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ARTICLE

Do lifestyle choices influence the development of overweight and obesity in the South African Air Force, Bloemfontein?

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Objectives: A study was undertaken to determine the prevalence of overweight and obesity at Air Force Base Bloemspruit in Bloemfontein, Free State, and the dietary and lifestyle factors and physical activity which may play a role in the development thereof.
Design: This was a descriptive cross-sectional study.
Setting: Five units situated at the Air Force Base Bloemspruit, Bloemfontein were included.
Subjects: The study included 166 active-duty military personnel (136 males and 30 females) aged 21–59 years. A convenience sample of volunteers participated in the study.
Outcome measures: The body mass index (BMI) of the participants was calculated using weight and height, and waist circumference was measured using standardised techniques. The dietary intake of participants was evaluated using a self-administered food frequency questionnaire.
Results: A high prevalence of overweight (38.6%) and obesity (36.1%) was identified in the study population. No significant associations were detected between lifestyle factors or physical activity and BMI. The majority of participants (59.6%) consumed three meals per day. Meal frequency did not differ between different BMI categories, and no associations were found between meal frequency and being overweight or obese. Inadequate intake of fruit and vegetables was observed.
Conclusion: A high prevalence of overweight and obesity was observed in this study, which calls for urgent intervention. No associations were, however, found between dietary and lifestyle factors and the presence of overweight and/or obesity. Further investigation is required to identify the causes of overweight and obesity and effective ways to address this health challenge.

Keywords: overweight, obesity, dietary intake, physical activity, military

Introduction

The prevalence of overweight and obesity has shown a steady upward trend in the global population during recent years.[1–5] This trend has also been observed in numerous military communities around the world.[6–10] The increase in the prevalence of overweight and obesity in these communities is concerning, as a high body mass index (BMI) has been associated with a decrease in force readiness, workforce maintenance and productivity.[11]

According to the South African Defence Review 2015, defence force members are responsible for maintaining their health and fitness within the requirements of the Defence Force.[12] To this end, Defence Force members are subjected to BMI and fitness evaluations on a biannual basis. Failure to comply with the standards will result in the defence force member being granted the opportunity to correct any non-compliance; however, continual non-compliance may result in dismissal. South African Air Force members are expected to maintain a BMI below 30 kg/m^2.[12]

Numerous factors have been associated with the development of overweight and obesity. These include energy balance,[13,14] the experience of stress,[15,16] sleep deprivation,[17–21] smoking,[10,22] and alcohol intake.[23,24]

The main modifiable risk factor in the development of obesity is undoubtedly a high energy intake, leading to a positive energy balance and weight gain.[13,14] Physical inactivity, which typically contributes to a positive energy balance, has been associated with the development of obesity.[25] Short sleep duration seems to impact on energy consumption, and an increase in sleep duration of as little as one hour has shown a 14% reduction in the odds of developing obesity.[21] Cigarette smoking has been negatively associated with the development of obesity,[10,22] and identified as a protective factor against the development of obesity.[10] Smoking cessation, however, is a contributing factor in the development of obesity.[10,22] Increased alcohol intake contributes to the development of obesity, most likely due to the high energy content of alcohol and the fact that alcohol metabolism takes priority leading to greater fat storage in the body.[26] Contradictory evidence concerning alcohol consumption and the development of obesity has, however, also been documented.[27,28] Data regarding the prevalence of overweight and obesity in the South African military population and contributing lifestyle factors are limited. Information regarding the prevalence of overweight and obesity and contributing lifestyle factors in the South African military is essential for addressing the problem of overweight and obesity.

Air Force Base (AFB) Bloemspruit, located approximately 15 km outside of Bloemfontein, Free State province, South Africa, consists of five units, namely the primary base personnel, 87 Helicopter Flying School, 16 Squadron, 6 Air Support Unit and 506 Protection Squadron. A medical clinic providing primary health care services, including nursing, dietetics and social work services, is available on the AFB Bloemspruit base.

The study aimed to determine the overweight and obesity prevalence at AFB Bloemspruit and to identify dietary and lifestyle factors associated with the development thereof. To reach the aim, the study objectives included determining overweight and obesity prevalence amongst male and female uniformed members of AFB Bloemspruit, to assess their dietary intake, lifestyle factors and physical activity level to describe possible relationships between dietary intake, lifestyle factors and physical activity.

Methods

Study design and participants

This study was conducted at the five units situated at AFB Bloemspruit during November 2017. A cross-sectional study design was used. The study population comprised 601 active-duty military personnel from different ethnic groups, performing military duties, including administrative and physically laborious tasks, at AFB Bloemspruit. A convenience sample of volunteers participated in the study.

Inclusion and exclusion criteria

Male and female active-duty military personnel aged 18–60 years were invited to participate, provided that they were either permanently employed or on medium-term employment with the South African Air Force. Participants had to be present and stationed at AFB Bloemspruit during November 2017 to be able to participate. Members who provided informed consent were included in the study. Reserve force members and members on deployment or detached duty during November 2017 were not included.

Data collection

Anthropometric data

Overweight and obesity were classified using body mass index (BMI) and waist circumference (WC) as set forth by the World Health Organization (WHO). Weight was measured in kilograms (kg) to the nearest 0.1 kg using an ADAM MDW 250-L scale (AE Adam GmbH, Felde, Germany).[29] The height of participants was measured using an ADAM MDW 250 L stadiometer (AE Adam GmbH, Felde, Germany), which is fixed to the scale, and recorded to the nearest 0.1 centimetres (cm).[29] Body mass index is calculated by dividing weight in kg by height in metres squared (kg/m^2) and evaluated according to the WHO classifications,[30] as indicated in Table 1. Underweight and normal weight BMI categories were combined after data collection as only two participants were classified as being underweight.

Table 1: Classification of adult weight status according to body mass index (BMI)[30]

Classification	BMI	Risk of co-morbidities
Underweight	<18.5 kg/m^2	Low (but the risk of other clinical problems increases)
Normal range	18.5–24.9 kg/m^2	Average
Overweight	25.0–29.9 kg/m^2	Increased
Obesity class 1	30.0–34.9 kg/m^2	Moderately increased
Obesity class 2	35.0–39.9 kg/m^2	Severely increased
Obesity class 3	≥40.0 kg/m^2	Very severely increased

Waist circumference was measured using a non-elastic Seca measuring tape (Seca GmbH & Co. KG, Hamburg, Germany). Weight circumference was measured halfway between the lower edge of the ribcage and the upper edge of the iliac crest, and measurements were recorded to the nearest 0.1 cm.[31] A WC below 94 cm in men and 80 cm in women was considered low risk; between 94 cm and 101 cm in men and 80 cm and 87 cm in women increased risk, and greater or equal to 102 cm in men and 88 cm in women was considered substantially increased risk.[30]

Data collection

Food frequency questionnaires (FFQ) are generally used to estimate food intake in terms of predetermined food groups. Participants usually indicate their consumption of the different foods as stipulated on the questionnaire in terms of frequency of intake in a specified period of time.[32] The intake can be measured as daily, weekly, monthly or yearly.[31,32] For this study, a self-administered unquantified FFQ, lifestyle and physical activity questionnaire was completed in a group setting. The questionnaire was available only in English, which is the official language used for all communication in the South African National Defence Force.

Participants were required to recall and report on various dietary factors such as daily and weekly food intake and lifestyle factors such as stress, sleep, and cigarette and alcohol use. Stress was measured using a scale from 1 to 10, where members were requested to rate their level of perceived stress. Physical activity was determined by using the International Physical Activity Questionnaire (IPAQ), developed by the IPAQ Research Committee.[32] The April 2004 IPAQ Short Form was used in this study.[33]

Physical activity results were classified according to current recommendations for physical activity from the American Cancer Association, which are 150 minutes of moderate-intensity physical activity per week, or 75 minutes of vigorous physical activity spread throughout the week.[34]

Data analysis

Data were entered in duplicate in two Excel spreadsheets (Microsoft Corp, Redmond, WA, USA) by the researcher and checked via electronic comparison to identify possible input errors or missing data. The original data sheets were stored numerically to locate and check missing or erroneous data. All missing information or mistakes that could not be found on the original datasheets were regarded as missing data.

Statistical analysis was performed by the Department of Biostatistics, Faculty of Health Sciences, the University of the Free State by means of Statistical Analysis Software (SAS 9.4; SAS Institute, Cary, NC, USA). Continuous variables were summarised by medians, minimums, maximums and percentiles, while categorical variables were summarised by frequencies and percentages. Differences between groups were evaluated using chi-square tests and Fisher's exact test for unpaired data.

Pilot study

A pilot study was conducted in October 2017. Twenty individuals from the Fire Section, situated at AFB Bloemspruit, were included in the pilot study. All questionnaires and anthropometric measuring techniques were tested during the pilot study. Because no changes were required to questionnaires or

Table 2: Frequency of consumption of different fat sources during the past 12 months in relation to body mass index (BMI) categories

Question and options	Underweight and normal weight		Overweight		Obese		*p*-value
	n	**%**	***n***	**%**	***n***	**%**	
1. Do you use full cream milk, 2% fat milk or fat-free milk at home?							
Full cream milk (*n* = 126, 75.9%)	35	27.8	49	38.9	42	33.3	0.3604
2% fat milk (*n* = 23, 13.8%)	3	13.0	7	30.4	13	56.6	
Fat-free milk (*n* = 10, 6.0%)	3	30.0	5	50.0	2	20.0	
I do not use milk (*n* = 7, 4.2%)	1	14.4	3	42.8	3	42.8	
2. How often do you eat foods cooked in margarine, butter, or oil?							
Never (*n* = 6, 3.6%)	1	16.7	2	33.3	3	50.0	0.9496
1–2 times per week (*n* = 58, 34.9%)	13	22.4	21	36.2	24	41.4	
3–4 times per week (*n* = 49, 29.5%)	14	28.6	21	42.8	14	28.6	
5–6 times per week (*n* = 20, 12.0%)	6	30.0	7	35.0	7	35.0	
At least once per day (*n* = 33, 19.9%)	8	24.2	13	39.4	12	36.4	
3. How often do you eat sausage, ham, salami, viennas, Russians, polony or bacon?							
Never (*n* = 14, 8.4%)	6	42.9	5	35.7	3	21.4	0.3324
1–2 times per week (*n* = 93, 56.0%)	17	18.3	38	40.9	38	40.9	
3–4 times per week (*n* = 36, 21.7%)	13	36.1	12	33.3	11	30.6	
5–6 times per week (*n* = 9, 5.4%)	3	33.3	2	22.2	4	44.4	
At least once per day (*n* = 14, 8.4%)	3	21.4	7	50.0	4	28.6	
4. How often do you use margarine or butter on bread or rolls?							
Never (*n* = 38, 22.9%)	10	26.3	17	44.7	11	28.9	0.2557
1–2 times per week (*n* = 39, 23.5%)	6	15.4	20	51.3	13	33.3	
3–4 times per week (*n* = 36, 21.7%)	10	27.8	14	38.9	12	33.3	
5–6 times per week (*n* = 21, 12.6%)	8	38.1	5	23.8	8	38.1	
At least once per day (*n* = 32, 19.3%)	8	25.0	8	25.0	16	50.0	
5. How often do you use cheese or cheese spread?							
Never (*n* = 32, 19.3%)	10	31.2	10	31.2	12	37.5	0.1788
1–2 times per week (*n* = 78, 47.0%)	13	16.7	38	48.7	27	34.6	
3–4 times per week (*n* = 37, 22.3%)	14	37.8	11	29.7	12	32.4	
5–6 times per week (*n* = 10, 6.0%)	2	20.0	2	20.0	6	60.0	
At least once per day (*n* = 9, 5.4%)	3	33.3	3	33.3	3	33.3	
6. How often do you eat 'slap' chips or 'vetkoek'?							
Never (*n* = 33, 19.9%)	7	21.2	13	39.4	13	39.4	0.8709
1–2 times per week (*n* = 107, 64.4%)	27	25.2	43	40.2	37	34.6	
3–4 times per week (*n* = 15, 9.0%)	4	26.7	5	33.3	6	40.0	
5–6 times per week (*n* = 3, 1.8%)	2	66.6	0	0	1	33.3	
At least once per day (*n* = 8, 4.8%)	2	25.0	3	37.5	3	37.5	
7. How often do you add margarine, butter or oil to vegetables when cooking?							
Never (*n* = 34, 20.5%)	10	29.4	12	35.3	12	35.3	0.4521
1–2 times per week (*n* = 70, 42.2%)	15	21.4	29	41.4	26	37.1	
3–4 times per week (*n* = 33, 19.9%)	9	27.3	11	33.3	13	39.4	
5–6 times per week (*n* = 15, 9.0%)	5	33.3	3	20.0	7	46.7	
At least once per day (*n* = 14, 8.4%)	3	21.4	9	64.3	2	14.3	
8. How often do you use mayonnaise, salad dressing or salad cream?							
Never (*n* = 34, 20.5%)	9	26.4	14	41.2	11	32.4	0.6848
1–2 times per week (*n* = 96, 57.8%)	21	21.8	39	40.6	36	37.5	
3–4 times per week (*n* = 25, 15.1%)	8	32.0	7	28.0	10	40.0	
5–6 times per week (*n* = 5, 3.0%)	3	60.0	1	20.0	1	20.0	
At least once per day (*n* = 6, 3.6%)	1	16.7	3	50.0	2	33.3	

(*Continued*)

Table 2: Continued.

Question and options	Underweight and normal weight		Overweight		Obese		
	n	%	*n*	%	*n*	%	*p*-value
9. How often do you use sauces or gravy on rice, samp, or pasta?							
Never (*n* = 21, 12.6%)	4	19.0	8	38.1	9	42.8	0.4872
1–2 times per week (*n* = 70, 42.2%)	17	24.3	26	37.1	27	58.7	
3–4 times per week (*n* = 46, 27.7%)	11	23.9	20	43.5	15	32.6	
5–6 times per week (*n* = 17, 10.2%)	7	41.2	3	17.6	7	41.2	
At least once per day (*n* = 12, 7.2%)	3	25.0	7	58.3	2	16.7	
10. When you eat meat or chicken, do you cut the fat from the meat or take the skin off the chicken?							
Yes, I cut it off before cooking (*n* = 53, 32.0%)	12	22.6	18	34.0	23	43.4	0.7301
Yes, I cut it off after cooking (*n* = 41, 24.7%)	12	29.3	16	39.0	13	31.7	
No, I don't remove it at all (*n* = 72, 43.4%)	18	25.0	30	41.7	24	33.3	
11. How many times a week do you use frying as a cooking method when preparing food?							
Never (*n* = 25, 15.1%)	6	24.0	11	44.0	8	32.0	0.3406
1–2 times per week (*n* = 88, 53.0%)	21	23.9	37	42.0	30	34.1	
3–4 times per week (*n* = 39, 23.5%)	9	23.1	11	28.2	19	48.7	
5–6 times per week (*n* = 9, 3.0%)	5	55.6	2	22.2	2	22.2	
At least once per day (*n* = 5, 3.0%)	1	20.0	3	60.0	1	20.0	
12. How many times a week do you use coffee creamers such as Ellis Brown or Cremora?							
Never (*n* = 116, 69.9%)	25	21.5	46	39.7	45	38.8	0.4870
1–2 times per week (*n* = 19, 11.4%)	6	31.6	7	36.8	6	31.6	
3–4 times per week (*n* = 14, 8.4%)	6	42.8	3	21.4	5	35.7	
5–6 times per week (*n* = 5, 3.0%)	2	40.0	1	20.0	2	40.0	
At least once per day (*n* = 12, 7.2%)	3	25.0	7	58.3	2	16.7	
13. How often do you eat baked products such as pies, cakes, muffins, rusks and cookies?							
Never (*n* = 27, 16.3%)	4	14.8	14	51.9	9	33.3	0.2778
1–2 times per week (*n* = 110, 66.3%)	28	25.4	43	39.1	39	35.5	
3–4 times per week (*n* = 20, 12.0%)	5	25.0	5	25.0	10	50.0	
5–6 times per week (*n* = 3, 1.8%)	2	66.7	0	0	1	33.3	
At least once per day (*n* = 6, 3.6%)	3	50.0	2	33.3	1	16.7	

techniques used during the pilot study, these data were included in the main study.

Ethical considerations

Ethical approval to conduct the study was obtained from the Health Sciences Research Ethics Committee (HSREC189/2016), University of the Free State (UFS) (UFS-HSD2016/1516) and from the 1 Military Hospital Ethics Committee of the South African Military Health Services situated at in Pretoria, Gauteng (REC-111208-019-RA). Voluntary written informed consent was obtained from participants. Participants could withdraw from the study at any time.

Participant anonymity was protected by numbering the questionnaires. Completed questionnaires were placed into a sealed box by the participants. Anthropometric data were collected in a private consultation room.

Results

The study included 166 active-duty military personnel (136 males and 30 females) aged 21–59 years (response rate = 27.6%). Most of the study respondents were of African ethnicity (45.7%), followed by White ethnicity (32.5%), Coloured (17.5%), and Indian (1.2%); five (3.0%) participants did not respond to the question regarding ethnicity. The median age was 33, 35 and 41 years for the underweight/normal weight, overweight and obese groups, respectively. Although there was a slight increase in median age with the increase in BMI, these findings were not statistically significant. Most were classified as being either overweight (38.6%) or obese (36.1%), while only a quarter (25.3%) were classified as underweight/normal weight.

Most males with an underweight/normal BMI, as well as those with an overweight BMI classification, had a low risk (WC < 94 cm) for the development of metabolic complications. Most male participants (58.7%) classified as obese presented with a substantially increased risk (WC > 102 cm) of developing metabolic complications. These differences were statistically significant ($p < 0.0001$), indicating that obese individuals had a higher WC and are at a substantially increased risk of developing metabolic complications. In the female underweight/normal

Table 3: Frequency of consumption of sugary foods and drinks in relation to body mass index (BMI) categories

	Underweight and normal weight		Overweight		Obese		
Question and options	***n***	**%**	***n***	**%**	***n***	**%**	***p*-value**
1. How often do you drink sugary drinks or soft drinks such as Coke, Fanta, Stoney, Iron Brew or flavoured water or ice teas?							
Never (*n* = 13; 7.8%)	3	23.1	7	53.8	3	23.1	0.1128
1–2 times per week (*n* = 72, 43.4%)	13	18.1	28	38.9	31	43.0	
3–4 times per week (*n* = 31, 18.8%)	14	45.2	9	29.0	8	25.8	
5–6 times per week (*n* = 17, 10.2%)	2	11.8	9	52.9	6	35.3	
At least one glass (250 ml) per day (*n* = 17, 10.2%)	6	35.3	7	41.2	4	23.5	
More than one glass (250 ml) per day (*n* = 16, 9.6%)	4	25.0	4	25.0	8	50.0	
2. How often do you eat sweets or chocolates?							
Never (*n* = 25, 15.1%)	3	12.0	12	48.0	10	40.0	0.3151
1–2 times per week (*n* = 105, 63.2%)	25	23.8	44	41.9	36	34.3	
3–4 times per week (*n* = 20, 12.0%)	7	35.0	4	20.0	9	45.0	
5–6 times per week (*n* = 8, 4.8%)	4	50.0	2	25.0	2	25.0	
At least once per day (*n* = 8, 4.8%)	3	37.5	2	25.0	3	37.5	
3. How many times per week do you drink caffeine-containing energy drinks such as Red Bull, Monster or Play?							
Never (*n* = 107; 64.4%)	28	26.2	35	32.7	44	41.1	0.4671
1–2 times per week (*n* = 40, 24.1%)	11	27.5	18	45.0	11	27.5	
3–4 times per week (*n* = 12, 7.2%)	2	16.7	7	58.3	3	25.0	
5–6 times per week (*n* = 4, 2.4%)	0	0	3	75.0	1	25.0	
At least once per day (*n* = 3, 1.8%)	1	33.3	1	33.3	1	33.3	
4. How many teaspoons of sugar do you drink in your coffee or tea?							
None (*n* = 45, 27.1%)	8	17.8	20	44.4	17	37.8	0.8376
One teaspoon (*n* = 25, 15.1%)	7	28.0	10	40.0	8	32.0	
Two teaspoons (*n* = 41, 24.7%)	10	24.4	16	39.0	15	36.5	
Three teaspoons (*n* = 46, 27.7%)	13	28.3	15	32.6	18	39.1	
More than three teaspoons (*n* = 9, 5.4%)	4	44.4	3	33.3	2	22.2	

weight group, most participants (88.9%) were classified as having a low risk of metabolic disease. In the overweight category, the largest proportion was in the increased-risk category. Most female participants with an obese BMI (78.6%) were categorised as substantially increased risk individuals. These differences were also statistically significant ($p < 0.0003$).

Three-quarters of participants (75.9%) used full cream milk, with a slightly higher percentage (83.3%) using full cream milk in the underweight/normal weight category (Table 2). The intake of processed meats (once or twice weekly) was slightly higher in the overweight (40.8%) and obese groups (40.9%) compared with the underweight/normal group (18.3%). However, intakes of processed meats consumed three or more times a week showed a similar distribution across the BMI categories. The number of individuals using margarine or butter on bread and rolls at least once per day in the obese group (50.0%) was double that of the underweight/normal weight (25.0%) or overweight (25.0%) groups. 'Vetkoek' and 'slap chips' were consumed once or twice per week by most (64.4%). A higher percentage of overweight (40.2%) and obese (34.6%) individuals consumed 'vetkoek' and 'slap chips' than those in the underweight/normal weight category (25.2%). Most (69.0%) did not use coffee creamers in their tea or coffee. Fifty-eight participants indicated that they consumed food cooked with added margarine, butter and oil once or twice per week. Of these 58 participants, 22.4% were classified as underweight/normal weight, while 36.2% were overweight and 41.1% were obese.

The intake of sugary cold drinks was relatively low in all the weight categories, with 10.2% of participants consuming sugary cold drinks daily (Table 3). Most participants (63.2%) consumed sweets and chocolates once or twice a week. The percentage of individuals who consumed sweets and chocolates once or twice per week was slightly higher in the overweight group (41.9%), compared with the obese group (34.3%) and the underweight/normal weight group (23.8%). Of the 20 participants who reported consuming sweets and chocolates three to four times a week, 45.0% ($n = 9$) were classified as obese. A large percentage of participants (64.4%) reported never consuming caffeine-containing energy drinks.

Most participants (59.6%) consumed three meals per day (Table 4). Only 3.6% consumed less than two meals per day. Overall, 45.8% indicated that they snacked once a day, while 19.9% indicated that they snacked twice daily.

Meals consumed outside the home were determined by questions related to takeaway meals and restaurants. Most participants (70.5%) consumed takeaway meals only once per

Table 4: Meal frequency during the past 12 months in relation to body mass index (BMI) categories

Question and options	Underweight and normal weight		Overweight		Obese		*p*-value
	n	%	*n*	%	*n*	%	
1. How many meals do you consume per day?							
One meal per day (*n* = 6, 3.6%)	2	33.3	2	33.3	2	33.3	0.7269
Two meals per day (*n* = 48, 28.9%)	10	20.8	20	41.7	18	37.5	
Three meals per day (*n* = 99, 59.6%)	25	25.3	36	36.4	38	38.4	
More than three meals per day (*n* = 13, 7.8%)	5	38.5	6	45.2	2	15.4	
2. How often do you eat breakfast during the week?							
Never (*n* = 14, 8.4%)	3	21.4	6	42.9	5	35.7	0.4099
Once per week (*n* = 10, 6.0%)	5	50.0	4	40.0	1	10.0	
Twice per week (*n* = 18, 10.8%)	4	22.2	9	50.0	5	27.8	
Three times per week (*n* = 20, 12.0%)	2	10.0	7	35.0	11	55.0	
Four times per week (*n* = 14, 8.4%)	5	35.7	4	28.6	5	35.7	
Five or more times per week (*n* = 90, 54.2%)	23	25.6	34	37.8	33	36.7	
3. How often do you eat lunch during the week?							
Never (*n* = 4, 2.4%)	1	25.0	1	25.0	2	50.0	0.4493
Once per week (*n* = 5, 3.0%)	3	60.0	1	20.0	1	20.0	
Twice per week (*n* = 7, 4.2%)	0	0	5	71.4	2	28.6	
Three times per week (*n* = 15, 9.0%)	3	20.0	5	33.3	7	46.7	
Four times per week (*n* = 20, 12.0%)	3	15.0	8	40.0	9	45.0	
Five or more times per week (*n* = 115, 69.3%)	32	27.8	44	38.3	39	33.9	
4. How often do you eat supper during the week?							
Never (*n* = 0, 0%)	0	0	0	0	0	0	0.4213
Once per week (*n* = 2, 1.2%)	1	50.0	0	0	1	50.0	
Twice per week (*n* = 3, 1.8%)	2	66.7	0	0	1	33.3	
Three times per week (*n* = 2, 1.2%)	0	0	2	100.0	0	0	
Four times per week (*n* = 7, 4.2%)	2	28.6	2	28.6	3	42.8	
Five or more times per week (*n* = 152, 91.6%)	37	24.3	60	39.5	55	36.2	
5. How many times per day do you eat anything in between meals?							
Never (*n* = 21, 12.6%)	5	23.8	8	38.1	8	38.1	0.9770
Once per day (*n* = 76, 45.8%)	17	22.4	29	38.2	30	39.5	
Twice per day (*n* = 33, 19.9%)	9	27.3	14	42.4	10	30.3	
Three times per day (*n* = 17, 10.2%)	6	35.3	5	29.4	6	35.3	
Four times per day (*n* = 8, 4.8%)	3	37.5	3	37.5	2	25.0	
Five or more times per day (*n* = 11, 6.6%)	2	18.2	5	45.5	4	36.4	
6. How often do you eat takeaways or fast food?							
Never (*n* = 25, 15.1%)	8	32.0	6	24.0	11	44.0	0.2623
Once per month (*n* = 117, 70.5%)	26	22.2	46	39.3	45	38.5	
Twice per month (*n* = 18, 10.8%)	7	38.9	8	44.4	3	16.7	
1–2 times per week (*n* = 4, 2.4%)	0	0	3	75.0	1	25.0	
3–4 times per week (*n* = 2, 1.2%)	1	50.0	1	50.0	0	0	
7. How often do you eat in a restaurant?							
Once per month (*n* = 30, 18.1%)	11	36.7	13	43.3	6	20.0	0.3143
Twice per month (*n* = 69, 41.6%)	14	20.3	24	34.8	31	44.9	
1–2 times per week (*n* = 41, 24.7%)	10	24.4	16	39.0	15	36.6	
3–4 times per week (*n* = 22, 13.2%)	7	31.8	8	36.4	7	31.8	
5–6 times per week (*n* = 4, 2.4%)	0	0	3	75.0	1	25.0	

month. There were no significant differences between the intake of takeaway meals and weight categories. The highest percentage (41.2%) of participants reported dining at restaurants twice per month, while 24.7% visited a restaurant once to twice per week. Of the participants who attended restaurants twice per month, 44.9% were obese, while the lowest percentage (20.3%) were underweight/normal weight.

A low intake of fruits and vegetables was observed across the BMI categories. Most participants consumed fruit only once

Table 5: Fruit and vegetable intake during the past 12 months and stress, sleep and smoke patterns during the past month in relation to body mass index (BMI) categories

	Underweight and normal weight		Over weight		Obese		
Question and options	***n***	**%**	***n***	**%**	***n***	**%**	***p*-value**
1. How many fruits do you consume in a day?							
One fruit per day (*n* = 109, 65.7%)	30	27.5	35	32.1	44	40.4	0.2815
Two fruits per day (*n* = 42, 25.3%)	9	21.4	21	50.0	12	28.6	
Three fruits per day (*n* = 11, 6.6%)	2	18.2	5	45.5	4	36.4	
Four or more fruits per day (*n* = 4, 2.4%)	1	25.0	3	75.0	0	0	
2. How many vegetables do you consume in a day?							
One vegetable per day (*n* = 71, 42.8%)	19	26.8	32	45.1	20	28.2	0.3650
Two vegetables per day (*n* = 58, 34.9%)	12	20.7	17	29.3	29	50.0	
Three vegetables per day (*n* = 25, 15.1%)	7	28.0	11	44.0	7	28.0	
Four vegetables per day (*n* = 5, 3.0%)	2	40.0	1	20.0	2	40.0	
Five or more vegetables per day (*n* = 7, 4.2%)	2	28.6	3	42.8	2	28.6	
3. On a scale from 1–10 how stressed would you say you normally are?							
1–3 (Low stress levels) (*n* = 23, 1.2%)	6	26.1	6	26.1	11	47.8	0.5076
4–6 (Medium stress levels) (*n* = 66, 39.7%)	17	25.8	26	39.4	23	34.8	
7–10 (High stress levels) (*n* = 77, 46.4%)	19	24.7	32	41.5	26	33.8	
4. On average how many hours of sleep do you get in a 24-hour period?							
Less than 7 hours of sleep per day (*n* = 33, 19.9%)	7	21.2	11	33.3	15	45.5	0.9123
Equal to or more than 7 hours of sleep per day (*n* = 133, 80.1%)	35	26.3	53	39.8	45	33.8	
5.Do you currently smoke? (*n* = 165)							
Yes (*n* = 52, 31.5%)	15	28.8	21	40.4	16	30.8	0.6308
No (*n* = 113, 68.1%)	27	24.0	43	38.0	43	38.0	

daily, while the vegetable intake was also limited to once per day (Table 5).

Most participants regarded themselves as either moderately (39.7%) or highly stressed (46.4%) individuals. The distribution of stress levels was again found to be similar within the different BMI categories. Most participants (80.1%) obtained adequate sleep (more than 7 hours of sleep per day). The distribution of participants who slept more than 7 hours per night was highest in the overweight group (39.8%) and lowest (26.3%) for the underweight/normal weight group. These differences were, however, not statistically significant.

Most participants were currently non-smokers (68.5%), regardless of their BMI category. No statistically significant differences were found for any of the behaviour questions regarding the BMI categories.

Alcohol intake during the past 30 days was also determined and compared regarding the distribution of consumption across the three BMI categories, and no statistically significant differences ($p = 0.3624$) were identified. Table 5 reports the responses to the behaviour questions.

Physical activity was classified as moderate and vigorous activity. Most participants (68.0%) reported engaging in moderate physical activity, with 31.9% reporting no moderate physical activity. The minimum time spent on moderate physical activity was 10 minutes, while the maximum was 2 520 minutes (42 hours) per week. The median amount of time spent on moderate physical activity was the highest for the obese group (202 minutes), followed by the overweight group (127 minutes), with the lowest reported for the underweight/normal weight category (120 minutes). No statistically significant difference was found regarding moderate physical activity duration across the three BMI categories.

Table 6: Physical activity during the past seven days according to BMI categories

BMI category	***n***	**Median**	**Minimum**	**Maximum**	***p*-value**
Moderate physical activity in minutes per week:					
Under- and normal weight	29	120	10	840	0.4891
Overweight	46	127	15	2 520	
Obese	38	202	10	1 440	
Vigorous physical activity in minutes per week:					
Under- and normal weight	27	180	10	720	0.9879
Overweight	44	180	30	2 520	
Obese	36	180	10	840	

Most participants (64.4%) reported participating in vigorous physical activity, with 35.5% of participants reporting no vigorous physical activity (Table 6). The minimum time spent engaging in vigorous physical activity was 10 minutes, while the maximum was 2 520 minutes (42 hours) per week. The median for vigorous physical activity was 180 minutes per week for all the BMI categories, and no statistically significant difference was found regarding vigorous physical activity across the three BMI categories.

Discussion

A large proportion of the study population was either overweight (38.6%) or obese (36.1%) according to their BMI, with a combined prevalence of 74.7%. A high prevalence of overweight and obesity was also identified in the United States Army in a study conducted on 12 756 military individuals in 2002, where 57.2% were overweight or obese, and in 2005 60.5% were either overweight or obese.[35] A study conducted in the Saudi Arabian Military on 10 229 individuals reported that 40.9% were overweight and 29% obese.[9] The prevalence of overweight and obesity (40.4%) in the Nigerian military is lower than that seen in AFB Bloemspruit, the United States Army or Saudi Arabian military; however, a prevalence of 40.4% for overweight and obesity is also considered high.[36] Body composition is not measured by the BMI method, which is a typical shortcoming of using BMI. The overweight male participants may therefore have higher proportions of lean body mass, resulting in a higher BMI.

In this study, most of the obese individuals had a high risk for the development of metabolic complications, according to the WHO WC cut-off points,[30] in both the male and female groups. The National Health and Nutrition Examination Survey III (NHANES III)[37] conducted in Atlanta included 33 199 participants. Both male (84.8%) and female (97.5%) obese participants were classified as high-risk individuals. In this study, 58.7% of obese males and 78.6% of obese females had a substantially increased risk for the development of metabolic complications, both lower than in the findings of the NHANES III study. A relatively low prevalence of high-risk WC was observed in the overweight male category, which supports the findings of this study.

Increased dietary energy intake has been significantly associated with an increase in bodyweight, according to a WHO global analysis.[38] Fat and high-fat foods have a high energy density, which can lead to an increase in bodyweight.[39] In this study, however, fatty food intake was similar in all the BMI categories, which may suggest that the quantity of consumption instead of the frequency should be considered as a risk factor for the development of obesity. The members of AFB Bloemspruit frequently participate in numerous dietary intake education sessions presented at the base by a registered dietitian. Members undergo yearly health assessments, and obese individuals are referred for dietary treatment, which could have resulted in members reporting intake according to the guidelines received instead of a true reflection of their actual intake.

The global intake of caloric sweeteners increased significantly (21%) between 1962 and 2000,[40] mirrored by a significant increase in the prevalence of overweight and obesity during the last three to four decades.[2–4] The increase in caloric sweetener intake has been implicated in the development of overweight and obesity. No significant differences were, however, found concerning sugar intake across BMI categories in this study.

The consumption of smaller, more regular meals (four or more meals per day) has an inverse relationship with obesity development. A higher risk of obesity was observed in individuals who did not eat breakfast regularly.[41] Farshchi *et al*.[42] found that irregular meal patterns were also associated with a decrease in postprandial energy expenditure and the thermogenic effect of food in comparison with regular meal frequency amongst 10 premenopausal obese women aged between 32 and 47 years. In comparison, a study performed on 16 male and female subjects aged 18–55 years by the Behavioural and Metabolic Unit of the University of Ottawa, Canada found that there were no differences regarding weight loss between the two groups on an energy-restricted diet concerning meal frequency.[43] Most participants in this study consumed three meals per day, and the largest percentage of participants consumed one or more snacks per day. No statistically significant difference in meal frequency was identified between the different BMI categories. In a study performed by Ma *et al*.[41] where data from 499 study participants who participated in the Seasonal Variation of Blood Cholesterol Study (1994–1998) from Worcester County, United States were included, the frequent consumption of meals consumed outside the home showed a significant association with the development of obesity. A low frequency of eating away from home was observed in this study, with no significant differences observed regarding the intake of meals outside the home across the BMI categories.

Fruit and vegetable intake in this study did not meet the minimum of five fruits and vegetables as recommended by the South African Food-Based Dietary Guidelines.[44] Most participants consumed only one fruit per day and one to two vegetables per day. This could lead to a low intake of fibre, vitamins and minerals and, in turn, increase disease risk.[44] No significant differences were observed for fruit and vegetable intake across BMI categories; however, a study based on data gathered during the Nurses' Health Study, where 74 063 female nurses were followed up during a 12-year period, found that individuals with higher consumption of fruit and vegetables had a significantly lower risk for the development of obesity.[45]

High levels of perceived stress have been shown to be causative in the development of obesity, independent of eating behaviours.[15] High levels of perceived stress are also positively associated with unhealthy eating behaviours.[15] A study conducted on a Mexican population reported that highly stressed individuals had a significantly higher rate of physical inactivity (56.3%) and a higher prevalence of obesity (48.3%).[16] Obesity development can therefore be positively associated with increased levels of perceived stress. However, in this study, the perceived stress levels were not statistically different between BMI categories.

Sleep deprivation is associated with the development of obesity in numerous studies.[17–19] Sleep deprivation increases daytime ghrelin concentrations, increasing appetite and decreasing energy expenditure, leading to a positive energy balance.[46] With this, a reduction in the anorexigenic hormone leptin has also been observed, further contributing to a positive energy balance.[20,46] In this study, 80.1% of participants reported adequate sleep, and 19.9% could be sleep-deprived. No statistically significant differences were found regarding hours of sleep between the BMI categories.

Smokers are generally less likely to experience weight gain compared with their non-smoking counterparts.[10,22] Grotto *et al*.[10] reported that military members who were smokers before recruitment were less likely to develop obesity than those who initiated smoking after recruitment. Smoking cessation is a considerable risk factor for an increase in BMI in those who are underweight or have a normal weight.[10,22] However, individuals who initiate smoking tend to lose weight, but only minor changes in weight status were observed.[22] In this study, 31.3% of the population indicated that they smoke. No statistically significant difference in BMI categories was observed between smokers and non-smokers.

Alcohol consumption is associated with the development of obesity.[23,24] This can be attributed to the high energy density of alcohol at 29 kJ per gram, its pharmacological effect on the nervous system, and because it cannot be stored and is given priority over energy derived from other sources.[26] In this study, alcohol consumption across the different BMI categories did not differ significantly.

Studies have proven a strong association between the development of obesity and physical inactivity.[10,22,47] Physical activity increases energy output, which results in a negative energy balance and weight loss.[25,48] Regardless of the strong evidence to support the association between lower bodyweight and physical activity, there were no significant differences between BMI categories and physical activity in this study. However, due to the abnormally high activity levels reported, the possibility of over-reporting does exist in this study population.

Study limitations

The primary study limitation was the low response rate from the study population. In addition, the use of self-administered questionnaires may have resulted in some incorrect responses due to questions being misunderstood, resulting in under- or over-reporting of information. The evaluation of stress should be done using an internationally recognised screening tool in future studies. Recall bias was also a limitation due to the 12-month period over which dietary intake was requested.

The study population has free access to medical care, including nutritional counselling by registered dietitians, as numerous preventative projects are in place to ensure the military community's health and well-being. Most participants have thus received some form of nutrition counselling. Therefore, it can be assumed that some misreporting took place during the completion of questionnaires.

Conclusion

A high prevalence of overweight and obesity was identified in this study; however, no associations were identified across the BMI categories between dietary intake, lifestyle factors or physical activity.

Compulsory yearly occupational health evaluations are undertaken in the military community, and any identified health risks are referred for the appropriate medical interventions. However, despite these interventions, including dietary and lifestyle intervention, overweight and obesity prevalence remains high, and further research into the causative factors and targeted interventions should be undertaken.

Recommendations

It is recommended that future studies include measurements such as fat percentage, hip circumference and waist–hip ratio to obtain a better representation of body composition. In addition, the use of structured interviews and 24-hour recall food intake analysis is recommended to give a better indication of dietary intake. Finally, a future study of a similar nature should be conducted among the South African Army, South African Police Service and South African Traffic Department officers.

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