ORIGINAL ARTICLE

Secular trends in BMI changes among the military population between 2000 and 2010 in Poland – a retrospective study

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Abstract

OBJECTIVES: The aim of the study was to investigate secular trends in body mass index among the young military population. This involved a comparison of changes in the body mass index (BMI) and height among 19-year-old males from 11 successive birth cohorts.

DESIGN: Samples of a total of 37,934 conscripts between 2000 and 2010 were examined using the BMI defined as weight (kg)/ height (m^2).

SETTING: The analysis included each medical record for all recruits reporting for examination between 2000 and 2010 to the Military Headquarters in south-east of Poland. Underweight, overweight and obesity were estimated according to World Health Organization criteria. Means of the BMI, body mass and height were calculated for the following three subgroups: (1) rural resident; (2) urban resident (towns with population of 10,000+); and, (3) urban resident (cities with populations of 100,000+).

RESULTS: Secular trends in body mass index have changed significantly between 2000 and 2010. A statistically significant increase in both the prevalence of overweight (10.5% to 15.6%) and obesity (2.5% to 3.8%) were observed. However, the prevalence of underweight also increased from 8.3% to 10.2%.

CONCLUSIONS: Secular trends in BMI have been unfavourable for the military population over the last 10 years studied and, therefore, the need for promotion of health among recruits is very important.

INTRODUCTION

An epidemic of overweight and obesity has become a serious and growing problem for public health systems. It has been documented for all age groups including young people (WHO 2008; Georgiadis & Nassis 2007; Booth *et al.* 2007). According to the World Health Organization (WHO), worldwide obesity has nearly doubled from 5% to 10% among men and from 8% to 14% among women between 1980 and 2008, and in 2008 1.5 billion adults aged 20 and older were overweight (Finucane *et al.* 2011; Kelly *et al.* 2008; WHO 2008).

Recent military studies have demonstrated that military populations also are experiencing a trend towards increased body mass index (BMI), which mirrors that of the general population. The prevalence of overweight and obesity among civilian recruits to the military service has increased during the last decades (Sudom *et al.* 2011; Bae *et al.* 2011; Fear *et al.* 2011; Sudom *et al.* 2010; Gantt *et al.* 2008; Hsu *et al.* 2007; Nolte *et al.* 2002; Bielecki *et al.* 2000). Since military recruits are drawn from the civilian population, negative trends observed in many countries in body mass index may have an impact on the ability of military organizations to recruit healthy and high-quality military personnel. The physically demanding nature of military service requires from recruits a good level of health and fitness, therefore the body mass index, as one component of physical fitness, is an important factor in predicting effectiveness in military service as well as on military operations. A recent study has shown that 80% of physical readiness test failures occurred among overweight or obese personnel (Gantt *et al.* 2008). Therefore, changes in trends in BMI may not only have an impact on the prevalence of obesity and overweight, they also affect the effectiveness of personnel in military service.

The aim of the present study was to investigate the secular trends in body mass index among the young military population.

MATERIAL AND METHODS

A retrospective analysis was conducted among 37,934 randomly selected 19-year-old male recruits from south-eastern Poland. The analysis included each medical record for all recruits reporting for examination between 2000 and 2010 to the Military Headquarters in the Podkarpacki region (south-east of Poland). The study was carried out under the auspices of the Voivodeship Chief of the Ministry of National Defence.

The analysis was conducted with the use of a questionnaire. The subject of the analysis was the somatic development of young adults and particularly the BMI, which is defined as the weight in kilograms divided by the square of the height in meters (kg/m^2). Underweight, overweight and obesity were estimated according to World Health Organization criteria, and categorized as follows: underweight (17.00–18.49); normal weight (18.50–24.99); overweight (25.00–29.99); and, obese (over 30.00) (WHO 2004; WHO 2000; WHO 1995).

Means of the BMI, body mass and height were calculated for the following three subgroups: (1) rural resident; (2) urban resident (towns with population of 10,000+); and, (3) urban resident (cities with populations of 100,000+).

The gathered data were prepared using the statistical package STATISTICA 10.0. The results presented are for mean value and standard deviation, median, upper quartile, lower quartile and variation interval for height, body mass and BMI. An ANOVA was carried out to investigate changes in BMI.

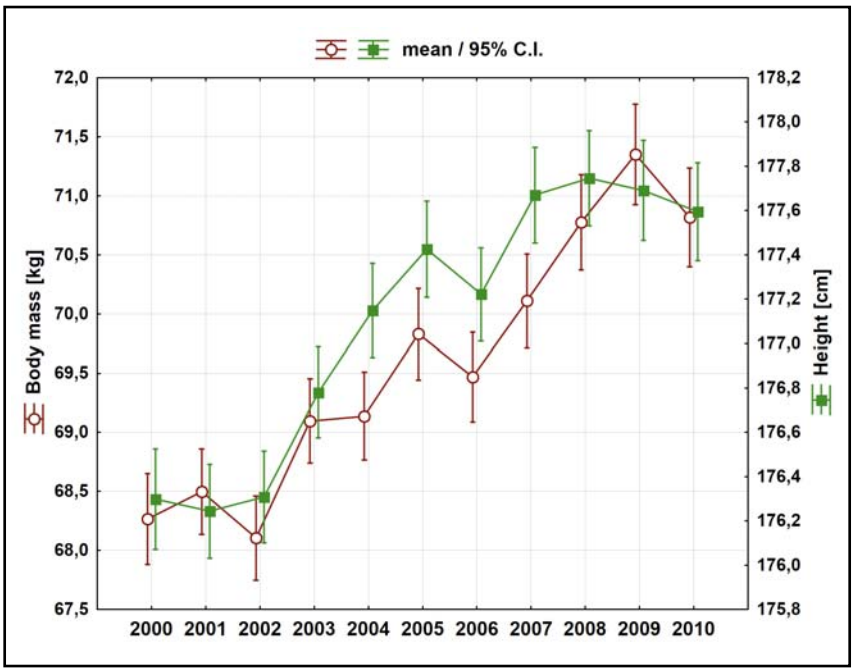

Fig. 1. Height and body mass distribution.

RESULTS

Mean height increased from 176.3 cm to 177.6 cm between 2000 and 2010, (p=0.0000). Between 2000 and 2010 mean height values varied, but the trend was for an increase. Between 2004 and 2010 the trend was for an increase in the mean height, which showed statistical significance (Table 1; Figure 1). The mean body mass steadily increased from 68.3 kg in 2000 to 70.8 kg in 2010, and this showed statistical significance (p=0.0000), as shown in Table 2 and Figure 2. The mean BMI increased from 21.9 kg/m^2 in 2000 to 22.2 kg/m^2 in 2005,

Tab. 1. Height distribution of population studied.

Year	Height						
	N	$\bar{x}$	Me	s	c_{25}	c_{75}	CI
2000	3,004	176.3	176	6.4	172	180	176.1–176.5
2001	3,425	176.2	176	6.3	172	180	176.0–176.5
2002	3,547	176.3	176	6.3	172	180	176.1–176.5
2003	3,637	176.8	177	6.3	173	181	176.6–177.0
2004	3,540	177.1	177	6.4	173	181	176.9–177.4
2005	3,308	177.4	177	6.3	173	182	177.2–177.6
2006	3,702	177.2	177	6.5	173	182	177.0–177.4
2007	3,612	177.7	178	6.6	173	182	177.5–177.9
2008	3,435	177.7	178	6.4	173	182	177.5–178.0
2009	3,407	177.7	177	6.7	173	182	177.5–177.9
2010	3,317	177.6	178	6.5	173	182	177.4–177.8
p-value$_{ANOVA}$	0.0000***						

N - number of respondents; $\bar{x}$ - mean value; Me - median;
S - standard deviation; c_{25} - 25th percentile; c_{75} - 75th percentile;
CI - confidence interval

Tab. 2. Weight distribution of population studied.

Year	Body mass						
	N	$\bar{x}$	Me	s	c_{25}	c_{75}	CI
2000	3,003	68.3	67	10.8	61	73	67.9–68.7
2001	3,420	68.5	67	10.8	61	74	68.1–68.9
2002	3,544	68.1	67	10.8	61	73	67.7–68.5
2003	3,633	69.1	68	11.0	62	75	68.7–69.5
2004	3,538	69.1	68	11.3	62	75	68.8–69.5
2005	3,308	69.8	68	11.4	62	75	69.4–70.2
2006	3,701	69.5	68	11.7	62	75	69.1–69.8
2007	3,612	70.1	68	12.2	62	76	69.7–70.5
2008	3,435	70.8	69	12.1	62	77	70.4–71.2
2009	3,405	71.4	69	12.7	63	77	70.9–71.8
2010	3,317	70.8	69	12.3	62	77	70.4–71.2
p-value$_{ANOVA}$	0.0000***						

N - number of respondents; $\bar{x}$ - mean value; Me - median;
S - standard deviation; c_{25} - 25th percentile; c_{75} - 75th percentile;
CI - confidence interval

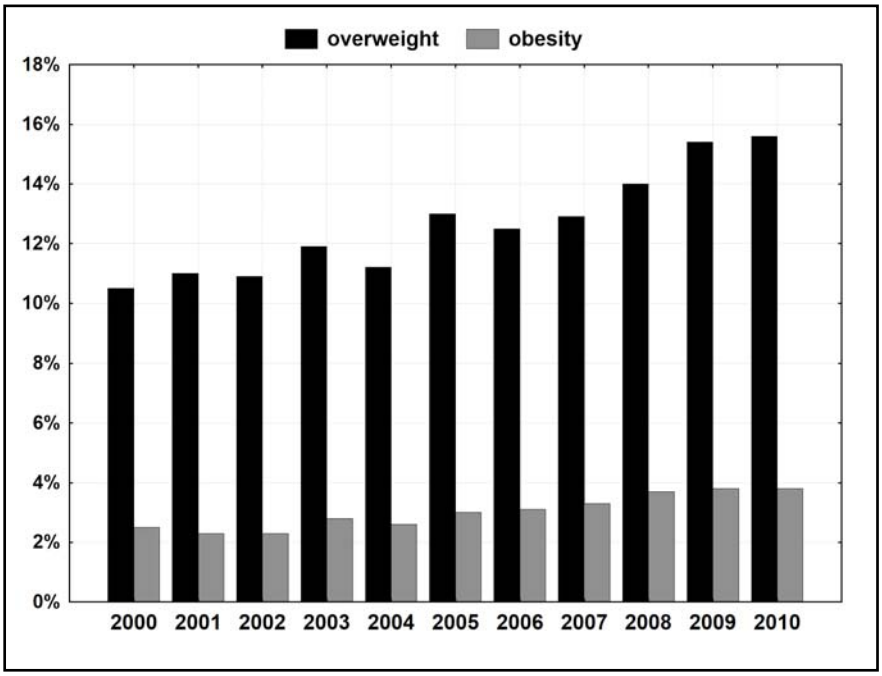

Fig. 2. Prevalance of overweight and obesity.

and then varied for the next three years. A significant increase was observed from 21.8 kg/m^2 in 2008 to 21.9 kg/m^2 in 2009, and this showed statistical significance (p=0.0000), as in Table 3. Mean BMI increased for individual years, and especially in range c75, while in range c25 it was stable. Statistically significant increases in the prevalence of obesity were seen between 2000 and 2010 (2.5% to 3.8%, p=0.0000), and in overweight (10.5% to 15.6%) for the whole population, as shown in Table 4. However, the prevalence of underweight increased from 8.3% in 2000 to 10.2% in 2010, and in 2002, 2006, 2007 and 2010 the increase was statistically significant; the exceptions to this increase were the years 2001 (7.0%) and 2009 (7.1%) where the underweight decreased (p=0.0000), as in Table 4.

The majority of the study's respondents (53.1%) were from rural areas, with 33.1% coming from cities with populations of 100,000+, and the rest (13.8%) from towns of 10,000+. When stratified by place of residence, the prevalence of overweight and obesity was seen to be highest among urban residents: overweight was 13.7% and obesity 3.4% in cities of 100,000+. The corresponding figures for cities 100,000+ were overweight 11.5% and 2.2% obesity; and, in rural areas the equivalent values were overweight 12.2% and obesity 3.0%. The prevalence of underweight was as follows: towns 10,000+; 10.2%; cities 100.000+; 8.6%; and rural areas: 8.1%. Differences between the studied groups are very significant (p=0.0000***).

DISCUSSION

The aim of the present study was to investigate the secular trends in body mass index among young military population. Overall, the body mass index changed significantly between 2000 and 2010. Statistically sig-

Tab. 4. BMI classification in population studied.

Year	BMI Classification (p=0.0000***)				Total
	Underweight 17.00–18.49	Normal weight 18.50–24.99	Overweight 25.00–29.99	Obesity >30	
2000	248 (8.3%)	2.364 (78.7%)	316 (10.5%)	75 (2.5%)	3.003
2001	241 (7.0%)	2.722 (79.6%)	377 (11.0%)	80 (2.3%)	3.420
2002	321 (9.1%)	2.757 (77.8%)	385 (10.9%)	81 (2.3%)	3.544
2003	283 (7.8%)	2.818 (77.6%)	432 (11.9%)	100 (2.8%)	3.633
2004	316 (8.9%)	2.734 (77.3%)	397 (11.2%)	91 (2.6%)	3.538
2005	268 (8.1%)	2.509 (75.8%)	431 (13.0%)	100 (3.0%)	3.308
2006	372 (10.1%)	2.751 (74.3%)	464 (12.5%)	114 (3.1%)	3.701
2007	336 (9.3%)	2.692 (74.5%)	465 (12.9%)	119 (3.3%)	3.612
2008	296 (8.6%)	2.531 (73.7%)	480 (14.0%)	128 (3.7%)	3.435
2009	243 (7.1%)	2.505 (73.6%)	526 (15.4%)	131 (3.8%)	3.405
2010	304 (9.2%)	2.370 (71.5%)	516 (15.6%)	127 (3.8%)	3.317
Total	3.228	28.753	4.789	1.146	37.916

Tab. 3. BMI distribution of population studied.

Year	BMI						
	N	$\bar{x}$	Me	s	c_{25}	c_{75}	CI
2000	3,003	21.9	21.5	3.1	19.9	23.2	21.8–22.0
2001	3,420	22.0	21.5	3.1	20.0	23.4	21.9–22.1
2002	3,544	21.9	21.4	3.1	19.8	23.3	21.8–22.0
2003	3,633	22.1	21.5	3.1	20.0	23.6	22.0–22.2
2004	3,538	22.0	21.5	3.2	19.9	23.4	21.9–22.1
2005	3,308	22.2	21.6	3.3	19.9	23.7	22.0–22.3
2006	3,701	22.1	21.5	3.4	19.8	23.5	22.0–22.2
2007	3,612	22.2	21.6	3.4	19.9	23.7	22.1–22.3
2008	3,435	22.4	21.8	3.5	20.0	24.1	22.3–22.5
2009	3,405	22.6	21.9	3.5	20.2	24.3	22.4–22.7
2010	3,317	22.4	21.8	3.5	19.9	24.2	22.3–22.5
p-value$_{ANOVA}$	0.0000***						

N - number of respondents; $\bar{x}$ - mean value; Me - median;
S - standard deviation; c_{25} - 25th percentile; c_{75} - 75th percentile;
CI - confidence interval

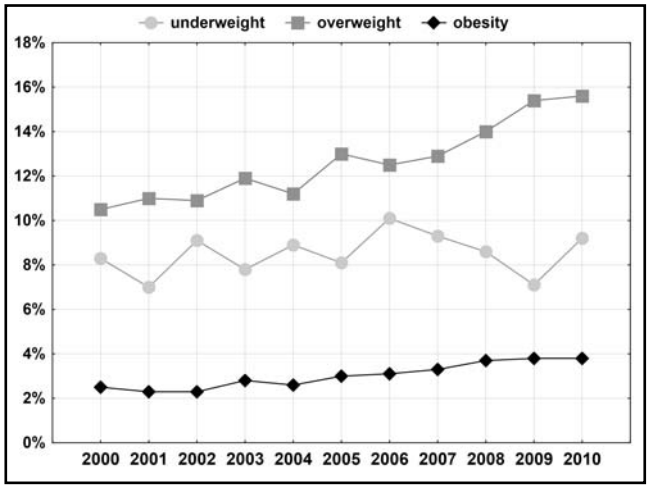

Fig. 3. Underweight overweight and obesity trend and age.

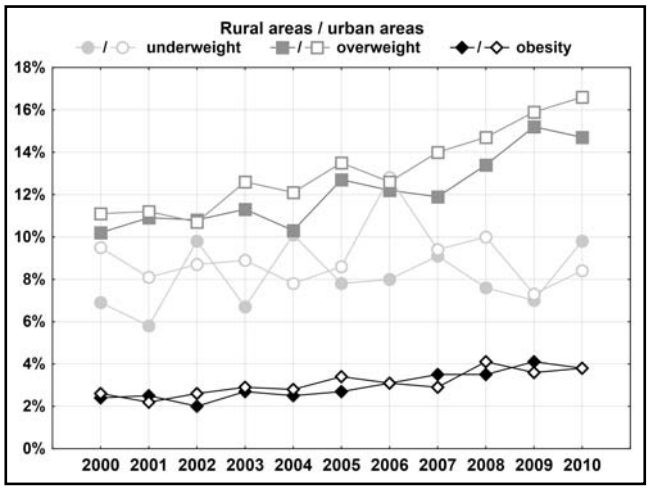

Fig. 4. Underweight overweight and obesity trend and place of residence.

nificant increases in both the prevalence of overweight (10.5% to 15.6%) and obesity (2.5% to 3.8%) were observed. However, the prevalence of underweight also increased (8.3% to 10.2%). Our study revealed a gradual and constant increase in underweight, overweight and obesity among military population of 19-year-old recruits; a result which was also obtained by Bielecki *et al.* (2000) who found that between 1965 and 1995 there was an increase in both the overweight (6.7% in 1965, 10.9% in 1986 and 13.7% in 1995) and underweight (5.1% in 1965, 6.3% in 1986 and 7.8% in 1995) popula-

tions. Likewise, similar findings regarding underweight were obtained by Klos *et al.* (2005). Recent studies of military populations have demonstrated that there is a trend toward increased BMI and a greater prevalence of overweigh and obesity (Fear *et al.* 2011; Packnett *et al.* 2011; Sharp *et al.* 2002). The findings of this study support those of Neovius *et al.* (2010) who reported that the prevalence of obesity had increased continuously from 1970 to 2005. However, the study performed by Sundquist *et al.* (2010) found that the prevalence of obesity was not increasing among young men.

The secular trends changes in BMI and the increasing prevalence of overweight and obesity in young military recruits over time correlates with similar changes in the general population (Packnett *et al.* 2010; Hsu *et al.* 2007; Franke *et al.* 2002; Flegal *et al.* 1998). The prevalence of overweight among the Polish military population of young adults increased by about 5.6% from 1975 to 2004, whereas in the US military population it increased by about 25% from 1960 to the 1990s (Kłos *et al.* 2005; Kłos & Bertrandt 2003; Nolte *et al.* 2002; Flegal *et al.* 1998).

The last decade was a period when a number of positive changes in the socio-economic conditions in Poland were observed, including reduced unemployment, increased wages, a reduced number of the least educated people and significant increase in people with higher education. Despite the lack of a coordinated programme to combat overweight and obesity in children and adults, changes have occurred that could affect the results observed by us. During this period, the number of mandatory physical education classes in schools and middle schools increased to 180 minutes a week. The number of sports fields, gyms and new swimming pools has increased. The majority of primary and secondary school vending machines have removed sugary drinks and sweets. The Chief Sanitary Inspectorate and the Polish Federation of Food association has conducted a nationwide educational programme entitled "Keep your form!" promoting a balanced diet and physical activity among youth. In 2007, in accordance with European Union guidelines the "National Programme for the prevention of overweight and obesity and chronic non-communicable diseases through improved nutrition and physical activity for the years 2007–2011" was developed (National Programme for the Prevention of Overweight and Obesity and Chronic non-communicable diseases through Improved Nutrition and Physical Activity for 2012–2014, Ministry of Health 2012). In the mass media information has increasingly appeared about the risks of overweight and obesity in children and adolescents. In recent years, the media has been dominated by a kind of cult of thinness. In contrast to overweight and obesity, thinness has become an important factor in achieving social recognition and popularity.

Woynarowska, 2004 from an evaluation of the nutritional behaviour of adolescents in Poland, found that nearly every fourth boy and every second girl has a need to lose weight . With age, the need has clearly intensified among girls. Meanwhile, among boys the percentage of weight loss and those who believed that they should lose weight decreased with age, and the number of boys who thought that they should put on weight significantly increased. In the opinion of Ulijaszek & Koziel (2007) there was no significant change in overall dietary energy availability for any category of East European nation between 1990–1992 and 2005 (Haase *et al.* 2004). On the basis of this macro-level evidence, the increasing rates of obesity in East European countries cannot be attributed to increased dietary energy availability. There are three possible, non-exclusive macro-level explanations for the emergence of obesity that do not rely on increased per capita daily energy availability. The first is that physical activity declined throughout the period 1990–1992 and 2005. The second is that increased real income resulted in increased economic access to foods, generally. The third is that increased economic inequality resulting in increased inequality of access to dietary energy. Haase *et al.* (2004) analyzed data from the International Health and Behaviour Survey carried out among university students in 23 countries between 1999 and 2001 which shows that female youth in East European countries (Bulgaria, Hungary, Poland, Romania, Slovakia) are much less active than their counterparts in Western Europe and North America, while male East European students are only slightly less active than their Western European and North American counterparts. Ulijaszek (2007) suggests that the obesity patterns observed in East European nations reflect a decline in physical activity and differences in wealth. The two are likely to be linked, since greater wealth is usually associated with greater overall consumption, not just of food energy. This usually includes the consumption of goods that can contribute to a decline in physical activity, such as cars, televisions and computers. In this sense, obesity in Eastern Europe can be considered as much a disorder of convenience as elsewhere in the industrialized world. Perhaps these observations by Ulijaszek (2007) may explain the increase found by us in the mean BMI in different years, especially in the range c75, while the range c25 showed stabilization.

In our study, place of residence had an important effect on the prevalence of overweight and obesity. We found overweight and obesity significantly more often among urban conscripts than those from rural areas. The most common occurrence of overweight and obesity was observed in areas of large urban agglomerations. Similar results were obtained by Kłos & Bertrandt (2003), who found a steady increase in obesity among the population of men from large cities throughout the period analyzed by them . However, recent data obtained by Befort *et al.* (2012) from the US indicate the presence of obesity among youth might be higher in rural areas.

In the Polish military population, an increase of the proportion of underweight by 3% in the period from 1965 to 1995 was also observed (Bielecki *et al.* 2000). The study of Kłos & Bertrandt (2003), also revealed a systematic increase, over the years, of overweight occurrence among young men coming from big cities. Between 1996 and 2003, a considerable percentage decrease in people with underweight was found among men from both the cities and small towns (31.1–13.4%) and from the rural areas (24.3–11.8%). At the same time the prevalence of overweight increased from 5.1% to 16.9% (cities and small towns) and from 3.9% to 15.1% (rural areas). The prevalence of underweight among the group of men coming from cities and small towns was (43.0% in 2002 and 26.3% in 2003). In the same group the percentage of obese men decreased from 8.5% in 1996 to 3.2% in 2003. Among recruits from rural areas the highest prevalence of underweight was 40.2% in 1997 and the lowest was 26.0% in 1996. The percentage of obese men slightly decreased from 4.9% in 1997 to 2.4% in 2002.

There are particular limitations of this study. Until 2010, Poland operated a system of conscription for military service with recruits drawn from across the general population; therefore, there might be some inconsistencies when comparing the evidence of the literature. Since recruits from other countries represent professional military services they are general healthier than their peers in the general population. Furthermore, until 2010 women in Poland were not recruited for military service, though the gender differences are not mentioned they might be very important in examining the secular trends in BMI changes. It must be also noted that another limitation of this study is the age of the population of recruits, where young individuals of 19 years of age are still growing, and this may be reflected in the BMI scores. What is more, despite the fact that BMI is correlated with the percentage of body fat, our study does not provide information about the distribution of body fat.

In conclusion, despite the limitations of this study, secular trends in BMI were found to be unfavourable in the military population over the last studied 10 years. Political and economic transformation, progressive computerization, the increase in the number of cars in the household, the expansion of supermarket chains and fast-food restaurants, and advertising in the media have encouraged the development of overweight and obesity in men in this age group. At the same time, during the observed period a number of changes to prevent this adverse phenomenon have been made, as previously described. Because it is easier to prevent than to cure, most of the activities and resources should be focused on prevention. The main task should be to develop a programme of health education, particularly in the fields of rational nutrition and increased physical activity, and create the infrastructure for its implementation.

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