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Effects of military life on changes in body mass index of enlisted men: a cross-sectional study

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ABSTRACT

Background Obesity is a serious health problem with an incidence that is increasing rapidly. Enlisted men are a distinctive group characterised by 24-hour community-living and are likely to experience changes in body weight as a result of regular diet and exercise during enlistment.

Methods This study reviewed data from the Second Military Health Survey. Changes in body mass index (BMI) before and during military service were analysed using paired t-test. We calculated OR and 95% CI for factors affecting weight improvement during military service through logistic regression.

Results The mean BMI in the underweight group increased by 5.87 kg/m² during service, while that in the normal weight group increased by 1.18 kg/m². In contrast, the mean BMI in the overweight group decreased by 5.47 kg/m² during service. The OR for an improved BMI in the subjective good health group compared with the subjective poor health group was statistically significant (OR=1.71, 95% CI 1.02 to 2.87). The OR for an improved BMI was significantly higher in the group with three or more times per week of strength training than in the group with one to two times per week of strength training, and was higher among the marines compared with the Army soldiers (OR=1.48, 95% CI 1.03 to 2.12 and OR=2.15, 95% CI 1.07 to 4.32, respectively).

Conclusions Strength training showed a statistically significant increase in BMI during military service. Furthermore, the BMI of men who were underweight before their service increased, while it decreased among those who were overweight.

INTRODUCTION

According to the WHO, the number of obese (body mass index (BMI) ≥ 30 kg/m²) people worldwide has tripled since 1975, and as of 2016, 39% of adults are overweight (BMI ≥ 25 kg/m²) or obese.¹ Excess body fat impairs health and increases the risk of mortality and morbidity such as cardiovascular disease, diabetes mellitus, hypertension, musculoskeletal disorders and cancer.²⁻⁷ Obesity is a serious health problem, and its incidence has been increasing rapidly not only in Western countries, but also in many Asian countries, including South Korea.⁸⁻¹¹ Although the rate of obesity in South Korea is lower than that in any other country of the Organisation for Economic Co-operation and Development, it has increased in recent years.¹²⁻¹⁴ In particular, the number of overweight or obese Korean men has been increasing rapidly.^{7 15-17}

South Korean men are required by the Military Service Act to undergo draft physical examination in the year they turn 19 years old.¹⁸ They must also

Key messages

- ⇒ The number of overweight or obese Korean men has been increasing rapidly.
- ⇒ Most men are required to go through military service in their early 20s and this is an important shared experience for them.
- ⇒ Enlisted men are a distinctive group characterised by 24-hour community life.
- ⇒ They are likely to experience changes in body weight as a result of regular diet and exercise during enlistment.
- ⇒ Regular diet and exercise during military service improved enlisted men's body mass index.

serve in the military for approximately two years during a certain period.¹⁹ Men are required to go through military service in their early 20s and this is an important shared experience for them.²⁰

Previous studies in adolescents and adults have shown that obesity is related to factors such as sex, age, race, eating habits, smoking, physical activity, sleep duration, stress and depression.²¹⁻²⁶ Enlisted men are a distinctive group characterised by 24-hour community life.²⁰ They are likely to experience changes in body weight as a result of regular diet and exercise during enlistment. However, studies on obesity among enlisted Korean soldiers are scarce; domestic studies have been conducted mainly on military officers.⁷

This study aimed to analyse changes in BMI of enlisted men before and during military service and to investigate the effects of military life, with its regular diet and exercise, on BMI. Our principal conclusion is that BMI improves to normal during military service, irrespective of whether the individual participant was overweight or underweight before service.

MATERIALS AND METHODS

Study design and participants

This study reviewed data from the Second Military Health Survey (2015) after obtaining approval from the School of Military Medicine in South Korea.²⁷⁻³⁰ The Second Military Health Survey included a final sample of 2500 officers and enlisted men in the Army, Navy, Marine Corps and Air Force after stratification for class, branch of military service and regional distribution using a questionnaire from July to August 2015. The response rate was 100.0% as all officers and enlisted soldiers completed the survey. This study used the data collected from the Army, Navy, Marine Corps and Air Force enlisted men performing mandatory military service. After the exclusion of 520 officers and eight enlisted men



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Table 1 Changes in BMI before and during military service according to general characteristics

	n	%	Difference in BMI		P value*
			Mean	SD	
Age (years)					
<20	69	3.5	-0.09	4.46	0.8626
20–21	1521	77.1	0.13	4.73	0.2808
≥22	382	19.4	0.16	4.72	0.4999
Educational level					
High school	288	14.6	0.26	4.88	0.3642
College or above	1684	85.4	0.11	4.69	0.3507
Smoking status					
Non-smoker	1039	52.7	-0.08	4.82	0.6145
Ex-smoker	173	8.8	0.39	4.50	0.2538
Current smoker	760	38.5	0.35	4.62	0.0372
Subjective health status					
Good	1148	58.2	0.05	4.61	0.6923
Normal	677	34.3	0.16	4.79	0.3857
Poor	147	7.5	0.58	5.24	0.1825
Physical activity (MET-min/week)					
<600	376	19.1	0.45	4.81	0.0695
600–3000	661	33.5	-0.13	4.75	0.4801
>3000	935	47.4	0.18	4.66	0.2285
Strength training					
None	436	22.1	0.47	4.93	0.0454
1–2 times per week	460	23.3	0.01	5.10	0.9642
≥3 times per week	1076	54.6	0.04	4.45	0.7656
Sleep duration (hours/day)					
<6	59	3.0	-0.15	4.10	0.7747
6–7	1273	64.6	0.13	4.72	0.3299
≥8	640	32.5	0.16	4.77	0.4085
Sleep disturbance					
No	1724	87.4	0.10	4.69	0.3840
Yes	248	12.6	0.34	4.92	0.2710
Stress					
None	534	27.1	0.09	4.57	0.6662
Moderate	893	45.3	0.37	4.49	0.0148
Severe	545	27.6	-0.22	5.19	0.3285
Depression					
No	1915	97.1	0.12	4.72	0.2831
Yes	57	2.9	0.59	4.78	0.3598
Total	1972	100	0.13	4.72	0.2238

*Analyses were performed using paired t-test.
BMI, body mass index; MET, metabolic equivalent of task.

who provided incomplete responses, 1972 were included in the final analysis. In addition, to compare BMI before and during military service for each participant, data on BMI before service were collected from the Military Entrance Physical Examination database conducted on the day of enlistment, after obtaining approval from the Republic of Korea Army Headquarters Personnel Administration. 'During military service' was defined as the time of response to the survey.

Main outcome variables

Changes in BMI were determined by calculating the difference in BMI (BMI during military service – BMI before military

service) for each participant. Participants with BMI <18.5 kg/m² were classified as underweight, those with BMI 18.5–24.9 kg/m² were classified as normal weight, and those with BMI ≥25 kg/m² were classified as overweight. Change in BMI was analysed according to whether the participant's weight during service was maintained, improved or deteriorated compared with the weight before service. Weight was considered maintained if the weight during military service was unchanged compared with the weight before service. Weight was considered to have improved if an individual who was underweight or overweight before service had normal weight during service. Weight was considered to have deteriorated if an individual with normal weight before service became either underweight or overweight during service, or if someone underweight before service became overweight, or if someone overweight became underweight during service.

Covariates

Because the participants in this study were all male, the variable sex was excluded from the general characteristics. Age was divided into three categories: <20, 20–21 and ≥22 years. Educational level was divided into high school graduates and college graduates or above. Smoking status was classified into non-smoker, ex-smoker and current smoker. Subjective health status was rated according to responses on a 5-point Likert scale: very good, good, normal, poor and very poor. Responses of 'very good' and 'good' were grouped together as 'good', and responses of 'poor' and 'very poor' were grouped together as 'poor'.

Physical activity was measured using the International Physical Activity Questionnaires and was based on the metabolic equivalent of task (MET). The physical activity variable was calculated as MET-min/week scores. Total physical activity was divided into those who did not exercise except for activities of daily life (METs <600), those who exercised some (600 ≤ METs ≤ 3000) and those who exercised more to promote health (METs >3000).^{31 32}

Strength training was not scored as MET in the questionnaire domain was related to physical activity. Strength training was used as a separate variable and classified as none, one to two times per week, and three or more times per week based on participants' responses to the number of days they performed the training.

Sleep duration was divided into three categories: less than six hours, six to seven hours, and eight or more hours. Sleep disturbance was rated according to three items (having difficulty falling asleep, difficulty staying asleep and lack of sleep due to waking up too early) using a 5-point Likert scale. Responses of 'slightly severe' and 'very severe' were grouped together as having sleep disturbance, whereas other responses were grouped as having no sleep disturbance.

Military characteristics were classified according to the branch participants served in (Army, Navy, Marine Corps or Air Force) and were further divided into combat branch, technical branch and administrative/special branch. Service period was divided into four categories: <6, 6–11, 12–17 and ≥18 months. The types of workplace were divided into large, middle and small cities; 'gun' (country), 'eup' (town) and 'myeon' (township); and remote areas. Working hours were classified into <40 hours, 40–55 hours and ≥56 hours.

Statistical analyses

The general and military characteristics of the participants were analysed using frequency analysis. Changes in BMI before and during military service were analysed using paired t-test.

Table 2 Improvements in body weight during military service according to general characteristics

	n	Maintenance		Improvement		Deterioration		P value*
		n	%	n	%	n	%	
Age (years)								0.2169
<20	69	38	55.1	20	29.0	11	15.9	
20–21	1521	850	55.9	447	29.4	224	14.7	
≥22	382	218	57.1	93	24.4	71	18.6	
Educational level								0.0621
High school	288	151	52.4	79	27.4	58	20.1	
College or above	1684	955	56.7	481	28.6	248	14.7	
Smoking status								0.8001
Non-smoker	1039	575	55.3	295	28.4	169	16.3	
Ex-smoker	173	103	59.5	47	27.2	23	13.3	
Current smoker	760	428	56.3	218	28.7	114	15.0	
Subjective health status								0.0004
Good	1148	669	58.3	329	28.7	150	13.1	
Normal	677	371	54.8	188	27.8	118	17.4	
Poor	147	66	44.9	43	29.3	38	25.9	
Physical activity (MET-min/week)								0.7800
<600	376	210	55.9	104	27.7	62	16.5	
600–3000	661	369	55.8	183	27.7	109	16.5	
>3000	935	527	56.4	273	29.2	135	14.4	
Strength training								0.0024
None	436	225	51.6	129	29.6	82	18.8	
1–2 times per week	460	249	54.1	123	26.7	88	19.1	
≥3 times per week	1076	632	58.7	308	28.6	136	12.6	
Sleep duration (hours/day)								0.2552
<6	59	41	69.5	10	17.0	8	13.6	
6–7	1273	714	56.1	360	28.3	199	15.6	
≥8	640	351	54.8	190	29.7	99	15.5	
Sleep disturbance								0.4993
No	1724	963	55.9	497	28.8	264	15.3	
Yes	248	143	57.7	63	25.4	42	16.9	
Stress								0.5259
None	534	304	56.9	146	27.3	84	15.7	
Moderate	893	512	57.3	252	28.2	129	14.5	
Severe	545	290	53.2	162	29.7	93	17.1	
Depression								0.6554
No	1915	1074	56.1	546	28.5	295	15.4	
Yes	57	32	56.1	14	24.6	11	19.3	
Total	1972	1106	56.1	560	28.4	306	15.5	

*Analyses were performed using χ^2 test.
MET, metabolic equivalent of task.

Changes in weight before and during military service were divided into maintenance, improvement and deterioration and were analysed using the χ^2 test. Fisher's exact test was performed

when an expected frequency was <5. To identify the factors affecting improvements in BMI, we performed a logistic regression analysis after excluding the maintenance group and setting

Table 3 Changes in BMI before and during military service according to the weight group before military service

Weight group before military service	n	BMI before service, kg/m ²		BMI during service, kg/m ²		Difference in BMI		P value*
		Mean	SD	Mean	SD	Mean	SD	
Underweight	230	17.49	0.70	23.36	2.76	5.87	2.85	<0.0001
Normal	1269	21.64	1.76	22.82	2.63	1.18	3.12	<0.0001
Overweight	473	28.18	2.70	22.71	2.50	-5.47	3.55	<0.0001
Total	1972	22.72	3.86	22.85	2.62	0.13	4.72	0.2238

*Analyses were performed using paired t-test.
BMI, body mass index.

Table 4 Improvements in body weight during military service according to weight group before military service

Weight group before military service	n	Maintenance		Improvement		Deterioration		P value
		n	%	n	%	n	%	
Underweight	230	4	1.7	171	74.4	55	23.9	<0.0001*
Normal	1269	1026	80.9	–	–	243	19.1	
Overweight	473	76	16.1	389	82.2	8	1.7	
Total	1972	1106	56.1	560	28.4	306	15.5	

*Analyses were performed using Fisher's exact test.

the deterioration group as the reference group, and then calculated the OR and 95% CI. We considered values of $p < 0.05$ as statistically significant. All analyses were performed using SAS V.9.4 software.

RESULTS

A high proportion of participants were aged 20–21 years (1521 or 77.1% of all participants). A high proportion also reported that they were non-smokers, their perceived health was good, they performed strength training three or more times per week, and their stress level was moderate.

From before military service to during, BMI in smokers increased by 0.35 kg/m^2 , which is statistically significant ($p = 0.0372$). Similarly, BMI increased by 0.47 kg/m^2 ($p = 0.0454$) in those reporting no strength training and by 0.37 kg/m^2 ($p = 0.0148$) in those whose perceived stress level was moderate (Table 1).

Changes in body weight during military service are shown in Table 2. Of the participants, 28.4% improved in weight, which is a much higher proportion than those whose weight deteriorated (15.5%). Among those who perceived their health status as poor, the proportion of those with deteriorated health status was higher than those with maintained health status ($p = 0.0004$). Among those who reported performing strength training three or more times per week, the proportion of those with maintained health status was higher than those with deteriorated health status ($p = 0.0024$).

On grouping the participants according to BMI before military service, BMI in the underweight group increased during military service, whereas that in the overweight group decreased, showing that BMI returned to normal ranges during military service (Table 3). The mean BMI in the underweight group increased by 5.87 kg/m^2 during service, while that in the normal weight group increased by 1.18 kg/m^2 . In contrast, the mean BMI in the overweight group decreased by 5.47 kg/m^2 during service. There was a statistically significant change in BMI in all groups ($p < 0.0001$).

In the underweight group, most participants had an improvement in weight (171, 74.4%) during military service. In the normal weight group, most participants maintained their weight. Similarly, most participants in the overweight group showed improvement during service ($p < 0.0001$). A total of 74.4% of participants who were underweight and 82.2% of participants with obesity before military service showed improvements and attained normal weights during service ($p < 0.0001$) (Table 4). Changes in body weight according to military characteristics were also observed (online supplementary appendix A–C).

The OR for an improved BMI in the subjective good health group compared with the subjective poor health group was statistically significant (OR=1.71, 95% CI 1.02 to 2.87). The OR for an improved BMI was significantly higher in the group with three or more times per week of strength training than in

the group with one to two times per week of strength training and was higher among the marines compared with the Army soldiers (OR=1.48, 95% CI 1.03 to 2.12 and OR=2.15, 95% CI 1.07 to 4.32, respectively) (Table 5).

DISCUSSION

This study investigated changes in BMI among enlisted men before and during military service and showed that the pattern of change was an improvement in health status. Our results revealed that 74.4% of soldiers who were underweight (BMI $< 18.5 \text{ kg/m}^2$) before military service improved to normal weight, with an average BMI increase of 5.87 kg/m^2 , whereas 82.2% of those who were overweight (BMI $> 25 \text{ kg/m}^2$) before service improved to normal weight, with an average BMI decrease of 5.47 kg/m^2 (Tables 3 and 4). These findings are consistent with the results of a previous study on changes in BMI before and during military service²⁰ and a previous study on BMI according to military service area (geographical area).³³ Positive effects on BMI are expected as a result of regular diet and exercise characteristic of military life.

When we investigated factors including the general and military characteristics of the participants, we found that age, subjective health status, strength exercise and military variables were all significantly associated with improvements in BMI (Table 5). Enlisted men aged 20–21 years were more likely to show improvements in BMI than those aged over 21 years. These results are consistent with those of previous studies involving adolescents and adults, which showed that excess weight increases with age.^{26–34} In contrast, another study analysing changes in obesity status among enlisted soldiers before and during military service²⁰ showed that BMI in older age groups decreased during military service.

BMI was more likely to improve in participants who perceived their health status as good than in those who perceived their health status as poor. This result is consistent with the results of a previous study in adults.³⁵ BMI of those who performed strength training three or more times per week was more likely to improve than those who performed strength training one to two times per week. The analysis of the changes in BMI with respect to participants' general characteristics also showed that strength training was a variable exhibiting significant differences between the groups (Table 1). Performing strength training had significant effects on both changes in BMI and improvements in weight. Therefore, further studies that can reflect changing exercise trends while measuring strength exercise as a key variable of physical activity are required.

Among the military forces (Army, Navy, Marine Corps and Air Force), the proportion of participants who improved to normal weight from overweight before military service was highest in the marines, and the proportion of those who deteriorated to overweight or underweight from normal weight before service was lowest also in the marines (online supplementary appendix

Table 5 Factors associated with improvements in BMI during military service according to general and military characteristics

	Improvement group	
	OR*	95% CI
Age (years)		
<20	1.20	0.50 to 2.87
20–21	1.48	1.01 to 2.17
≥22	Ref	
Educational level		
High school	Ref	
College or above	1.32	0.89 to 1.96
Smoking status		
Non-smoker	Ref	
Ex-smoker	1.14	0.66 to 1.98
Current smoker	1.14	0.83 to 1.56
Subjective health status		
Good	1.71	1.02 to 2.87
Normal	1.32	0.79 to 2.22
Poor	Ref	
Physical activity (MET-min/week)		
<600	Ref	
600–3000	0.95	0.63 to 1.44
>3000	0.96	0.64 to 1.44
Strength training		
None	1.21	0.80 to 1.81
1–2 times per week	Ref	
≥3 times per week	1.48	1.03 to 2.12
Sleep duration (hours/day)		
<6	0.67	0.25 to 1.76
6–7	Ref	
≥8	1.03	0.75 to 1.41
Sleep disturbance		
No	Ref	
Yes	0.86	0.55 to 1.36
Military		
Army	Ref	
Navy	1.40	0.86 to 2.27
Marine Corps	2.15	1.07 to 4.32
Air Force	1.12	0.68 to 1.86
Branches		
Combat	Ref	
Technical	1.06	0.70 to 1.61
Administrative/special	1.19	0.67 to 2.11
Service period (months)		
<6	Ref	
6–11	0.89	0.57 to 1.40
12–17	0.82	0.53 to 1.26
≥18	0.94	0.54 to 1.64
Type of workplace		
Large, middle and small cities	Ref	
Country, town, township	1.02	0.69 to 1.49
Remote areas	0.78	0.43 to 1.39
Working hours (hours/day)		
<40	1.14	0.76 to 1.72
40–55	Ref	
≥56	1.24	0.88 to 1.75

*Regression analysis was performed using the deterioration group as the reference (ref) group. Stress and depression variables were excluded from the table because they did not show significant results during the analysis. BMI, body mass index; MET, metabolic equivalent of task.

B,C). Our analysis showed that the marines were significantly more likely to show improvements in BMI than the Army soldiers, who showed consistent results.

This study has limitations. First, we did not investigate eating habits, a major contributor to obesity. In the military, enlisted men are supposed to eat at designated times following a planned diet of 3300 kcal per day, which means that eating habits in the military are more controlled than among civilians. However, differences may still occur in individuals' meal sizes and snack intake. Second, the Military Health Survey used in this study was conducted among enlisted men during service. Therefore, if the general characteristics of the survey participants changed during their military service, for example, if sleep duration was shorter than before service, the data collected would not reflect such changes. Third, military service can lead participants to change many aspects of their lifestyle, such as smoking, physical activity and sleep, from their lifestyle before service. Fourth, these results may not be generalisable to non-conscripted Armed Forces as our population only consisted of enlisted Armed Forces. Any generalisations to other Armed Forces which rely on volunteers who arrive fitter than the conscripted are not recommended in similar studies associated with BMI. Further studies are required with regard to changes in health behaviour before and during military service. These could build on the Military Health Survey, which is conducted at the time of enlistment and which could help overcome the limitations of previous cross-sectional studies that have relied on recollections of concerned participants.

This study also has strengths. To our knowledge, it is the first to investigate BMI among enlisted men using a representative sample from the Army, Navy, Marine Corps and Air Force. Moreover, we identified changes in individual participants' BMI by merging the Military Health Survey data with participants' Military Entrance Physical Examination data. In addition, this study not only analysed changes in BMI in terms of gain and loss but also determined whether the pattern of such changes led to an improvement in health. Lastly, a military health survey is conducted among current officers and soldiers from July to August. To compare the parameters before and during military service of 1972 participants enrolled in the study, we matched the before military service data with the physical examination data collected on the day of enlistment. This made it possible to control for the time between enlistment and survey completion, resulting in a better understanding of the intensity and duration of the training received.

The results show that the majority of participants with abnormal weight, either overweight or underweight, improved to normal weight. Future research is required to analyse the differences in military obesity management programmes among the Army, Navy, Air Force and Marine Corps and to develop standardised health promotion programmes.

CONCLUSIONS

In our investigation, strength training showed a statistically significant increase in BMI during military service. Furthermore, BMI in men who were underweight before their service increased, whereas BMI in those who were overweight decreased. This pattern indicates that BMI returns to normal ranges during military life.

Contributors BNL, SWB, SYO, JHY, JR and JUW conceived and planned the study. BNL, SWB, SYO and JHY performed the analysis. BNL, SWB and SYO wrote the original draft with input from all authors. BNL, SWB and JHY visualised the results. SYO, JR and JUW validated the study. BNL, SWB, SYO and JUW contributed to the

interpretation of the results. JUW supervised the entire process. All of the authors read and approved the final manuscript.

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Patient consent for publication Not required.

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