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THE INTRODUCTION OF HEALTH BEHAVIOR PROFILES IN THE HUNGARIAN DEFENSE FORCES: A CLUSTER ANALYSIS OF LIFESTYLE FACTORS ACCORDING TO THE HEALTH SCREENING TESTS PERFORMED IN 2011–2015

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Abstract
Objectives: The main aim of this study was to examine the health behavior patterns of soldiers in the Hungarian Defense Forces and to introduce health behavior profiles according to the cluster analysis of lifestyle factors. **Material and Methods:** The soldiers (N = 5475) who underwent health tests in 2011–2015 participated in this cross-sectional study. The factors included in the analysis are the following: age, sex, diseases diagnosed, the body mass index, eating habits, the smoking status, daily physical activity, sporting habits, the presence of psychosomatic symptoms, mental toughness and sleep apnea. The response options for each factor were scored on a linear scale; the minimum number of points available was –47.5 pts and the maximum number was 48.5 pts according to the 24 factors. Finally, the authors created health profiles typical of the pattern with the cluster analysis of the data. **Results:** As a result of the cluster analysis, 16 distinct profiles were found, 10 of which differed significantly ($p < 0.05$) from each other. The lowest point value achieved was 3.1 pts and the highest was 26.2 pts. The lowest number of points was achieved by the cluster, 1.8% of the sample, with the highest average age (43.5±7.2 years) in which women showed the highest participation (46%). The 2 clusters with the highest numbers of points, 2.9% and 5.5% of the sample, were the 2 groups with the lowest average age (33.7±7.1 years and 34.3±7.9 years). **Conclusions:** The significance of the health profiles obtained during this examination with the Hungarian Defense Forces is that the health promotion intervention opportunities may be determined by clusters, the health behavior factor with which the authors can reach higher health benefits can be chosen and the effectiveness of the interventions carried out can be traced easily. Int J Occup Med Environ Health. 2019;32(1):99–114

Key words:
health promotion, cluster analysis, health behavior, Hungarian Defense Forces, health profile, military health

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INTRODUCTION

Health-related behavior includes behavior patterns, activities and routine which are important for maintaining, restoring or improving health [1]. Changing health behavior, from a public point of view, is one of the biggest challenges. Several factors have been determined to either have prophylactic properties or appear as risk factors [2]. The main objective of health improving activities is to positively affect health behavior by strengthening preventive forms of behavior (sports, maintaining energy balance) and/or reducing risk behavior (smoking, alcohol consumption). The actual impact of health-related behavior on health is of crucial importance in preventing morbidity and mortality [3–5]. Research findings have shown that certain forms of behavior may be effectively modified by interventions aiming at a variety of changes [6,7]. The results on the long-term sustainability of this modified behavior, however, are controversial [8,9]. The significance of preventive forms of health behavior is emphasized for those people who have an existing chronic disease, and with a healthy lifestyle, in many cases, the progression of the disease may be delayed [10–12]. It is demonstrably more efficient to endeavor to change 1 or possibly 2 health behavior factors [13,14], which might result in the improvement of other factors. Higher physical activity or a positive change in diet may facilitate giving up smoking [15,16]. By improving sporting habits the quality of sleep may become better [17]. Measuring the effectiveness of health improvement is a difficult task because of the need to identify starting points. A health-promoting lifestyle profile [18], which was created in 1987 and updated in 1995, is still used for the civilian population [19].

At an international level, persons entering the armed forces enjoy better health than the average civilian population. However, following the completion of military service, these health benefits decrease and their health status may become worse than that of civilians [20–22].

In Hungary, when comparing the civilian population with soldiers, it is plausible to say that the morbidity odds ratio in the military forces increases less steeply over time that is, age is not as much of a burden on soldiers as on civilians [23,24]. Based on the authors' earlier examinations in the Hungarian Defense Forces, men are more prone to diseases than women [25]. The successful change of health behavior in a positive direction largely depends on its personalization. With respect to health development, in the case of such a large population as the Hungarian Defense Forces, individual intervention is almost impracticable. The starting point of this research was the assumption that, with respect to health behavior patterns, there are individuals who are more similar to each other so that they could be categorized in a group and, accordingly, several different groups could be formed. In the course of dimensionality reduction, the aim of the authors was to assign the available data blocks and observation units to relatively homogeneous groups. Based on the health determinants, the authors created health behavior profiles and examined their structure.

MATERIAL AND METHODS

For this research, the authors conducted a cross-sectional study in the Hungarian Defense Forces, including both those belonging to professional personnel and staff recruited on a contractual basis who underwent health screenings in 2011–2015 (N = 17 722). In the statistical analysis, only the questionnaires with the written consent of the examined respondents were analyzed, so that the data could be used for statistical purposes, and which were duly completed in terms of the variables under investigation. Strong emphasis was placed on compliance with ethical standards during data collection and analysis (detailed informed consent, personal identification was not possible during the analysis), as the publishing of the results hereinafter was meant to follow the ethical standards. After data clearing, the data obtained from 5465 questionnaires

were processed. In the sample, the youngest person was 19 years old, the oldest 66 years old, and the average age was 36.93 years old (±7.46 years). Women accounted for 21.1% of the sample.

The *Personal Screening Data Sheet* [26] completed during the screenings, which was created with the contribution of the head physicians of the Hungarian Defense Forces and introduced in 2009, adds considerable weight to the mapping of factors related to lifestyle and subjective well-being. One group of the factors included in the analysis consists of the so-called "hard" indicators (objective variables): age, sex, diseases diagnosed (according to ICD-10), and the body mass index (BMI). The other group consists of the so-called "soft" indicators (subjective variables): eating habits, the smoking status, daily physical activity, sporting habits, the presence of psychosomatic symptoms, mental toughness (*Mental Toughness Questionnaire* – MTQ) [27,28] and sleep apnea (obstructive sleep apnea syndrome – OSAS) [29]. The response options for each factor were scored by taking international and national scientific literature into account; the minimum number was –47.5 pts and the maximum number was 48.5 pts according to the 24 factors. As the final step, the authors created health profiles typical of the pattern with the cluster analysis of the data.

The scoring system of the variables involved in the research was developed as follows.

Objective variables

The objective variables included:

- age (–2 to 0 pts):
  - < 30 years of age: 0 pts,
  - 30–40 years: –1 pt,
  - > 40 years: –2 pts;
- sex (–1 to 0 pts):
  - man: –1 pt,
  - woman: 0 pts;
- diseases diagnosed (recognized by a doctor, chronic non-communicable diseases) (–9 to 3 pts):
  - 1 disease: –3 pts,
  - 2 diseases: –6 pts,
  - > 2 diseases: –9 pts;
- the body mass index (BMI) (–5 to 1 pt) – the authors established 5 categories related to this variable:
  - category 1 (man BMI < 20): 0 pts,
  - category 2 (woman BMI < 20 or in the case of both sexes BMI 25–30): –1 pt,
  - category 3 (BMI 30–35): –3 pts,
  - category 4 (BMI > 35): –5 pts,
  - category 5 (BMI 20–25): 1 pt [30].

Variables based on subjective assessment

Nutrition

Score: –12.5 to 13.5 pts. The regularity of main meals (breakfast, lunch, dinner) and the qualitative composition of diets were observed. With regard to regularity, the authors examined the weekly frequency of main meals during working days and these were scored on a scale from –2.5 to 3 by setting 3 categories.

In the case of breakfast and lunch:

- category 1 – never/once/twice a week,
- category 2 – three times/week,
- category 3 – four or five times/week.

As regards breakfast, those belonging to category 1 received the lowest number of points (–1.5 pts), those within category 2 received 0 pts and the highest number of points was received by those in category 3 (1.5 pts). As regards lunch, those belonging to category 1 received –1 pt, those within category 2 received 0 pts and those in category 3 received 1 pt.

In the case of dinner:

- category 1 – never/once a week,
- category 2 – two or three times/week,
- category 3 – four or five times/week.

As regards dinner, those belonging to category 2 received the highest number of points (0.5 pt) while those within categories 1 and 3 received 0–0 pts [31,32].

While analyzing the qualitative factors of nutrition, the authors studied, on the one hand, the prevalence of vegetables, fruit, dairy products and grains in the diet, which were scored on a scale from –6 to 5 pts. On the other hand, they observed the preferences for the types of meat, grain and fat, scored on a scale from –2 to 3.5 pts. The categories of prevalence were the following:

- category 1 – never,
- category 2 – less often than once/week,
- category 3 – once/week,
- category 4 – two/three/four times/week,
- category 5 – five or six times/week,
- category 6 – once/day,
- category 7 – several times/day.

In terms of fruit and dairy products, the lowest number of points (–1 pt) was assigned to those in categories 1, 6 and 7; those in categories 2 and 3 received 0 pts and the highest number of points (1 pt) was received by those in categories 4 and 5. As regards vegetable consumption, those in categories 1 and 2 received –2 pts, in category 3: –1 pt, in category 4: 0 pts, in categories 5 and 6: 1 pt, and in category 7: 2 pts.

In terms of grain consumption, the scoring system was similar with only one difference; those in category 7 received only 1 pt.

In terms of meat consumption, a preference for white meat scored 1 pt and for red meat –1 pt.

Mixed consumption scored 0.5 pt and no consumption scored 0 pts.

In terms of grains and bakery products, those preferring mainly white flour received –1 pt, those consuming brown flour received 0.5 pt and those preferring whole wheat flour received 1 pt. Those who broadly consumed all of these received 0 pts.

Those who used vegetable or animal fat received 0.5 pt, those who used both received 1 pt and those who used hardly any fat received 1.5 pts [33–35].

In terms of fluid intake, those who usually drank water/mineral water received 1 pt, those who drank tea received 0 pts, those consuming fruit juices received –0.5 pt and those who drank fizzy drinks received –1 pt. In terms of the amount of daily fluid intake, those who drank > 1.5 l of liquids received 1 pt, those who drank 1–1.5 l of liquids received 0 pts and those who drank < 1 l of liquids a day received –1 pt.

Smoking status

As regards the smoking status (–5 to 0 pts), those who smoked received the lowest number of points (–5 pts), those who had given up smoking received –3 pts and those who had never smoked received 0 pts.

Physical activity

Score: –5 to 22 pts. As regards daily physical activity, the authors examined transportation behavior, the time spent doing sports in a week and the level of intensity of the sporting activities. In the former case, they examined the preferred means of transport (on foot, by bicycle, by car or by public transport) and the time spent between the workplace and home. Those respondents who reached their workplace in < 1 h on foot or by bicycle received 1 pt, those who commuted 1–2 h received 4 pts and those who got to their workplace in > 2 h received 6 pts [35]. Those who commuted by car received –3 pts, –4 pts, –5 pts, while those who used public transport received 0 pts, –1 pt, –2 pts [23,36].

When scoring the frequency of doing sports, those who did sports every day received 12 pts, those who did sports 2–3 times/week received 9 pts, those who did sports on a weekly basis received 6 pts and those who did sports less frequently than once a week received 0 pts [25]. Consciousness was also taken into account and those who monitored their heart rate while training received 1 pt. The authors also differentiated between various post-workout fatigue levels. Those who were not tired at all

after training did not receive a point. However, if they felt slightly tired, they received 1 pt. Those who experienced medium or extreme levels of fatigue received 3 pts and those who trained extremely hard and reached maximum fatigue received 2 pts [37].

Sleep

Score: –4 to 3 pts. Those who woke up tired received –2 pts and those who woke up feeling fresh received 3 pts. The authors examined sleep apnea using the Berlin questionnaire – for < 6 pts: 0 pts, 6–8 pts: –1 pt and for > 8 pts: –2 pts were given to the respondents [25,38].

Mental toughness (MTQ)

Score: –3 to 8 pts. The MTQ test used in the Hungarian Defense Forces measures the level of psychological resilience through the effectiveness of automatic thinking patterns typical of an individual [27]. The test consists of 20 statements/highly emotional situations which the participants were asked to assess on a 5-grade Likert scale, on the basis of the level of their agreement deriving from their self-description, with the indicator taking a value of 20–100. For scoring purposes, the authors transformed this scale to a scale between –3 and 8 pts by multiplying the MTQ points by 11/80 and then by subtracting 5.75 [39].

Psychosomatic symptoms

Score: –6 to 0 pts. The authors examined and evaluated the frequency of the most common psychosomatic symptoms (backache, headache, stomach ache and abdominal pain, bad mood, irritability, nervousness and fatigue) according to the following frequency categories:

- category 1 – almost every day,
- category 2 – several times a week,
- category 3 – weekly,
- category 4 – monthly and
- category 5 – rarely or never.

Those in category 1 received the lowest number of points (–3 pts), those in category 2 received –2 pts, in category 3: –1 pt, in category 4: –0.5 pt and in category 5: 0 pts in respect of all the symptoms.

The authors scored backache separately, based on the above categories, as they had found in their previous research that, out of all psychosomatic symptoms, the frequency of backache had the greatest influence on the incidence of diseases. The scores for the other symptoms were added up and divided by 6 [40,41]. In the case of MTQ, it was the score achieved.

Statistics

The authors carried out the statistical analysis of the data in R environment with the R-Studio software and found the groups and clusters arising from the structure of the data. One of the most important clustering factors was to determine metric; the authors used the Euclidean metric where the distance function was [42]:

$$d(x,y)=\sqrt{\sum_{i=1}^{n}(x_i-y_i)^2} \quad (1)$$

where:

$x,y \in R^n$ – vector

$x_i, y_i \in R$ – coordinate

Firstly, the authors examined the problem with a hierarchical clustering method to gain an insight into the desired structure.

Hierarchical algorithm:

input:

$$S = \{s_{ij}:s_{ij} = d(s_i,s_j);\ i, j = 1, 2, \ldots, N;\ i < j\} \quad (2)$$

while $(1 < |S|)$ {

$s_{ab} = \min(S)$

agglomerate (S, s_{ab})

}

agglomerative algorithm:

$$\begin{aligned} &\text{agglomerate}\,(S, s_{ab})\{ \\ &s_{a\cup b,c} = \frac{1}{2}s_{ac} + \frac{1}{2}s_{bc} + \frac{1}{2}|s_{ac} - s_{bc}| = \max(s_{ac}, s_{bc}) \\ &\text{delete } s_{ac}, s_{bc} \text{ from } S\,(\text{all remaning c}) \\ &\text{add } s_{a\cup b,c} \text{ to } S\,(\text{all remaning c}) \\ &\} \end{aligned} \tag{3}$$

The results were represented by a cluster dendrogram in which the authors used red lines to visualize clustering (Figure 1).

Based on this structure, it can be concluded that at least 8–10 clusters are necessary to separate the dataset sufficiently.

In the next step, all the coordinates were taken into account in this clustering. The algorithm used was the k-means algorithm [43,44]. To represent distance, the authors once more employed the Euclidean metric. Due to the high number of elements, they chose the k-means clustering method from the analysis methods available.

For the k-means algorithm, the following measures should be introduced:

$$SSE = \sum_{i=1}^{K} \sum_{x \in C_i} (d(x, c_i))^2 \tag{4}$$

where:

K – the number of clusters,

C_i – the i-th cluster,

c_i – the "centroid" of C_i (depending on the metric)

The necessary c_i centroids were determined according to the Euclidean metric.

$$\begin{aligned} &\frac{\partial}{\partial c_k} SSE = \frac{\partial}{\partial c_k} \sum_{i=1}^{K} \sum_{x \in C_i} (d(x, c_i))^2 = \frac{\partial}{\partial c_k} \sum_{i=1}^{K} \sum_{x \in C_i} (x - c_i)^2 = \\ &\sum_{i=1}^{K} \sum_{x \in C_i} \frac{\partial}{\partial c_k} (x - c_i)^2 = \sum_{x \in C_i} \frac{\partial}{\partial c_k} (x - c_k)^2 = \sum_{x \in C_k} (-2)(x - c_k) \end{aligned} \tag{5}$$

So:

$$(-2) \sum_{x \in C_k} (x - c_k) = 0 \tag{6}$$

$$c_k = \frac{1}{N_k} \sum\nolimits_{x \in C_k} x = \overline{x_{c_k}} \left(N_k = |C_k|\right) \tag{7}$$

That is, every centroid can be best approached by the mean of the elements belonging to that specific cluster.

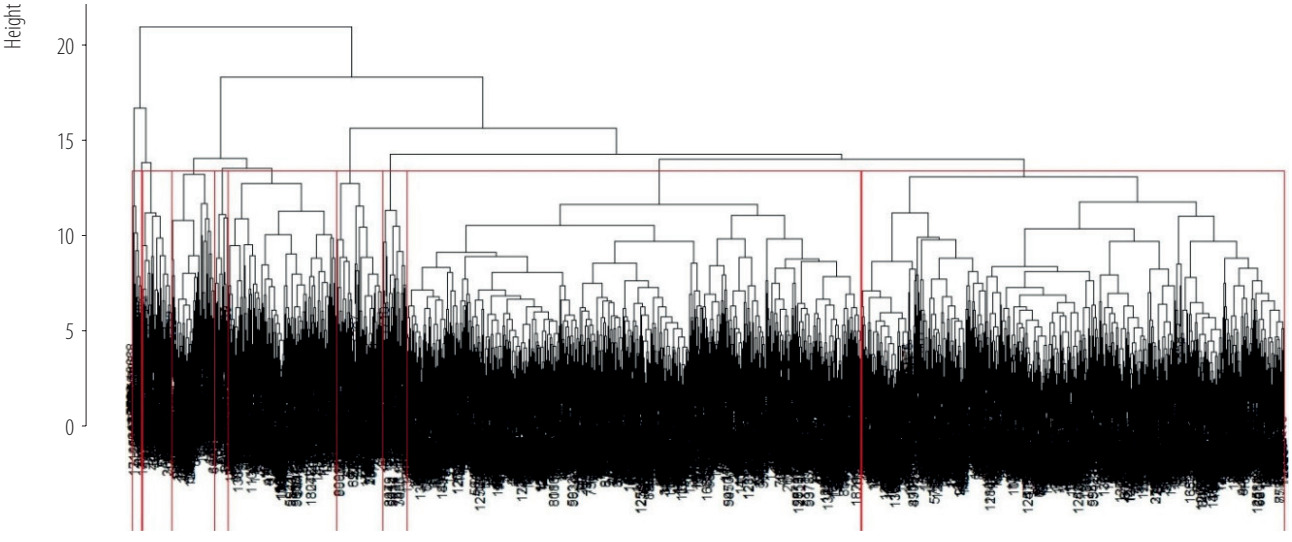

Figure 1. A cluster dendrogram in the cross-sectional study in the Hungarian Defense Forces in 2011–2015

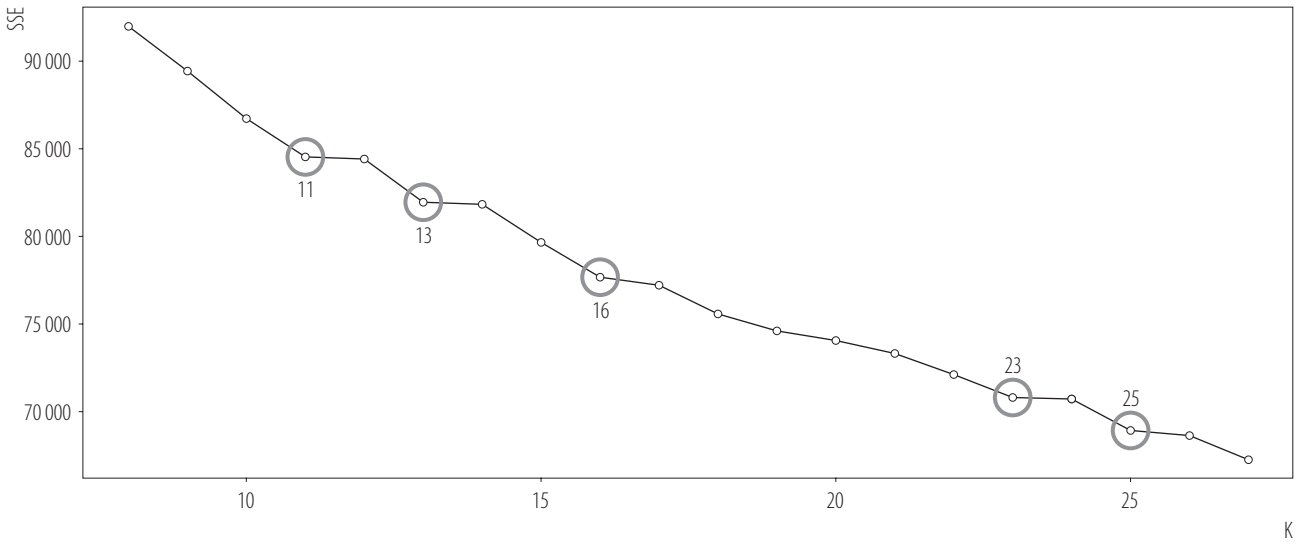

Figure 2. The sum of squared errors (SSE) values in the cross-sectional study in the Hungarian Defense Forces in 2011–2015

The k-means algorithm from k = 8 to k = 27; the received sum of squared errors (SSE) values was delineated.

By using the elbow method, it is concluded that clusters 11, 13, 16, 23 or 25 should be separated in the examinated sample (Figure 2).

In this research, the case when K = 16 was examined. The problem could be approached by different metrics (the discrete metric, the Minkowski metric, the Chebysev metric).

RESULTS

As a result of the cluster analysis, the authors found 16 distinct profiles, 10 of which differed significantly ($p < 0.05$) from each other. According to the 24 factors under examination, the lowest number of points that could be achieved was –47.5 pts and the highest number of points was 48.5 pts. The lowest achieved point value was 3.1 pts, and the highest was 26.2 pts. The lowest number of points was achieved by the cluster, 1.8% of the sample, with the highest average age (43.5±7.2 years) in which women showed the highest participation (46%). The 2 clusters with the highest number of points, 2.9% and 5.5% of the sample, were the 2 groups with the lowest average age (33.7±7.1 years and 34.3±7.9 years). The authors presented the values of the examined objective variables by clusters in Table 1. For the sake of clarity, color-coding was used for demonstrating the risk factors affecting health by clusters. The values worse than the average rate are marked in red, the values better than the average rate are marked in green and the average rate itself is marked in white. The average values and those better than the average rate but adverse from the health status point of view and therefore constituting risk factors, are marked with "!". (For example, the value of BMI category 3 [BMI 30–35] in the case of cluster 6 is 10% which is 12.68% better than the average rate, however, it is adverse from the health status point of view, because 10% of those in cluster 6 are overweight.)

Nutrition

As regards the regularity of main meals on workdays, the authors did not find any significant deviations between different clusters; the majority of the sample had proper breakfast (76%), lunch (86%) and dinner (85%). As regards the quality factors of nutrition, the regularity of vegetable, fruit, dairy product and grain consumption is shown in Table 2 where the authors used the same marks as presented above. As regards grains, the majority of

Table 1. The objective variables of the scoring system involved in the cross-sectional study in the Hungarian Defense Forces in 2011–2015 (N = 5 475)

Cluster	Rank*	Score [pts] (M = 15.8)	Age [years] (M±SD) (M = 36.9)	Women [%] (M = 21.1)	Diseases [%] (M = 15.32)	BMI category[a] [%]				
						1 (M = 1.25)	2 (M = 47.75)	3 (M = 12.68)	4 (M = 2.3)	5 (M = 35.93)
1	16	3.1	43.5±7.2	46	100	1	43!	22	6	28
2	8*	17.3	34.4±6.7	7	0	1	51	13!	2!	33
3	12	12.7	41.6±6.9	34	100	0	50	18	6	25
4	9*	13.6	37.3±6.8	13	0	0	79	19	2!	0
5	15*	4.6	38.5±7.4	25	21	2	41!	18	4!	35!
6	6*	18.6	37.2±6.3	24	0	0	52	10!	1	37!
7	4	22.4	34.7±6.9	12	0	0	52	8!	1	40!
8	11	12.9	37.5±6.4	15	0	0	51	20	2!	27
9	1*	26.2	34.3±7.9	15	0	2	46!	8!	1	43!
10	2*	24.8	33.4±7.1	9	1!	1	53	9!	1	36!
11	3*	22.5	36.5±7.6	25	0	1	48!	9!	0	42!
12	5*	21.5	34.4±7.5	11	0	2	48!	7!	1	42!
13	7	18.6	35.5±7.6	29	0	7	0	0	0	93
14	10*	13.2	35.8±6.7	18	0	1	50	14!	2!	32
15	13	12.5	38.3±7.0	30	0	1	52	10!	1	37!
16	14*	8.3	41.7±7.0	29	100	1	48!	18	7	26

The values worse than the average rate are marked in red, the values better than the average rate are marked in green and the average rate is marked in white.
"!" – Risk factors: the average values and those better than the average but adverse from the health status point of view.
* $p \leq 0.05$.
[a] Category 1 – male BMI < 20; category 2 – female BMI < 20 or in the case of both sexes BMI 25–30; category 3 – BMI 30–35; category 4 – BMI > 35; category 5 – BMI 20–25.

Table 2. The lifestyle factors in the cross-sectional study in the Hungarian Defense Forces in 2011–2015 (N = 5 475)

Cluster	Rank	Qualitative factors of dietary habits [%]				Never smoked [%]	Physical activity		Sleeping [%]		Psychosomatic symptoms [average pts]	Backache [%]	MTQ [average pts]
		vegetables (M = 35.88!)	fruit (M = 53.54!)	dairy products (M = 46.16!)	grains (M = 58.33!)	(M = 47.07!)	transport [%] (M = 47.42!)	sport [average pts] (M = 9.01)	waking up fresh (M = 95.02)	OSAS (M = 91.71)	(M = –0.341)	(M = 61.20)	(M = 2.21)
1	16	38! (10)	51 (8)	41 (9)	70 (1)	12 (5)	55! (7)	8.97 (3)	0 (4)	68 (13)	–0.906 (16)	27 (15)	1.76 (16)
2	8	40! (8)	56! (3)	46! (4)	56 (8)	0 (7)	0 (12)	12 (1)	100 (1)	94 (5)	–0.227 (4)	70 (5)	2.31 (6)
3	12	45! (4)	52 (7)	49! (2)	64 (3)	100 (1)	47! (9)	8.85 (5)	100 (1)	85 (10)	–0.361 (13)	54 (12)	2.20 (11)
4	9	39! (9)	60 (2)	51! (1)	56 (8)	0 (7)	80 (5)	8.49 (9)	100 (1)	91 (6)	–0.270 (8)	66 (7)	2.26 (9)
5	15	29 (13)	46 (11)	44 (6)	56 (8)	39 (6)	37 (10)	0 (12)	90 (3)	84 (11)	–0.352 (12)	50 (13)	2.14 (13)
6	6	44! (5)	52 (7)	45! (5)	63 (4)	100 (1)	0 (12)	8.43 (11)	100 (1)	95 (5)	–0.257 (5)	65 (8)	2.39 (2)
7	4	51! (1)	53! (6)	42 (8)	66 (2)	100 (1)	0 (12)	12 (1)	99 (2)	97 (2.	–0.224 (3)	79 (1)	2.30 (7)
8	11	27 (14)	54! (5)	46! (4)	42 (12)	67! (2)	3 (1)	8.46 (10)	100 (1)	87 (8)	–0.342 (11)	58 (11)	2.33 (5)
9	1	48! (2)	49 (9)	42 (8)	60 (6)	100 (1)	87 (2)	12 (1)	100 (1)	96 (2)	–0.182 (1)	76 (2)	2.54 (1)
10	2	35! (12)	51 (8)	46! (4)	49 (11)	53! (3)	83 (4)	9.81 (2)	99 (2)	95 (4)	–0.285 (9)	63 (9)	2.20 (11)
11	3	43! (6)	61 (1)	48! (3)	57! (7)	100 (1)	87 (2)	8.55 (8)	100 (1)	98 (2)	–0.268 (7)	71 (4)	2.36 (3)
12	5	41! (7)	52 (7)	46! (4)	54 (10)	0 (7)	90 (1)	12 (1)	100 (1)	96 (3)	–0.219 (2)	72 (3)	2.33 (4)
13	7	46! (3)	49 (9)	49! (2)	61 (5)	0 (7)	86 (3)	8.61 (7)	100 (1)	98 (2)	–0.286 (10)	69 (6)	2.18 (12)
14	10	36! (11)	53! (6)	45! (5)	55 (9)	0 (7)	0 (12)	8.49 (9)	100 (1)	91 (3)	–0.266 (6)	59 (10)	2.27 (8)
15	13	36! (11)	55! (4)	48! (3)	66 (2)	52! (4)	57! (6)	8.91 (4)	0 (4)	86 (8)	–0.638 (15)	46 (14)	2.00 (15)
16	14	45! (4)	47 (10)	43 (7)	63 (4)	0 (7)	49! (8)	8.67 (6)	100 (1)	80 (12)	–0.368 (14)	54 (12)	2.13 (14)

The numbers in brackets show the ranking.
OSAS – obstructive sleep apnea syndrome; MTQ – *Mental Toughness Questionnaire*.
Explanations as in Table 1.

the sample (77%) consumed products made with brown or whole wheat flour, with cluster 3 having the best value (88%) and cluster 5 the worst value (69%). As regards meat, the number of those who consumed only white meat was low (32%), as the majority consumed both red and white meat (63%). Those who only consumed white meat mostly belonged to cluster 9 (40%), while in cluster 15 they were the least present (23%).

Smoking status

Forty-seven percent of the sample had never smoked. The reference values are presented in Table 2 by clusters. Five clusters (3, 6, 7, 9, 11) included only those who had never smoked and 5 clusters (1, 5, 8, 10, 15) those who smoked at the time of the study. The ratio of smokers and those who had given up smoking was the same in the sample (27% vs. 26%). The highest ratio of smokers was recorded in cluster 13.

Physical activity

As regards transportation behavior, 43% of the soldiers under examination used their car and almost 34% of them commuted on foot or by bicycle. Almost all members of 5 groups (2, 6, 7, 8, 14,) only used their car to go to work. There is 1 cluster (10) in the sample in which everybody commuted on foot or by bicycle. Almost 7% of the soldiers under examination spent > 1 h in their car. In 6 clusters (4, 9, 10, 11, 12, 13) nobody commuted to work by car. In Table 2, the proportion of transportation behavior that is worth extra points in this scoring system is shown by clusters.

As regards sporting habits, there is only 1 cluster (5) out of the 16 clusters that consists only of those people who did sports less than once a week. On the contrary, there are 4 groups (2, 7, 9, 12) in which everybody did sports as often as possible. More than 51% of the respondents had sufficient (2–3 times/day, min. 30 min with medium or higher intensity) sporting habits. Thirty-one percent of the soldiers did sports for at least 30 min/day. In Table 2 the scores related to sporting activities were calculated in respect of the number of people in different sporting categories (i.e., daily regularity, 2–3 times/week, weekly, less often). In the case of each cluster, the number of items was multiplied by the scores assigned to each category and then the result was divided by the number of persons in the cluster. Eighty-seven percent of the sample monitored their heart rate while doing sports and more than 81% of them experienced a medium level of fatigue after doing sports.

Sleeping

Table 2 summarizes the distribution of those waking up feeling fresh and having OSAS scores under 6 points in each cluster.

Mental toughness (MTQ)

In Table 2, the values obtained through scale transformation are shown by clusters.

Psychosomatic symptoms

In Table 2, the average values on the psychosomatic symptoms scale are shown by clusters. As regards backache, the shares of respondents who hardly ever or never experienced backache are presented by clusters.

On the basis of these factors, the soldiers' attitude towards a healthy lifestyle may be determined and their health behavior may be inferred. Based on the knowledge thus gained, the health improvement intervention possibilities become adequate. The authors found the 16 examined clusters that cover 100% of the samples ideal. It may be concluded that it is necessary to improve dietary habits both as regards conscious use of raw materials and of eating frequency.

DISCUSSION

The following groups were identified according to the variables and background variables concerning health behavior.

Clusters (according to the rank)

Leader (Cluster 9)

There are no diseases, the group is younger than average and nobody smokes. High daily physical activity and more appropriate sporting habits (in terms of frequency) are the characteristics of the group. In terms of the psychosomatic burden, the lowest mean values may be found here, along with the highest mean value as regards mental toughness. Therefore, this cluster comes first in the ranking.

Pursuer (Cluster 10)

This is the lowest average-age group, with high daily physical activity and appropriate sporting habits. The psychosomatic burden is below the average level but mental toughness is just average in this group. In addition, smokers can be found. This cluster comes second in the ranking. Better results could be achieved by higher-intensity workout and training strengthening mental toughness.

Pioneer (Cluster 11)

This is an average-age group with no diseases, in which nobody smokes and daily physical activity is high, while sporting habits are slightly less appropriate than average. The psychosomatic symptoms are less frequent than average and the group members' mental toughness takes the second best value. This cluster comes third in the ranking. Its members could advance by raising daily physical activity and doing sports more frequently.

Enduring (Cluster 7)

The age of this group's members is lower than the average age, similar to the previous group. Their daily physical activity is low but they spend more time doing sports. Nobody smokes or suffers from chronic diseases. There is only a low burden of psychosomatic symptoms and mental toughness is above average. This cluster comes fourth in the ranking. Its members could get into a better health behavior zone by enhancing their daily physical activity.

Gambler (Cluster 12)

This group is characterized with the highest daily physical activity and the most frequent workout with the highest intensity. Members of this group are active smokers or have already stopped smoking; however, there are no recorded diseases. The burden of psychosomatic symptoms is low and the average score for mental toughness is high. This cluster comes fifth in the ranking. It differs from the leading clusters in terms of eating habits. Intervention opportunities related to both eating and smoking habits could bring the highest benefits.

Above average (Cluster 6)

Low daily physical activity and the average or below-average frequency of doing sports are characteristic features of this group's members, none of whom smokes or suffers from a disease. The occurrence of psychosomatic symptoms is less frequent than average and mental toughness is the highest in this group. Therefore, it comes sixth in the ranking. The way forward could be enhancing daily physical activity.

In good shape (Cluster 13)

This is a group of soldiers with proper weight, and with high daily physical activity and almost average sporting habits. Members of this group do not suffer from diseases but they smoke. They report just a few psychosomatic symptoms but their mental toughness is low. They come seventh in the ranking. To improve their health behavior, different stress and distress reducing techniques, along with smoking cessation programs, self-awareness training and behavior therapies could bring most health benefits.

Aspiring (Cluster 2)

This group consists almost only of middle-aged men. They have no chronic diseases that would need treatment, their psychosomatic stress is low and their mental toughness is higher than average. All of them do a lot of sports; however, their everyday physical activity is low and they smoke or have just stopped smoking. They come eighth in the

ranking. The best results in this group could be achieved by programs that facilitate daily physical activity and make it easier to stop smoking.

Average (Cluster 4)

This group typically consists of overweight soldiers and their number is above average. Their age is above average; they smoke or have already stopped smoking. The group displays a lower-than-average psychosomatic stress and mental toughness at about the average level. Its members do not suffer from diseases, their daily physical activities are more frequent and their sporting habits are slightly worse than average, thus they come ninth in the ranking. The most effective health improvement trend would probably involve body weight management and giving up smoking.

Prodigal (Cluster 14)

This group consists of young people. They do not suffer from diseases, their daily physical activity is low, their sporting habits are close to average and everybody smokes. The psychosomatic stress lower than average and mental toughness above the average level are characteristic features of the group. It comes 10th in the ranking. Members of this group could advance to a higher-score cluster by changing their smoking habits and enhancing daily physical activity.

Close to average (Cluster 8)

Members of this group are older than average and there are more obese persons than the average number in other groups. Their daily physical activity is low and the time spent doing sports is close to the average rate. The group members suffer from no diseases. The number of smokers or those who have stopped smoking is lower than average. The occurrence of psychosomatic symptoms is at the average level while mental toughness is above average. This cluster comes 11th in the ranking. The way forward could be enhancing daily physical activity and body weight management.

Survivor (Cluster 3)

This is the second group with the highest share of women, none of whom smoke. All of them have reported diseases and a great number of them have weight problems. In this group, the frequency of daily physical and sporting activities is at the average level but the incidence of sleep apnea is higher than average. The psychosomatic stress is higher than average and mental toughness is at the average level. This cluster comes 12th in the ranking. The most effective health improvement trend would probably be body weight management.

Threshold (Cluster 15)

In this group, there are no recorded diseases, very low daily physical activity and sporting habits close to average. The group consists of people who all wake up tired. They come 13th in the ranking. There is a heavy burden of psychosomatic symptoms and their mental toughness is low.

Resigned (Cluster 16)

This is the second oldest group. The number of obese people is above the average level. Their daily physical activity and sporting habits are close to average. All members of the group smoke or have smoked. All of them suffer from one or more chronic diseases. They are ranked 14th. Along with reducing smoking, mental training and stress reducing techniques are preferred.

Hesitating (Cluster 5)

Members of this group are older than average. Solely those who do not do any sports belong here, their daily physical activity is low and the occurrence of obesity is higher than average. Active smokers, those who have already stopped, non-smokers and those whose condition has deteriorated due to diseases are in this cluster. They are ranked last but one. In this group, the best results could be achieved by physical activity incentive programs.

Struggler (Cluster 1)

Women and older persons are over-represented in this group. All of them have experienced chronic diseases. In terms of sleep, relaxation and psychosomatic symptoms, their situation appears the least favourable. In addition, the group members' mental toughness is also the poorest. They come last in the ranking. This group can reach the highest health benefits by employing various stress and distress reducing techniques, self-awareness training and behavior therapies, apart from therapies they undergo because of their diseases.

At the community level

The sample is suitable to make it representative even of the whole army or specific corps. Thus, health behavior pattern can be mapped onto different scenes to facilitate efforts of the planned force generation. At the corps level, preventive professional training can become easier to plan and can be better targeted. The dimension reducing procedure of this cross-sectional study is suitable, and forms the appropriate basis, for making follow-up easier in the context of the Hungarian Defense Forces.

At the individual level

The sample would provide a more nuanced picture of health behavior habits. For instance, among those who came second in the ranking (Cluster 10, "Pursuer") 30 people are smokers. If the participants had just been divided into 2 groups of smokers and non-smokers, these soldiers would have been included in the group of smokers and would have been sent to a smoking cessation therapy, whether or not they wanted to break this habit. The authors think otherwise. By focusing on strengths, such as good behavior patterns, higher health benefits for those getting high scores can be expected anyway. In the cluster including soldiers of proper weight (Cluster 13, "In good shape"), the eating habits were not better, the respondents had no outstanding physical activity, they were not the youngest and all of them were smokers. Nonetheless, they received the seventh highest score. What should be done when there are no specific strengths that could be developed with a moderate energy input? Offering a smoking cessation therapy would be obvious, but what if the person concerned is not willing to do so?

With mental fitness programs (e.g., Williams LifeSkills), as this cluster gained a lower mean value than the average, the authors could proceed to a better ranking. According to the authors, in view of their clustering procedure, it is easier to find ways within the world of various health prevention factors to gain health benefits than if they just focused on bad health behavior habits and tried to change them. For this reason, the authors find it necessary to group and customize their health improvement or health prevention programs within these groups so that they could serve as the basis for future studies. These could entail the group's dynamics and the minimum effort on the part of an individual in order to advance to clusters with higher scores.

CONCLUSIONS

According to the authors, the army personnel can be divided into groups by taking the similarities and differences in health behavior into account. The so obtained health improvement intervention opportunities of the clusters and the tracking of their reults can be made easier. It is seen in several clusters that their members fall in groups where there are no diseases despite harmful attitudes. Members of these clusters can increase the number of healthy life years with appropriate intervention. The health behavior factor which should be changed in order to gain the most desirable health benefits for soldiers can be chosen.

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