lutz et al. 2019 (a)	USA	Longitudinal cohort study	*n* = 19 mean age, 23 years M = 63% F = 37%	Army	110 item block FFQ (2010)	Macro: energy, protein, fat, CHO. Micro: Ca, vit D, vit K, P, Mg, Na. Results = mean/d measured at baseline	Energy: 13519 kjs, Protein: 117 g, CHO: 409 g, Fat: 120 g, Ca: 1150 mg, Mg: 427 mg, Na: 5152 mg, P: 1722 mg, vit K: 208 μg, vit D: 4.4 μg	Army members did not meet the MDRI for energy, but meet the MDRI for all other nutrients
Lutz et al. 2019 (b)	USA	Cross-sectional study	*n* = 266 mean age, 19 years M = 53% F = 47%	Army	127-Item block FFQ (2014)	Intake of folate, β-carotene and α-carotene expressed as mean/d. Intake of fruit and vegetable servings. Results = cups/d	α-carotene: M – 354 μg and F – 563 μg, β-carotene: M – 2095 μg and F – 2355 μg, folate: M – 609 (DFE) and F – 456 (DFE), Fruit: M – 1.4 and F – 1.3, Vegetables: M – 1.2 and F – 1.1	Army members displayed suboptimal intake of fruits and vegetables, but met the MDRI for folate
Nakayama et al. 2019	USA	Cross-sectional study	*n* = 401 mean age, 19 y M = 45% F = 55%	Marines, Army and Air Force	110-item block FFQ (2005)	Macro: energy, fat, CHO and protein. Micro: Ca and K. Foods: nuts, eggs, meat, seafood and refined grains. Results = mean/d. Number of fruit, dairy, vegetables, soy and legumes. Results = cups/d	Energy: 8970 kjs, Ca: 1050 mg, K: 2659 mg, nuts: 0.8 oz, eggs: 0.7 oz, meat: 3.7 oz, seafood: 0.6 oz, refined grains: 4.6 oz, fruit: 0.5, vegetables: 1.4, dairy: 1.9, soy: 0.2, legumes: 0.1	Defence members did not meet the MDRI for energy or K. Defence members have suboptimal intakes of fruit, vegetables and legumes
Nykänen et al. 2019	Finland	Longitudinal cohort study	*n* = 40 mean age, 29 years M = 100% F = 0%	Army	3-day food diaries	Macro: energy, fat, CHO and protein. Other: fibre and water. Results = mean/d measured at baseline	Energy: 10268 kjs, fat: 95.6 g, CHO: 242.8 g, protein: 132.5 g, fibre: 17.5 g, water: 4.5 ml	Army members did not meet the MDRI's for energy and have suboptimal intake of fibre
Anyżewska et al. 2020	Poland	Cross-sectional study	*n* = 12 mean age, 28 y M = 100% F = 0%	Army	61 item FFQ	Intake of fruit, vegetables, cereals, legumes, dairy, meat and fish, sweats and snacks, soft drinks and alcohol. Results expressed as frequency of consumption (%)	Only 30% consume fruit ≥ 1 per day, 31% consume vegetables ≥ 1 per day, 27% consume wholegrains ≥ 1 per day, 6% eat nuts ≥ 1 per day, 10% eat oily fish several times per week or more, 60% eat sausages several time per week or more, 34% add sugar to sweeten beverages ≥ 1 per day	Army members dispalyed suboptimal intakes of fruit, vegetables, legumes, wholegrains, nuts and oily fish. Army members have high intakes of processed meats and added sugars
Chapman et al. 2020	England	Longitudinal cohort study	*n* = 19 mean age, 20 years M = 100% F = 0%	Army	Food weight and plate waste assessed at the DF. Diaries used between meals	Macro: energy, fat, CHO and protein. Results = mean/d measured at baseline	Energy: energy 11200 kjs, fat: 121 g, CHO: 280 g, Protein: 115 g	Army members did not meet the MDRI for energy or CHO

Table 2. (*Continued*)

Author/year	Country	Design	Participants	Military branch	Diet measure or nutrient analysis method	Diet components assessed	Results	Comparison to dietary reference ranges and values
De Bry et al. 2020	Belgium	Cross-sectional study	*n* = 85 mean age, 7 years M = 100% F = 0%	Army	Food diaries	Macro: energy, fats, CHO and protein. Results = g/bw and expressed as mean/d	Energy: 14874 kjs, Fats: 1.7 g/bw, saturated fats: 0.8 g/bw, CHO: 5.4 g/bw, protein: 1.6 g/bw	Army members did not meet the MDRI for energy or CHO. Protein and fat intake were adequate
Doupis et al. 2020	Greece	Longitudinal cohort study	*n* = 284 mean age, 31 years M = 91% F = 9%	Navy	FFQ	Intake of fruit, salad, meat, fast food, alcohol and soda. Results expressed as frequency of consumption (%)	50% consume fruit ≥ 6 times/week, 53% consume salad ≥ 6 times/week, 62% consume meat ≥ 4 times/week, 28% consume fast food ≥2 times/week, 56% consume ≥2 units of alcohol per week and 47% consume ≥2 cans of soda/sugary drinks per week	Roughly half of navy members consume adequate servings of fruit and vegetables. Consumption of soda/sugary drinks was high
Ghodsi et al. 2020	Iran	Cross-sectional study	*n* = 180 mean age, 33 years M = 100% F = 0%	NR	147 item FFQ	Macro: energy, fats, CHO, protein. Micro: Ca, Fe, P, Zn, Mg, Cu and Se. Other: fibre. Results = mean/d	Energy: 11502 kjs, fats: 80 g, CHO: 423 g, protein: 96 g, fibre: 32 g, Ca: 1150 mg, Fe: 24 mg, P: 1554 mg, Zn: 12 mg, Mg: 424 mg, Cu: 2 mg and Se: 141 μg	Defence members meet the MDRI for all nutrients except for energy and Zn
Rittenhouse et al. 2020	USA	Cross-sectional study	*n* = 531 mean age, 27 years M = 78% F = 22%	Army	110 item block FFQ (2005)	Intake of vegetables, fruit, grains, dairy, protein, seafood/plant protein, fatty acids, Na and refined sugar. Results converted to a HEI score (_/100)	Total vegetables: 3.2/5, total fruit: 3.7/5, dairy: 5.2/10, protein: 4.2/5, seafood/plant protein: 3.7/5, fatty acid: 4.9/10, Na: 3.7/10 and added sugar: 7.8/10. Total HEI score: 60/100	Army members displayed fair diets (require improvement) according to the HEI score, and display suboptimal intake of fruits and vegetables, seafood/plant protein, dairy, fatty acids and Na
Daniels & Hanson 2021	USA	Cross-sectional study	*n* = 37 mean age, 22 years M = 70% F = 30%	Army	General nutrition assessment FFQ	Macro: energy. Micro: vit A, C, E, B12, folate, Ca, Fe and Na. Other: saturated fat and fibre. Food: wholegrains. Results = mean/d	Energy: 10012 kjs, wholegrains: 1.9 oz, saturated fat: 33 g, fibre: 20 g, vit A: 996 μg, vit C: 109 mg, vit E: 20 IU, B12: 7 μg, Folate: 496 μg, Ca: 1063 mg, Fe: 15.6 mg and Na: 4205 mg	Army members met the MDRI for all nutrients except for total energy intake. However, Army members display suboptimal intakes of wholegrains and fibre
Parastouei et al. 2021	Iran	Cross-sectional study	*n* = 400 mean age, 38 years M = 100% F = 0%	NR	168 item FFQ	Macro: energy, fat. Micro: Na, other: fibre. Foods: wholegrains, legumes, nuts and seeds, fruits and vegetables, unprocessed red meat and processed meat. Results = mean/d and converted to a total HDI score (_/7)	Energy: 8481 kjs, wholegrains: 208 g, legumes: 28 g, nuts and seeds: 19 g, fruits and vegetables: 843 g, fibre: 29 g, total fat: 32% of total energy, saturated fat: 10% of total energy, Na: 3440 mg, unprocessed red meat: 73 g and processed meat 13 g. Total HDI score: 5.9/7	Defence members displayed fair diets (require improvement) according to the HDI score. Additionally, defence members did not meet the MDRI for energy or Na. Or meet the AI for fibre
Bukhari et al. 2022	USA	Quasi-experimental study	*n* = 77 mean age, 25 years M = 83% F = 17%	Army	127-item block FFQ (2014)	Energy, fat, saturated fat, MUFA, PUFA, trans fat, linoleic acid, α-linolenic acid, stearidonic acid, AA, EPA and DHA. Results = mean/d for the control group at baseline	Energy: 9288 kjs, total fat: 94 g, saturated fat: 31 g, MUFA: 37 g, PUFA: 18 g, trans fat: 3 g, linoleic acid: 15 g, α-linolenic acid: 1.5 g, stearidonic acid: 3 mg, AA: 200 mg, EPA: 24 mg and DHA 11 mg	Army members meet the AI for linoleic acid and α-linolenic acid. However, they do not meet the MDRI for energy and exceed recommendations for trans fat

Table 2. (*Continued*)

Author/year	Country	Design	Participants	Military branch	Diet measure or nutrient analysis method	Diet components assessed	Results	Comparison to dietary reference ranges and values
Edwards et al. 2022	England	Cross-sectional study	*n* = 13 mean age, 23 years M = 46% F = 54%	Army	Food weight, blood waste and food diaries	Macro: energy, fats, CHO and protein. Results = mean/d for Camp training group	Energy: M – 16095 kjs and F – 13276 kjs, fat: M – 1.9 g/kg/d and F – 1.8 g/kg/d, CHO: M – 5.4 g/kg/d and F – 5.4 g/kg/d, protein: m -1.8 g/kg/d and F – 1.7 g/kg/d	Both male and female army members did not meet the MDRI for energy and CHO. However, members exceed guidelines for protein and fat
Peoples et al. 2022	Australia	Longitudinal cohort	*n* = 117 mean age, NR M = 68% F = 32%	Army	Mess menu analysis and blood tests for fatty acid analysis	Macro: energy, fats, CHO and protein. Other: saturated fat, PUFA, MUFA, trans fat, linoleic acid, α-linolenic acid, EPA and DHA. Results = 14-day average	Energy: 17401 kjs, CHO: 385 g, protein: 249 g, Fat: 170 g, saturated fat: 55 g, PUFA: 27 g, MUFA: 74 g, trans fat 3 g, linoleic acid: 22 g, α-linolenic acid: 4.6 g, EPA: 75 mg and DHA: 111 mg	Army members met the MDRI for energy and protein. However, they displayed suboptimal intakes of trans fat, PUFA, EPA and DHA
Ahmed et al. 2023	Canada	Cross-sectional study	*n* = 18 mean age, NR M = NR F = NR	NR	Weighted food diary	Macro: energy, fats, CHO and protein. Other: saturated fat, fibre, caffeine. Micro: Vit A, B1, B2, B3, B6, B12, C, D, folate, Ca, Na, Fe, Mg, P, K and Zn. Results = mean/d for home dietary intake	Energy: 11117 kjs, CHO: 298 Gg, protein: 127 g, total fat: 100 g, saturated fat: 30 g, fibre: 25 g, vit A: 936 μg, vit C: 139 mg, B1: 1.6 mg, B2: 2mg, B3: 30 NE, B6: 3 mg, B12: 9.5 μg, vit D: 4.8 μg, folate: 394 DFE, Ca: 862 mg, Na: 3962 mg, Fe: 20 mg, Mg: 366 mg, P: 1195 mg, K: 2879 mg, Zn: 14 mg, caffeine: 139 mg	Defence members did not meet the MDRI for energy, vit A, B3, folate, Ca, Na, Mg, K, Zn. They exceeded the MDRI for protein, however they did not meet the AI for fibre
Salehi et al. 2023	Iran	Cross-sectional study	*n* = 300 mean age, 23 years M = 100% F = 0%	NR	168 item FFQ	Macro: energy, fats, CHO and protein. Other: fibre	Energy: 11807 kjs, fat: 150 g, CHO: 560 mg, protein: 151 g and fibre: 34 g	Defence members did not meet the MDRI's for energy but exceeded recommendations for protein and the AI for fibre

Key: AI, adequate intake; AA, arachidonic acid; AHEI, Alternative Healthy Eating Index; ARFS, Australian Recommended Food Score; bw, body weight; CHO, carbohydrate; DF, dining facility; DFE, dietary folate equivalents; DHQ, Diet History Questionnaire; DQES, Dietary Questionnaire for Epidemiology Studies; DRI, Dietary Reference Intake; F, Female; HDI, Healthy Diet Indicator*; HEI, Healthy Eating Index**; HES-5, Healthy Eating Score***; M, male; MDRI, military dietary reference intake; NR, not reported; RCT, randomised control trial; Se, Selenium; Ω-3, omega 3

*HDI scores: 6–7 = good diet, 4–5 = fair diet, requires improvement, and 0–3 = a poor diet

**HEI scores: >80 = good diet, scores 51–80 = fair diet, requires improvement, and scores <51 = a poor diet

***HES-5 scores: ≥20 = good diet, 13–19 = fair diet, ≤12 = poor diet

All energy measurements converted from kcal to kjs and Vitamin D IU converted to μg

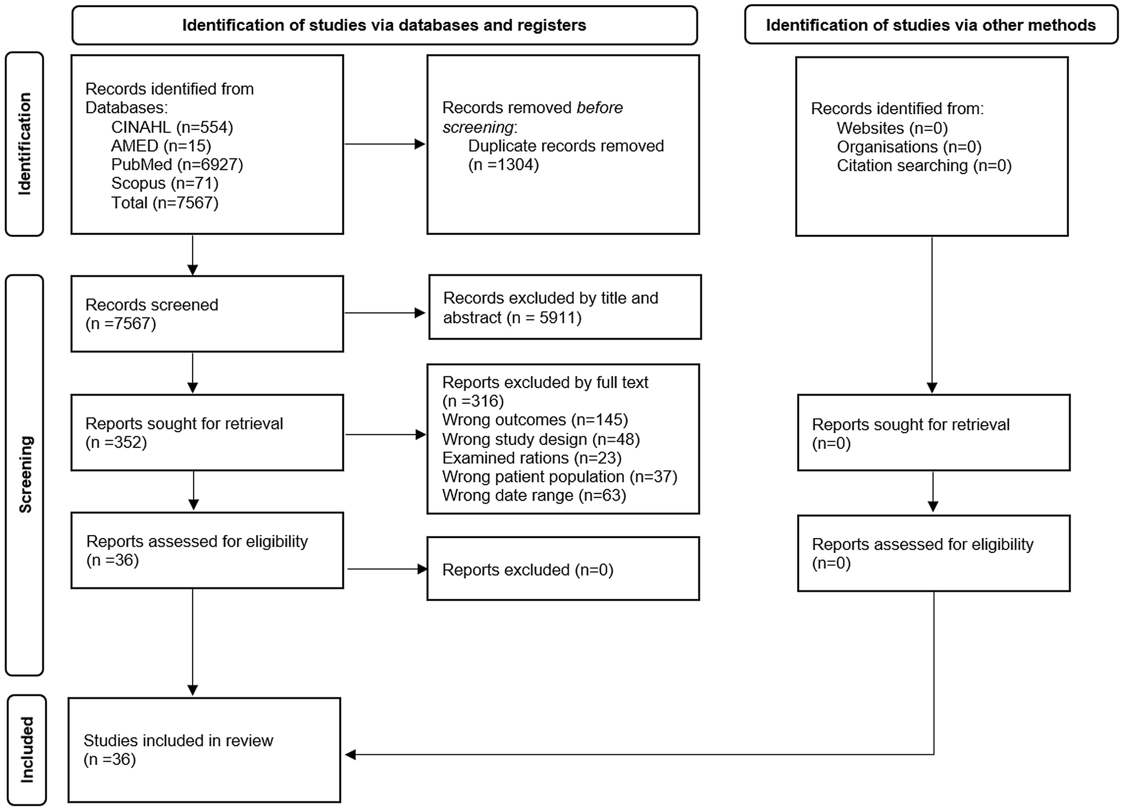

Fig. 1. PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources. *From:* Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi:10.1136/bmj.n71. For more information, visit: http://www.prisma-statement.org/.

Discussion

This is the first systematic literature review to assess the dietary intake and nutritional status of defence members worldwide. The overall quality of the evidence was high with a low risk of bias. The evidence presented in this review demonstrates that overall, defence members have a low diet quality, and one that may not be conducive to the nutritional requirements for the rigours of active duty. In particular, defence members display low intakes of fruits, vegetables, wholegrains, seafood, plant protein and nuts. The low intake of these food groups may explain the inadequate intake of several vital nutrients, particularly fibre, essential fatty acids, vitamin A, vitamin E, folate, Mg, Zn and iodine.

The low intake of nutrients identified in this review is concerning considering their importance in ensuring military readiness, optimal performance, recovery after training, and physical exertion, and prevention of injury[1–3]. For example, essential fatty acids such as PUFA, can reduce exercise-induced muscle damage[60]. Exercise-induced muscle damage leads to transient muscle inflammation, loss of strength, reduced range of motion, delayed onset muscle soreness and impaired recovery, causing reduced exercise performance[61]. Increased intake of PUFA have shown to reduce the effects of exercise-induced muscle damage via its anti-inflammatory action[60]. Mg is another crucial nutrient important for optimal physical performance and recovery[62]. It is involved in protein synthesis, bone metabolism, electrolyte balance and neuromuscular functions[62]. Mg has also been shown to increased physical endurance and reduce muscle cramps[62]. Therefore, ensuring adequate intake among defence members should be considered a priority.

Recently, mounting evidence has highlighted the important role of diet and nutrition for mental health[63,64]. Given the unique challenges and stress that accompany military life[65] and the increased risk of mental health conditions among defence members[66], nutrition which supports mental wellbeing should be a priority. This review has shown that defence members consume inadequate quantities of several key nutrients important for mental health including folate, vitamin A, Mg, Zn and PUFA which have been reported to play an important role in the pathophysiology of depression[67]. More research is needed to thoroughly explore the effect of dietary intake and nutritional quality on mental health outcomes in defence members.

This review has found substantial evidence that the diet quality and nutrition intake of defence members is suboptimal. Particular areas found for improvement included intake of fibre, essential fatty acids, vitamin A, vitamin E, folate, Mg, Zn and I. This has important implications for policymakers and governments who wish to implement frameworks, policies and strategies to improve the nutrition and health of defence members and optimise military performance. These results can be used to help identify priority areas which demand urgent

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attention. Supplementation, as well as dietary modification, may be supported where nutritional deficiencies remain consistent or are unable to be modified by diet alone due to resource or logistical constraints.

This review found high consumption of added sugars, trans fats and processed meat among defence members. Consumption of these foods has been linked to a number of diseases, including obesity[68], cardiovascular disease[69] and diabetes[70]. As diet is considered a significant modifiable risk factor for each of these conditions, it is important that defence members are provided with healthy food options which reduce chronic disease risk. Resource and logistical constraints affecting diet during deployment or on exercise are expected, but this review highlights that the diets of military members remain poor even without these constraints. It is therefore important that the military food environment is conducive in supporting healthy diets. Unfortunately, studies have shown that the military food environment and options available to defence members on-base do not support healthy eating[71]. On-base grocery stores and food vendors are often dominated by fast-food outlets, convenience/processed foods and snack foods high in added sugar, Na and fat[72,73]. This issue requires the urgent attention of policymakers in order to facilitate change to the military food environment, and support healthy eating among defence members.

While the overall quality of the included articles was high, this review has limitations that need to be acknowledged. The initial search resulted in a large number of diverse studies. However, a significant number of these were over 30 years old. Therefore, to provide a contemporary synthesis of the current diet intake of defence members, the inclusion criteria were further refined to only include articles published within the last 10 years and to exclude veteran populations. While this refinement of the inclusion and exclusion criteria allowed for a more focused review, it may have resulted in an incomplete or biased representation of results.

An additional review examining the diet quality of veterans is required, as the dietary and energy needs of active serving military and veterans varies considerably. Given the long-term and often inter-generational impact of nutritional status, studies of the long-term impact of military service on dietary behaviours of military and veteran populations may also be warranted. Additionally, although the findings suggesting requirements to improve diet quality was observed across all study settings in this review, over half of all included studies were from the USA and data were completely absent for most other countries. Broader international attention is required for this important issue. This review provides a narrative synthesis of the results which comes with a risk of interpretation bias from the authors. Only published trials available on the preselected databases were available to be reviewed, which may have skewed the findings.

Conclusion

This review has critically appraised existing evidence related to the diet quality and nutritional intake of defence members. The overall quality of the included articles was high with a low risk of bias. In all eight studies which calculated a diet quality score, the results showed poor to fair diet quality which requires improvement. In particular, defence members displayed low intakes of fruits, vegetables, wholegrains, seafood, plant protein and nuts and high intakes of added sugars, trans fat and processed meat. The review also found suboptimal intake of nutrients, particularly fibre, essential fatty acids, vitamin A, vitamin E, folate, Mg, Zn and iodine. The suboptimal intake of these vital nutrients may lead to reduced performance, increased risk of chronic diseases and mental health disorders. More research is needed that explores the long-term consequences of poor diet quality in defence members. These results require the attention of policymakers to ensure that military education and food environment is supportive of healthy eating.

Supplementary material

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Statement of authors' contributions to manuscript

J.B., R.L. and J.W. contributed to the design of the research question, development of the search terms, and contributed to the review protocol. J.B. conducted the initial database search with the final articles reviewed by E.B. J.B. and E.B. conducted the ROB analysis. J.B. extracted and analysed the data. J.B. drafted the manuscript with reviews and edits by E.B., R.L. and J.W. J.B. has primary responsibility for the final content. All authors have read and approved the final manuscript.

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References

[1] Ramsey CB, Hostetler C, Andrews A (2013) Evaluating the nutrition intake of U.S. military service members in garrison. *Mil Med* **178**(12), 1285–1290. doi: 10.7205/milmed-d-13-00178.

[2] Roy MD (2021) *Influencing healthy food choices in the marine corps*. Monterey, CA; Naval Postgraduate School.

[3] Pļaviņa L & Ģēģere S (2019) Importance of dietary habits for military personnel. In *12th International Scientific Conference on Rural Environment Education Personality (REEP)*. Latvia University of Life Sciences and Technologies.

[4] Karl JP, Margolis LM, Fallowfield JL, Child RB, Martin NM, McClung JP (2022) Military nutrition research: contemporary issues, state of the science and future directions. *Eur J Sport Sci* **22**(1), 87–98.

[5] Collins RA, Baker B, Coyle DH, Rollo ME, Burrows TL (2020) Dietary assessment methods in military and veteran populations: a scoping review. *Nutrients* **12**(3), 769.

[6] Jaenen S (2009) Identifying the most physically demanding tasks. *Optimizing Operational Physical Fitness*.
[7] Baker-Fulco CJ, Bathalon GP, Bovill ME, Lieberman HR (2001) Military dietary reference intakes: rationale for tabled values. Army Research Inst of Environmental Medicine Natick MA.
[8] Institute of Medicine. Dietary Reference Intakes Tables. http://www.nationalacademies.org/hmd/Activities/Nutrition/SummaryDRIs/DRI-Tables.aspx (accessed 2023).
[9] Regulation A (2017) Nutrition and Menu Standards for Human Performance.
[10] Palmer S (1991) Military nutrition initiatives. National Research Council Washington DC.
[11] Probert B & Bui L (2013) Nutritional Composition of Australian Combat Ration Packs and Options for Improvement. Defence Science and Technology Organisation Victoria (Australia).
[12] McLaughlin T, De Diana J, Bulmer S, Pike A (2018) Comparative Field Evaluation of the In-Service and Prototype Modular Mission Adaptive Combat Ration Packs. *Defence Science and Technology Group, Scottsdale*.
[13] Lenferna De La Motte K-A, Schofield G, Kilding H, Zinn C (2023) An alternate approach to military rations for optimal health and performance. *Mil Med* **188**(5-6), e1102–e1108.
[14] Huang L, Gan LSH, Law LYL (2014) Evaluation of a prototype ration aimed at increasing caloric intake in a field environment. *Mil Med* **179**(2), 190–196.
[15] Bui LT & Coad R (2014) Military ration chocolate: the effect of simulated tropical storage on sensory quality, structure and bloom formation. *Food Chem* **160**, 365–370.
[16] Belanger BA & Kwon J (2016) Effectiveness of healthy menu changes in a nontrainee military dining facility. *Mil Med* **181**(1), 82–89.
[17] Bukhari AS *et al.* (2022) A food-based intervention in a military dining facility improves blood fatty acid profile. *Nutrients* **14**(4), 743.
[18] Kullen C, Mitchell L, O'Connor HT, Gifford JA, Beck KL (2022) Effectiveness of nutrition interventions on improving diet quality and nutrition knowledge in military populations: a systematic review. *Nutr Rev* **80**(6), 1664–1693.
[19] Ahmed M, Mandic I, Lou W, Goodman L, Jacobs I, L'Abbé MR (2023) Dietary intakes from ad libitum consumption of canadian armed forces field rations compared with usual home dietary intakes and military dietary reference intakes. *Mil Med* **188**(1-2), e205–e213.
[20] Lutz LJ *et al.* (2013) Assessment of dietary intake using the healthy eating index during military training. *US Army Med Department J*, 91–96.
[21] Ramsey CB, Hostetler C, Andrews A (2013) Evaluating the nutrition intake of US military service members in garrison. *Mil Med* **178**(12), 1285–1290.
[22] Page MJ *et al.* (2021) The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* **372**, 71.
[23] EndNote (2013) Clarivate, Philadelphia, PA.
[24] www.covidence.org (2023) Veritas Health Innovation, Melbourne, Australia [Online]. Available: www.covidence.org.
[25] Tufanaru C, Munn Z, Aromataris E, Campbell J, Hopp L (2017) Systematic reviews of effectiveness. Joanna Briggs Institute reviewer's manual 3.
[26] Thomas J, Higgins JPT, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (2022) *Cochrane handbook for systematic reviews of interventions*. Cochrane. [Online]. Available: www.training.cochrane.org/handbook.
[27] Smith TJ *et al.* (2013) Eating patterns and leisure-time exercise among active duty military personnel: comparison to the Healthy People objectives. *J Acad Nutri Diet* **113**(7), 907–919.
[28] Kullen CJ, Farrugia J-L, Prvan T, O'Connor HT (2016) Relationship between general nutrition knowledge and diet quality in Australian military personnel. *Br J Nutr* **115**(8), 1489–1497.
[29] Rahmani J, Milajerdi A, Dorosty-Motlagh A (2018) Association of the Alternative Healthy Eating Index (AHEI-2010) with depression, stress and anxiety among Iranian military personnel. *BMJ Mil Health* **164**(2), 87–91.
[30] Lutz LJ, Gaffney-Stomberg E, Karl JP, Hughes JM, Guerriere KI, McClung JP (2019) Dietary intake in relation to military dietary reference values during army basic combat training; a multicenter, cross-sectional study. *Mil Med* **184**(3-4), e223–e230.
[31] Nakayama AT, Lutz LJ, Hruby A, Karl JP, McClung JP, Gaffney-Stomberg E (2019) A dietary pattern rich in calcium, potassium, and protein is associated with tibia bone mineral content and strength in young adults entering initial military training. *Am J Clin Nutr* **109**(1), 186–196.
[32] Ghodsi R, Rostami H, Parastouei K, Taghdir M, Esfahani A, Nobakht M (2020) Adherence to healthy dietary patterns and its association with physical fitness in military personnel. *BMJ Mil Health* **169**(2), 133–138.
[33] Daniels E & Hanson J (2021) Energy-adjusted dietary intakes are associated with perceived barriers to healthy eating but not food insecurity or sports nutrition knowledge in a pilot study of ROTC Cadets. *Nutrients* **13**(9), 3053.
[34] Parastouei K, Sepandi M, Eskandari E (2021) Predicting the 10-year risk of cardiovascular diseases and its relation to healthy diet indicator in Iranian military personnel. *BMC Cardiovasc Disord* **21**, 1–8.
[35] Salehi Z, Ghosn B, Rahbarinejad P, Azadbakht L (2023) Macronutrients and the state of happiness and mood in undergraduate youth of a military training course. *Clin Nutr ESPEN* **53**, 33–42.
[36] Purvis DL, Lentino CV, Jackson TK, Murphy KJ, Deuster PA (2013) Nutrition as a component of the performance triad: how healthy eating behaviors contribute to soldier performance and military readiness. *US Army Med Department J*, 66–78.
[37] Taleghani EA, Sotoudeh G, Amini K, Araghi MH, Mohammadi B, Yeganeh HS (2014) Comparison of antioxidant status between pilots and non-flight staff of the Army Force: pilots may need more vitamin C. *Biomed Environ Sci* **27**(5), 371–377.
[38] Beals K *et al.* (2015) Suboptimal nutritional characteristics in male and female soldiers compared to sports nutrition guidelines. *Mil Med* **180**(12), 1239–1246.
[39] Hruby A, Lieberman HR, Smith TJ (2018) Self-reported health behaviors, including sleep, correlate with doctor-informed medical conditions: data from the 2011 Health Related Behaviors Survey of US Active Duty Military Personnel. *BMC Public Health* **18**, 1–16.
[40] Chapman S, Roberts J, Smith L, Rawcliffe A, Izard R (2019) Sex differences in dietary intake in British Army recruits undergoing phase one training. *J Int Soc Sports Nutr* **16**(1), 59.
[41] Anyżewska A *et al.* (2020) Association between diet, physical activity and body mass index, fat mass index and bone mineral density of soldiers of the polish air cavalry units. *Nutrients* **12**(1), 242.
[42] Rittenhouse M, Scott J, Deuster P (2020) Healthy eating index and nutrition biomarkers among army soldiers and civilian control group indicate an intervention is necessary to raise omega-3 index and vitamin d and improve diet quality. *Nutrients* **13**(1), 122.
[43] Edwards VC *et al.* (2022) Nutrition and physical activity in british army officer cadet training part 2—daily distribution of energy and macronutrient intake. *Int J Sport Nutr Exer Metabol* **32**(3), 204–213.
[44] Mullie P, Deliens T, Clarys P (2016) Relation between sugar-sweetened beverage consumption, nutrition, and lifestyle in a military population. *Mil Med* **181**(10), 1335–1339.

[45] De Bry W, Mullie P, D'Hondt E, Clarys P (2020) Dietary intake, hydration status, and body composition of three belgian military groups. *Mil Med* **185**(7-8), e1175–e1182.
[46] Carlson AR, Smith MA, McCarthy MS (2013) Diet, physical activity, and bone density in soldiers before and after deployment. *US Army Med Department J*, 25–31.
[47] Nykänen T, Pihlainen K, Santtila M, Vasankari T, Fogelholm M, Kyröläinen H (2019) Diet macronutrient composition, physical activity, and body composition in soldiers during 6 months deployment. *Mil Med* **184**(3-4), e231–e237.
[48] Doupis J *et al.* (2020) The consumption of fast food favors weight increase in young hellenic navy personnel: a 10-year follow-up study. *Metab Syndr Relat Disord* **18**(10), 493– 497.
[49] Peoples GE *et al.* (2022) The influence of a basic military training diet on whole blood fatty acid profile and the Omega-3 Index of Australian Army recruits. *Appl Physiol Nutr Metab* **47**(2), 151– 158.
[50] Farina EK *et al.* (2017) Effects of deployment on diet quality and nutritional status markers of elite US Army special operations forces soldiers. *Nutr J* **16**(1), 1–9.
[51] Sepowitz JJ, Armstrong NJ, Pasiakos SM (2017) Energy balance and diet quality during the US marine corps forces special operations command individual training course. *J Special Oper Med Peer Rev J SOF Med Professionals* **17**(4), 109–113.
[52] McAdam J *et al.* (2018) Estimation of energy balance and training volume during Army Initial Entry Training. *J Int Soc Sports Nutr* **15**(1), 55.
[53] Lutz LJ, Nakayama AT, Karl JP, McClung JP, Gaffney-Stomberg E (2019) Serum and erythrocyte biomarkers of nutrient status correlate with short-term A-carotene, B-carotene, folate, and vegetable intakes estimated by food frequency questionnaire in military recruits. *J Am Coll Nutr* **38**(2), 171–178.
[54] Chapman S *et al.* (2020) Dietary intake and nitrogen balance in British Army infantry recruits undergoing basic training. *Nutrients* **12**(7), 2125.
[55] Frank LL & McCarthy MS (2016) Telehealth coaching: impact on dietary and physical activity contributions to bone health during a military deployment. *Mil Med* **181**(suppl_5), 191–198.
[56] Gaffney-Stomberg E *et al.* (2014) Calcium and vitamin D supplementation maintains parathyroid hormone and improves bone density during initial military training: a randomized, double-blind, placebo controlled trial. *Bone* **68**, 46–56.
[57] Barringer ND *et al.* (2016) Fatty acid blood levels, vitamin D status, physical performance, activity, and resiliency: a novel potential screening tool for depressed mood in active duty soldiers. *Mil Med* **181**(9), 1114–1120.
[58] Cole RE, Bukhari AS, Champagne CM, McGraw SM, Hatch AM, Montain SJ (2018) Performance nutrition dining facility intervention improves special operations soldiers' diet quality and meal satisfaction. *J Nutr Educ Behav* **50**(10), 993–1004.
[59] Wakimoto P & Block G (2022) A revision of the Block Dietary Questionnaire and database, based on NHANES III data.
[60] Kyriakidou Y, Wood C, Ferrier C, Dolci A, Elliott B (2021) The effect of Omega-3 polyunsaturated fatty acid supplementation on exercise-induced muscle damage. *J Int Soc Sports Nutr* **18(**1), 9.
[61] Harty PS, Cottet ML, Malloy JK, Kerksick CM (2019) Nutritional and supplementation strategies to prevent and attenuate exercise-induced muscle damage: a brief review. *Sports Med-Open* **5**, 1–17.
[62] Hunt G, Sukumar D, Volpe SL (2021) Magnesium and Vitamin D supplementation on exercise performance. *Transl J Am Coll Sports Med* **6(**4), e000179.
[63] Bayes J, Schloss J, Sibbritt D (2022) The effect of a Mediterranean diet on the symptoms of depression in young males (the "AMMEND: A Mediterranean Diet in MEN with Depression" study): a randomized controlled trial. *Am J Clin Nutr* **116**(2), 572–580.
[64] Marx W *et al.* (2023) Clinical guidelines for the use of lifestyle-based mental health care in major depressive disorder: world Federation of Societies for Biological Psychiatry (WFSBP) and Australasian Society of Lifestyle Medicine (ASLM) taskforce. *World J Biol Psychiatry* **24**(5), 1–54.
[65] Dell L *et al.* (2022) Mental health across the early years in the military. *Psychol Med* **53**(8), 1–9.
[66] Fikretoglu D *et al.* (2022) Pathways to mental health care in active military populations across the five-eyes nations: an integrated perspective. *Clin Psychol Rev* **91**, 102100.
[67] LaChance LR & Ramsey D (2018) Antidepressant foods: an evidence-based nutrient profiling system for depression. *World J Psychiatry* **8**(3), 97.
[68] Mozaffarian D (2020) Dietary and policy priorities to reduce the global crises of obesity and diabetes. *Nat Food* **1**(1), 38–50.
[69] Nestel PJ & Mori TA (2022) Dietary patterns, dietary nutrients and cardiovascular disease. *Rev Cardiovasc Med* **23(**1), 17.
[70] Mozaffarian D (2017) Foods, obesity, and diabetes—are all calories created equal?. *Nutr Rev* **75**(suppl_1), 19–31.
[71] Carins J & Rundle-Thiele S (2014) Fighting to eat healthfully: measurements of the military food environment. *J Soc Mark* **4**(3), 223–229.
[72] Quadri Z (2022) TGI Fridays in Kandahar: fast food, military contracting, and intimacies of force in the Iraq and Afghanistan Wars. *J Transnational Am Stud* **13**(1), 143–161.
[73] AAFCANS (Army & Airforce Canteen Service). AAFCANS: Our Menus. https://www.aafcans.gov.au/outlet/puckapunyal-barracks/ (accessed 2023).

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