The Correlates and Treatment of Obesity in Military Populations: A Systematic Review

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Keywords

Systematic review · Obesity · Military population · Correlates · Treatment

Summary

Objective: The emergence of obesity as a distinct disease could have far reaching consequences for an organisation where optimum health and physical fitness are required for personnel to perform their occupational roles effectively. The objectives of this paper are to systematically review the literature concerning correlates and treatment of obesity in military populations.

Methods: Through computerised searches of English language studies, 17 papers were identified (treatment (13), correlates (4)). **Results:** Successful treatment interventions incorporated exercise, healthy eating information, behavioural modification, self-monitoring, relapse prevention, and structured follow-up and were supported by trained personnel. Efficacy due to physical activity was underreported. Reduction in body fat rather than body weight was the most significant outcome. The major significant correlates of obesity were being enlisted personnel, male, ≥ 35 years of age, African-American/Hispanic ethnicity, and married (with spouse present).

Conclusion: This systematic review highlights the deficit in knowledge concerning treatment and the lack of engagement in relation to the specific correlates of obesity in military populations.

Introduction

With the global epidemic of obesity [1], some nations have identified a trend towards escalating levels of overweight and obesity within their military populations [2, 3]. It would appear that, despite body fat standards being imposed on military personnel, the armed forces population are experiencing similar patterns of increasing levels of overweight and obesity as observed in civilian society [3, 4]. A recent study from the US Department of Defence (DoD) ($n = 16,146$) indicates that 61% of men and 39% of women employed in the active component of the US Military are overweight and collectively 12% are obese [3]. Evidence from the UK shows lower collective values with 38% being overweight and 14% obese ($n = 4,500$) [5], but still being suggestive of a problem.

Several studies have investigated the associated costs of obesity to the military [6–8]. Dall and colleagues [6], for example, estimated that the financial cost of excess weight and obesity to the DoD was USD 1.1 billion. Such findings were corroborated by data from the US Medical Surveillance Monthly Report for January 2009 [3], indicating that 23% and 16% of US Service members diagnosed with overweight or obesity in 2008 had at least one medical encounter for a joint and back pain disorder, and that these conditions were among the leading causes of health care costs and lost duty time. Whilst the financial connotations of obesity are clearly important, the psychological and physiological impact to service personnel may have wider occupational implications due to the association between obesity and depressive symptoms [9], post-traumatic stress syndrome (PTSD) [10], cardiorespiratory fitness (CRF) and neuromuscular fitness [11], heat stress [12], sleep apnoea [13], and load carriage [14, 15]. Several investigations into load carriage within military populations have observed that ‘load carriage’ ability was reduced in ‘over-fat’ military personnel [14, 15]. Fogelholm et al. [11], concluded that individuals with higher levels of body fat had

not only impaired CRF but also reduced muscular and motor function, reducing the over-fat individual's ability to complete physically challenging military tasks.

Studies attempting to explore trends between physical activity (PA) and overweight [16], and the correlates of obesity [17], have to date been conducted on the general population and may not reflect a sub-population with relatively high levels of PA, such as the military [18]. Therefore, a greater understanding of the correlates of obesity could offer a means to mediate the effect on the military, allowing for specific prevention and treatment interventions. Given the established links between obesity and the major causes of morbidity and mortality [19] and their impact on personal and collective 'operational effectiveness' [20], the aim of this paper was to systematically review the current evidence in respect of the correlates and treatment of obesity in the armed forces.

Material and Methods

This study followed the procedures for systematic reviews outlined by the National Health Service (NHS) Centre for Reviews and Dissemination [21], and the National Institute for Health and Clinical Excellence (NICE) 'Methods for the Development of NICE Public Health Guidance' [22].

Search Strategy

The following electronic databases were searched, CINAHL, MedLine (PubMed), OCLC First Search, CSA Illumina, Sports Discus, and Cochrane electronic databases using the search terms 'Military' or 'Army' or 'Air Force' or 'Navy' or 'Marines' AND 'weight', 'overweight', 'obesity', 'weight maintenance', 'weight loss' or 'weight control'. Due to the restricted nature of some material concerning the military, an additional search of all military sponsored literature was conducted. This search strategy included numerous e-mails to several world-wide military departments (DoD, Australian Defence Force, New Zealand Army and Canadian Army etc.) and a focussed search of the North Atlantic Treaty Organisation (NATO) medical research publications.

Inclusion and Exclusion Criteria / Identification of Relevant Studies

For inclusion, studies were required to i) refer to a regular (as opposed to reservist) military population, ii) have an outcome that was weight-, health- or PA-related, and iii) be written in the English language and published between 1990 to May 2009. Studies were excluded if i) the focus was surgical or pharmaceutical, or ii) the intervention did not include obesity as a primary condition. The first author identified relevant papers through the search strategy by reading their titles and abstracts. If abstracts were not available or yielded insufficient data, the whole article was screened for suitability for inclusion. Data from papers meeting the inclusion criteria were extracted by the first author on a standardised form developed for this review

Study Type and Quality Appraisal

Studies were categorised by study design as described in the NICE 'Methods for Development of NICE Public Health Guidance' Annex D and E [22]. Quality appraisal was reflective of:

- *Population*: source, recruitment and representation
- *Method of allocation*: randomization, concealment and exposure
- *Outcomes*: measurement, reliability and follow-up
- *Analyses*: methods, intention to treat and calculable effect sizes
- *Summary*: validity and generalisability of findings.

Results

The literature searches yielded 595 potentially relevant articles. Based on the title and abstract, 544 papers were removed from the review. Duplications accounted for 2 papers; a further 29 papers did not withstand the criteria for the review (fig. 1). A final confirmatory filter with a second reviewer (SJHB) reduced the remaining 20 papers to 17. Of the papers included in the review, only one paper was from outside the USA (Israel). The 'grey literature' search returned 18 potential papers, none of which could be included in the review. In the main, these papers focussed on 'military policy' regarding obesity classification and associated regulations (fig. 1).

Papers were filtered into the sub-categories of treatment ($n = 13$) and correlates ($n = 4$). The quality appraisal by sub-category is shown in table 1. A quality assessment of '++' was allocated to the two randomized controlled trials (RCTs) and the one cluster randomized controlled trial (CRCT); the non-randomized controlled trial (NRCT) was assessed as '+'. The remaining papers were cross-sectional (CS) ($n = 4$) and non-experimental pre-post (NEPP) ($n = 9$), and were assessed as '-'.

Treatment

13 studies (RCT = 2, CRCT = 1, NRCT = 1, NEPP = 9) examining the treatment of obesity in military populations were reviewed (table 2). The period of intervention ranged from 3 weeks to 12 months, with an associated follow-up of 3–18 months. The average sample size was 134 (range 31–624), and the reported average age was 31.5 years (range 19–50 years). In general terms the sampling reflected both genders ($n = 10$); however, 3 studies reflected a single sex sample (2 male, 1 female). The majority of papers ($n = 9$) reported an intervention based on cognitive behavioural theory (CBT; $n = 8$), or the transtheoretical model (TTM; $n = 1$). All interventions included PA as part of the treatment process; diet modification was offered by 9 of the interventions [23–31], with diet education incorporated into all but one [32]. With the exception of 3 interventions [26, 32, 33], self-monitoring techniques were generally included. Behavioural or lifestyle change was a central topic in all but one of the interventions [32], whilst creating a supportive environment was only partially referred to in 8 of the interventions [23–30], each of which followed a 'cognitive-behavioural' approach. Significantly the intervention that used PA in isolation [32] was the least effective, achieving <1% weight loss. Where comparison is possible [34, 35, 54], a reduction in reported body fat (Cohen's $d = 0.42$ – 0.66) as opposed to body weight ($d = 0.14$ – 0.38) or BMI ($d = 0.03$ – 0.53) was observed to be more significant. Several of the interventions [26–30, 34] could be defined as successful as they produced reductions in body weight beyond that required by the US Institute of Medicine [35] ($\geq 5\%$ of initial body weight). Whilst the most successful ($>10\%$ weight loss) interventions [29, 30] all followed the 'Healthy Lifestyles, Ex-

Fig. 1. Flow diagram of study selection

Table 1. Quality assessment by sub-category

	Quality assessment		
	–	+	++
Treatment	9	1	3
Correlates	4	0	0

ercise and Emotions, Attitudes and Nutrition' (LEAN) programme, these interventions reflected individuals that were heaviest at baseline in comparison with the participants taking part in the other studies reviewed.

Correlates

Four cross-sectional studies concerning the correlates of obesity were included in this review. Table 3 follows a similar

approach advocated by previous reviews [17, 36, 37] and classifies correlates as demographic and biological; psychological, cognitive and emotional; dealing with behavioural attributes and skills; social and cultural; dealing with physical environment; or dealing with PA characteristics. The study populations ranged from 27 to 46,213 and reflected both genders (male = 78% (n = 36,021); female = 22% (n = 10,192)); age ranged between 18 and 55 years. A total of 19 correlates were identified from the 4 papers, with all of the evidence being based on 1 of the studies, or on 2 studies with conflicting evidence; therefore the quality of the evidence is classified as weak or mixed. These 19 correlates consisted of 8 demographic and behavioural, 5 psychological, cognitive and emotional, and 3 environment factors. One correlate was identified for behavioural attributes and skill. Social and cultural

Table 2. Summary of studies for the treatment of obesity in military populations

Reference	Sample size	Study design	Intervention	Duration and Follow-up	Main findings (effect sizes (ES) – Cohen's d values of 0.2, 0.5 and 0.8 represent small, medium and large effects respectively)
Veverka et al., 2003 [33]	39	RCT	treatment group access to web-site, stage-matched health information control group had no access to web site	6 months	the percentage of body weight reduction was significant, as was BMI ($p < 0.002$) and body-fat ($p < 0.0004$) data offered the following ES – body weight (0.38 (S)), BMI – (0.53 (M)) and body fat (0.42 (S)) increases in PA were insignificant the sample was small and reflected one American air base.
Dennis et al., 1999 [34]	31	RCT	1 h/week treatment consisted of: diet, behavioural modification, cognitive and emotional factors and exercise (same as control)	16 weeks	reductions to body weight ($p = 0.05$), BMI ($p = 0.05$) and body fat ($p < 0.05$) were all significant ES data indicated that only body-fat (0.63 (M)) had a graded ES sample was small, on board ship and did not reflect females or officers PA was not part of the intervention
Hunter et al., 2007 [46]	446	CRCT	treatment = internet based behavioural, dietary and exercise information control = see primary care provider once annually for a preventative health risk	6 months	Reductions to body weight, BMI and body fat were all significant ($p < 0.001$) for the BIT (treatment) as opposed to the UC (control). ES were all un-graded. The intervention aimed to e prevent weight gain and promote weight loss, there were a broad spectrum of associated outcomes. PA measured by IPAQ was un-significant.
James et al., 2001 [23]	48	NRCT	treatment = interactive-video link for individuals on deployable ships control = weekly sessions (nutritional guidance and behavioural modification).	1 year, follow-up 3 months	reductions to body weight and BMI ($p = 0.005$) were both significant BMI was reduced in the NIATV as opposed to the IATV ($p = 0.05$) all results include the former treatment (LE3AN) which all study participants undertook no real reference as to the efficacy of the telehealth intervention was offered in isolation.
Davis, 1996 [24]	46	NEPP	report on the weight loss programme for soldiers using the FLEX programme 3 phases including PA, diet, behavioural and relapse	3 weeks, follow-up 6 months	reductions to body weight and body fat were both significant ($p < 0.001$) at end of the intervention (3 weeks) most values returned to pre-intervention status at follow-up (apart from HDL – $p > 0.01$) BMI and PA were not reported
Earles et al., 2007 [25]	167	NEPP	multi-disciplinary in-patient intervention, involving exercise, attitudes, emotions and nutrition	1–3 weeks, follow-up 1 year	only significant outcome reported was BMI ($p < 0.001$) many un-significant outcomes and although PA was central to the intervention it was not reported
Trent and Stevens, 1995 [31]	624	NEPP	evaluation of the Navy obesity treatment programme level 1 = conditioning, level 2 = counselling, level 3 = in-patient	6 weeks, follow-up 6 and 12 months	reductions to body weight ($m = p < 0.001$, $f = p < 0.01$), BMI ($m + f = p < 0.01$) and body-fat ($m + f = p < 0.001$) were all significant body weight and BMI reflected small ES (0.22 and 0.34), body fat medium ES (0.66) PA was not reported.
Simpson et al., 2004 [26]	111	NEPP	1x per week multi-disciplinary in-patient coupled with a 1-year out-patient weekly follow-up involving exercise, attitudes, emotions and nutrition	1 year	reductions to body weight was significant for both ethnic groups ($p = 0.001$), with an associated ES of (0.56 (M)) treatment was more effective for the European-American sample as opposed to the African-American sample ($p < 0.05$) the final small sample of 65 did not include minor ethnic groups body fat, BMI and PA were not reported
James et al., 1999 [27]	40	NEPP	3x per week multi-disciplinary in-patient coupled with a 1-year out-patient follow-up involving exercise, attitudes, emotions and nutrition	3 weeks, follow-up 6, 12, 18 months	data only expressed in crude form reporting a (calculated) reduction in male body weight post intervention (6%) and at follow-up (6 months – 8.5%, 12 months – 6.7%, 18 months – 6.8%) the results for the female cohort were – post intervention – 3.4%, follow-up (6 months – 12.7%, 12 months – 12.3%, 18 months – 15.3%)

Table 2 continued on next page

Table 2. Continued

Reference	Sample size	Study design	Intervention	Duration and Follow-up	Main findings (effect sizes (ES) – Cohen's d values of 0.2, 0.5 and 0.8 represent small, medium and large effects respectively)
Bowles et al., 2006 [28]	53	NEPP	report on the LIFE weight loss programme 2 phases including PA, nutritional education and stress management	1 month, follow-up 6 and 12 months	reductions to body weight and BMI were significant ($p < 0.001$), body fat was not reported ES were stated for body weight ($m = 0.42$ (S), $f = 0.48$ (S)) most weight was reported to be lost in the initial 6 months (follow-up 6/12 months) PA was not reported.
James et al., 1997 [29]	40	NEPP	3 × per week multi-disciplinary in-patient coupled with a 1-year out-patient follow-up involving exercise, attitudes, emotions and nutrition	3 weeks, follow-up 6 months	data expressed in basic form reporting a (calculated) $m = 6.3\%$, $f = 4.5\%$ decrease in body weight at the end of the programme, $m = 9.3\%$, $f = 12.3\%$ reduction at follow-up the study suffered from reduced sample at follow-up ($m = 10$, $f = 2$), lack of available data at follow up for fitness, and lack of stratification for gender (fitness)
Woodruff et al., 1992 [32]	110	NEPP	sub-base: 3 × per week 1.5 h – physical exercise air base: 3 × (min) per week; 6 offered, 40–45 min physical exercise	24 weeks	all participants significantly improved their general fitness (sub base – $p = 0.008$ and air base $p = 0.04$), body weight and body fat were insignificant body fat was reduced in over-fat individuals at the sub-base ($p = 0.026$), and in the obese individuals at the air base ($p = 0.005$)
James et al., 1997 [30]	64	NEPP	3 × per week multi-disciplinary in-patient coupled with a 1-year out-patient follow-up involving exercise, attitudes, emotions and nutrition	3 weeks, follow-up 6 months	reduction in body weight was offered at the post intervention and the 6-month follow-up the male sample had a reduction of 4.2%, at follow-up this figure rose to 10.8% at post intervention the female sample reduction was 5.9% and 15.6% at follow-up the study did not report PA, BMI or body-fat

factors were represented by a single correlate, as was PA characteristics. The information offered by Bray et al. [20] represents the strongest evidence as data is derived from large-scale probability samples from three separate surveys (1995, 1998 and 2002). This study concluded that age, education, gender, pay group, marital status, and ethnicity were all significant ($p < 0.05$) correlates of obesity. Based on a large mixed Israeli sample ($n = 22,671$), Grotto et al. [38] reported that education (both participant and parents), smoking status, and PA level were linked to obesity status ($p \leq 0.035$). Sigrist et al. [39] focussed on a small sample of senior officers ($n = 52$); the primarily male (93%) sample indicated that 'not liking cooking' and 'lack of time', and 'low priority' were barriers to eating healthily and undertaking PA. Additionally, this study concluded that 'limited access' to fitness facilities, healthy food choices, and mixed media messages were all factors related to obesity. The final reviewed study [40] concentrated on a small Navy sample ($n = 27$) and offered one significant correlation ($p < 0.05$) in reference to the 'perceptions of exercise leadership'.

Table 3. Factors associated with becoming overweight/obese

Determinant	Review	Reference
<i>Demographic and biological factors</i>		
Age (≥ 35)	+	[20]
Subjects education	0	[20, 38]
Parents education (father's schooling ≤ 12 years)	+	[38]
Gender (male)	+	[20]
Pay group (enlisted)	+	[20]
Marital status (married spouse present)	+	[20]
Race/ethnicity (non-white)	+	[20]
Oral contraceptives (females not taking)	+	[38]
<i>Psychological, cognitive and emotional factors</i>		
Lack of time (to eat healthily / undertake PA)	+	[39]
Low priority (to eat healthily / undertake PA)	+	[39]
Do not like to cook	+	[39]
Perceptions of exercise leadership	+	[40]
<i>Behavioural attributes and skills</i>		
Smoking status (ex smokers)	+	[38]
Social and cultural factors		
Armed service (Navy)	+	[20]
<i>Physical environmental factors</i>		
Reduced access to fitness facilities	+	[39]
Healthful food choices (not available)	+	[39]
Confusion from the media	+	[39]
<i>PA characteristics</i>		
PA level (low)	+	[38]
+ Weak evidence of a positive association with obesity. 0 Mixed evidence as to the positive/negative association with obesity.		

Discussion

The purpose of this systematic review was to evaluate the available literature on the treatment and correlates of obesity in the armed forces. This paper is the first of its kind to systematically review these areas. The main findings of the study will be discussed in terms of these two areas below:

- Treatment
- Correlates.

Treatment

Of the 13 reported studies, 6 [23, 25–27, 29, 30] referred to the LEAN intervention programme. However, each study reported on either a specific population or an evolution of the original framework based on CBT. A similar ‘cognitive behavioural’ approach was also followed in the ‘Lifestyle Change, Individual Readiness, Fitness Excellence and Eating Healthy’ (LIFE) [28] and ‘Fat Loss and Exercise’ (FLEX) [24] programmes. The TTM was applied in 1 study [33], with the remaining 4 studies having no reported theoretical framework. Universally the interventions that were supported by theoretical methodologies displayed greater efficacy in respect of weight loss. Previous reviews have highlighted the value of using behavioural theory to clarify individual component effectiveness [19] and the influence of mediating variables [41].

Most interventions incorporating PA were poorly described, with little reference made to the prescriptive elements. All LEAN intervention programmes [23, 25–27, 29, 30] advocated low intensity PA (a target pulse rate of 60–70% of maximum heart rate) for 40 min (Monday to Friday = 200 min/week) [27]. Current recommendations suggest that 45–60 min/day of moderate intensity activity is required to prevent the transition to overweight or obesity and that 60–90 min/day is required for the prevention of weight regain in formerly obese individuals [42]. The advocacy of low-intensity PA in the LEAN programmes was based on 1 study using a civilian female sample [43] and may not adequately reflect a sub-population that is predominantly male who regularly engage in vigorous PA. The existence of dietary modification and diet education was another central topic of most of the interventions and is reflective of recent literature [19, 44]. Two studies [24, 27] reported the dietary modification applied (male 1,500–2,000 kcal/day, female 1,400–1,600 kcal/day), and these values are broadly in keeping with civilian recommendations [45]. Whilst both studies were successful in reducing body weight, the ‘multi-component’ nature of the interventions precludes comment as to the efficacy of the individual component.

With the exception of 5 studies [31–34, 46], general reference was made to the multi-disciplinary nature of the interventions and to the requirement for suitably trained professionals to support the intervention process. Health psychologists, dieticians, physical therapists, and other paraprofession-

als supported all of the LEAN programmes [23, 25–27, 29, 30], with similar support evident for the FLEX [24] and LIFE [28] programmes. A self-monitoring process was employed in the majority of interventions. The LEAN programmes incorporated specific self-monitoring techniques, that was based on evidence gained from ‘binge eating’ [29] which attempted to highlight food relationships (family and social-environmental), and extended beyond food journals utilized in most other interventions [24, 34, 46]. The keeping of detailed records in regards to nutrition and PA are often considered one of the key features of behavioural therapy [47] and have been associated with quick reductions in food intake and an associated weight loss [48]. Collectively the programmes that employed self-monitoring techniques were the more successful (in terms of % of body weight lost) than those who did not [32, 33].

The most successful interventions [26, 27, 29, 30] lasted 12 months; however, in the 1 study where data were presented beyond 12 months [29], the majority of weight loss occurred in the first 6 months. These findings were corroborated in an evaluation of the US Navy’s obesity treatment programme [31] in that individual weight loss at 6 months remained in a virtual plateau until 12 months. One paper [24] indicated that out-patient follow-up was hampered by changes in assignments, field exercises, and mission requirements. The lack of genuine follow-up in most cases prevents any informed conclusion as to the long-term efficacy of the separate interventions. This fact remains problematic as most weight loss programmes can achieve satisfactory initial weight loss [44]; however, maintenance of weight loss is rarely retained [49].

The majority of the interventions [24, 25, 27–31, 34] delivered the intervention through a combination of group and individual therapy; 4 programmes relied on individual, one-to-one treatment; group therapy alone was utilized by 1 intervention [32]. In general the interventions that used a combined approach were more successful. Two of the interventions that used individual treatment were web-based [33, 46]; both interventions were statistically successful at reducing body weight, BMI, and body fat although the effect sizes were not clinically meaningful for 1 intervention [46]. Internet-based programmes may present a platform for a widespread approach to weight management [50] and offers a possible treatment option for those working in isolated areas. All of the interventions reviewed were undertaken within armed forces real-estate, with all personnel subject to military rules; therefore, attendance may not have been purely voluntary. The LEAN programmes all had a period of in-patient care at an army medical centre. Three other interventions [24, 28, 31] utilized an initial in-patient process for some or all of the tiered interventions. The remaining 4 interventions [32–34, 46] were based in the workplace. Of the remaining 2 programmes, 1 [32] compared the efficacy of 2 conditioning programmes for land-based naval personnel. Both programmes utilized exercise as a singular intervention component. Whilst trends towards fitness improvement were reported [32], poor

compliance and lack of a multi-disciplinary approach were suggested as reasons for the failure to elicit significant changes in weight status. Such findings are supportive of previous studies, suggesting that interventions utilizing a multi-disciplinary approach may be more effective [44, 51].

Correlates

Demographic and Biological Factors

Bray et al. [20] concluded that a higher educational level was correlated with obesity prevalence in US armed forces personnel. Yet in a study based on the Israeli military [38], lower, but not higher educational level (for study subject and male parent) was correlated to obesity. Current opinion concurs with the findings of Grotto et al. [38] and is supportive of a relationship between lower educational attainment and higher levels of obesity [17]. Bray et al. [20] suggested that 'pay group' status of military personnel was correlated with obesity in that those on lower pay displayed higher levels of obesity. There is a direct correlation between the hierarchical system of rank employed within the military and 'pay-group', with higher rank commanding higher wages. Several studies have highlighted the relationship between socioeconomic status, obesity-relevant health behaviours [52] and income inequality [53]. In one obesity review [54], it was proposed that there may be psychosocial consequences of living in a 'more hierarchical society'. Therefore, it is not surprising that obesity was more common in the lower paid 'enlisted ranks' as opposed to the higher paid 'officer class' [20]. Obesity was found to be more prevalent in males aged ≥ 35 years [20], which has also been observed in civilian samples [17]. Being 'married' was linked to a higher level of obesity [20]. Specifically, married individuals who were accompanied by their wife/partner at their place of work had a higher propensity of obesity. This suggests that future obesity treatment interventions should also include spouses and partners [2]. Within the review stratification the injury status was not alluded to; military populations have high levels of musculoskeletal injury [55], and obesity is one outcome associated with long-term injury [56]. A recent study involving the British Navy [57] stated that those individuals deemed medically unfit (21.8%) as opposed to fit (12.1%) were almost twice as likely to be obese; therefore, injury status should be investigated further.

Psychological, Cognitive and Emotional Factors

Lack of time, low priority, and not liking cooking were offered as barriers to healthy living [39], with lack of time and low priority largely attributed as barriers towards PA and healthy eating. Within the correlates of PA, lack of time as a negative association has attracted repeated support [37, 58]. Although based on a small specific sample, the allocation of time for PA and healthy eating deserves further investigation. Sigrist et al. [39] further concluded that enjoyment of cooking may influ-

ence obesity status. Lack of cooking confidence, ability, and enjoyment may impact on the ability to prepare healthy and inexpensive meals [59] and could enforce a reliance on convenience foods, many of which are high in fat [60]. However, this knowledge should reflect the institutional nature of the military services in regards to habitation and access to cooking facilities. The reviewed papers do not attempt to gain an understanding as to the food choices military personnel make or why they participate in PA. Due to the prospective impact of dietary habits and PA, the psychological factors that inform these decisions should be further investigated. Perceptions of exercise leadership displayed a negative association with reductions in body fat. Paradoxically those individuals less approving of the exercise leader displayed greater reductions in body fat [40]. The authors postulated that the greater levels of self-motivation displayed by the participants showing the most significant weight loss could offer a possible explanation for this outcome [40], and this suggested explanation has been supported in a further study [61]. For countries such as the UK with dedicated military physical training instructors, additional investigations are required to understand the positive or negative influence of fitness instructors.

Behavioural Attributes and Skills

One behavioural attribute was identified from the 4 studies; Grotto et al. [38] concluded that smoking status (non-smoker) was associated with lower BMI, which is a generally accepted relationship [17]. The military is an institution with an habitual alcohol intake [57], and long-term alcohol intake has been observed to increase BMI [62]. This is an area worthy of investigation within the military.

Social and Cultural Factors

Bray et al. [20] concluded that Navy personnel, as opposed to individuals serving in the army, airforce and marine corps, displayed a higher prevalence of obesity. One paper has suggested that snacking and a lack of fresh food, which may be specific to ship-bound personnel, may offer an explanation for this finding [34]. Social support was not reported to be a significant factor for weight and fat loss [40]; however, this conclusion is not generally supported [63]. One study [64] offered that those individuals with less social ties were more likely to be obese. Due to the social support network modifications linked to the regular location changes associated with military service, the perceived level of individual social support/isolation should be assessed.

Physical Environmental Factors

Reduced access to fitness facilities was offered as a correlate of obesity [39] while the restriction was not clarified as actual or perceived. Similar findings have been suggested in the area of PA correlates [37]. Within most military units, fitness facilities are freely available; however, within the operational envi-

ronment access to fitness facilities could be markedly reduced. Thus the actual and perceived availability of suitable facilities warrants further investigation. Sigrist et al. [39] concluded that the lack of healthy food choices and mixed media 'nutrition'-based messages could influence the prevalence of obesity. Within work-site interventions, pricing has been observed to increase the consumption of healthy snacks [65]. Alternatively, increasing the availability of low-cost convenience foods may contribute to obesity [66]. The issue of food availability and price is, however, a multi-level issue for the military due to the centralised feeding associated with single personnel and the influence of the marital home, and should be further instigated within the environmental constraints.

PA Characteristics

Grotto et al. [38] concluded that high levels of PA (≥ 4 aerobic sessions/week) were negatively associated with an increase in BMI and that low levels of PA (< 1 aerobic session/week) were positively associated with overweight in females. Bray et al. [20] postulated that an increase in the prevalence of obesity in military personnel from 1995 to 2002 measured by BMI was associated with an increase in strenuous exercise across the same time period. However, definition of weight status by the use of BMI in isolation could be misleading in a military population as the BMI may simply reflect greater muscle mass [4]. In a review of the variables independently associated with obesity in the European Union, Martinez et al. [17] concluded that low participation in leisure-time PA was associated with higher levels of obesity. Further clarity is required as to the association between PA and obesity. However, to fully appreciate the multiple factors associated with PA, allied to the impact of increasing sedentary behaviours, a wider ranging epidemiological investigation may be required [17].

Conclusions and Recommendations

This review has highlighted the lack of information available as to the probable correlates of obesity in military personnel. The information that is available on treatment is reflective of

an American population and therefore raises significant issues of generalisability for other military populations. For the treatment of obesity, the reviewed papers suggest that a multi-component approach to obesity within the military offers the most effective method. Whilst insufficient follow-up prohibits conclusions on the long-term efficacy of interventions, the application of CBT to the intervention process was in the main supportive of significant weight loss. However, if theory is to be applied, measurement of the mediating variables should be undertaken as this will indicate the efficacy of the supporting theoretical framework and the mediating effect of the theoretical constructs [19, 41]. Although seldom mentioned in the reviewed papers, the institutional nature of the armed services may significantly impact on many aspects of an individual's immediate social and environmental surroundings. It follows, therefore, that interventions will need to account for the individual behaviour and the environment in which they interact with. Ecological models [67] may offer a theoretical process that can fully reflect the physical, economic, sociocultural, environmental and policy influences of obesity [68]. Significantly, all of the correlate studies included in the review were of a cross-sectional nature; therefore, causal relationships cannot be implied. Furthermore, in each instance the evidence was based on a single paper and was focussed on a US or Israeli sample, presenting significant generalisability issues for other military populations. It is recommended that future correlate studies on the military should attempt to reflect the multi-factorial nature of obesity [45], the interaction with civilian society, and the immediate institutional environment.

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