



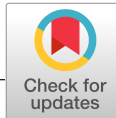
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# Performance and image enhancing drugs use in active military personnel and veterans: A contemporary review

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## Abstract

The use of performance and image enhancing drugs (PIEDs) among active military personnel and veterans presents a public health concern. Deeper understanding of PIEDs use in those populations is necessary to understand what underpins their use and provide information to help shape interventions with the aim of reducing impacts on individuals' health, wellbeing, social circumstances, public perception and, in serving personnel, any wider military performance. A contemporary review was conducted using five academic journal databases, citation searching, and hand searching. Studies were excluded if published prior to 2000 or did not specify PIEDs use. Following this search, 20 studies were identified for review. Findings suggest that anabolic steroids and weight-loss supplements were the most used PIEDs. Image enhancement was mentioned the most as a reason for PIEDs use followed by keeping up with the physical and emotional demands of active duty. Additionally, findings suggested that young, male non-commissioned Army personnel were most likely to use PIEDs. There were clear gaps in the current literature surrounding PIEDs use, as well as an understanding of when service personnel began using PIEDs. Further research should aim to answer these questions.

## KEYWORDS

armed forces, military services, performance and image enhancing drugs, PIEDs, veterans

## 1 | 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.<sup>1</sup> A further study in Denmark highlighted that within recreational athletes it was young men who were most likely to use PEDS.<sup>2</sup> Findings from research conducted in the UK also identify young male gym goers as the primary users of PEDS.<sup>3,4</sup> Whereas there is increasing

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evidence suggesting women are more likely to engage in PED use for image enhancement and weight-loss<sup>5</sup>; hence, these substances are now known collectively as performance and image enhancing drugs (PIEDs).

Motivations for taking PIEDs are usually reported as enhancement of performance and changes to physical appearance.<sup>6</sup> Current literature suggests that the main motivation for PIEDs usage is to modify physical appearance and enhance performance by building muscle beyond what was possible from natural training alone.<sup>7</sup>

Use of PIEDs is not without risk.<sup>6</sup> Increasing prominence is being paid to reports of negative health consequences, including organ damage, reduced fertility, mental health problems, and even sudden cardiac death.<sup>8–11</sup> In addition to health concerns, concerns have been raised about the legality of some substances as many PIEDs are illegal to sell and to purchase so involvement with them results in a risk of users becoming involved with criminality, potentially becoming part of the sales team, as well as the risk of getting involved in any criminality and violence that may accompany both the use and distribution of PIEDs.<sup>12</sup> The sale and purchasing behavior of PIEDs, however, usually followed the model of “social supply,” which refers to the sale of drugs between friends and associates for little to no profit, often to supplement the person's own use.<sup>13</sup>

Users report severe uneasiness about the quality and safety of the drugs being used. A UK study found that the quality of PIEDs available was poor as nearly all samples tested turned out to be low-quality counterfeits.<sup>14</sup> Little is known about the long-term effects of some of the substances being sold and how these interact with other medications and existing health conditions.

Due to the above risks and issues, governments across the globe are concerned about the trafficking, use, and misuse of PIEDs. A UNESCO-funded study found that countries have varying levels of importance attached to legislation that surrounds PIEDs use.<sup>15</sup> Houlihan and Garcia categorized nations' responses into four categories:

- Category A PEDS-specific legislation
- Category B General sports legislation (eg, including violence, corruption in sport as well as doping)
- Category C General drugs legislation (indicated where coverage of WADA PEDS is especially limited)
- Category D Other legislation (medicines legislation, customs legislation, public health legislation, food, and drugs legislation).

All of the countries that responded fitted into one of those categories as they all adhered to World Anti-Doping Agency (WADA) principles. Most also had legislation that related to controlling the production, movement, importation, distribution, and supply of performance enhancing drugs.

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.<sup>16</sup> In the USA, for example, a Department of Defense survey reported a 4% increase in the use of anabolic steroids between 2002 and 2011.<sup>17</sup> 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,<sup>18</sup> 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.<sup>19</sup>

### 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.

## 2.3 | Quality assessment

In the first instance, all papers included were assessed for quality using an amended CASP checklist.<sup>20</sup> 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.<sup>21</sup>

## 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

**TABLE 1** Inclusion/exclusion criteria

	Inclusion criteria	Exclusion criteria
Study type	Published from 2000 to present Available in English language Reporting original findings	Published prior to 2000 Not available in English language Non-original findings, for example, reviews, editorials
Participants	Current or ex-military personnel participant sample Army, Navy, Air-Force, Marines <sup>a</sup> , 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
Drug type	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

<sup>a</sup>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.

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.

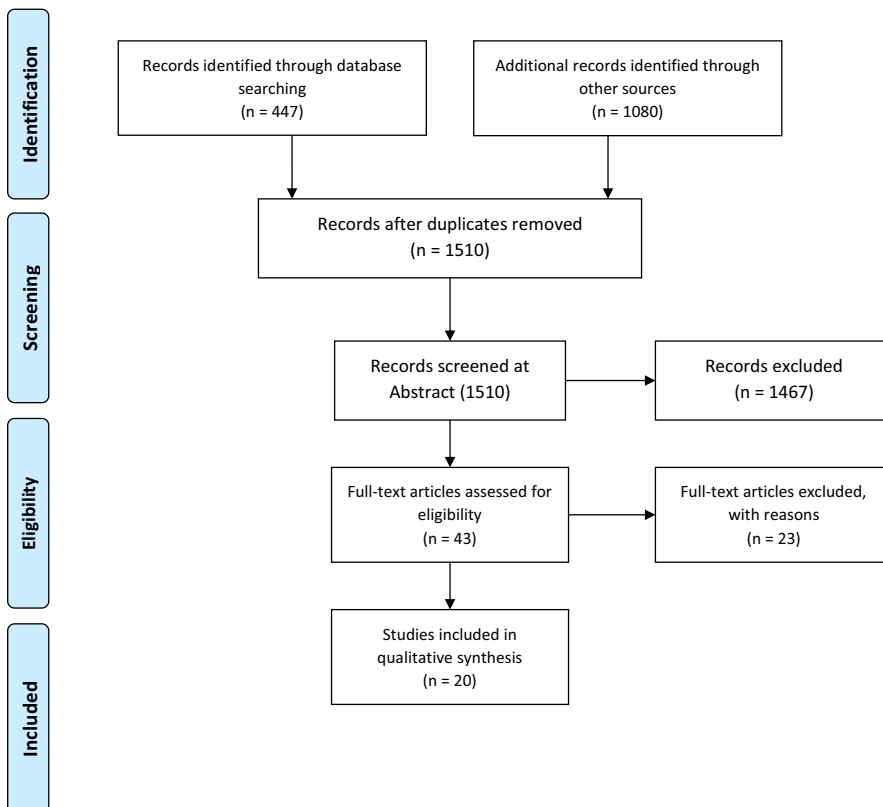
### 3.1 | Results of the search

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 ( $N = 7$ ).



**FIGURE 1** PRISMA flowchart depicting the flow of information through the different phases of the systematic review of literature related to military personnel and PIEDs use

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		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-Force	USA	Anabolic steroids	Aggression			Users of steroid products reported feeling less friendly and more aggressive
Boos et al	2010	Quant	Active	Did not specify	UK	Anabolic steroids, PEDs, hormone Boosters	Insomnia, mood changes, palpitations, anxiety	Physical expectations of the job, image enhancement		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 steroids	Liver injury	Image enhancement, muscle growth		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)

TABLE 2 (Continued)

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	Seen as acceptable, physical expectations of the job, keeping up with others, influence of others, coping with combat	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, Bowsler &	2016	Quant	Active	Army, Navy, Air-Force	USA	Bodybuilding supplements, weight-loss supplements	Men—performance enhancement, image enhancement women—weight loss and overall health	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	(Continues)

**TABLE 2** (Continued)

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

(Continues)



TABLE 2 (Continued)

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

(Continues)

TABLE 2 (Continued)

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)

TABLE 2 (Continued)

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

(Continues)

TABLE 2 (Continued)

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
Varney 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 coincidental

### 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.<sup>22–24</sup> 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.<sup>25</sup>

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.<sup>26–30</sup> 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.<sup>26,31</sup> In addition, lower rank was also associated with higher likelihood of PIEDs use.<sup>29,31</sup> Army personnel was the most likely to use PIEDs when compared to other military forces.<sup>22,29</sup> 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.<sup>26,28,32</sup> 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.<sup>27,32,33</sup> Keeping up with the physical demands of service was linked with the demands of physical expectations and the strength-based nature of military service.<sup>26,28,34</sup> 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.<sup>35</sup> 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.<sup>33,36–40</sup> Mental health concerns such as panic attacks, extreme aggression, negative self-image, disturbing thoughts, and behavioral change were reported following PIEDs use.<sup>23,24,26,34,35,40,41</sup>

### 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.<sup>22,35</sup> 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.<sup>33,34</sup> 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.<sup>26,34,35</sup> 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.<sup>35</sup> 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%).<sup>26</sup>

### 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,<sup>42</sup> 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.<sup>43</sup> 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",<sup>33</sup> pre-workout formulas,<sup>35</sup> and protein shakes<sup>40</sup> 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.<sup>34</sup> 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.<sup>22</sup> 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,<sup>35,36</sup> or non-use of validated measures.<sup>26,27</sup> Moreover, the quality of these studies lacks research reliability due to their descriptive nature and the use of case studies.<sup>34,37</sup> Finally, the definitions of PIEDs differed between studies, with some studies considering them as nutritional body-building or weight-loss supplements<sup>22,27,28,33</sup> whereas others classified them as proscribed medical or pharmaceutical substances.<sup>26,31,35,36</sup>

## 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.<sup>24</sup> 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.<sup>25,39</sup> Finally, the general accessibility bordering on acceptability of PIEDs use in the military and the general population further compounds the issue.<sup>7,44</sup> This perceived degree of “acceptability” removes many barriers that may discourage the use of PIEDs,<sup>45,46</sup> 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.<sup>26,28,34,35</sup> 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.<sup>35</sup> 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<sup>33,36–40</sup> and mental health problems.<sup>23,24,26,34,35,40,41</sup> As such, they present serious implications for both the health and service readiness of military personnel.<sup>36</sup> Potentially poor health,<sup>37,39</sup> lack of regulation around sources of PIEDs,<sup>26</sup> and doubts about the quality of PIEDs being used<sup>26,39</sup> are all reported and have possible negative consequences.<sup>36</sup>

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.<sup>24,35,37</sup> 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<sup>37,39</sup> 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<sup>22,23</sup> 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.<sup>20,34</sup> 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.<sup>35</sup> 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,<sup>47</sup> and the problems experienced by some veterans in attempting to transition successfully back into their communities without becoming involved with the criminal justice system,<sup>18</sup> 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.

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