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

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Research

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RESEARCH

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

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Abstract

Background: An increase in the prevalence of overweight and obesity has been reported globally amongst the general public as well as military populations around the world. No information about the prevalence of overweight and obesity as well as the lifestyle choices that influence the development is available for the South African military population. The aim of this study was too determine the prevalence of overweight and obesity at Air Force Base Bloemspruit in Bloemfontein, Free State, South Africa, as well as the dietary and lifestyle factors and physical activity which may play a role in the development thereof.

Methods: A descriptive cross-sectional study was performed on active military personnel, by taking anthropometric measurements and collecting data using a self-administered 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 body mass index 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 intakes of fruit and vegetables were observed.

Conslusion: 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

Background

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 an unhealthy high body mass index BMI has been associated with a decrease in force readiness, workforce maintenance and productivity.[11]

Numerous factors have been associated with the development of overweight and obesity. These include factors such as energy balance,12,13the experience of stress[14,15] sleep deprivation[16,20] smoking,[10,21] as well as alcohol intake.[22,23]

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.[12,13] Physical inactivity, which typically contributes to a positive energy balance, has been associated with the development of obesity.[24] Short sleep duration seems to have an 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.[20] Cigarette smoking has been negatively associated with the development of obesity,[10,21] and identified as a protective factor against the development of obesity.[10] Smoking cessation, however, is a contributing factor in the development of obesity.[10,21] 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.[25] Contradicting evidence concerning alcohol consumption and the development of obesity has, however, also been documented.[26,27] Data regarding the prevalence of overweight and obesity in the South African military population and contributing lifestyle factors are required to be able to address the increasing problem of overweight and obesity.

Methods

Aim

The study aimed to determine the prevalence of overweight and obesity at Air Force Base Bloemspruit and to identify the dietary and lifestyle factors associated with the development of overweight and obesity.

Study design and participants

This study was conducted at five units situated at Air Force Base Bloemspruit during November 2017. A cross-sectional study design was used. The study population consisted of 601 active-duty military personnel from different ethnic groups, performing military duties at Air Force Base Bloemspruit. Duties included administrative activities as well as physically laborious activities. A convenience sample of members who volunteered to participate in the study was taken.

Male and female active-duty military personnel between the ages of 18 and 60 years were invited to participate in the study, provided that they were either permanently employed or on medium-term employment with the South African Air Force. The participants had to be present and stationed at Air Force Base Bloemspruit during November 2017 to be able to participate in the study, and only members who provided informed consent for participation in the study were included. Reserve force members and members who were deployed or on detached duty during November 2017 were not included in the study.

Setting

Air Force Base Bloemspruit is located approximately 15 km outside of Bloemfontein in the Free State Province, South Africa. The Air Force Base consists of five different units; namely the primary base personnel, 87 Helicopter Flying School, 16 Squadron, 6 Air Support Unit and 506 Protection Squadron. A medical clinic is also situated on the base, to provide medical services, such as primary health care, nursing, dietetics and social work services to military members on the base.

Data collection

Overweight and obesity were classified and identified using body mass index BMI and waist circumference WC. Anthropometric data collected included weight, height and WC. Weight was measured using an ADAM MDW 250-L scale $AEAdamGmbH, Germany$ with a current and valid calibration certificate. Weight was measured in kilograms (kg) to the nearest 0.1 kg, by using standard methods.28 The height of participants was measured using an ADAM MDW 250L stadiometer $AEAdamGmbH, Germany$, which is fixed to the scale. Height measurements were recorded to the nearest 0.1 centimetres cm using standardised techniques.[28] Body mass index is calculated by dividing weight in kg by height in meters squared kg/m^2.29 The World Health Organization WHO cut-off points[29] for the evaluation of BMI, as indicated in Table 1, were used to interpret BMI. Underweight and normal weight BMI categories were combined after data collection due to the fact that only two participants were classified as being underweight. To support

Table 1 Classification of adult weight status according to body mass index BMI.[29]

the use of BMI as criteria to evaluate weight status, WC was measured by making use of a non-elastic Seca measuring tape $SecaGmbH\&Co.KG, Germany$. Weight circumference was measured half way between the lower edge of the ribcage, and the upper edge of the iliac crest and measurements were recorded to the nearest 0.1cm.30 Waist circumference was interpreted by making use of the WHO cut-off points [29], as shown in Table 2. Food frequency questionnaires are generally used

Table 2 Risk of metabolic complications with respect to waist circumference WC.[29]

to estimate food intake in terms of pre-determined 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.31 The intake can be measured as daily, weekly, monthly or yearly.[30,31] For the purpose of this study, a self-administered food frequency questionnaire, compiled according to available

literature for the study population, was used in a group setting and measured food intake on a weekly or daily basis.

Data on lifestyle factors such as stress, sleep, cigarette use and alcohol intake were collected by making use of a self-administered lifestyle questionnaire completed in a group setting. Participants were required to recall and report on various lifestyle factors of the past month. Physical activity was determined by making use of the International Physical Activity Questionnaire $IPAQ$, developed by the IPAQ Research Committee.32 The April 2004 IPAQ Short form was used in this study.[32]

The physical activity questionnaire required the participants to recall their physical activity during the past week. Physical activity results were classified according to the 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.[33]

Data analysis

The data collected in the study were entered in duplicate in two Excel spreadsheets by the researcher. The data was electronically checked through the comparison of the two excel sheets to identify possible input errors or missing data. The original data sheets were stored numerically to locate and check missing or faulty data with ease. All missing information or mistakes, which could not be found on the original data-sheets, were regarded as missing data. The statistical analysis of the data was performed by the Department of Biostatistics, Faculty of Health Sciences of the University of the Free State. Statistical Analyses Software $SAS9.4$ was used in analysing the data. Continuous variables were summarised by medians, minimums, maximums and percentiles while categorical variables were summarised by frequencies and percentages. Differences between groups were evaluated through the use of Chi-Square tests and the Fisher's Exact test for unpaired data.

Results

The study included 166 active-duty military personnel $136 males and 30 females$ between the ages of 21 and 59 years $responserate = 27.6\%$. The underweight and normal weight BMI groups were combined following the data collection phase since only two members were underweight. The median age of the underweight and normal weight group was 33 years, for the overweight group 35 years and for the obese group 41 years. Although there was a slight increase in median age with the increase in BMI; these findings were not statistically significant. Most of the participants 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 of the males with an underweight / normal BMI, as well as those with an overweight BMI classification, had a low risk $WC below 94 cm$ for the development of metabolic complications according to their WC. As can be expected, the majority of male participants 58.7% in the obese BMI category presented with a substantially increased risk $WC exceeding 102 cm$ of developing metabolic complications according to their WC. These differences were statistically significant $p < 0.0001$, which indicates that obese individuals had a higher WC and are at a substantially increased risk for the development of metabolic complications. In the female underweight/normal weight group, most participants 88.9% were classified as having a low risk for metabolic disease. In the overweight category, the largest proportion was in the increased-risk category. Most of the female participants with an obese BMI 78.6% were categorised as substantially increased risk individuals. These differences are also statistically significant $p < 0.0003$.

As shown in Table 3, the largest proportion of all the participants 75.9% used full cream milk, with a slightly higher percentage 83.3% of participants using full cream milk in the underweight/normal weight category. The intake of processed meats *onceortwiceweekly* was slightly higher in the overweight 40.8% and obese

groups 40.9% compared to 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 who used 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% of the participants. 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 of the participants 69.0% did not use coffee creamers in their tea or coffee. Fifty-eight of the 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 in the underweight/normal weight BMI category, while 36.2% were in the overweight, and 41.1% in the obese category. The sugar-related

Table 3 Frequency of consumption of different fat sources during the past 12 months in relation to body mass index BMI categories.

food frequency questions are indicated in Table 4. The intake of sugary cold drinks was relatively low in all the weight categories, with 10.2% of the study population consuming sugary cold drinks daily. Most of the 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 to the obese group with 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 in the obese BMI category. A large percentage of the study participants 64.4% reported never consuming caffeine containing energy drinks. Table 5 shows the results for questions

Table 4 Frequency of consumption of different sugar sources during the past 12 months in relation to body mass index BMI categories.

related to meal frequency as well as for meals consumed outside of the home. Most

of the participants 59.6% consumed three meals per day. Only 3.6% of participants consumed less than two meals per day. Overall, 45.8% of participants indicated that they snacked once a day while 19.9% of participants indicated that they snacked twice daily.

Meals consumed outside of the home were determined by questions related to takeaway meals and restaurants. Most of the participants 70.5% consumed takeaway meals only once per month. There were no significant differences between the intake of takeaway meals and the 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 visited restaurants twice per month, 44.9% were in the obese BMI category, while the lowest percentage 20.3% were in the underweight/normal weight category. A low intake of fruits

Table 5 Meal frequency during the past 12 months in relation to body mass index BMI categories.

and vegetables was observed across the BMI categories in this study. Most of the participants consumed fruit only once daily, while the vegetable intake was also limited to once per day. Table 6 shows the results from questions relating to fruit and vegetable consumption. Most of the participants regarded themselves as either

Table 6 Fruit and vegetable intake during the past 12 months in relation to body mass index BMI categories.

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 of the 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 BMI category 39.8% and lowest 26.3% for the underweight/normal weight BMI category. These differences were, however, not statistically significant.

Most of the participants were currently non-smokers 68.5%, regardless of their BMI category. No statistically significant differences were found for any of the behaviour questions with regard to 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 7 reports the responses to the behaviour questions. Physical activity was classified as moderate

Table 7 Stress, sleep and smoke patterns during the past month in relation to body mass index BMI categories.

and vigorous activity. Most of the participants 68.0% reported engaging in moderate physical activity, with 31.9% of participants 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, with 202 minutes being reported, followed by the obese group with 127 minutes and the lowest median for physical activity was reported for the underweight/normal weight category. No statistically significant difference was found with regard to moderate physical activity duration across the three BMI categories.

Most of the participants 64.4% reported taking part in vigorous physical activity, with 35.5% of the participants reporting no vigorous physical activity. The minimum time spent engaging in vigorous physical activity was 10 minutes, while the maximum reported for vigorous physical activity was again 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 with regard to vigorous physical activity across the three BMI categories. Table 8 provides a summary of the median, minimum and maximum exercise duration as reported for each BMI category.

Table 8 Physical activity during the past 7 days according to BMI categories.

Discussion

This study shows that most of the participants were classified as being either overweight 38.6% or obese 36.1% according to their BMI, which gives 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 where 57.2% were found to be overweight or obese in 2002, and 60.5% were either overweight or obese in 2005.[34] 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 Air Force Base Bloemspruit, the United States Army or Saudi Arabian Military, however, a prevalence of 40.4% for overweight and obesity is also considered high.[35]

In the current study, most of the obese individuals had a high risk for the development of metabolic complications according to the WHO WC cut-off points [29] in both the male and female groups. The National Health and Nutrition Examination Survey III $NHANESIII$ conducted in Atlanta, included 33 199 participants. Both male 84.8% and female 97.5% obese participants were classified as high-risk individuals, in the current study 58.7% of the obese male participants had a substantially increased risk for the development of metabolic complications, while 78.6% of the obese female participants had a substantially increased risk for the development of metabolic complications which are both lower than was found in the NHANES III study.[36] A relatively low prevalence of high-risk WC was observed in the overweight male category, which supports the findings in the current study.[36] Waist circumference is a good indicator of android adiposity,[29] which might indicate that the overweight males in the current study had lower levels of android adiposity and possibly higher levels of lean body mass, therefore resulting in a higher BMI. Body

composition is not measured by the BMI method which is a typical shortcoming of the use of the BMI method.

Increased dietary energy intake has been significantly associated with an increase in body weight according to a WHO global analysis performed.[37] Fat contains 37.6 kJ/gram, more than double that of carbohydrate or protein. Foods that are high in fat are generally also high in energy, which can lead to an increase in body weight.[38] In the current study, however, the intake of fatty foods 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 Air Force Base Bloemspruit have also had the opportunity to participate in numerous dietary intake education sessions presented at the base by a qualified dietitian. Members are required to undergo yearly health assessments and are referred for dietary treatment when obesity is identified in an individual, which could have resulted in members reporting intake according to the guidelines that they have received instead of a true reflection of their actual intake.

The global intake of caloric sweeteners has increased significantly 21% between 1962 and 2000,[39] which has been 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 in the current study concerning sugar intake across the three BMI categories.

The consumption of smaller, more regular meals $four or more meals per day$ has been shown to have an inverse relationship with the development of obesity, while a higher risk of obesity was observed in individuals who did not eat breakfast on a regular basis.[40] In a study [41] performed on ten premenopausal obese women aged between 32 and 47 years, it was found that irregular meal patterns were also associated with a decrease in postprandial energy expenditure as well as a decrease

in the thermogenic effect of food in comparison to regular meal frequency. In comparison, a study performed on 16 male and female subjects between the ages of 18 and 55 years by the Behavioural and Metabolic Unit of the University of Ottawa, Canada, found that there were no differences with regard to weight loss between the two groups on an energy-restricted diet with regard to meal frequency.[42] Most of the participants in the current 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 could be identified between the different BMI categories. In a study performed by Ma et al.,[40] where data from 499 study participants who participated in the Seasonal Variation of Blood Cholesterol Study 1994–1998 from Worcester County, Massachusetts in the United states of America 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 the current study with no significant differences observed regarding the intake of meals outside the home across the BMI categories.

Fruit and vegetable intake in the current study did not meet the minimum of five fruits and vegetables as recommended by the South African Food-Based Dietary Guidelines.43 Most of the 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, which could lead to an increase in disease risk.[43] 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.[44]

High levels of perceived stress have been shown to be causative in the development of obesity; independent of eating behaviours.[14] High levels of perceived stress are also positively associated with unhealthy eating behaviours.[14] 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%.[15] It can be said that the development of obesity can be positively associated with increased levels of perceived stress. In the current study, the perceived stress levels were not statistically different between the different BMI categories.

Sleep deprivation has been associated with the development of obesity in numerous studies.[16-18] Sleep deprivation increases daytime ghrelin concentrations, which are responsible for an increase in appetite and a decrease in energy expenditure, which may lead to a positive energy balance.45 With this, a reduction in the anorexigenic hormone, leptin, has also been observed, which may lead to the development of a positive energy balance.[19,45] In the current study, 80.1% of the participants reported that they slept for 7 hours or more per night. Therefore, 19.9% of the study population could be classified as being 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 to their non-smoking counterparts.[10,21] In a study performed by Grotto et al,[10] it was reported that military members who were smokers before recruitment into the military 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.[10,21] However, individuals who initiate smoking tend to lose weight, but only small changes in weight status were observed.[21] In the current study, 31.3% of the population indicated that they smoke. No statistically significant difference in BMI categories were observed between smokers or non-smokers.

Alcohol consumption has been associated with the development of obesity.[22,23] 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.[25] In the current study, alcohol consumption across the different BMI categories was analysed and no statistically significant differences between the groups were observed.

Studies have proven a strong association between the development of obesity and physical inactivity.[10,21,46] Physical activity increases energy output, which in turn results in a negative energy balance and weight loss.[24,47] Regardless of the strong evidence to support the association between lower body weight and physical activity, there were no significant differences between BMI categories and physical activity in the current study. Due to abnormally high levels of activity reported, the possibility of over-reporting does exist in this study population.

Study limitations

The main limitation of this study was the low response rate from the study population. The self-administration of the questionnaires may have resulted in some of the questions being misunderstood by participants, which may have led to under- or over-reporting of information. Recall bias was also a limitation of the study, due to the 12-month period over which dietary intake was requested.

Conclusion and recommendations

A high prevalence of overweight and obesity was identified in the current study; however, no associations were identified across the BMI categories between dietary intake, lifestyle factors or physical activity. The high prevalence of overweight and obesity in the study population is concerning and should be addressed in the military.

A more in-depth analysis of anthropometric indicators, such as fat percentage, hip circumference as well as waist-hip ratio, is needed to provide more insight into

the body composition of the study participants as part of their routine screening. Making use of structured interviews and 24 hour recall food intake analysis is recommended as it might provide a better indication of the energy and nutrient content of participants.

The Military is dedicated to improving the health and well-being of members serving in the South African National Defence Force. The members undergo a compulsory medical evaluation on a yearly basis in order to identify possible health risks. Members presenting with overweight and obesity are promptly referred for dietary advice and management as well as physical activity interventions. Members are expected to maintain a healthy weight in order to be considered for promotional courses, deployments and contract renewal. Despite these interventions, the prevalence of overweight and obesity is still high and further research into the causes of overweight and obesity in the study population is recommended in order to develop targeted interventions.

Ethics approval and consent to participate

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

The questionnaires were numbered, and the identity of the member was not included on the questionnaires. The members completed the questionnaire in a group setting while the researcher read and explained the questions as they were answered. The participants were instructed not to discuss the questions with fellow participants. After the measurements were taken in a private room, the anonymous questionnaires were placed in a box by the participants to ensure their anonymity. The data sheets were kept safe in a locked cabinet following the data capturing process.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Sources of funding

University of the Free State

Author's contributions

C. Haasbroek devised the project, the main conceptual ideas and proof outline under the leadership of Dr R. Lategan-Potgieter and M. Jordaan. C. Van Rooyen performed the statistical analysis for the research. C. Haasbroek wrote the manuscript with contributions from Dr R. Lategan-Potgieter, M. Jordaan and C. Van Rooyen. The manuscript was edited by T. Muldert.

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TABLE 1: Classification of adult weight status according to body mass index (BMI).[29]

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

TABLE 2: Risk of metabolic complications with respect to waist circumference (WC).[29]

Risk of metabolic complications	Waist circumference (cm)	
	Men	Women
Low risk	< 94 cm	< 80 cm
Increased risk	≥ 94 cm	≥ 80 cm
Substantially increased risk	≥ 102 cm	≥ 88 cm

Table 3

TABLE 3: 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	

TABLE 3: Frequency of consumption of different fat sources during the past 12 months in relation to body mass index (BMI) categories (continued).

Question and options	Underweight and normal weight		Overweight		Obese		*p*-value
	n	%	n	%	n	%	
6. How often do you eat "slap" chips or "vetkoek"?							
Never (n = 33, 19.9%)	7	21.2	13	39.4	13	39.4	
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	0.8709
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	
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	0.4521
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	
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	0.6848
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	
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	
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	0.4872
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	

TABLE 3: Frequency of consumption of different fat sources during the past 12 months in relation to body mass index (BMI) categories (continued).

Question and options	Underweight and normal weight		Overweight		Obese		*p*-value
	n	%	n	%	n	%	
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	
Yes, I cut it off after cooking (n = 41, 24.7%)	12	29.3	16	39.0	13	31.7	0.7301
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	
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	0.3406
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	
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	0.4870
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	
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	0.2778
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	

Table 4

TABLE 4: Frequency of consumption of sugary foods and drinks in relation to body mass index (BMI) categories.

Question and options	Underweight and normal weight		Overweight		Obese		*p*-value
	n	%	n	%	n	%	
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	
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	0.1128
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	
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	0.3151
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	
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	0.4671
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	
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	0.8376
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	

Table 5

TABLE 5: 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	

TABLE 5: Meal frequency during the past 12 months in relation to body mass index (BMI) categories (continued).

Question and options	Underweight and normal weight		Overweight		Obese		*p*-value
	n	%	n	%	n	%	
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	
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	0.9770
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	
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	0.2623
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	
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	0.3143
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	

TABLE 6: Fruit and vegetable intake 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 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	

Table 7

TABLE 7: Stress, sleep and smoke patterns during the past month in relation to body mass index (BMI) categories.

Question and options	Underweight and normal weight		Overweight		Obese		*p*-value
	n	%	n	%	n	%	
1. 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	
4 – 6 (Medium stress levels) (n = 66, 39.7%)	17	25.8	26	39.4	23	34.8	0.5076
7 – 10 (High stress levels) (n = 77, 46.4%)	19	24.7	32	41.5	26	33.8	
2. On average how many hours of sleep do you get in a 24-h 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	
3. 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	

TABLE 8: Physical activity during the past 7 days according to BMI categories.

Moderate physical activity in minutes per week					
BMI category	**n**	**Median**	**Minimum**	**Maximum**	***p*-value**
Under and normal weight	29	120	10	840	
Overweight	46	127	15	2520	0.4891
Obese	38	202	10	1440	
Vigorous physical activity in minutes per week					
BMI category	**n**	**Median**	**Minimum**	**Maximum**	***p*-value**
Under and normal weight	27	180	10	720	
Overweight	44	180	30	2520	0.9879
Obese	36	180	10	840	