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The association between nutrition and behavioural health in a US Army population

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Abstract

Objective: The relationship between nutrition and behavioural health (BH) outcomes has been established in the literature. However, the relationship between nutrition and anxiety is unclear. Furthermore, the relationship between nutrition and BH outcomes has not been examined in a US Army Soldier population. This study sought to understand the relationship between Soldiers' nutritional intake and anxiety as well as depression.

Design: This cross-sectional study utilised multivariable logistic regression analyses to examine the relationship between nutritional intake and BH outcomes.

Setting: The study utilised data collected in 2018 during a BH epidemiological consultation conducted at one Army installation.

Participants: Participants were 7043 US Army Soldiers at one Army installation.

Results: Of the Soldiers completing the survey, 12 % (*n* 812) screened positive for anxiety and 11 % (*n* 774) for depression. The adjusted odds of anxiety were significantly higher among Soldiers who reported low fruit intake compared with Soldiers who reported high fruit intake (adjusted OR (AOR) 1·36; 95 % CI 1·04, 1·79). The adjusted odds of depression were higher for Soldiers who reported low fruit intake (AOR 1·35; 95 % CI 1·01, 1·79) and/or low green vegetable intake (AOR 1·37; 95 % CI 1·02, 1·83). Lastly, the adjusted odds of depression were lower for Soldiers who reported low sugary drink intake (AOR 0·62; 95 % CI 0·48, 0·81).

Conclusions: This study is the first to examine the important connection between nutritional intake and anxiety and depression at a US military installation. The information learned from this study has implications for enhancing Soldiers' nutritional knowledge and BH, ultimately improving Soldiers' health and medical readiness.

Keywords
Nutrition
Public health
US Army
Behavioural health

Behavioural health (BH)* disorders include both mental and substance use/abuse disorders.

Mental disorders can include anxiety, depression, post-traumatic stress disorder (PTSD), psychosis and personality disorder. The prevalence of BH disorders in the civilian population of the USA is 18·3 %[1]. In 2017, 15 % of Soldiers in the US Army had a diagnosis of one or more BH disorders[2]. Approximately 110 000 individual Soldiers seek care for BH conditions each year[2], and BH disorders follow injuries as having the largest health impact on Soldiers. BH disorders negatively impact the lives of Soldiers, their families, co-workers and friends and have a detrimental effect on military readiness[2].

The Army has recognised the importance of lifestyle medicine to minimise BH disorders.

This is illustrated by the development of the Army's Performance Triad (P3) in 2013, which highlights the need for Soldiers to focus on sleep, physical activity and nutrition. P3 links poor sleep, activity and nutrition to medically non-deployable Soldiers, first-term attrition, obesity, musculoskeletal injury and fatigue[3]. The P3 factors are part of lifestyle psychiatry[4]; however, P3 has not examined the relationship between each of the three critical factors and BH.

P3 recommends eating at least eight servings of fruit and vegetables per day and endorses the Centers for Disease Control and Prevention's recommendation to consume whole grains, fruits, vegetables and lean proteins, as well as to consume water rather than sugar-based beverages. Although P3 suggests that nutrition improves focus and

*In 2011, the Office of The Surgeon General/U.S. Army Medical Command (OTSG/MEDCOM) replaced the term 'mental health' with 'behavioral health' with the intent to reduce the stigma associated with the provision of BH services.

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concentration, neither P3 nor the military's BH prevention and intervention programs have made the important connection between Soldiers' nutrition and their BH and readiness. With BH issues as the second leading cause of medical non-readiness[2], identifying modifiable risk and protective factors for BH disorders is imperative. The Army has conducted studies examining factors related to Soldiers' BH[5,6]; however, none has focused on the association of food and nutrition with a Soldier's BH status.

This study seeks to fill that gap by examining Soldiers' self-reported food consumption and BH symptoms and diagnoses. Studying Soldiers' food consumption and its potential correlations with BH problems could provide the groundwork for additional studies of larger scale to better understand how a Soldier's diet could be influencing his or her BH. Findings could enhance medical readiness, a crucial factor in maintaining a strong, lethal force. In addition, the findings could influence policy on the food served in Army dining facilities, other installation restaurants and from vending machines. The objective of our study is to determine if different dietary choices are associated with anxiety or depression among a sample of Soldiers in the US Army.

Methods

Study population and design

This cross-sectional study utilised data collected during a BH epidemiological consultation conducted among US Army Soldiers at one active-duty installation during the summer of 2018 to evaluate social and BH factors that may contribute to preventable fatalities. The active-duty installation and the timing of this survey have been anonymised to protect confidentiality. Analyses included only those participants who were in the military at the time of the survey; were 17–65 years of age; reported sex, rank, average sleep hours of ≤12 h and provided responses to all nutrition questions. The survey was anonymous, participation was voluntary and no survey questions were mandatory. Prior to survey administration, informed consent was obtained for each participant. Since the survey was sent to all Soldiers at the active-duty installation, a power calculation was not done prior to the study.

Data collection

An online survey created with the Verint® Systems Enterprise Edition survey software tool[6] captured demographic, food intake, sleep, deployment, depression, anxiety, PTSD and hazardous/unhealthy drinking behaviour data from participants during the summer of 2018.

Demographic variables included sex (i.e. male and female), age (i.e. 17–24, 25–29, 30–34, 35–39 and 40–65 years), race (i.e. White, Black, Hispanic/Latino, Asian, Native Hawaiian/Pacific Islander and American Indian/Alaskan Native), education (i.e. high school/GED or less, some college/associate's degree, bachelor's degree, post-bachelor's degree), marital status (i.e. single, married, domestic (e.g. domestic partnership), divorced/separated/widowed), rank (i.e. E1–E4, E5–E9, O1–O3, O4–O9 and WO1–CW5), sleep (i.e. <8 h, 8–12 h) and ever deployed (i.e. yes/no).

Food intake information was obtained for the following food categories: fish, green vegetables, fresh fruit, lean meats (e.g. chicken, turkey), whole grains (e.g. oats, brown rice), dairy (e.g. yogurt, milk and cheese), processed food (e.g. chips, candy, cookies and crackers) and sugary drinks (e.g. soda, juice). Participants were asked to select their most accurate food consumption frequency for each category. These categories included never, four times per month, two to three times per week and daily. These categories were condensed to form the following three food consumption frequency categories: high frequency (i.e. daily), middle frequency (i.e. two to three times per week) and low frequency (i.e. never, four times per month).

The survey length was minimised for operational reasons. As a result, shorter versions of food intake, anxiety, depression, PTSD and Alcohol Use Disorders Identification Test scales were used. The Generalized Anxiety Disorder 2-item scale, a self-report measure of generalised anxiety disorder[7], was used to screen for anxiety among participants. Generalized Anxiety Disorder 2-item scores of three or more indicated a positive anxiety screening (i.e. yes), while scores of less than three indicated a negative anxiety screening (i.e. no). The Patient Health Questionnaire-2 scale, a self-report measure of depression[8], was used to screen for depression among participants. Patient Health Questionnaire-2 scores of three or more indicated a positive depression screening (i.e. yes), while scores of less than three indicated a negative depression screening (i.e. no). The PTSD Checklist 2-item scale, a self-report measure of PTSD symptoms[9], was used to screen for PTSD among participants. PTSD Checklist 2-item scores of four or more indicated a positive PTSD screening (i.e. Yes), while scores of less than four indicated a negative PTSD screening (i.e. no). The Alcohol Use Disorders Identification Test[10], a three-question self-report screening tool, was used to identify heavy drinking and/or active alcohol abuse or dependence among Soldiers. Alcohol Use Disorders Identification Test scores greater than or equal to four (for women) and five (men) indicated positive hazardous/unhealthy drinking behaviour screening (i.e. yes), while scores of less than four (for women) and five (for men) indicated negative hazardous/unhealthy drinking behaviour screening (i.e. no). The study adhered to all standards of the Strengthening The Reporting of Observational Studies in Epidemiology checklist for cross-sectional studies.

Data analysis

Of the 9022 Soldiers who took the survey, 78 % (*n* 7043) were included in the analyses because they reported

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complete data on all nutrition items, had an average sleep duration of 12 h or less and provided demographic information. Of those who were not included in this analysis, 17 % (*n* 1553) did not report complete data on all nutrition items, 17 % (*n* 1492) either did not report their average sleep hours (*n* 1228) or reported over 12 h of sleep (*n* 264), 5 % (*n* 482) reported ages outside of 17–65 years, 5 % (*n* 464) did not report their military rank and 3 % (*n* 274) did not report their sex. Descriptive statistics (i.e. frequencies and percentages) were calculated for all variables including the outcomes of interest (depression and anxiety). χ^2 tests were used to identify differences in demographic and mental health characteristics between those with and without the two outcomes: (1) anxiety and (2) depression.

Multivariable logistic regression analyses were used to evaluate the relationship between each food consumption category and each outcome of interest, adjusting for potential confounders. The following covariates were included in the multivariable anxiety model: sex, age, race, marital status, rank, sleep, deployment, PTSD, depression and hazardous/unhealthy drinking behaviour. The following covariates were included in the multivariable depression model: sex, age, race, marital status, rank, sleep, deployment, PTSD, anxiety and hazardous/unhealthy drinking behaviour. These models were used to calculate adjusted odds ratios (AOR) and 95 % confidence intervals (CI). Population attributable risk percentages were calculated for anxiety and depression. Statistical Analysis System (SAS®), version 9.4, was used to conduct statistical analyses. All statistical tests were two-sided, and *P*-values of ≤0·05 were considered statistically significant.

Results

Demographic and mental health characteristics of Soldiers are reported in Table 1. The majority of Soldiers were male, <25 years old, married, junior enlisted, White, had some college or less and had no history of deployment. For mental health conditions, 12 % (*n* 812) screened positive for anxiety and 11 % (*n* 774) screened positive for depression. Moreover, 16 % had a positive Alcohol Use Disorders Identification Test score, indicating hazardous/unhealthy drinking behaviour. At the bivariate level, statistically significant differences ($P \leq 0{\cdot}05$) in green vegetable, fruit, lean meat, whole grain, dairy and sugary drink intake were observed between Soldiers with positive anxiety screening and negative anxiety screening (Table 2). There were no statistically significant ($P \leq 0{\cdot}05$) differences in fish or processed food intake between Soldiers with positive anxiety screening and negative anxiety screening. Furthermore, statistically significant differences ($P \leq 0{\cdot}05$) in fish, green vegetable, fruit, lean meat, whole grain, dairy and sugary drink intake were observed between Soldiers with positive depression screening and negative depression screening (Table 2). There were no statistically significant ($P \leq 0{\cdot}05$) differences in processed food intake between Soldiers with positive depression screening and negative depression screening.

OR were calculated to determine if there were any significant associations between anxiety (Table 3) and depression (Table 4) with food intake, controlling for confounders. The adjusted odds of anxiety among Soldiers with low fruit intake was 36 % greater than those with high fruit intake (AOR 1·36; 95 % CI 1·04, 1·79). The adjusted odds of depression among Soldiers with low and medium fruit intake were 35 % (AOR 1·35; 95 % CI 1·01, 1·79) and 28 % (AOR 1·28; 95 % CI 1·02, 1·62) greater, respectively, than those with high fruit intake. Results also showed that the adjusted odds of depression among Soldiers with low green vegetable intake were 37 % greater than those with high green vegetable intake (AOR 1·37; 95 % CI 1·02, 1·83). Sugary drink intake was also significantly associated with depression in the multivariable model. The adjusted odds of depression were 38 % lower among Soldiers with low intake of sugary drinks compared to those with high intake of sugary drinks (AOR 0·62; 95 % CI 0·48, 0·81). The population attributable risk proportion for anxiety and depression ranged from 2·6 % to 3·4 %, assuming everyone followed fruit and vegetable nutrition guidelines faithfully.

Discussion

Our study found that the odds of anxiety were significantly higher among Soldiers who reported a low fruit intake compared with Soldiers who reported a high fruit intake. Furthermore, Soldiers who reported a low fruit intake, low green vegetable intake and/or a high sugary drink intake had a higher odds of depression.

Previous research has consistently documented the association between nutrition and depression[11,12], but few studies have examined the relationship between nutrition and anxiety. Both of the previous studies that examined this relationship found a relationship between fruit and vegetable intake and anxiety. However, both samples were among immigrant populations; therefore, there may have been confounding factors within immigrant samples that influenced either the predictor (e.g. cultural cuisine choices) or the outcome (e.g. anxiety about moving to a new country). To our knowledge, ours is the first study on the relationship between nutrition and anxiety in a primarily native population, and it has important implications for improving Soldiers' BH and nutrition prevention and intervention programs. This study is the first of its kind to explore those correlations in a US Army population and is valuable because improving Soldiers' BH improves readiness. Readiness of the Force to execute its mission

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Table 1 χ^2 differences in depression and anxiety by demographic and mental health characteristics among US Army Soldiers (*n* 7043)

Characteristic	*n*	%	Anxiety (*P*-value)*	Depression (*P*-value)*
Sex			*<0·0001*	*0·0001*
Male	6330	89·9		
Female	713	10·1		
Age			*0·01*	*<0·0001*
17–24	3682	52·3		
25–29	1820	25·8		
30–34	831	11·8		
35–39	416	5·9		
40–65	294	4·2		
Marital status			*<0·0001*	*<0·0001*
Single	2712	38·9		
Married	3615	51·9		
Domestic	297	4·3		
Divorced/separated/widowed	344	4·9		
Not specified	75	–		
Rank			*<0·0001*	*<0·0001*
E1–E4	4194	59·5		
E5–E9	1918	27·2		
O1–O3	746	10·6		
O4–O9	113	1·6		
WO1–CW5	72	1·0		
Race			0·38	*0·0009*
White	4185	61·6		
Black	940	13·8		
Hispanic/Latino	1039	15·3		
Asian	263	3·9		
Native Hawaiian/Pacific Islander	126	1·9		
American Indian/Alaskan Native	246	3·6		
Not specified	244	–		
Education			*<0·0001*	*<0·0001*
High school/GED or less	3187	45·6		
Some college/Associate's degree	2519	36·0		
Bachelor's degree	1021	14·6		
Post-bachelor's degree	261	3·7		
Not specified	55	–		
Ever deployed			0·32	*0·04*
No	4473	64·0		
Yes	2516	36·0		
Not specified	54	–		
Sleep			*<0·0001*	*<0·0001*
<8 h	5993	85·1		
8–12 h	1050	14·9		
PCL-2 (PTSD)			*<0·0001*	*<0·0001*
Yes (positive)	637	9·0		
No (negative)	6406	91·0		
GAD-2 (anxiety)			–	*<0·0001*
Yes (positive)	812	11·5		
No (negative)	6231	88·5		
PHQ-2 (depression)			*<0·0001*	–
Yes (positive)	774	11·0		
No (negative)	6269	89·0		
AUDIT-C (hazardous drinking)			*<0·0001*	*<0·0001*
Yes (positive)	1122	15·9		
No (negative)	5921	84·1		

AUDIT-C – Alcohol Use Disorders Identification Test, GAD-2 – Generalized Anxiety Disorder 2-item Scale, PHQ-2 – Patient Health Questionnaire-2 Scale, PCL-2 – PTSD (posttraumatic stress disorder) checklist 2-item.
The Generalized Anxiety Disorder 2-item (GAD-2) scale was used to measure anxiety. Scores ≥ 3 resulted in a positive anxiety screening. The Patient Health Questionnaire-2 (PHQ-2) scale was used to measure depression. Scores ≥ 3 resulted in a positive depression screening. PTSD checklist 2-item (PCL-2) was used to measure PTSD. Scores ≥ 4 resulted in a positive PTSD screening. The Alcohol Use Disorders Identification Test (AUDIT-C) scale was used to measure hazardous/unhealthy drinking behaviour. Scores ≥ 4 for women and ≥5 for men resulted in a positive hazardous/unhealthy drinking behaviour screening.
*Statistically significant *P*-values (≤0·05) are italicised.

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Table 2 χ^2 differences in depression and anxiety by food intake (*n* 7043)

Food category	*n*	%	Anxiety (*P*-value)*	Depression (*P*-value)*
Fish			0·0536	*0·0095*
Low	4906	69·7		
Medium	1839	26·1		
High	298	4·2		
Vegetable			*<0·0001*	*<0·0001*
Low	1020	14·5		
Medium	2843	40·4		
High	3180	45·2		
Fruit			*<0·0001*	*<0·0001*
Low	1143	16·2		
Medium	2987	42·4		
High	2913	41·4		
Lean meat			*0·0086*	*0·0154*
Low	651	9·2		
Medium	2922	41·5		
High	3470	49·3		
Whole grain			*<0·0001*	*<0·0001*
Low	1008	14·3		
Medium	2797	39·7		
High	3238	46·0		
Dairy			*0·0074*	*0·0028*
Low	924	13·1		
Medium	2508	35·6		
High	3611	51·3		
Processed food			0·21	0·0512
Low	2231	31·7		
Medium	3244	46·1		
High	1568	22·3		
Sugary drink			*0·0111*	*<0·0001*
Low	2723	38·7		
Medium	2564	36·4		
High	1755	24·9		

The Generalized Anxiety Disorder 2-item (GAD-2) scale was used to measure anxiety. Scores ≥3 resulted in a positive anxiety screening. The Patient Health Questionnaire-2 (PHQ-2) scale was used to measure depression. Scores ≥3 resulted in a positive depression screening.
*Statistically significant *P*-values (≤0·05) are italicised.

is of vital importance to the military. Given that BH issues are the second leading cause of medical non-readiness[2], finding new ways to prevent and treat BH problems is imperative for a healthy, ready Force.

The rationale for these findings is sound given recent developments in the field of nutritional psychiatry. Nutritional psychiatry utilises food and targeted supplements as part of an integrated treatment approach to prevent and treat BH disorders[13,14]. Countless research studies have shown that adequate nutrition is essential for proper brain functioning and BH[4,12,15,16]. Poor nutrition has specifically been tied to psychotic symptoms, social withdrawal, mania, anxiety, dementia, memory impairment, lack of motivation, poor energy, depression and isolation[17].

The connection between nutrition and BH is multifaceted and includes chronic inflammation, dysregulated blood sugar, oxidative stress, gut microbiome dysregulation and mitochondrial dysfunction among others[13]. Depression is related to inflammation, and blood sugar dysregulation increases levels of inflammation in the body[18,19]. Systemic inflammation related to stress, poor sleep, smoking and diet is related to mental health conditions such as depression, bipolar disorder and schizophrenia[17]. Diets containing processed food (i.e. processed foods containing *n*-6 fatty acids that cause inflammation) may be a risk factor for depression[20–22].

A diet rich in fruits, vegetables and fish reduces inflammation and regulates blood sugar. This type of diet has been associated with a lower risk of developing depression[21,23–27]. Healthy fats have been shown to reduce inflammation. *n*-3 fatty acids, EPA and DHA found in fish and commercial fish oils have antidepressant[15,16,22]

Table 3 OR from simple and multivariable logistic regression models for anxiety by food intake (*n* 7043)

Food category	Consumption frequency	Total (*n* 7043)	Positive anxiety	%	Crude OR	95 % CI	Adjusted OR	95 % CI
Fish	Low	4906	591	12·0	0·97	0·68, 1·38	0·83	0·50, 1·38
	Medium	1839	184	10·0	0·78	0·54, 1·14	0·76	0·44, 1·29
	High	298	37	12·4	Ref	Ref	Ref	Ref
Vegetable	Low	1020	163	16·0	*1·60*	*1·31, 1·96*	1·08	0·82, 1·44
	Medium	2843	311	10·9	1·03	0·88, 1·22	0·86	0·69, 1·07
	High	3180	338	10·6	Ref	Ref	Ref	Ref
Fruit	Low	1143	188	16·4	*1·92*	*1·57, 2·35*	*1·36*	*1·04, 1·79*
	Medium	2987	353	11·8	*1·31*	*1·11, 1·54*	1·05	0·84, 1·31
	High	2913	271	9·3	Ref	Ref	Ref	Ref
Lean meat	Low	651	96	14·7	*1·46*	*1·15, 1·86*	1·23	0·88, 1·72
	Medium	2922	348	11·9	1·14	0·98, 1·33	0·88	0·71, 1·09
	High	3470	368	10·6	Ref	Ref	Ref	Ref
Whole grain	Low	1008	165	16·4	*1·79*	*1·46, 2·19*	1·25	0·95, 1·66
	Medium	2797	328	11·7	*1·22*	*1·03, 1·43*	0·94	0·76, 1·17
	High	3238	319	9·9	Ref	Ref	Ref	Ref
Dairy	Low	924	130	14·1	*1·39*	*1·12, 1·72*	1·02	0·76, 1·38
	Medium	2508	302	12·0	1·16	0·99, 1·37	0·96	0·78, 1·20
	High	3611	380	10·5	Ref	Ref	Ref	Ref
Processed food	Low	2231	258	11·6	0·90	0·74, 1·10	1·00	0·77, 1·31
	Medium	3244	355	10·9	0·85	0·70, 1·02	0·88	0·69, 1·13
	High	1568	199	12·7	Ref	Ref	Ref	Ref
Sugary drink	Low	2723	310	11·4	0·83	0·69, 1·00	1·21	0·94, 1·55
	Medium	2564	267	10·4	*0·75*	*0·62, 0·91*	0·89	0·69, 1·15
	High	1755	235	13·4	Ref	Ref	Ref	Ref

Statistically significant odds ratios (≤0·05) are italicised.

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Table 4 OR from simple and multivariable logistic regression models for depression by food intake

Food category	Consumption frequency	Total (*n* 7043)	Positive depression	%	Crude OR	95 % CI	Adjusted OR	95 % CI
Fish	Low	4906	574	11·7	1·10	0·76, 1·61	1·58	0·91, 2·75
	Medium	1839	168	9·1	0·84	0·56, 1·25	1·19	0·67, 2·12
	High	298	32	10·7	Ref	Ref	Ref	Ref
Vegetable	Low	1020	161	15·8	*1·80*	*1·46, 2·21*	*1·37*	*1·02, 1·83*
	Medium	2843	313	11·0	*1·19*	*1·01, 1·40*	1·19	0·95, 1·49
	High	3180	300	9·4	Ref	Ref	Ref	Ref
Fruit	Low	1143	175	15·3	*1·91*	*1·55, 2·35*	*1·35*	*1·01, 1·79*
	Medium	2987	347	11·6	*1·39*	*1·17, 1·65*	*1·28*	*1·02, 1·62*
	High	2913	252	8·7	Ref	Ref	Ref	Ref
Lean meat	Low	651	88	13·5	*1·39*	*1·09, 1·80*	0·99	0·70, 1·41
	Medium	2922	338	11·6	1·17	1·00, 1·38	1·09	0·88, 1·36
	High	3470	348	10·0	Ref	Ref	Ref	Ref
Whole grain	Low	1008	156	15·5	*1·77*	*1·44, 2·18*	1·25	0·93, 1·67
	Medium	2797	315	11·3	*1·23*	*1·04, 1·45*	1·15	0·92, 1·44
	High	3238	303	9·4	Ref	Ref	Ref	Ref
Dairy	Low	924	126	13·6	*1·44*	*1·16, 1·79*	1·16	0·86, 1·57
	Medium	2508	291	11·6	*1·20*	*1·02, 1·41*	1·13	0·90, 1·41
	High	3611	357	9·9	Ref	Ref	Ref	Ref
Processed food	Low	2231	230	10·3	*0·79*	*0·65, 0·97*	0·83	0·63, 1·10
	Medium	3244	345	10·6	*0·82*	*0·68, 0·99*	0·91	0·71, 1·17
	High	1568	199	12·7	Ref	Ref	Ref	Ref
Sugary drink	Low	2723	248	9·1	*0·61*	*0·51, 0·73*	*0·62*	*0·48, 0·81*
	Medium	2564	278	10·8	*0·74*	*0·62, 0·89*	0·84	0·65, 1·08
	High	1755	248	14·1	Ref	Ref	Ref	Ref

Statistically significant odds ratios (≤0·05) are italicised.

and anti-anxiety effects[28]. Blood sugar regulation is vital to most systems in the body. Excess dietary sugar leads to blood sugar dysregulation and is associated with inflammation[29,30]. Anxiety, phobias, nervousness, irritability, depression, violent outbursts, obsessive compulsive behaviour, forgetfulness and anti-social behaviours have all been associated with hypoglycaemia (low blood sugar)[19].

The nutritional psychiatry research literature provides clear findings from a systematic review for identifying which foods optimise BH. LaChance and Ramsey[31] have shown that a key set of nutrients is critical to brain health and function, which influence BH. The top nutrients for influencing BH include long-chain *n*-3 fatty acids, vitamin B_{12} and Mg. Foods with the highest amounts of these important nutrients have been compiled into the brain food scale. The foods ranked highest on the brain food scale include leafy greens (e.g. spinach, kale and collard greens), seafood (e.g. salmon and oysters), bell peppers, cruciferous vegetables (e.g. broccoli and cauliflower), berries (e.g. blueberries and strawberries), nuts (e.g. walnuts and almonds) and meat (e.g. wild game and grass-fed beef). This information could be used to influence the choice of food served in Army dining facilities, food stocked at the commissary, restaurants allowed on military installations and food available in vending machines. In addition, policies could be created to require that Soldiers be taught about these foods in basic training and as part of their ongoing Personal Readiness Training.

As the first of its kind to examine nutrition and BH in an Army population, this study has areas for improvement. The first limitation was that there were a small number of questions pertaining to nutrition. The nutrition questions on the survey were adapted from the International Food Information Council Foundation's 2018 Food and Health Survey[32]; however, because the nutrition questions were part of a much larger survey, their number was limited. Second, our survey asked for retrospective recall of food intake. Although retrospective recall in food intake studies has been shown to have inaccuracies, it is used to increase understanding of a new area of study and is a common component of nutrition research[33]. Third, there was a lack of assessment of food sensitivities. Consumption of food to which an individual might have a sensitivity can cause 'leaky gut' and inflammation in the body. Water and caffeine consumption was also not assessed. This is a potential limitation because dehydration from lack of water and/or overconsumption of caffeine affects serotonin, tryptophan and essential amino acids in the body and brain. Mild dehydration can cause feelings of anxiety and irritability[34]. Fourth, shorter versions of BH (i.e. anxiety, depression) scales were used due to the command's desire for a shorter yet comprehensive survey, but these shorter scales have demonstrated a high reliability in numerous populations. Fifth, demographic differences between Soldiers who were and were not included in the study were not obtained and thus generalisability cannot be assessed. Sixth, this survey did not ask about participants' Service component (Regular Army or Reserve). Likely differences in the built environment for these components could affect Soldiers' nutritional choices. Stressors are also likely to differ, which may affect anxiety and/or depression. Given this potential

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for confounding, future analyses of nutrition in the military should determine if findings differ by component. Seventh, there were covariates that were not measured which could have been related to the predictor and/or outcome of interest (e.g. obesity). Lastly, since the study design was cross-sectional, temporality could not be assessed, and it is possible that the BH conditions preceded the current diet.

The Army does not currently monitor the nutritional status of Soldiers beyond meeting weight classifications for physical fitness tests. Monitoring the foods and nutrients that Soldiers regularly consume could provide a baseline understanding of their nutritional status. The Army does monitor the BH status of Soldiers by means of yearly health assessments to identify the prevalence of BH issues and substance use problems. Once an understanding of baseline nutritional status is developed, future studies could systematically examine relationships between nutritional status and BH. This study establishes a first step in demonstrating the need for a more global assessment of Soldiers' nutrition as related to BH and medical readiness. Interventions that include the nutritional research presented here can be implemented, and subsequent monitoring of nutritional status and BH could offer useful insight into the impact of nutritional improvements on BH and readiness.

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