INTRODUCTION

The use of performance enhancing drugs (PEDS) and substances in sport has caused concerns for many sporting governing bodies. The use of performance enhancing drugs in sports typically includes the use of anabolic steroids, human growth hormones, erythropoietin (EPO), stimulants, and similar substances. In recent decades, PEDS use has become well-documented within sporting literature, with recreational athletes being the largest users. A further study in Denmark highlighted that within recreational athletes it was young men who were most likely to use PEDS. Findings from research conducted in the UK also identify young male gym goers as the primary users of PEDS. Whereas there is increasing
There is growing concern about PIEDs use in military service personnel and veterans (defined as a person who has served at least 1 day in the military armed forces, for example, Army, Navy, Air Force, Marines, Military Police) highlighted by a health and military performance symposium held in April 2015. In the USA, for example, a Department of Defense survey reported a 4% increase in the use of anabolic steroids between 2002 and 2011. Although some research has examined PIEDs use in serving military personnel, less is known about the use of PIEDs following retirement from the Armed Forces. With the use of drugs being linked more generally to increased criminal behavior in veteran communities, and with negative physical, mental and legal outcomes of PIEDs use being identified within the wider population, it is necessary to gain further knowledge surrounding the prevalence, motivations and wider impact of PIEDs use in current and ex-Service men and women. In particular, there is a need to identify whether military personnel and veterans who are now users, became users in service, after leaving the service or whether they used PIEDs prior to enlisting. The current review aims to examine the literature on the prevalence and motivations for using PIEDs in serving military personnel and veterans, with a view to answering the following questions:

1. What are the current usage trends for PIEDs in serving military personnel and veterans (including the type of PIEDs being used)?
2. What are the motivations for using PIEDs amongst serving military personnel and veterans?
3. What are the effects of PIEDs use on mental and physical health in military personnel?
4. How are serving military personnel and veterans introduced to PIEDs (ie, was their introduction pre-, during-, or post-service)?

A greater understanding of the current literature is also necessary to underpin further research specific to both the active military and veteran communities.

2 | METHODS

This contemporary review followed the PRISMA guidelines.

2.1 | Searches

In February 2019, systematic searches were conducted in the following databases: Ovid Medline, Embase, PsycINFO, PubMed, and CINAHL. The databases were selected by four experienced postdoctoral researchers based on topic area, type of likely publications, and the target participants.
Additionally, 10 military-specific journals were hand searched for appropriate articles. A total of 172 search terms were used in the database search with 52 search terms being used to identify military personnel, such as: veteran, soldier, army, war-fighter, and marine. One hundred and twenty search terms were used to identify performance and image enhancing drugs, such as: PEDs, PIEDs(s), performance enhancers, anabolic agents, and steroids. Search terms were selected through an iterative process and initial search terms were refined by the research group and further refined as the search progressed. In addition, reference lists of identified studies were searched for “non-database” published studies. In some cases, authors were contacted to obtain further information and copies of articles that were not available via open access.

2.2 | Inclusion and exclusion criteria

All search results were screened for inclusion by two members of the research team: Details of inclusion and exclusion criteria are noted in Table 1. Any differences were resolved through consensus and consultation between the researchers and a third member of the research team. The search only considered articles from the year 2000 onwards. This was related to the change in nomenclature and, therefore, to a great extent potential users. Prior to 2000 the term PIEDs was pretty much unknown. The acronym applied then was PEDS with papers being mainly concerned with performance enhancing drugs and the links to competitive performance or similar. The concept of the drugs being used for image enhancement is relatively contemporary. Articles were initially screened by reading the title and abstract to determine if the articles met the inclusion criteria. Full texts were screened for those articles that satisfied the abstract screening or where it was unclear from the abstract if the paper involved PIEDs.

| Inclusion criteria | Exclusion criteria |
|--------------------|--------------------|
| Study type         | Published from 2000 to present |
|                    | Available in English language |
|                    | Reporting original findings |
| Participants       | Published prior to 2000 |
|                    | Not available in English language |
|                    | Non-original findings, for example, reviews, editorials |
| Drug type          | Current or ex-military personnel participant sample |
|                    | Army, Navy, Air-Force, Marines, and Military Police |
|                    | Veterans were defined as persons who had served at least one day in the armed forces |
|                    | Non-military participant sample |
|                    | Military sample was not distinguishable from other samples |
|                    | Clear reference to performance and/or image enhancing drugs by brand or ingredients, for example, anabolic steroids |
|                    | Reference to “bodybuilding supplements” and/or “weight-loss supplements” |
|                    | Herbal or natural dietary supplements that had no performance or image enhancing properties |
|                    | PIEDs findings were indistinguishable from other drugs |

*Although Marines form part of the naval forces in the UK, they are considered a separate population in other countries, notably the USA identify them as separate combat forces.*

2.3 | Quality assessment

In the first instance, all papers included were assessed for quality using an amended CASP checklist. This quality assessment considered of the following five measures and the results are noted in italics:

1. Does the study clearly state aims and details of sample population? *Met*
2. Does the study use random sampling? *No—most were small case study approaches using purposively identified samples; or self-reported investigations of purposive groups in deployment*
3. Is the sample size over 200 participants? *No—for the same reasons as 2, above.*
4. Is the response rate over 60% *Yes—the studies were mainly qualitative and therefore the participants were willing to contribute*
5. Does the study use a validated measure? *No, as there were limited studies of relevance with validated measures. Due to the types of study that were identified the measures were mainly descriptive self-reports, interviews or desk-based case studies.*

As such, the research group felt that “identified quality” could not be used as a criterion for inclusion or exclusion. The critical appraisal skills program checklist was used to assess the quality, and studies were assessed for bias by checking results and funders.

2.4 | Data extraction

The data extracted from studies that satisfied the inclusion and exclusion criteria were entered into evidence tables by two researchers. The following information was extracted...
from each study: authors’ names, year of publication, methodological approach, main findings, participant population (active/veteran, service type, and country), type of drug, adverse effects, reasons for use and when usage started.

2.5 | Synthesis

Due to the variety of study methodologies and outcome measures reported, this review did not explicitly extract and analyze numerical data. In lieu of this, the current review used a narrative synthesis approach to compare and contrast the study outcomes.

3 | RESULTS

This review aimed to collate and critically review existing literature in the area of PIEDs use among active military personnel and veterans. Further, it aimed to highlight gaps in the current literature to act as a base for future studies.

3.1 | Results of the search

The database, citation, and hand searching yielded an initial sample of 1557 papers. After duplicate papers and papers that did not satisfy the inclusion and exclusion criteria were screened-out, 43 papers were identified as relevant and full-text screening of those papers was undertaken. Of these, 20 papers met the inclusion and exclusion criteria (see Figure 1 for a detailed PRISMA flowchart and Table 2 for summary of the included papers).

3.2 | Characteristics of the included studies

Only one paper identified during the search was conducted using a solely veteran population, which was a case study reporting PIEDs use by a single veteran. Two other papers included ex-service personnel within a wider participant sample and 17 papers used a sample of active service personnel. The Army (N = 13) was the most researched military service, followed by Air force (N = 6), Navy (N = 5), and Marines (N = 3). Five studies did not specify the service and 6 studies used a sample from more than one service. No studies reported a sample of Military Police. The majority of the studies reviewed were conducted with armed forces from the USA (N = 14), followed by UK (N = 2), Australia (N = 2), Hungary (N = 1), and Finland (N = 1). Of the 20 papers included in the review, only one paper was published prior to 2010. Most of the studies included in the review were quantitative in approach and utilized questionnaires (N = 12). The remaining 8 were qualitative, of which the majority were case studies of individuals (N = 7).
### TABLE 2 Data extraction summary of systematic review of PIEDs use among military personnel

| Author name                      | Year of publication | Methodological approach | Active/veteran | Service type | Country | Type of drug | Adverse effects                  | Reasons for use                           | When started using | Main findings                                                                 |
|----------------------------------|---------------------|-------------------------|----------------|--------------|----------|--------------|----------------------------------|-------------------------------------------|-------------------|-------------------------------------------------------------------------------|
| Austin et al                     | 2015                | Quant                   | Active         | Army         | USA      | Weight-loss supplements, anabolic steroids | Physical expectations of the job          | Physical | The prevalence of DS (weight-loss supplement) use for promoting weight loss was significantly less among deployed (12%) compared with garrison (16%) personnel. However, use of weight-loss DS to improve weight loss was more prevalent among garrison (3%) than deployed (0.5%) soldiers. No significant difference in anabolic steroid use between garrison and deployment |
| Austin, McGraw & Lieberman       | 2014                | Quant                   | Active         | Army, Air-F | USA      | Anabolic     | Aggression                       | Users of steroid products reported feeling less friendly and more aggressive |
| Boos et al                       | 2010                | Quant                   | Active         | Did not specify | UK       | Anabolic     | Insomnia, mood changes, palpitations, anxiety | Physical expectations of the job, image enhancement | Physical | There were 14 persons (1.4%) who admitted to current use of anabolic steroids. The most frequent reason for taking supplement was to “increase muscle bulk” (40.4%). Users of anabolic steroids were significantly younger than non-users, (24.4 [6.4] y vs 25.6 [7.3]; P = .002) and were all male. Persons currently taking anabolic steroids exercised (non-significant trend) more regularly (6.3 [2.2] vs 5.0 [2.3] exercise sessions per week; P = .07). There were no other identifiable factors that predicted their use |
| Brazeau et al                    | 2015                | Case study              | Active         | Army         | USA      | Anabolic     | Liver injury                     | Image enhancement, muscle growth          | Physical | A case of a healthy, young, active duty male Army soldier who developed pruritis and jaundice shortly after starting to take a bodybuilding supplement containing anabolic steroids. He was subsequently found to have significant drug-induced liver injury |

(Continues)
| Author name, Year of publication | Methodological approach | Active/veteran | Service type | Country | Type of drug | Adverse effects | Reasons for use | When started using | Main findings |
|----------------------------------|-------------------------|----------------|--------------|---------|--------------|----------------|----------------|-------------------|---------------|
| Bucher 2012                      | Qual                    | Active         | Army         | USA     | Anabolic steroids | Negative body image, aggression | Some participants mentioned using “recreational drugs” before during and after military service. One started using PIEDs in basic training, and two while deployed in a combat zone | Participants reported that forces medics were dealing steroids; one medic admitted to dealing steroids before they started to use themselves. Participants reported concerns that steroids contributed to non-combat deaths and poor conduct. Qualitative findings illustrated reasons for use, when use started and side effects |
| Campagna, Bowsher & 2016         | Quant                   | Active         | Army, Navy, Air-Force | USA     | Bodybuilding supplements, weight-loss supplements | Men—performance enhancement, image enhancement women—weight loss and overall health | The prevalence rate of all service members with body dysmorphic disorder is 15.3%. The prevalence of BDD in soldiers is 18.4%, which is higher than sailors (11.8%) or airmen (13.1%). Disordered self-image is much higher in women (n = 82, 21.7%) and 10-12 times greater than that of the general population. The prevalence rate of MD was 9.3% for all service members, with a breakdown of Army at 9.4%, the Navy at 10.1%, and the Air Force at 10.2%. The prevalence rate for male service members is 12.7%, and for females, 4.2%, was markedly greater than expected. Reported supplement use in service members was extremely common with 59% reporting use of any type of supplement |
| Author name          | Year of publication | Methodological approach | Active/veteran | Service type | Country | Type of drug                          | Adverse effects                        | Reasons for use | When started using | Main findings                                                                                           |
|----------------------|---------------------|-------------------------|----------------|--------------|----------|--------------------------------------|----------------------------------------|----------------|-------------------|---------------------------------------------------------------------------------------------------------|
| Carol, 2013          | 2016                | Case study              | Active         | Army         | USA      | Weight-loss supplements              | Pain, cramping, vomiting, rhabdomyolysis | Concerns about weight gain due to injury and restricted exercise |                |                   | Dietary supplements containing caffeine may potentiate the rhabdomyolysis cascade, and present an area of attainable prevention. Presented are three cases of soldiers using the weight-loss supplement, Hydroxycut. Patient education regarding caffeine and supplement safety may shield against morbidity and delayed soldier readiness associated with over-caffeination. In each of the cases presented, the use of weight-loss supplements was not perceived as potentially harmful by the patient. |
| Casey et al          | 2014                | Quant                   | Active         | Army         | UK       | Anabolic steroids, hormone boosters | Physical expectations of the job       |                |                   | A small proportion of respondents reported the use of amphetamines and similar compounds (1.6%), cocaine (0.8%), anabolic androgenic steroids (1.1%), growth hormone (2.0%), and other anabolic agents, for example, testosterone (4.2%), junior non-commissioned officers reported greater use of steroids than other groups |
| Harris, Winn & Ableman | 2017               | Case study              | Active         | Air-Force    | USA      | Bodybuilding supplements             | Hemorrhagic stroke, severe headache, nausea, vomiting, and balance disturbances |                |                   | Case of a healthy 25-y-old active duty male who experienced a bilateral cerebellar hemorrhagic stroke occurring shortly after taking a supplement named animal rage XL |
| Author name                      | Year of publication | Methodological approach | Active/veteran | Service type | Country | Type of drug | Adverse effects | Reasons for use | When started using | Main findings                                                                 |
|---------------------------------|---------------------|--------------------------|----------------|--------------|---------|--------------|-----------------|-----------------|-------------------|-----------------------------------------------------------------------------|
| Herbst, McCaslin & Kalapatapu   | 2017                | Case study               | Veteran        | Army         | USA     | Bodybuilding supplements | Panic attacks, disturbing thoughts | Image enhancement |                   | The patient is a 31-y-old male student and army veteran who served two tours in Iraq as a medic. A year after returning from his last deployment, and 6 mo after he separated from the military, he began experiencing PTSD symptoms. Patient saw noticeable drop in PTSD symptoms after discontinuing PIED use and starting cognitive behavioural therapy |
| Jacobson et al                  | 2012                | Quant                    | Active         | Army, Navy, Air-Force, Marines | USA     | Weight-loss supplements, bodybuilding supplements | Physical expectations of the job, coping with combat |                   | Male deployers were more likely to use bodybuilding supplements, whereas female deployers were more likely to use weight-loss supplements. Physically active and younger subjects reported all types of supplement use. 17.3% reported use of bodybuilding supplements (22.8% of men, 5.3% of women), and 19.4% reported use of weight-loss supplements (15.9% of men, 26.9% of women). Deployment experience, younger age, and problem drinking were significantly associated with increased adjusted odds of reporting bodybuilding and weight-loss supplement use |
| Liane & Magee                   | 2016                | Case study               | Active         | Marines      | USA     | Anabolic steroids within PED | Pancreatitis, cramping, nausea, decreased appetite |                   | Steroid-induced pancreatitis in young active marine                          |
| Author name  | Year of publication | Methodological approach | Active/veteran | Service type | Country | Type of drug                          | Adverse effects                                                                 | Reasons for use                                                                                                           | When started using | Main findings                                                                                                                                                                                                                                                                                                                                 |
|-------------|---------------------|-------------------------|---------------|--------------|---------|--------------------------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Lui et al   | 2018                | Quant                   | Both          | Army, Navy   | Australia| Weight-loss supplements, bodybuilding supplements | Veterans who did not report using supplements regularly on deployment were less likely to use them subsequently | Overall use of supplements was highest on deployment to Afghanistan (27.8%) compared with in Iraq (22.0%, $P < .001$) or post-deployment (current use 21.2%, $P < .001$). Men were more likely to use bodybuilding supplements while women more often used weight-loss supplements. Combat exposure, mixed duty cycles, and working long hours during deployment were associated with higher supplement use. Use of body-building supplements and energy supplements was particularly common among Army personnel compared with other services |
| Lukas, Muranyi & Tury | 2007 | Quant                   | Active        | Did not specify | Hungary | Anabolic steroids                      | Comparison of bodybuilding behaviors and supplement use in military and general public. Military college sample (3.3%) used significantly more anabolic androgenic steroids than general public college sample (1.5%) |                                                                                                                                                                                                                         |
| Magee et al | 2016                | Case study              | Active        | Did not specify | USA     | Anabolic steroids, bodybuilding supplements | Liver injury                                                                 | Two case reports of bodybuilding supplement users suffering liver injury. Analysis of supplements demonstrated they were falsely labeled and presented a significant clinical risk to health and mission readiness                                                                 |

(Continues)
| Author name  | Year of publication | Methodological approach | Active/veteran | Service type | Country   | Type of drug | Adverse effects                     | Reasons for use | When started using | Main findings                                                                                                                                                                                                 |
|--------------|---------------------|-------------------------|----------------|--------------|-----------|--------------|-------------------------------------|----------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mattila et al | 2010                | Quant                   | Active         | Did not specify | Finland   | Weight-loss supplements, anabolic steroids | Study involved Finnish male conscripts entering obligatory military service. 0.9% reported PIED use and 0.6% reported willingness to use PIEDs if they could obtain them. Participants over 20 y were 2.4 times more likely to use than under 20s. Participants with a lower educational level were more likely to use PIEDs. Smoking, drinking, and exercise frequency were also significantly associated with PIED use. |
| Paisley,     | 2015                | Quant                   | Active         | Army         | USA       | Weight-loss supplements, PEDs | Shortness of breath, dizziness, dehydration, pain, sickness, insomnia | Image enhancement, muscle strength | 77% reported using at least one supplement during deployment. On average, 2.5 supplements were used per individual surveyed. Nine respondents reported adverse effects of supplement use. None reported serious complications of supplement use, drug interactions, or seeking medical care for adverse supplement effects. The Internet was the most frequently reported source of information on supplement use. Supplements were most frequently acquired by internet mail order. 3.59% used weight-loss supplements, 27.89% used pre-workout PEDs |
| Author name          | Year of publication | Methodological approach | Active/veteran | Service type | Country                  | Type of drug                                                                 | Adverse effects                  | Reasons for use                                                                 | When started using | Main findings                                                                                                                                                        |
|---------------------|---------------------|-------------------------|----------------|--------------|--------------------------|-------------------------------------------------------------------------------|---------------------------------|------------------------------------------------------------------------------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| van de Pols et al   | 2017                | Quant                   | Both           | Army, Navy, Air-Force | Australia             | Weight-loss supplements, bodybuilding supplements | Headaches, sleeping difficulties, flatulence, diarrhea, indigestion | BODYBUILDING SUPPLEMENTS WERE USED BY 17.5% OF PARTICIPANTS AND WEIGHT-LOSS SUPPLEMENTS BY 7.6%. BODYBUILDING SUPPLEMENTS WERE MORE OFTEN USED BY MEN, YOUNGER PERSONS AND THOSE IN THE ARMY, WHILE WEIGHT-LOSS SUPPLEMENTS WERE MORE COMMONLY USED BY WOMEN AND NAVY PERSONNEL |
| Vanez et al         | 2017                | Quant                   | Active         | Army, Navy, Air-Force, Marines | USA                  | PEDs, weight-loss supplements | Insomnia                        | BOOST ENERGY, ENHANCE PERFORMANCE, IMPROVE HEALTH, DECREASE FAT, LOSE WEIGHT, GAIN STRENGTH, GAIN MUSCLE MASS | 65% OF PARTICIPANTS REPORTED INCREASED USE AND INCREASED FREQUENCY OF USE OF SUPPLEMENTS DURING DEPLOYMENT COMPARED WITH PRE-DEPLOYMENT. PED USE INCREASED 8% DURING DEPLOYMENT WHEN COMPARED TO PRE-DEPLOYMENT AND THERE WAS A REPORTED 1% INCREASE IN WEIGHT-LOSS SUPPLEMENT USE |
| Young et al         | 2012                | Case study              | Active         | Did not specify        | USA                  | PEDs, hormone boosters | Hemorrhagic stroke, behavior change, headache | IT IS UNCLEAR WHETHER JACK3D USE DIRECTLY CAUSED THIS PATIENT'S HEMORRHAGIC STROKE OR WHETHER JACK3D IN COMBINATION WITH OTHER PREDISPOsing FACTORS (EG. TOBACCO USE, PHYSICAL EXERTION, OR ANATOMIC ABNORMALITY SUCH AS AN UNDETECTABLE BERRY ANEURYSM OR PFO (HOLE IN THE HEART) CONTRIBUTED TO THE EVENT OR WHETHER JACK3D USE WAS MERELY COINCIDENTIAL |
3.3  What are the current usage trends for PIEDs in serving military personnel and veterans (including the type of PIEDs being used)?

There was a variety of PIEDs mentioned in the studies included in the review and most studies investigated more than one PIEDs. Anabolic steroids (N = 10) and weight-loss supplements (N = 10) were the most mentioned PIEDs, followed by bodybuilding supplements (N = 7) and hormone boosters, a term employed generically to describe androgenic drugs (N = 3).

Five studies compared the frequency of PIEDs use before, during and/or after deployment. To avoid any confusion, post-deployment refers to active service following a deployment and veteran refers to service personnel who have left the armed forces. The literature suggests that PIEDs are used before, during, and after deployment, with the majority of current literature suggesting that use of PIEDs significantly increases during deployment compared to prior or post-deployment.22–24 Conversely, a different study found no significant difference in anabolic steroid use on deployment when compared to in-garrison and a reduction in the use of weight-loss supplements during deployment.25

Males are more likely to use performance enhancing PIEDs such as anabolic steroids and body building supplements whereas women were more likely to use more image focused PIEDs such as weight-loss supplements.26–30 Age was also highlighted as a predictive factor for PIEDs use in military personnel with younger military personnel being more likely to use PIEDs than older personnel.26,31 In addition, lower rank was also associated with higher likelihood of PIEDs use.29,31 Army personnel was the most likely to use PIEDs when compared to other military forces.22,29 Other factors such as excessive alcohol consumption, cigarette smoking, lower educational level, deployment experience, and higher levels of physical activity were associated with PIED use.26,28,32 The current literature suggests that young, male non-commissioned Army personnel are the most likely to use PIEDs.

3.4  What are the motivations for using PIEDs amongst serving military personnel and veterans?

During the review, we found six motivations for PIEDs. The most cited motivation for PIEDs use was “image enhancement” (N = 7) followed by “keeping up with the physical demands of service” (N = 5), “performance enhancement” (N = 2), “coping with the demands of combat” (N = 2), “keeping up with the performance of others” (N = 1), and “peer pressure or the influence of others” (N = 1). Image enhancement was reported as the most prevalent reason for PIEDs use in military personnel and this was related to weight loss, muscle growth, body dysmorphic disorder and disordered self-image.27,32,33 Keeping up with the physical demands of service was linked with the demands of physical expectations and the strength-based nature of military service.26,28,34 A qualitative study reported service personnel using PIEDs during deployment to cope with the physical demands of long patrols and also the psychological demands of engaging in combat, holding their nerve and potentially taking another person’s life.35 One participant in the study provided substantial detail about his struggle with deployment and his reservations about firing his weapon and how PIEDs helped him to feel more aggressive and able to engage in combat. Additionally, participants mentioned the impacts of others, both from a performance comparison perspective, as well as peer pressure. Some participants specifically mentioned using PIEDs after they were suggested to them by service medics.

3.5  What are the effects of PIEDs use on mental and physical health in military personnel?

Across the 20 studies involved in the review, several adverse effects of PIEDs use on physical and mental health were mentioned. The literature presented cases of physical health concerns such as hemorrhagic stroke, severe liver injury, rhabdomyolysis, pancreatitis, insomnia, headaches, and muscle spasms steroids.33,36–40 Mental health concerns such as panic attacks, extreme aggression, negative self-image, disturbing thoughts, and behavioral change were reported following PIEDs use.33,23,24,26,34,35,40,41

3.6  How are serving military personnel and veterans introduced to PIEDs (ie, was their introduction pre-, during-, or post-service)?

Of the papers included in the current review, only four alluded to how users were first exposed to PIEDs. The small amount of data available suggests that PIEDs use often begins with combat deployment; one participant also mentioned beginning PIEDs use in basic training.22,35 This contrasts with other studies reporting that PIEDs use may have started after a break from the armed forces training due to leave or injury.33,34 However, research investigating when PIEDs use commenced in armed forces users is limited so any generalization must be treated with caution.

Although few studies investigated when service personnel began using PIEDs, some did question how service
personnel acquired or purchased PIEDs. The literature included in the current review suggests that active service personnel either purchased PIEDs online, from other countries when visiting, or from fellow members of the armed forces. In a qualitative study, participants mentioned traveling to Mexico when stationed in southern USA to purchase anabolic steroids in pill form or to receive anabolic steroid injections. In addition, other participants reported purchasing anabolic steroids from other members of the armed forces including army medics. This was corroborated by the testimony of an army medic who stated that he started using PIEDs himself after supplying others with anabolic steroids. Less is known about purchasing PIEDs in the UK military, albeit one study of a British military sample suggested that 43% of PIEDs and supplements purchased by their sample of services personnel were purchased while on deployment and sourced locally on-base in Basra or Kuwait. Others purchased PIEDs in the UK or Germany (13.8%) and online (10.8%).

3.7 Methodological flaws in the current literature

Of the studies included in the current review, there were two different methodologies employed: qualitative (N = 8) and quantitative (N = 12). The majority of qualitative studies used a case study approach (N = 7). To better understand details of the motivations and experiences of a PIEDs user, a qualitative methodology would seem most appropriate to get depth of detail. The lack of qualitative research (other than single person case-studies) makes it difficult to gain a deeper understanding of the personal motivations and experiences of PIEDs users in the military. Also, due to the ethical implications involved in conducting randomized control trials with drugs that are not necessary for health, the majority of findings related to health impacts and side effects of PIEDs use comes from clinical case studies.

All 20 of the studies, including the case-studies, used versions of self-report measures, thus reports of PIEDs use were reliant on military personnel’s accurate and truthful disclosure of their PIEDs usage. As PIEDs usage could potentially affect an active service person’s fitness for duty (eg, health consequences such as hemorrhagic incidents), make them unfit for duty, or even lead to reprimand and disciplinary sanction, many military personnel involved in the studies may not have been honest about their PIEDs usage. Additionally, there is also the issue of memory-decay that is inherent in self-reported historical accounts of experiences. Due to the reliance on self-report measurements, it is likely that PIEDs use has been underestimated, as is the case in many studies using self-reporting to measure drug use. Additional inaccuracy relating to the use of self-report measures will be caused in cases where personnel may be taking certain supplements but may be unclear as to what type of PIEDs are included and in what concentrations. There was a large variety of PIEDs identified during the current review, and many of the PIEDs branded as weight-loss supplements or body building supplements had a variety of different PIEDs ingredients. Many supplements mentioned in the clinical case studies, such as proprietary “fat burners”, pre-workout formulas, and protein shakes were bought without clear knowledge or labeling relating to their performance enhancing ingredients.

A notable limitation of the review reflected the lack of studies with veteran samples, despite this group being an initial key target. Only one case study included in the current review focused entirely on PIEDs use in veterans, and this only presented the case of one veteran. One other study included both active-duty personnel and veterans but did not separate out the samples; therefore, no analysis was offered of PIEDs use in veterans only. The employment of veteran recounts requires substantive work to enhance the current literature, especially as there would be less reason for “hiding” usage during service.

Our review also only considered English language studies, however, that was based on the fact that this language is currently the main language for scientific communication globally. Nonetheless, a future study may wish to extend its search to include non-English language databases and papers.

Additionally, this review has included research that might otherwise not have been considered as it did not meet “identified quality” criteria, for example, due to low sample size, or non-use of validated measures. Moreover, the quality of these studies lacks research reliability due to their descriptive nature and the use of case studies. Finally, the definitions of PIEDs differed between studies, with some studies considering them as nutritional bodybuilding or weight-loss supplements, whereas others classified them as proscribed medical or pharmaceutical substances.

4 DISCUSSION

As with the Results section, this final section will be structured around the four research questions posed at the end of the Introduction.

4.1 What are the current usage trends for PIEDs in serving military personnel and veterans (including the type of PIEDs being used)?

The findings of our review highlight that PIEDs use is reported in the active military at all levels and across all armed forces.
forces. The actual extent of PIEDs use in the military may be larger than demonstrated in the current review. The scarcity of appropriate literature gives support to this proposition with further backing reflecting the reliance on self-reporting of PIEDs use. All cited studies were self-reported or had components that necessitated self-reporting. Moreover, the confusion over the definition of PIEDs and the debate over the inclusion or exclusion of more general bodybuilding supplements caused further disparity in the research. Finally, the general accessibility bordering on acceptability of PIEDs use in the military and the general population further compounds the issue. This perceived degree of “acceptability” removes many barriers that may discourage the use of PIEDs, and to some extent, it could be argued that this usage is condoned in certain circumstances.

4.2 What are the motivations for using PIEDs amongst serving military personnel and veterans?

The literature presents damaging attitudes towards PIEDs use in military personnel, with studies suggesting some service personnel see PIEDs use as acceptable and necessary to meet the physical and psychological demands of their job. The reasons surrounding the use of PIEDs in the military were noteworthy, specifically the qualitative findings in which participants mentioned needing to use PIEDs to feel capable to cope with the demands of training, physical testing, and to cope with the physical and psychological burdens of combat deployment. To add to those concerns, none of the papers reported any testing regimes within the military. This means that more users may be accessing PIEDs due to a perceived sense of need coupled with little chance of being caught.

4.3 What are the effects of PIEDs use on mental and physical health in military personnel?

Performance and image enhancing drugs are linked with serious physical and mental health problems. As such, they present serious implications for both the health and service readiness of military personnel. Potentially poor health, lack of regulation around sources of PIEDs, and doubts about the quality of PIEDs being used are all reported and have possible negative consequences.

One thing that is apparent from the findings of many of the studies included in the current review is that PIEDs use is resulting in potentially dangerous physical and behavioral changes in service personnel, such as increased risks of hemorrhagic stroke, liver damage, and severe behavior change. The impacts of PIEDs use on physical health have been much more widely investigated than the impacts on the mental health of active military personnel and veterans, and this needs addressing in the future.

4.4 How are serving military personnel and veterans introduced to PIEDs (ie, was their introduction pre-, during-, or post-service)?

The quantitative studies included in this review had larger sample sizes yet had several other methodological issues. Little research has explored the attitudes and influences surrounding the initial use of PIEDs by service personnel with only two studies reporting when service personnel began using. However, in these studies, the information presented was limited and did not present a suitable level of clarity about how active military personnel and veterans were introduced to PIEDs.

One worrying aspect of PIEDs use was the increasing acceptability and normalization of drug-taking behavior due to medical personal providing PIEDs. These concerns have profound policy implications for the military. There needs to be a policy shift within the military to address the “acceptability” culture of PIEDs use in serving personnel.

4.4.1 Future directions

There are substantial gaps in the current literature surrounding PIEDs use in military personnel, even more so for PIEDs use in military veterans. Further research is necessary to gain a deeper understanding of how active military personnel and veterans are introduced to and begin taking PIEDs, who they access the PIEDs from, and what motivations underpin the motivations of PIEDs use in these populations. Furthermore, there is a need to investigate and understand when use begins, particularly whether it is pre-, during, or post-military service. This work would help target potential intervention strategies. In particular, there is a need to know what is known of the dangers and consequences of PIEDs use to inform interventions such as education and training strategies.

Many of the studies presented in this review offer scientific findings related to the health impacts of PIEDs use in military personnel using a case study methodology. This is relevant and appropriate for investigation into the health impacts of drug use but does not allow for suitable generalization to the wider military population.

As there was only one qualitative study that used a larger sample included in the current review, further qualitative research is necessary to get a deeper and clearer understanding of the attitudes and perceptions of PIEDs use in both active
and former military personnel. Moreover, notwithstanding some studies that mixed active with non-active personnel, there is no published work specifically relating to veterans’ use of PIEDs. Given the concerns about veterans’ health, especially mental health,47 and the problems experienced by some veterans in attempting to transition successfully back into their communities without becoming involved with the criminal justice system,18 further empirical research is needed with this group.

This latter point regarding transitioning identifies some potential implications, such as ensuring better support for those found using PIEDs when they transition out of military service. This would be beneficial not only for those taking PIEDs but also for wider society. For example, there are likely to be impact on health services such as the UK’s NHS because of health complications from PIEDs use. Moreover, the fact that in many countries PIEDs use is illegal, or at least the trafficking/sale of PIEDs is illegal, then there is likely to be an impact upon countries’ criminal justice systems.

4.5 | Perspective

This paper reviews the literature on PIEDs use in active military personnel and veterans. However, the review is limited by the small number of available studies, restrictive methods of data collection, and reliance on self-report measures of PIEDs use. In addition, the current review only presents studies written in English which could present a further limitation to the number of studies included. From the literature presented, there are clear health concerns related to PIEDs use in military personnel and a potential impact on combat readiness. In addition, the research presented suggests that certain groups of military personnel feel that PIEDs use is necessary to keep up with the physical and emotional requirements of their post, which could present a cause for concern within the armed forces and the wider community. The current review has underscored the need for further and more detailed research into the experiences and perceptions of PIEDs users within the active and retired military, and how this drug use affects their lives over both the short term and the long term.

CONFLICT OF INTEREST

All authors declare that there are no conflicts of interest. The authors alone are responsible for the content and writing of the manuscript.

REFERENCES

1. Parkinson AB, Evans NA. Anabolic androgenic steroids: a survey of 500 users. Med Sci Sports Exerc. 2006;38(4):644-651.

2. Bojesen-Moller J, Christiansen AV. Use of performance-and image-enhancing substances among recreational athletes: a quantitative analysis of inquiries submitted to the Danish anti-doping authorities. Scand J Med Sci Sports. 2010;20(6):861-867.

3. Bolding G, Sherr L, Elford J. Use of anabolic steroids and associated health risks among gay men attending London gyms. Addiction. 2002;97(2):195-203.

4. Santos GH, Coomber R. The risk environment of anabolic–androgenic steroid users in the UK: examining motivations, practices and accounts of use. Int J Drug Policy. 2017;40:35-43.

5. Pillitteri JL, Shiffman S, Rohay JM, Harkins AM, Burton SL, Wadden TA. Use of dietary supplements for weight loss in the United States: results of a national survey. Obesity. 2008;16(4):790-796.

6. Piacentino D, Kotzalidis GD, Longo L, et al. Body image and eating disorders are common among professional and amateur athletes using performance and image enhancing drugs: a cross-sectional study. J Psychoactive Drugs. 2017;49(5):373-384.

7. Brennan R, Wells JS, Van Hout MC. The injecting use of image and performance-enhancing drugs (IPED) in the general population: a systematic review. Health Soc Care Community. 2017;25(5):1459-1551.

8. van Amsterdam J, Opperhuizen A, Hartgens F. Adverse health effects of anabolic–androgenic steroids. Regul Toxicol Pharmacol. 2010;57(1):117-123.

9. Darke S, Torok M, Duflou J. Sudden or unnatural deaths involving anabolic-androgenic steroids. J Forensic Sci. 2014;59(4):1025-1028.

10. Hope VD, McVeigh J, Marongiu A, et al. Prevalence of, and risk factors for, HIV, hepatitis B and C infections among men who inject image and performance enhancing drugs: a cross-sectional study. BMJ Open. 2013;3(9):e003207.

11. Kao TC, Deuster PA, Burnett D, Stephens M. Health behaviors associated with use of body building, weight loss, and performance enhancing supplements. Ann Epidemiol. 2012;22(5):331-339.

12. Gustafsson U, Ravelius I. Using Performance-Enhancing Substances When Exercising the Human Body: A Study of Gym Users from a Social Worker Perspective. Gävle: Högskolan i Gävle; 2014.

13. Coomber R, Moyle L, South N. The normalisation of drug supply: the social supply of drugs as the “other side” of the history of normalisation. Drugs Educ Prev Polic. 2016;23(3):255-263.

14. Coomber R, Moyle L. Beyond drug dealing: developing and extending the concept of ‘social supply’ of illicit drugs to ‘minimally commercial supply’. Drugs Educ Prev Polic. 2014;21(2):157-164.

15. Houlihan B, García B. The Use of Legislation in Relation to Controlling the Production, Movement, Importation, Distribution and Supply of Performance Enhancing Drugs in Sport (PEDS). Loughborough: Loughborough University; 2012.

16. Givens ML, Deuster PA, Kupchak BR. CHAMP symposium on anabolic steroids, anabolic androgens, and related substances: what we know and what we need to know. Mil Med. 2016;181(7):680-686.

17. Barlas FM, Higgins WB, Pfleger JC, Diecker K. 2011 Health Related Behaviors Survey of Active Duty Military Personnel. Fairfax VA: ICF International; 2013.

18. Schultz NR, Blonigen D, Finlay A, Timko C. Criminal typology of veterans entering substance abuse treatment. J Subst Abuse Treat. 2015;54:56-62.
CASP. 2019. http://www.casp-uk.net/#/casp-tools-checklists/c1888. Accessed September 28, 2019.

Moher D, Shamseer L, Clarke M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Syst Rev. 2015;4(1):1.

Armstrong-Moore R, Haighton C, Davinson N, Ling J. Interventions to reduce the negative effects of alcohol consumption in older adults: a systematic review. BMC Public Health. 2018;18(1):302.

Lui CW, Waller M, Bell A, van der Pols JC. Retrospective self-reported dietary supplement use by Australian military personnel during deployment to Iraq and Afghanistan: results from the Middle East Area of Operations Health Study. Appl Physiol Nutr Metab. 2019;44(6):674-680.

Paisley RD. Nutritional and sports supplement use among deployed US Army soldiers in a remote, austere combat outpost in eastern Afghanistan. Mil Med. 2015;180(4):391-401.

Varney SM, Ng PC, Perez CA, et al. Self-reported dietary supplement use in deployed United States service members pre-deployment vs. during deployment, Afghanistan, 2013–2014. Mil Med Res. 2017;4:2013-2014.

Austin KG, McLellan TM, Farina EK, McGraw SM, Lieberman HR. Soldier use of dietary supplements, including protein and body building supplements, in a combat zone is different than use in garrison. Appl Physiol Nutr Metab. 2015;41(1):88-95.

Boos C, Wheble GAC, Campbell MJ, Tabner KC, Woods DR. Self-administration of exercise and dietary supplements in deployed British military personnel during operation TELIC 13. J R Army Med Corps. 2010;156(1):32-36.

Campagna JD, Bowsher B. Prevalence of body dysmorphic disorder and muscle dysmorphia among entry-level military personnel. Mil Med. 2016;181(5):494-501.

Jacobson IG, Horton JL, Smith B, et al. Bodybuilding, energy, and weight-loss supplements are associated with deployment and physical activity in US military personnel. Ann Epidemiol. 2012;22(5):318-330.

van der Pols JC, Kanesarajah J, Bell A, Lui CW. Current dietary supplement use of Australian military veterans of Middle East operations. Public Health Nutr. 2017;20(17):3156-3165.

Lukács L, Murányi I, Tury F. Eating and body attitudes related to noncompetitive bodybuilding in military and general Hungarian male student populations. Mil Med. 2007;172(2):152-156.

Casey A, Hughes J, Izard RM, Greeves JP. Supplement use by UK-based British Army soldiers in training. Br J Nutr. 2014;112(7):1175-1184.

Mattila VM, Rimpeli A, Jormunainen V, Sahi T, Pihlajamäki H. Anabolic-androgenic steroid use among young Finnish males. Scand J Med Sci Sports. 2010;20(2):330-335.

Carol ML. Hydroxycut weight loss dietary supplements: a contributing factor in the development of exertional rhabdomyolysis in three US Army soldiers. Mil Med. 2013;178(9):e1039–e1042.

Herbst E, McCaslin S, Kalapatapu RK. Use of stimulants and performance enhancers during and after trauma exposure in a combat veteran: a possible risk factor for posttraumatic stress symptoms. Am J Psychiatry. 2017;174(2):95-99.

Bucher J. Soldiering with substance: substance and steroid use among military personnel. J Drug Educ. 2012;42(3):267-292.

Brazeau MJ, Castaneda JL, Huitron SS, Wang J. A case report of supplement-induced hepatitis in a active duty service member. Mil Med. 2015;180(7):e844–e846.

Harris BF, Winn C, Ableman TB. Hemorrhagic stroke in a young healthy male following use of pre-workout supplement animal rage XL. Mil Med. 2017;182(9-10):e2030-e2033.

Liane BJ, Magee C. Guerilla warfare on the pancreas? A case of acute pancreatitis from a supplement known to contain anabolic-androgenic steroids. Mil Med. 2016;181(10):e1395–e1397.

Magee CD, Witte S, Kwok RM, Deuster PA. Mission compromised? Drug-induced liver injury from prohormone supplements containing anabolic–androgenic steroids in two deployed US service members. Mil Med. 2016;181(9):e1169–e1171.

Young C, Oladipo O, Frasier S, Putro R, Chronister S, Marovich M. Hemorrhagic stroke in young healthy male following use of sports supplement Jack3d. Mil Med. 2012;177(12):1450-1454.

Austin KG, McGraw SM, Lieberman HR. Multivitamin and protein supplement use is associated with positive mood states and health behaviors in US Military and Coast Guard personnel. J Clin Psychopharmacol. 2014;34(5):595.

Ministry of Defense. 2013 JSP 835: Alcohol and Substance Misuse and Testing. [Online] MOD. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/425401/20131101-JSP_835-V2_0-U.pdf. Accessed April 16, 2019.

Hunt DE, Kling R, Almozlino Y, Jalbert S, Chapman MT, Rhodes W. Telling the truth about drug use: how much does it matter? J Drug Issues. 2015;45(3):314-329.

van de Ven K, Koenraadt R. Exploring the relationship between online buyers and sellers of image and performance enhancing drugs (IPEDs): quality issues, trust and self-regulation. Int J Drug Policy. 2017:50:48-55.

Bandura A. Selective moral disengagement in the exercise of moral agency. J Moral Educ. 2002;31(2):101-119.

Boardley ID, Grix J, Dewar AJ. Moral disengagement and associated processes in performance-enhancing drug use: a national qualitative investigation. J Sports Sci. 2014;32(9):836-844.

Murphy D, Ashwick R, Palmer E, Busuttil W. Describing the problem of procurers of image and performance enhancing drugs (IPEDs): quality issues, trust and self-regulation. Int J Drug Policy. 2017:50:48-55.

WHYTE ET AL.