REVIEW

Improvement of mental health among Chinese plateau military personnel, 1993–2017: a cross-temporal meta-analysis of the Symptom Checklist-90

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Abstract: Extreme occupational environments influence the military personnel's psychological functions. This study aims to investigate Chinese plateau soldiers' mental health, its changes over time and its correlation with social indicators. A cross-temporal meta-analysis of Symptom Checklist-90 (SCL-90) was employed to resolve these problems. Forty-six valid data with 23,481 samples at high altitude were screened from 34 journal articles between 1993 and 2017. The mental health of Chinese plateau soldiers showed significant improvement. The eight factor scores of SCL-90 showed a significantly negative correlation with years. The scores of Chinese plateau soldiers presented several peaks in the years 2000, 2008, and 2017, suggesting that the mental health may be influenced by momentous military events. The current-year ratio of defense budget to gross domestic product and divorce rate showed a significant correlation with mental health. The improvement of consumption level index could better explain the improvement of mental health in plateau soldiers. Also, the mental health level of soldiers might affect the 5-year-later consumption level index. The influence of social changes on mental health cannot be neglected. The characteristics of military mental health should be considered when designing the prevention, intervention, and treatment programs, and preparing policies to care military service members.

Keywords: cross-temporal meta-analysis, military personnel, mental health, Symptom Checklist-90

Introduction

The plateau is considered as an important defense area for the Chinese military. On June 18, 2017, the China–India border standoff occurred, making the Chinese military duty to maintain border stability and keep territorial integrity very onerous.[1]

Previous researches

The plateau soldiers work and live in a special military operating environment. Their mental health has been a major concern for many of the researchers. The research on Chinese plateau soldiers' mental health has been carried on over the past 30 years, and these researches were related to symptoms, characteristics, influence factors, interventions, and so on.[2–5] A self-reporting psychometric instrument of Symptom Checklist-90 (SCL-90) was used to investigate the status of

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mental health in Chinese plateau soldiers, but the results based on this instrument were widely divergent. The incidence rate range of mental health problems or disorders was from 6.44% to 73.10%.[6,7] Most of the studies focused on the influential factors, such as gender, age, education, length of military service, rank, and so on. Personality, coping style, social support, life events, and army motivation were also reported as influential factors.[8]

Besides, some studies believed that Chinese plateau soldiers' mental health was worse than that of Chinese adults and soldiers,[9–11] while few other studies showed a contradictory conclusion.[7] By meta-analysis,[12] Chinese plateau soldiers' mental health was proved to be worse than that of garrison troops present in cities and towns.[13] They also suggested that military and environmental factors must be considered while evaluating the mental health levels of military personnel.[13] However, this research did not answer the questions of how plateau soldiers' mental health was changed over time and how social changes affected it.

Social changes

The cross-temporal meta-analysis is an effective practice to explore the relationship between the psychological values and the social indicators.[14–16] This method has been used in many Chinese mental health studies among middle school students,[17] college students,[18] teachers,[19] urban peasant-workers,[20] and servicemen.[21] The research conducted in the Chinese military from 1990 to 2007 suggested that the level of Chinese military mental health has been improved over time, but it did not reveal the relationship with social indicators. Hence, it is necessary to investigate the relationship between social indicators and military mental health with the help of Military Demand-Resource (MDR) model.

US army has proposed MDR model for evaluating the military personnel mental health.[22] This model integrated the internal and external resources. Family and policy serve as the key external resources for strengthening individuals' performance and resilience. Based on this, three social indicators were chosen to quantify the external resources. The divorce rate (DR) and the consumption level index (CLI) reflect the family resource, and the ratio of defense budget to gross domestic product (DB/GDP) reflects the policy resource. These sources are officially obtained from the China National People's Congress, Ministry of Civil Affairs, National Bureau of Statistics, Chinese White Papers on National Defense, and central and regional government drafted budget.

This study aimed to investigate these plateau soldiers' mental health, its changes over time, and its correlation with social indicators.

Method and materials
The validity and reliability of SCL-90 scale

The SCL-90 scale consists of 90 items and 9 factors,[23,24] and it is regarded as the most popular psychological inventory in China.[25–28] It is widely used among the Chinese military till today. A number of studies have evaluated the clinical validity of this self-rating scale.[29–32] A large body of evidence confirmed the validity and reliability of SCL-90 as a measure of military mental health.[33–38]

Literature retrieval

All the studies were retrieved by using the China Academic Journal Network Publishing Database (CJAD), ScienceDirect and Web of Science (for journal articles). The following keywords of "plateau" or "high altitude", and "mental health" or "mental hygiene", and "military" or "soldiers" or "officers" were used as topics, keywords, and titles to search the relevant literature. If the data collection year was not mentioned in the article, the variable of the year was set as the published year of the article minus 2.[39] Thus, the year range in our research was from 1993 to 2017. The data in the year 1994 and 2016 were missing.

Inclusion criteria

The studies should meet the following criteria for inclusion:

a) The participants were Chinese plateau soldiers, including armed police.
b) The studies used the 1–5-point Likert SCL-90 scale as the measuring tool.
c) The studies reported sample size, mean, and standard deviation (N, *M, SD*) of SCL-90 9-factor scores.

Exclusion criteria

The studies with the following criteria were excluded:

a) The participants were under special scenarios including performing tasks, rushing into the plateau, military exercise, and training.

b) The studies used interventions, including psychological training and oxygen inhalation.

c) The participants were only recruiters, medical and nursing personnel, and child group.

d) If similar data were from the same author, only one data can be retained.

e) Case reports, reviews, meta-analysis studies, and duplicate reports were excluded.

Variables encoding

According to the steps of meta-analysis and the suggestions from Rosenthal (1995),[40] the journal types, plateau areas, and nationalities of each article were encoded. The plateau areas were divided according to garrison locations reported in the articles.

Data analyses

The cross-temporal meta-analysis emphasized the time effect and was supposed to be a within-scale meta-analysis.[41–43] According to the previous research,[44] the changes between M and SD with the year in both unweighted and weighted ways by sample size (n) were examined. These data showed ecological correlations.[45]

To exclude the influence of journals and subjects' characteristics, journal types, plateau areas, nationalities, and the year were analyzed in a stepwise regression way.[43,44]

We used linear regression equations based on the weighted means (y) of the year (x) to evaluate the concrete number of psychological indexes that changed over time.[44,46] Based on these equations, the mean scores of the first year 1993 (M_{1993}) and the last year 2017 (M_{2017}) could be obtained by calculation. M_{SD} was the mean of standard deviations. $M_{change} = M_{1993}–M_{2017}$, d was effect size ($d=M_{change}/M_{SD}$), $r^2 = d^2/(d^2+4)$. According to Cohen (1988),[43] the effect size was low, middle, and high if the effect size (d) ranged from 0.2 to 0.5, 0.5 to 0.8, and more than 0.8.

With the help of lag correlation analysis, it might be possible to reveal whether sociocultural environment changed the mental variables or the mental variables changed the sociocultural environment.[17,47,48] So, we matched the SCL-90 scores with the current-year, 5-years-ago, and 5-years-later social indicators (China's national economic and social development is basically considered as a five-year cycle) and examined their correlation with DB/GDP, CLI, and DR separately. The data of social indicators from 2018 to 2020 and the DR of 2017 are missing.

SPSS 24.0 and Excel 2016 were used to perform statistical analyses.

Results

Total sample and variable-encoding

The literature search yielded 34 articles, including 46 valid data with 23,481 Chinese plateau soldiers' samples (see Table 1). The results of variable-encoding are presented in Table 2.

Changes over time

The SCL-90 scores of Chinese plateau military personnel were decreased steadily between 1993 and 2017, showing a negative correlation between 8 factor scores and year. But the somatization showed no significant effect over time and the score was relatively high. Only the SD of paranoid ideation showed a significant difference with the year (see Table 3 and Figure 1). By taking obsessive-compulsive and interpersonal sensitivity factors as examples, the changes in the 8 factor scores were linear and not curvilinear overtime (see Figures 2 and 3).

The effect of year

The SCL-90 score was considered as a dependent variable in the regression equation. No matter whether the journal types, the plateau areas, and the nationalities were accepted into the equation or not, the effect of the year was shown to be significant (see Table 4).

The 8 factor scores were ranged from 1.028 (paranoid ideation) to 2.865 (hostility) in 1993 and were from 0.476 (paranoid ideation) to 2.481 (hostility) in 2017. The mean SD was from 0.50739 (phobic anxiety) to 0.6504 (interpersonal sensitivity). The means of 8 factor scores were declined from 0.60 (obsessive-compulsive) to 0.24 (phobic anxiety) over time. The effect size d was ranged from 0.473 (phobic anxiety) to 0.98996 (obsessive-compulsive), and the rate (r^2) was ranged from 5.297% (phobic anxiety) to 19.68% (obsessive-compulsive). According to Cohen (1988),[49] the variation of phobic anxiety remained the lowest and belonged to "low effect"; the declination in hostility, anxiety, and psychotism belonged to the middle degree; the range of ability of depression, interpersonal sensitivity, paranoid ideation, and obsessive-compulsive belonged to "high effect". The decent degree of obsessive-compulsive was the highest (see Table 5).

Table 1 Total samples

	1993	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2017
Data (n)	1	1	2	1	6	3	1	1	1	1	1	2	1	2	4	2	2	2	1	6	1	3	1
Total sample	185	213	351	80	562	317	156	143	769	256	462	737	1512	1652	1172	1022	879	414	96	476	236	11,635	156

Table 2 Variables encoding assignment

Variables	Encoding assignment	Valid data
Journal types	1=core journal 2=general journal	14 32
Plateau areas	1=Qinghai-Tibet 2=Sinkiang 3=Sichuan-Tibet 4=Unknown	25 9 3 9
Nationalities	1=Han nationality 2=Han and minority 3=Unknown	1 12 33

Table 3 Correlation coefficients between SCL-90 scores and year

Items	r_1	r_2	r_3	r_4
Somatization	−0.303	−0.333	−0.069	−0.096
Obsessive-compulsive	−0.795**	−0.794**	−0.182	−0.210
Interpersonal sensitivity	−0.843**	−0.833**	−0.330	−0.341
Depression	−0.740**	−0.738**	−0.297	−0.321
Anxiety	−0.617**	−0.663**	−0.207	−0.242
Hostility	−0.494*	−0.630**	−0.109	−0.165
Phobic anxiety	−0.426*	−0.524*	−0.139	−0.188
Paranoid ideation	−0.766**	−0.747**	−0.494*	−0.526**
Psychotism	−0.529**	−0.526**	−0.046	−0.065

Notes: r_1: unweighted correlation coefficients between M and year; r_2: weighted correlation coefficients between M and year; r_3: unweighted correlation coefficients between SD and year; r_4: weighted correlation coefficients between SD and year; weighted by the sample size (n). *$P<0.05$, **$P<0.01$.

Correlation with social indicators

The current-year DB/GDP showed a significant effect on the interpersonal sensitivity, depression, and anxiety of Chinese plateau military personnel, while the 5-year-ago and 5-year-later DB/GDP almost did not get affected (see Table 6).

Most of the SCL-90 scores were influenced by current-year, 5-year-ago, and 5-year-later CLI and the correlation degree remained high. Only phobic anxiety showed no relationship with the current-year and 5-year-ago CLI and the hostility had nothing to do with 5-year-later CLI (see Table 7).

The current-year DR had a correlation with SCL-90 scores, except anxiety, while the 5-year-later DR was influenced only by obsessive-compulsive and interpersonal sensitivity. The 5-year-ago DR had nothing to do with SCL-90 scores (see Table 8).

Discussion

Although the improvement is not smooth, the mental health of Chinese plateau military personnel is getting better indeed.
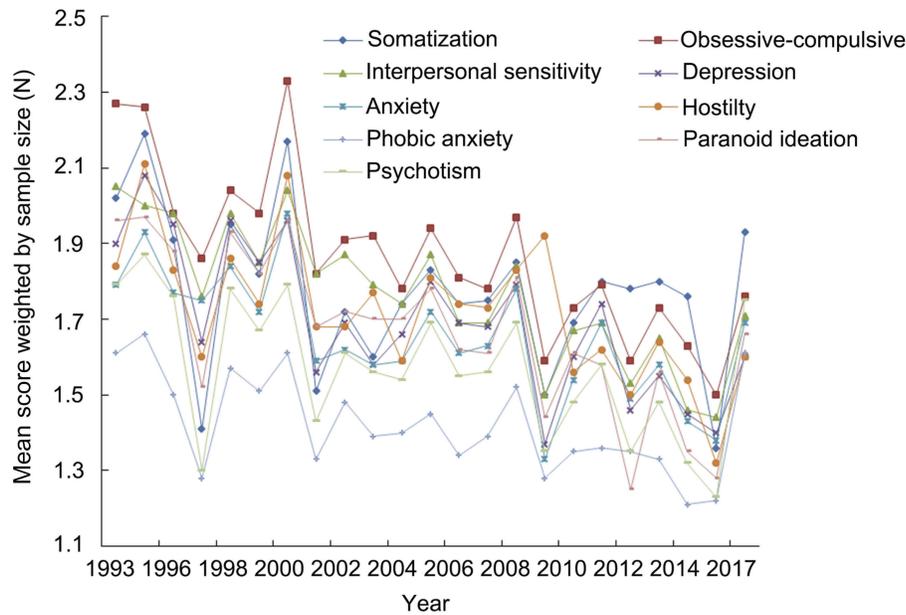
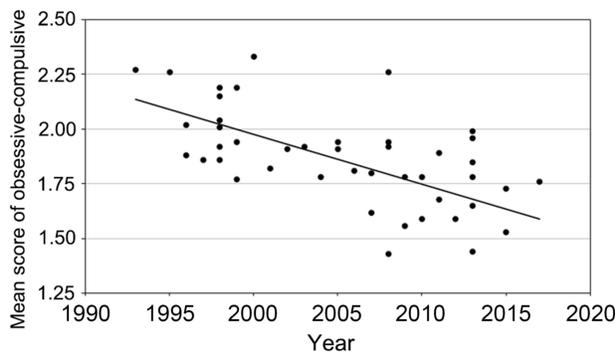**Figure 1** SCL-90 scores of Chinese plateau military personnel, 1993–2017.

Figure 2 Mean score of obsessive-compulsive over time.
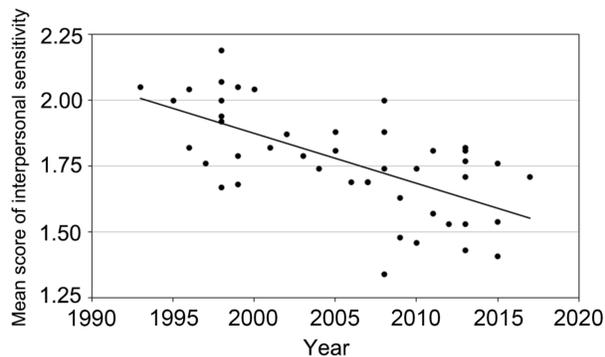

Figure 3 Mean score of interpersonal sensitivity over time.

Its improvement degree was significant without any influence of journal types, plateau areas, and nationalities. A similar conclusion has also been reported.[21] This might be

due to rapid economic development, improvement of citizens quality, national defense modernization, and development of psychological service work in China. Nonetheless, the mental health and well-being of service members in the United States were influenced by combat deployments.[50] There are different mental health outcomes observed between US and UK military personnel returning from Iraq.[51] The mental health of soldiers in cities is much better than those at high altitude.[13] As shown in the MDR model, the mental health of military personnel is affected by different resources, such as countries, combat deployments, and defense areas.

In addition, there are some differences in the mental health characteristics among the plateau army members. The somatization symptoms were stable and had a high score, showing no significant changes over time. This could be explained due to the special environmental effects of angiocarpy, gastrointestinal tracts, and respiratory system. Many researchers have demonstrated that high-altitude environment causes frequent awakenings, headaches, acute mountain sickness (AMS), visual impairment as well as other somatic damages.[25,52,53] So, somatization symptoms do not change quickly and easily over time. The score of other factors showed a linear downward trend with year, especially the obsessive-compulsive. This symptom was the most decreased factor with year and also had a high score. Obsessive-compulsive symptom that manifests as meaningless and uncontrollable ideations and behaviors according to

Table 4 Year effect in stepwise regression equation

Independent variable: Year	Obsessive-compulsive	Interpersonal sensitivity	Depression	Anxiety	Hostility[a]	Phobic anxiety	Paranoid ideation	Psychotism
Partial regression coefficient (B)	−0.033	−0.026	−0.024	−0.019	−0.034	−0.015	−0.034	−0.029
Standard error (SE)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Standardized regression coefficient (β)	−0.805	−0.735	−0.620	−0.541	−0.765	−0.539	−0.808	−0.724
t	−206.255	−236.261	−153.941	−128.704	−183.513	−127.972	−218.536	−166.306
p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: [a]Only the year and plateau areas were accepted into the equation.

Table 5 Variable quantity of Chinese plateau military personnel mental health

Item	M_{1993}	M_{2017}	M_{change}	M_{SD}	d	r^2
Obsessive-compulsive	1.676	1.076	0.600	0.606086957	0.98996	0.1968
Interpersonal sensitivity	1.166	0.638	0.528	0.650434783	0.8118	0.1415
Depression	1.173	0.669	0.504	0.622608696	0.8095	0.1408
Anxiety	2.819	2.459	0.360	0.57173913	0.6297	0.0902
Hostility	2.865	2.481	0.384	0.649130435	0.5916	0.0805
Phobic anxiety	1.373	1.133	0.240	0.507391304	0.4730	0.05297
Paranoid ideation	1.028	0.476	0.552	0.606956522	0.9085	0.1710
Psychotism	1.280	0.944	0.336	0.531304348	0.6324	0.0909

Note: $M_{change}=M_{1993}-M_{2017}$, $d=M_{change}/M_{SD}$, $r^2=d^2/(d^2+4)$.

Table 6 Correlation coefficients between SCL-90 scores and DB/GDP

	Obsessive-compulsive	Interpersonal sensitivity	Depression	Anxiety	Hostility	Phobic anxiety	Paranoid ideation	Psychotism
Current-year DB/GDP	−0.404	−0.420*	−0.517*	−0.498*	−0.056	−0.152	−0.297	−0.232
5-year-ago DB/GDP	−0.136	−0.254	0.038	−0.034	0.010	−0.048	−0.222	−0.050
5-year-later DB/GDP	−0.146	0.028	−0.177	−0.101	−0.262	−0.321	−0.025	−0.274

Note: *$P<0.05$; DB/GDP, the ratio of the defense budget to Gross Domestic Product.

Table 7 Correlation coefficients between SCL-90 scores and CLI

	Obsessive-compulsive	Interpersonal sensitivity	Depression	Anxiety	Hostility	Phobic anxiety	Paranoid ideation	Psychotism
Current-year CLI	−0.735**	−0.780**	−0.674**	−0.546**	−0.520*	−0.357	−0.738**	−0.490*
5-year-ago CLI	−0.715**	−0.748**	−0.657**	−0.518*	−0.525*	−0.317	−0.707**	−0.460*
5-year-later CLI	−0.760**	−0.866**	−0.663**	−0.617**	−0.296	−0.460*	−0.780**	−0.531*

Note: *$P<0.05$, **$P<0.01$.
Abbreviation: CLI, consumption level index.

SCL-90 showed correlation with cognitive function. The results are consistent with those of the previous studies.[54] Ascending to extreme altitudes can cause brain damage, forming subcortical lesions and cortical atrophy on magnetic resonance imaging (MRI).[55] We can conclude that high altitude makes obsessive-compulsive symptom of Chinese army man more serious than that at low altitude. And the high-altitude exposure on the brain areas can influence the cognition speed, sensitivity, reaction time and conflict control.[56–59] High risk and high intensity of military tasks might aggravate the obsessive-compulsive symptom.

Table 8 Correlation coefficients between SCL-90 scores and DR

	Obsessive-compulsive	Interpersonal sensitivity	Depression	Anxiety	Hostility	Phobic anxiety	Paranoid ideation	Psychotism
Current-year DR	−0.469*	−0.500*	−0.479*	−0.400	−0.449*	−0.511*	−0.619**	−0.602**
5-year-ago DR	−0.298	−0.217	−0.299	−0.095	−0.382	0.003	−0.178	−0.115
5-year-later DR	−0.510*	−0.617**	−0.287	−0.355	−0.043	−0.260	−0.507*	−0.224

Note: *$P<0.05$, **$P<0.01$.
Abbreviation: DR, divorce rate.

Chinese plateau military personnel have a high anxiety score and both anxiety and depression vary a lot over time. Few researchers have found the relationship between emotional regulation function and high altitudes, especially depression.[60–62] The phobic anxiety score of Chinese plateau military personnel was at a moderate level and its variation remained the lowest. The research conducted by Yi et al[21] demonstrated that the Chinese army had problems of phobic anxiety, while this symptom in soldiers at high altitude might be better than those present at low altitude. However, for those with low-score or relatively stable factors, such as interpersonal sensitivity, paranoid ideation, and phobic anxiety, the mental-health evaluation cycle was increased to reduce the economic as well as labor costs.

The SCL-90 scores of Chinese plateau soldiers showed several peaks in the years 2000, 2008, and 2017. Review of the major events in China from 1993 to 2017, we found that the military events likely caused the declination in mental health among Chinese soldiers. For example, the 1998 Yangtze River floods were considered to be the worst in Northern China flood over 40 years.[63] Indo–Pakistani War of 1999 led to tensions on the plateau border;[64] the situation of NATO bombing on the Chinese embassy in Yugoslavia affected China's national defense readiness;[65] Chen Shuibian, a Democratic Progressive Party (DPP) member, became the eventual winner in 2000 Taiwan presidential election.[66] The Chinese disarmament especially began from 1997 to 1999, and the Chinese Army was cut by 19%. On June 18, 2017, Sino-Indian Dong Lang standoff occurred, making the Chinese military nervous.[1] Chinese military is still in the stage of a new round of military reformation today. The mental health of Chinese soldiers might be influenced by military events. So, it is necessary to pay attention to military mental health in critical moments.

The current-year DB/GDP was directly related to Chinese plateau soldiers' depression, anxiety, and interpersonal sensitivity symptoms. DB is a special expense for safeguarding national survival and developing security and also involves the cost of military activities carried out by the state to prevent and resist aggression, stop armed subversion, safeguard national sovereignty, and unify territorial integrity and security, as well as political, economic, diplomatic, scientific, and technological education activities related to military affairs.[67] GDP is recognized as the best indicator to measure the economic condition of a country.[68] The DB/GDP reflects the ratio of China's defense construction to the economic input. So, this index can influence the current-year mental health level of Chinese plateau soldiers directly. This was consistent with the previous studies.[19] CLI has a full-dimension and space-time effect on the mental health of soldiers at high altitudes. CLI showed a significantly negative correlation with many factors. The improvement of CLI can better explain the improvement of mental health level of Chinese military personnel at high altitudes. At the same time, the mental health level of soldiers might also affect the 5-year-later CLI. The current-year DR has a correlation with the mental health of Chinese plateau military personnel, except the anxiety symptom. And the effect of 5-year-ago and 5-year-later DR on mental health was limited. Only the obsessive-compulsive and interpersonal sensitivity symptom might help in predicting the 5-year-later DR. The reality is that the obsessive-compulsive and interpersonal sensitivities scores of Chinese plateau soldiers' scores were decreased and the Chinese population DR tended to rise.[69]

Conclusion

The mental health of Chinese plateau military personnel is getting better. To monitor the development and changes of Chinese plateau soldiers' mental health over time, not only the high-score factors but also the changeable factors should be focused. At the same time, the influence of social indicators on military mental health cannot be neglected. We should continuously work on how to maintain the plateau soldiers' mental health with the help of social resources, military policies, medical security, and psychological training.

This study cannot be generalized to Chinese military population because it was examined only in Chinese plateau soldiers. In addition, the SCL-90 can only be used to assess one's psychological status within a week. Besides, the causal chain between society and psychological variables is relatively far away, and the interpretation of some results lacked the quantitative analysis. But our research has shed light on the relationship of mental health, policy, economy, and society.

Acknowledgments

Disclosure

The authors report no conflicts of interest in this work.

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