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Academic vs. non-academic neurosurgeons in China: a comparison in terms of workload, burnout, and engagement

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Running Title: Academic vs. Non-academic neurosurgeons in China

Abstract

Objectives: Chinese neurosurgery has made great progress during the past decades, yet little is known about their working status. This study aimed to evaluate the difference between academic and non-academic neurosurgeons, focusing on their professional burnout, job satisfaction, and work engagement.

Design: Cross-sectional national wide survey.

Study setting: The survey was conducted in China between 2017 and 2018.

Participants: A total number of 823 academic neurosurgeons and 379 non-academic neurosurgeons participated in this study.

Outcome measures: Professional burnout, job satisfaction, and work engagement were assessed using the Maslach Burnout Inventory, the Job Descriptive Index and the Utrecht Work Engagement Scale, respectively.

Results: The majority of respondents were male (92.93%), less than 45 years old (85.27%), and married (79.53%). Chinese neurosurgeons worked 63.91±11.04 hours per week. Approximately 45% of respondents were burnout. Compared with non-academic respondents, academic neurosurgeons had longer working hours ($p<0.01$), higher income ($p<0.01$), less willing to get married ($p<0.01$). In addition, they showed a lower degree of burnout ($p<0.01$), a higher level of job satisfaction ($p<0.01$), and were more enthusiastic at work ($p=0.015$). Multivariate regression analyses indicated that being divorced (OR 7.02, 95% CI 2.37-15.08) and hospital violence (OR 1.52, 95% CI 1.18-2.24) were associated with burnout for both academic and non-academic respondents. Long working hours (≥71 hours per week) and low annual income (<100,000 RMB) were risk factors for burnout among academic neurosurgeons. For non-academic neurosurgical surgeons, age between 36-45, working as attending doctors, serving in public hospitals, and having the first house living kid were closely related to the incidence of burnout.

Conclusions: Chinese neurosurgeons are under significant stress particularly for the non-academic neurosurgeons. Offering better opportunities for training, promotion, higher income, and safer working environments could be solutions to release burnout and improve career satisfaction and engagement.

Registration: Chinese Clinical Trial Registry (ChiCTR1800014762).

Strengths and limitations of this study:

This is the first national survey on academic and non-academic neurosurgeons in China.

Standard and developed scales such MBI, JDI, and UEWS were applied, allowing comparisons with results from other authors.

Selection bias may exist during the survey.

Introduction

Chinese neurosurgery has a relatively short history. The first formal record of neurosurgical procedure could be traced back to 1950, when the first craniotomy operation was performed in Shanghai by Dr. Kefei Shan and Yuquan Shi[17]. Back at that time, Chinese neurosurgical facilities started with only a few pioneer surgeons and limited beds[2,17]. A remarkable milestone in the development of Chinese neurosurgery is the foundation of Chinese Neurosurgical Society (CNS) in 1986, since when started the rapid development[1,22]. To date, China has over 11,000 registered neurosurgeons, consisting the largest neurosurgeon group of the world (data from the World Federation of Neurosurgical Societies official website, www.wfns.org). Modern neurosurgical clinic centers have been established in many major cities, with some performing over 8,000 sophisticated operations annually[17,22]. In addition to the increase in the number of surgeons and operations, Chinese neurosurgery has also made remarkable progress in academic research. Studies have indicated that China contributed approximately 4.2% of published neurosurgical research in the world. The amount was ranked fifth in the world, behind U.S, Japan, Germany, and U.K. More importantly, China has emerged as the only country among the top 5 with substantial growth of neurosurgical research productivity (121.9% ± 9.98% per year) [5].

Despite the remarkable achievement, to our knowledge, no study has been done to reveal the working status of Chinese neurosurgeons. The Chinese healthcare system recruits physicians to work in hospitals in three levels. General practitioners usually work in level I hospitals, also known as community health centers. Level I hospitals usually provide primary health care and are not equipped with neurosurgical facilities. The Level II

hospitals, also known as regional medical centers, recruit specialists of various fields. These hospitals largely focus on conducting treatment of common diseases including routine neurosurgical operations. The tertiary (level III) hospitals are usually university hospitals and national medical centers. Neurosurgeons working in tertiary hospitals are requested to take care of complex cases (usually transferred from regional hospitals), but also to conduct clinical/basic research, teaching, tutoring, and sometimes international cooperating projects. Therefore, the neurosurgical surgeons working in tertiary hospitals are usually considered academic neurosurgeons and those working in regional hospitals as the non-academic.

An inherent and nature belief holds that the academic neurosurgeons may under significant stress due to additional responsibilities. However, during our previous study to assess the working status of Chinese physicians from various specialties, subgroup analyses suggested that surgeons working in regional hospitals were actually more stressful (submitted and under review). Yet, in-depth investigations could not be performed due to limited case numbers. Here, we reported the results on a national survey on Chinese neurosurgeons. The focus of this study is to reveal the working status as well as the difference between academic and non-academic of neurosurgeons. Detailed methods and results are described below.

Materials and Methods

Study design & questionnaires

From Jun. 2017 to Sep. 2018, a national online survey was conducted in mainland China using both smartphone apps and website visiting with the support of the East Institution of China Academy of Information and Communications Technology. This study was a part of a two-phase national survey on the working and living status of Chinese physicians, which was approved and registered with the Chinese Clinical Trial Registry (ChiCTR1800014762). The Phase I investigation recruited 1167 physicians of various specialties including neurosurgery between Jun. 2017 to Feb. 2018. This part of the study focused on the comparison between specialties (submitted elsewhere and under review). The phase II investigation was conducted between Mar. to Sep. 2018, in which the

working and living status of each specialty is further investigated. Answers from practicing neurosurgeons in both phase I and II investigations were analyzed in this study. Potential respondents were invited to complete the online questionnaires via mailing lists of the Shanghai Medical Doctor Association, the national continuing education platform "Neurosurgery News", and the professional networks of the authors. Neurosurgeons were also invited during national or local conferences via QD scanning. All answers were collected anonymously. To avoid repeated participation, each IP address is restricted to fill out the questionnaire once.

The questionnaire consisted of 147 closed-end questions, organized in sections including demographic and practice characteristics, professional burnout, job satisfaction, and work engagement. Most questions were derived from the well-established and standard scales (see below). A few questions were derived from previous studies [16,19,20] or were developed by the authors. Details for each section are described as follows.

Demographic and practice characteristics

Respondents were asked to provide gender, marital and family status, job titles, nature of employer, weekly working hours, annual income, experience of hospital violence, and whether a respondent would encourage his/her kid(s) to become a doctor. Neurosurgical respondents working in tertiary hospitals were considered academic neurosurgeons, and those from regional hospitals were considered as non-academic neurosurgeons.

Burnout

Professional burnout was measured by the Maslach Burnout Inventory (MBI). The MBI has 22 items coving three dimensions: Emotional Exhaustion (EE, 9 items), Depersonalization (DP, 5items), and Personal Accomplishments (PA, 8 items). Answers to each question were designed according to the frequency of a respondent's encountering situations on a 7-point scale, from "never" (0 points) to "daily" (6 points). MBI scores of each dimension were further graded as high, intermediate, or low (low EE≤18; high EE≥27; low DP≤5, high DP≥10; low PA≤33; high PA≥40) [8]. A respondent

would be considered burnout if he/she had high scores in the Emotional Exhaustion or Depersonalization assessment [8,10,13]. The internal consistency of the questionnaire was presented as Cronbach's α values for each section (0.91, 0.90, and 0.85, respectively).

Job satisfaction

The respondents' job satisfaction was assessed by the Index of Job Satisfaction (JDI). The JDI questionnaire contained questions on five independent dimensions, namely, Work Itself (22 items), Pay (9items), Promotion (7 items), Co-workers (11 items), and Supervision (14 items)[6,14]. Each item was scored Yes=3, ?=1, and No=0, with negatively worded items being reverse-coded. A JDI score for each respondent was calculated as the sum of all his/her answers, with the scores of the Promotion and Pay sections being multiplied by 2. The Cronbach's α values of the 5 JDI subscales were 0.89, 0.94, 0.88, 0.90, and 0.87, respectively.

Work engagement

Work engagement was measured using the 17-item Utrecht Work Engagement Scale (UWES). The UWES had three subscales: Vigor (6 items), Dedication (5 items) and Absorption (6 items). All items were rated on a 7-point Likert scale (0-6). The sum of all items was used as a UWES score [4,11,12]. The internal consistency for the UWES questionnaire was presented as a Cronbach's α value of 0.85.

Data analysis

Data analysis was performed using SPSS 18 (SPSS Inc., Chicago, U.S.). Quantitative data were presented as means ± standard deviations (SD). Shapiro-Wilk W test and F test were performed for normality and homogeneity. Independent samples t-test, Wilcoxon rank-sum test, and one-way analysis of variance (ANOVA) were used for the quantitative data of independent groups. Chi-square and Fisher exact tests were used for nominal variables. Statistical significance was considered with a two-tailed p-value less than 0.05.

Results

Demographic & practice characteristics of respondents

A total number of 1,202 practicing neurosurgeons completed the survey. Considering the fact that approximately two-thirds of 11,000 registered neurosurgeons in China have received proper training and being active[21], the pool of responding neurosurgeons in this study may represent approximately 16% of Chinese neurosurgeons.

The demographic and practice characteristics of responding neurosurgeons were summarized in Table 1. Their mean age was 34.32±7.21 years, with a male to female ratio of 13.14:1. Among the respondents, 956 (79.53%) were married and 50 (4.16%) were divorced. Approximately three-quarters of neurosurgeons had home-living kids, and 23.87% (30.02% of the married) had more than one child. The majority (91.93%) of responding neurosurgeons worked in public hospitals. They work an average of 63.91±11.04 hours a week, with an annual income of 11.13±4.85^10^4 RMB (approximately 16,000±6,990 USD). Interns, residents, attending doctors, and senior/chief neurosurgeons constituted 3.00%, 27.95%, 42.35%, and 26.71% of all respondents, respectively. There were 37.94% of surveyed neurosurgeons claimed that they had experienced or witnessed hospital violence in the last 5 years. Only 6.6% of respondents would encourage their offspring to become a doctor.

Among all 1202 respondents, there were 823 (68.47%) academic and 379 (31.53%) non-academic neurosurgeons. The two groups had no statistical difference in terms of gender, age, marital status, and job titles. However, a larger proportion of academic neurosurgeons were single compared to the non-academic (19.93% vs. 8.44% $p<0.01$), and the former preferred to have fewer children after marriage (Table 1). While the majority (91.93%) of academic neurosurgeons working in public hospitals, nearly 18% of non-academic neurosurgeons chose to work in private medical facilities ($p<0.01$, Table 1). Both academic and non-academic neurosurgeons spent approximately 60 hours per week on clinical work (56.17±9.12 vs. 61.42±7.92 hours, $p<0.01$). The academic neurosurgeons required additional 8.21±4.64 hours per week on teaching and research such as university lectures, lab work, clinical trials, paper writing, etc., which made their average working hours longer than the non-academic ($p<0.01$, Table 1). Accordingly, the average annual income of the academic neurosurgeons was statistically higher than their

non-academic colleagues (11.37±4.29^10^4 RMB, 16,300±6,100 USD vs. 10.02±5.21^10^4 RMB,14,300±7,500 USD, p<0.01). The gap in income was also reflected by the difference in proportions of high-income individuals (Table 1). Some other notable difference included that the non-academic neurosurgeons had a higher risk of experiencing or witnessing hospital violence (44.06% vs. 35.12%, p<0.01), and they were less likely to encourage their child(ren) to become a doctor (p<0.01) (Table 1).

Career Burnout

Career Burnout was assessed by the MBI questionnaire and summarized in Table 2. Overall, 44.51% of responding neurosurgeons were burnout. There were 36.11% of respondents showing high levels of Emotional Exhaustion, 29.62% with high Depersonalization, and 12.26% with a low sense of Personal Accomplishment (Table 2). Although academic neurosurgeons had longer weekly working hours and more workload, the incidence of burnout was significantly lower among the academic neurosurgeons than among the non-academic (37.91% vs. 58.84%, p<0.01). In addition, the academic neurosurgeons scored better in all three assessed dimensions (p<0.01, p<0.01, and p<0.01, respectively, Table 2).

Job satisfaction

Job satisfaction was measured by JDI and the five subscales (Table 3). The mean JDI score for all surveyed neurosurgeons was 102.60±36.63. The academic neurosurgeons showed significantly higher scores (being more satisfied) when they were asked to comment on Work Itself, Promotion, and Supervision (p<0.01, p<0.01, and p<0.01, respectively, Table 3). There was no statistical difference in the comments on Pay and Coworker (p=0.059 and 0.45, respectively, Table 3).

Work engagement

The UWES scores indicated the difference of work engagement between the academic and non-academic neurosurgeons (Table 4). Overall, the academic neurosurgeons scored higher (being more enthusiasm for work) than their non-academic colleagues (p=0.015). For JDI subscales, academic neurosurgeons were more dedicated to work (p<0.01). Yet,

the academic and non-academic neurosurgeons showed no difference in the Vigor and Absorption assessment (p=0.057, 9=0.059, respectively, Table 4).

Multivariate analysis

Multivariate regression analyses indicated that, in general, being divorced, having one (or the first) home-living kid, working as attending doctors, prolonged working hours (≥71 hours per week), low annual income (<100,000 RMB, ~14,400 USD), and hospital violence were significantly related to professional burnout (Table 5). However, the impacts of the above factors were not constant between the academic and non-academic neurosurgeons. Working in public hospitals was an independent risk factor for burnout among non-academic neurosurgeons (OR 5.37, 95% CI 2.969-9.67, p<0.0001). In addition, surgeons' age, number of house living kids, and job titles were associated with burnout among non-academic neurosurgeons but not the academic respondents (Table 5). Subgroup analysis also indicated that academic neurosurgeons may have a relatively lower expectation of income. While the annual income between 110,000-150,000 RMB (14,400-21,600 USD) was negatively related to professional burnout among academic neurosurgeons (OR 0.63, 95% CI 0.46-0.86, p<0.01), a similar association was only observed when the annual income exceeded 160,000 RMB (23,000 USD) among non-academic respondents (OR 0.29, 95% CI 0.15-0.58, p<0.01, Table 5).

Discussion

There is no doubt that Chinese neurosurgery has made a remarkable improvement in the past decades [1,5,22]. On the stage of today's neurosurgery, the voice of Chinese can often be heard. Chinese neurosurgeons now present progress only in the case numbers and operating techniques, but also in the amount and quality of academic research. Yet, despite applaud for the great achievement, little attention has been paid to the working status of Chinese neurosurgical surgeons. In this study, our survey indicates that, in general, Chinese neurosurgeons were facing great pressure, from both the work itself and outside environment. In addition, although academic neurosurgeons had heavier workloads and longer working hours than non-academic neurosurgeons, they were more satisfied with their job and more committed to the work, and less likely to be professional

burnout. The reasons for the phenomena may be complex, yet we speculate several possible explanations, discussed as follows.

First of all, the income gap may play an important role. Probably one of the most apparent differences between Chinese academic and non-academic neurosurgeons is that the former in average has higher annual income (Table 1). It has been demonstrated many times that pay is one of the most important contributors to job satisfaction, work engagement, and consequently professional burnout in multiple industries [7,9,10,15]. Currently, Chinese tertiary hospitals are attracting an increasing number of patients due to reputations and skillful physicians. Under the principle of performance appraisal which has been emphasized and adapted by health care facilities across the nations, academic neurosurgeons were better paid. However, it does not imply that neurosurgeons are individuals with high-income. On the contrary, although neurosurgeons are paid approximately 100,000 to 110,000 RMB (14,400-15,800 USD) a year, which is 1.11-1.22 times more than the average wages of Chinese urban employees (89,993 RMB, 13,000 USD, data from the National Buraeu of Statistics of China, http://data.stats.gov.cn/easyquery.htm?cn=C01), they are actually underpaid considering the long working hours (nearly 70 hours per week), prolonged training, vast workload, and high responsibilities.

Second, academic neurosurgeons may have better career development. As employees of university hospitals and national medical centers, academic neurosurgeons have more opportunities to get funding support and build collaborations, which is crucial for research breakthroughs and development of personal career. According to the records of WFNS (www.wfns.org), AANS (American Association of Neurological Surgeons, www.aans.org), and EANS (European Association of Neurosurgical Societies, www.eans.org), the three major organizations each holding an international neurosurgical conference annually, almost all Chinese speakers or poster authors came from tertiary hospitals. In addition, the database from ClinicalTrails (www.clinicaltrials.gov) and Chinese Clinical Trial Registry (ChiCTR, www.chictr.org.cn) indicates that the majority of multi-center projects are led or exclusively recruit partners from tertiary hospitals. The

advantages in career development, especially getting support from a national level and collaborations with world-leading research facilities, may provide academic neurosurgeons sense of superiority, and consequently have positive impacts on job satisfaction and engagement [3].

Thirdly, tertiary hospitals may provide a safer working environment. The deterioration doctor-patient relationship has become a major issue in the Chinese medical system. During the last two decades, Chinese doctors have been threatened by a surge of hospital violence. In 2017, the Chinese Medical Doctor Association (CMDA) released the latest version of "*White paper on medical practice in China*", showing that 66% of Chinese physicians being involved in doctor-patient conflicts (www.cmda.net/u/cms/www/201807/06181247ffex.pdf). The increase of doctor-patient conflicts has a significant impact on physicians' burnout, mental health, job satisfaction, and drop-off [18,19]. In our survey, nearly 40% of neurosurgeons have encountered hospital violence in the last five years, but the incidence among academic neurosurgeons was significantly lower than that among non-academic neurosurgeons. One possible explanation is that, as university hospitals and national medical centers, tertiary hospitals provide better security service. In addition, the public holds the view that surgeons in tertiary hospitals are more skillful and better equipped. It is believed that academic neurosurgeons may represent the highest level in this country, hence more respect and fewer conflicts are expected. Fortunately, the Chinese authority has realized the severity of this issue. A series of measures have been taken including a new initiative launched in April 2014 to guarantee normal medical order and the interests of Chinese doctors.

The gap of pay, career development, and safety between academic and non-academic neurosurgeons has attracted an increasing number of young talents to work in tertiary hospitals. If the gap continues to exist or even widens further, an inevitable consequence is that patients would prefer to go to tertiary hospitals even if their disorders could be well treated in regional hospitals. This trend would lead to an imbalance in medical resources, increase the burden on tertiary hospitals, and affect the quality of medical care. In order to solve the problem, since 2016 the Chinese authority has introduced a new

standardization training program, requiring all Chinese neurosurgeons, particular those working in regional hospitals, to finish an additional 4 years of specialist training. The intention of this reform is to enable all Chinese neurosurgeons to receive standardized training and to narrow their gap in skills and knowledge. In addition, the research management agencies, such as the Nature Science Foundation of China and many local foundations, have also provided increasing support for projects from regional hospitals. Yet it may require years to see the effect of these policies.

This study has a few limitations. First of all, selection bias may exist during the process of the survey. Although the study was targeted random Chinese neurosurgeons, individuals who suffer from significant burnout or low morale were less likely to complete a voluntary survey. In other words, the survey may have provided more optimistic data. In addition, the questionnaires were distributed electronically via smart-phone APPs and web pages, which may recruit more young respondents than for elder surgeons. Also, for easier understanding and analysis, we simply considered neurosurgeons working in tertiary hospitals as the academic and those in regional hospitals as the non-academic. However, researches in regional hospitals are actually not down to zero. The Chinese healthcare system requires every doctor to publish at least two papers as one of the premise conditions for promotion, no matter in what kind of hospitals one may work. In major cities such as Beijing and Shanghai, the conditions for promotion are more demanding, requesting publication in high standard international journals. Therefore, neurosurgeons in regional hospitals also conduct clinical or basic researches, although these researches are usually with a limited amount and under the help of tertiary hospitals. However, under the aforementioned new policy, it is the fact that some non-academic neurosurgeons were devoted to research and have made remarkable achievements. Although their number may be limited, these “non-academic” neurosurgeons may stay as potential confounders in this anonymous survey.

Conclusion

This study reveals the working status of Chinese neurosurgeons. It also illustrates the difference between academic and the non-academic neurosurgeons in China. Our data

suggest that Chinese neurosurgeons are under stress, particularly for those working in regional hospitals. We hope this study would promote reforms for better support and a safer working environment for Chinese neurosurgeons. We also wish this study may offer valuable information for medical students and young talents who would choose neurosurgery, a promising but challenging profession, as a career.

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Competing interests

None declared.

Ethics approval

The Ethics Review Committee of Huashan Hospital, Fudan University approved the study design and the collection of the data through the questionnaire.

Data sharing statement

No additional data are available

Contributors

JY and YS drafted the manuscript and was involved in the interpretation of the data. JG and JC performed statistical analyses. JY, JC and YS played a major role in the questionnaire development. All the authors read and approved the final manuscript.

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Table 1. Demographic & practice characteristics of respondents

	All Neurosurgeons (n=1202)		Academic (n=823)		Non-academic (n=379)		p-value*
	n	%	n	%	n	%	
Gender							
Male	1117	92.93	757	91.98	360	94.99	0.069
Female	85	7.07	66	8.02	19	5.01	0.069
Age							
≤35	586	48.75	406	49.33	180	47.49	0.58
36-45	439	36.52	307	37.30	132	34.83	0.41
46-55	158	13.14	99	12.03	59	15.57	0.092
≥56	19	1.58	11	1.34	8	2.11	0.47
Marital status							
Married	956	79.53	630	76.55	326	86.02	**<0.01**
Unmarried	196	16.31	164	19.93	32	8.44	**<0.01**
Divorced	50	4.16	29	3.52	21	5.54	0.11
Number of kids (married only)							
0	80	8.37	74	11.75	6	1.84	**<0.01**
1	589	61.61	392	62.22	197	60.43	0.59
≥2	287	30.02	164	26.03	123	37.73	**<0.01**
Nature of current employer							
Public	1105	91.93	794	96.48	311	82.06	**<0.01**
Private	97	8.07	29	3.52	68	17.94	**<0.01**
Professional status							
Intern	36	3.00	25	3.04	11	2.90	0.99
Resident	336	27.95	241	29.28	95	25.07	0.13
Attending doctor	509	42.35	342	41.56	167	44.06	0.41
Senior/Chief	321	26.71	215	26.12	106	27.97	0.50
Working hours per week (hours, mean ±sd)							
Total	63.91±11.04	/	64.39±9.63	/	61.92±8.34	/	**<0.01**
Clinic	58.19±10.34	/	56.17±9.12	/	61.42±7.92	/	**<0.01**
Research	5.72±3.67	/	8.21±4.64	/	0.53±0.36	/	**<0.01**
Annual income (10,000RMB)							
<6	202	16.81	121	14.70	81	21.37	**<0.01**
6-10	384	31.95	231	28.07	153	40.37	**<0.01**
11-15	366	30.45	264	32.08	102	26.91	0.071
16-20	172	14.31	140	17.01	32	8.44	**<0.01**
≥20	78	6.49	67	8.14	11	2.90	**<0.01**
Experience or witness of hospital violence in the last 5 years							
Yes	456	37.94	289	35.12	167	44.06	**<0.01**
Encouraging child to become a doctor							
Yes	80	6.66	55	6.68	25	6.60	0.99
No	876	72.88	573	69.62	303	79.95	**<0.01**
Not sure	246	20.47	195	23.69	51	13.46	**<0.01**

* The p-values indicate the difference between the academic and non-academic neurosurgeons. A p-value less than 0.05 is considered as statistical significance.

Table 2. Burnout measured by MBI

Burnout Subscales	All Neurosurgeons (n=1202)		Academic (n=823)		Non-academic (n=379)		p-value*
	n	%	n	%	n	%	
Emotional Exhaustion							
Low	195	16.22	136	16.52	59	15.57	0.68
Intermediate	573	47.67	414	50.30	159	41.95	**<0.01**
High	434	36.11	273	33.17	161	42.48	**<0.01**
Depersonalization							
Low	543	45.17	394	47.87	149	39.31	**<0.01**
Intermediate	303	25.21	253	30.74	50	13.19	**<0.01**
High	356	29.62	176	21.39	180	47.49	**<0.01**
Personal Accomplishment							
Low	533	44.34	363	44.11	170	44.85	0.81
Intermediate	518	43.09	376	45.69	142	37.47	**<0.01**
High	151	12.56	84	10.21	67	17.68	**<0.01**
Burnout	535	44.51	312	37.91	223	58.84	**<0.01**

* The p-values indicate the difference between the academic and non-academic neurosurgeons. A p-value less than 0.05 is considered as statistical significance.

Table 3. Job satisfaction measured by JDI

JDI Subscales	All Neurosurgeons (n=1202)		Academic (n=823)		Non-academic (n=379)		p-value*
	Mean	Sd	Mean	Sd	Mean	Sd	
JDI Score	102.60	36.63	107.04	36.48	92.95	35.12	**<0.01**
Work Itself	24.27	11.76	24.55	11.93	22.30	12.49	**<0.01**
Pay	7.44	4.22	7.60	4.09	7.11	4.84	0.059
Promotion	6.73	4.55	7.09	4.29	5.92	4.99	**<0.01**
Supervision	25.44	13.35	27.14	13.83	21.76	11.41	**<0.01**
Coworker	24.53	10.60	25.32	10.76	24.83	10.07	0.45

* The p-values indicate the difference between the academic and non-academic neurosurgeons. A p-value less than 0.05 is considered as statistical significance.

Table 4. Job engagement measured by UWES

UWES Subscales	All Neurosurgeons (n=1202)		Academic (n=823)		Non-academic (n=379)		p-value*
	Mean	Sd	Mean	Sd	Mean	Sd	
UWES Score	61.27	26.21	62.52	25.53	58.55	27.49	**0.015**
Vigor	22.04	9.48	22.39	9.37	21.28	9.69	0.059
Dedication	18.03	8.83	18.57	8.48	16.86	9.46	**<0.01**
Absorption	21.20	9.75	21.57	9.55	20.41	10.13	0.057

* The p-values indicate the difference between the academic and non-academic neurosurgeons. A p value less than 0.05 is considered as statistical significance.

Table 5. Multivariate analysis on burnout

	All Neurosurgeons (n=1202)			Academic(n=823)			Non-academic(n=379)		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p value
Gender									
Male	1.43	0.91-2.26	0.14	1.44	0.84-2.49	0.23	1.04	0.41-2.65	0.99
Age									
≤35	1.07	0.85-1.35	0.55	1.11	0.84-1.47	0.46	1.045	0.69-1.58	0.82
36-45	1.20	0.95-1.52	0.13	1.06	0.79-1.12	0.70	1.75	1.12-2.71	**0.013**
≥46	0.61	0.43-0.85	**<0.01**	0.70	0.45-1.08	0.10	0.39	0.23-0.69	**<0.01**
Marital status									
Married	0.71	0.54-0.94	**0.018**	0.54	0.39-0.75	**<0.01**	1.02	0.56-1.83	0.99
Unmarried	0.92	0.68-1.26	0.61	1.45	1.03-20.6	**0.033**	0.29	0.13-0.62	**<0.01**
Divorced	7.02	2.37-15.08	**<0.01**	4.53	1.98-10.37	**<0.01**	7.52	1.84-28.43	**<0.01**
Number of kids (married only)									
0	0.48	0.29-0.80	**<0.01**	0.78	0.46-1.33	0.43	0.17	0.075-0.38	**<0.01**
1	1.47	1.12-1.92	**<0.01**	1.16	0.83-1.63	0.39	2.46	1.56-3.98	**<0.01**
≥2	0.83	0.63-1.11	0.21	0.95	0.65-1.38	0.20	0.49	0.31-0.77	**<0.01**
Nature of current employer									
Public hospital	1.39	0.91-2.14	0.13	0.36	0.16-0.77	**0.010**	5.37	2.99-9.67	**<0.01**
Job titles									
Intern/resident	0.88	0.69-1.12	0.29	0.99	0.74-1.33	0.99	0.82	0.52-1.28	0.41
Attending doctor	1.40	1.12-1.76	**<0.01**	1.05	0.79-1.40	0.73	2.57	1.67-3.96	**<0.01**
Senior/Chief	0.74	0.57-0.97	**0.031**	0.94	0.67-1.32	0.71	0.41	0.25-0.64	**<0.01**
Working hours per week									
≤55	0.49	0.38-0.63	**<0.01**	0.59	0.33-0.61	**<0. 01**	0.68	0.43-1.08	0.10
56-70	0.63	0.49-0.81	**<0.01**	0.47	0.34-0.65	**<0.01**	0.99	0.64-1.55	0.99
≥71	3.12	2.43-3.99	**<0.01**	4.56	3.33-6.22	**<0.01**	1.39	0.91-2.12	0.13
Annual income (10,000RMB)									
<10	1.85	1.47-2.32	**<0.01**	1.82	1.37-2.43	**<0.01**	1.33	0.88-2.03	0.17
11-15	0.76	0.59-0.98	**0.033**	0.63	0.46-0.86	**<0.01**	1.32	0.82-2.11	0.24
≥16	0.55	0.41-0.74	**<0.01**	0.77	0.55-1.07	0.12	0.29	0.15-0.58	**<0.01**
Experience or witness of hospital violence in the last 5 years									
Yes	1.52	1.18-2.24	**<0.01**	1.42	1.15-2.07	**0.011**	2.03	1.50-3.25	**<0.01**

* A p-value less than 0.05 is considered as statistical significance.

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Academic vs. non-academic neurosurgeons in China: a comparison in terms of workload, burnout, and engagement

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Academic vs. non-academic neurosurgeons in China: a comparison in terms of workload, burnout, and engagement

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Running Title: Academic vs. Non-academic neurosurgeons in China

Abstract

Objectives: Chinese neurosurgery has made great progress during the past decades, yet little is known about the working status of neurosurgeons. This study aimed to evaluate the difference between academic and non-academic neurosurgeons, focusing on their professional burnout, job satisfaction, and work engagement.

Design: Cross-sectional nationwide survey.

Study setting: The survey was conducted in China between 2017 and 2018.

Participants: A total number of 823 academic neurosurgeons and 379 non-academic neurosurgeons participated in this study.

Outcome measures: Professional burnout, job satisfaction, and work engagement were assessed using the Maslach Burnout Inventory, the Job Descriptive Index and the Utrecht Work Engagement Scale, respectively.

Results: The majority of respondents were male (92.93%), less than 45 years old (85.27%), and married (79.53%). Chinese neurosurgeons worked 63.91±11.04 hours per week, and approximately 45% experienced burnout. Compared with non-academic respondents, academic neurosurgeons had longer working hours ($p<0.01$), higher income ($p<0.01$), and were less willing to get married ($p<0.01$). In addition, they showed a lower degree of burnout ($p<0.01$), a higher level of job satisfaction ($p<0.01$) and were more enthusiastic at work ($p=0.015$). Multivariate regression analyses indicated that divorced (OR 7.02, 95% CI 2.37-15.08) and workplace violence (OR 1.52, 95% CI 1.18-2.24) were associated with burnout for both academic and non-academic respondents. Long working hours (≥71 hours per week) and low annual income (<100,000 RMB) were risk factors for burnout among academic neurosurgeons. For non-academic neurosurgical surgeons (age 36-45), working as attending doctors, serving in public hospitals, and having the first house-living child were all closely related to the incidence of burnout.

Conclusions: Chinese neurosurgeons are under significant stress particularly for the non-academic neurosurgeons. Offering better opportunities for training, promotion, higher income, and safer working environments could be solutions to relieve burnout and improve career satisfaction and engagement.

Registration: Chinese Clinical Trial Registry (ChiCTR1800014762).

Strengths and limitations of this study:

This is the first national survey to assess the working status of Chinese neurosurgeons.

Worldwide common questionnaires including MBI-HSS, JDI, and UEWS were applied in the survey. The results would facilitate a comparison to previous and future studies.

Subgroup analyses were performed to illustrate burnout levels among junior and senior neurosurgeons.

Despite a large number (1202) of respondents, the study covered approximately 16% of Chinese neurosurgeons. Selection bias may exist.

A comparison to other clinical specialists would also be interesting for future investigations.

Introduction

Chinese neurosurgery has a relatively short history. The first formal record of neurosurgical procedure could be traced back to 1950, when the first craniotomy operation was performed by Dr. Kefei Shan and Yuquan Shi in Shanghai [1]. At that time, Chinese neurosurgical facilities started with only a few pioneer surgeons and limited beds[1, 2]. A remarkable milestone in the development of Chinese neurosurgery was the foundation of the Chinese Neurosurgical Society (CNS) in 1986[3, 4]. To date, modern neurosurgical clinic centers have been established in many major cities, with some performing over 8,000 sophisticated operations annually[1, 4]. According to the World Federation of Neurosurgical Societies (WFNS) and the Chinese Neurosurgeon Society (CNS)[5], China has approximately 11,000 registered neurosurgeons, which is the largest group of neurosurgeons in the world. In addition, Chinese neurosurgery has made remarkable progress in academic research. It is indicated that China has contributed approximately 4.2% of published neurosurgical research in the world (ranked fifth in the world behind U.S, Japan, Germany, and U.K), and emerged as the only country among the top 5 with substantial growth of neurosurgical research productivity (121.9% ± 9.98% per year) [6].

Despite the remarkable achievement, to our knowledge, there have been few published studies revealing the working status of Chinese neurosurgeons. The training program and

career path of a neurosurgeon in China are different from that in the Western world. In China, the healthcare system involves hospitals of three levels. General practitioners usually work in level I hospitals, also known as community health centers. Level I hospitals provide primary health care and are not equipped with neurosurgical facilities. The Level II hospitals, also known as regional medical centers, recruit specialists including neurosurgeons. Routine neurosurgical operations can be performed in these hospitals. The level III (tertiary) hospitals are usually university teaching hospitals and national medical centers. Neurosurgeons working in tertiary hospitals are required to not only take care of complex cases (usually transferred from regional hospitals), but also conduct clinical/basic research, teaching, and tutoring. Therefore, the neurosurgical surgeons working in tertiary hospitals are usually considered academic neurosurgeons and those working in regional hospitals as the non-academic. For young doctors who are interested in neurosurgery, after graduation from medical school, they are recruited to work either in a regional or tertiary hospital and start their training as neurosurgeon residents. The updated (since 2003) training program requires a neurosurgeon resident to complete two stages (5-7 years in total) standardized training before they can apply for senior positions such as attending and then consulting neurosurgeons. Although young trainees may apply to work for a different hospital (e.g from a non-academic to academic center), the number of successful applicants is very limited. A brief introduction of the Chinese neurosurgery system and training system can be found elsewhere [4].

Due to the inherent difference of the academic and non-academic medical specialists in China, a natural belief holds that the academic neurosurgeons are under significant stress as a result of additional responsibilities. However, during our previous study to assess the working status of Chinese physicians from various specialties, subgroup analyses suggested that surgeons working in regional hospitals were actually more stressed (submitted and under review). Nevertheless, in-depth investigations could not be performed due to limited case numbers. Here we reported the results on a national survey on Chinese neurosurgeons. The focus of this study is to reveal the working status, as well as the difference between academic and non-academic of neurosurgeons. Detailed methods and results are described below.

Materials and Methods

Study Design and Questionnaires

From June 2017 to September 2018, a national online survey was conducted in mainland China using both smartphone apps and website visiting under the support of the East Institution of China Academy of Information and Communications Technology. This study was part of a two-phase national survey on the working and living status of Chinese physicians, which was approved and registered with the Chinese Clinical Trial Registry (ChiCTR1800014762). The Phase I investigation was conducted between June 2017 and February 2018, recruiting 1167 physicians of various specialties. This part focused on the comparison between specialties (submitted elsewhere and under review). The phase II investigation was conducted between March and September 2018, in which the working and living status of each specialty is further investigated. Answers from resident/attending/senior neurosurgeons in both phase I and II investigations were analyzed in this study. Potential respondents were invited to complete the online questionnaires via mailing lists of the Shanghai Medical Doctor Association, the national continuing education platform "Neurosurgery News", and the professional networks of the authors. Neurosurgeons were also invited during national or local conferences via two-dimensional barcodes scanning. An introduction of the research purpose and methods was provided at the beginning of the online survey. Informed consent was received electronically from each respondent. All answers were collected anonymously. To avoid repeated participation, each IP address was restricted to fill out the questionnaire once.

The questionnaire consisted of 147 closed-end questions, organized in sections including demographic and practice characteristics, professional burnout, job satisfaction, and work engagement. Most questions were derived from the well-established and standard scales (see below). A few questions were derived from previous studies [7-9] or were developed by the authors. Details for each section are described as follows.

Demographic and practice characteristics

Respondents were asked to provide gender, marital and family status, job titles, nature of employers, weekly working hours, annual income, experience of workplace violence, and whether a respondent would encourage his/her kid(s) to become a doctor. Neurosurgical respondents working in tertiary hospitals were considered academic neurosurgeons, and those from regional hospitals were considered as non-academic neurosurgeons.

Burnout

Professional burnout was measured by the 22-item Maslach Burnout Inventory-Human Services Survey (MBI-HSS). In previous studies on professional burnout, heterogeneities have been recognized regarding the different tools and questionnaire versions. However, the original 22-item version of MBI-HSS is still one of the most commonly used tools to measure burnout [10]. The 22 items coving three dimensions: Emotional Exhaustion (EE, 9 items), Depersonalization (DP, 5items), and Personal Accomplishments (PA, 8 items). Answers to each question were designed according to the frequency of a respondent's encountering situations on a 7-point scale, from "never" (0 points) to "daily" (6 points). MBI scores of each dimension were further graded as high, intermediate, or low (low EE≤18; high EE≥27; low DP≤5, high DP≥10; low PA≤33; high PA≥40) [11]. A respondent would be considered burnt out if he/she had high scores in the Emotional Exhaustion or Depersonalization assessment [11-13]. The internal consistency of the questionnaire was presented as Cronbach's α values for each section (0.91, 0.90, and 0.85, respectively).

Job satisfaction

The respondents' job satisfaction was assessed by the Index of Job Satisfaction (JDI). The JDI questionnaire contained questions on five independent dimensions, namely, Work Itself (22 items), Pay (9items), Promotion (7 items), Co-workers (11 items), and Supervision (14 items)[14, 15]. Each item was scored Yes=3, ?=1, and No=0, with negatively worded items being reverse-coded. A JDI score for each respondent was calculated as the sum of all his/her answers, with the scores of the Promotion and Pay sections being multiplied by 2. The Cronbach's α values of the 5 JDI subscales were 0.89, 0.94, 0.88, 0.90, and 0.87, respectively.

Work engagement

Work engagement was measured using the 17-item Utrecht Work Engagement Scale (UWES). The UWES had three subscales: Vigor (6 items), Dedication (5 items) and Absorption (6 items). All items were rated on a 7-point Likert scale (0-6). The sum of all items was used as a UWES score [16-18]. The internal consistency for the UWES questionnaire was presented as a Cronbach's α value of 0.85.

Data analysis

Data analysis was performed using SPSS 18 (SPSS Inc., Chicago, U.S.). Quantitative data were presented as means ± standard deviations (SD). Shapiro-Wilk W test and F test were performed for normality and homogeneity. Independent samples t-test, Wilcoxon rank-sum test, and one-way analysis of variance (ANOVA) were used for the quantitative data of independent groups. Chi-square and Fisher exact tests were used for nominal variables. Statistical significance was considered with a two-tailed p-value less than 0.05.

Patient and Public Involvement

No patients were involved in this study. The public has not been involved in the development of the research or in the study design. The study results will be disseminated to respondents via newsletters and publications.

Results

Demographic & practice characteristics of respondents

A total number of 1,202 neurosurgeons completed the survey. Considering the fact that approximately two-thirds of 11,000 registered neurosurgeons in China have received proper training and are active[19], the pool of responding neurosurgeons in this study may represent approximately 16% of Chinese neurosurgeons.

The demographic and practice characteristics of responding neurosurgeons were summarized in Table 1. Their mean age was 34.32±7.21 years, with a male to female ratio of 13.14:1. Among the respondents, 956 (79.53%) were married and 50 (4.16%)

were divorced. Approximately three-quarters of neurosurgeons had home-living children, and 23.87% (30.02% of the married) had more than one child. The majority (91.93%) of responding neurosurgeons worked in public hospitals. They worked an average of 63.91±11.04 hours a week, with an annual income of 11.13±4.85^10^4 RMB (approximately 16,000±6,990 USD). Interns, residents, attending doctors, and senior/chief neurosurgeons constituted 3.00%, 27.95%, 42.35%, and 26.71% of all respondents, respectively. Over one-third (37.94%) of surveyed neurosurgeons claimed that they had experienced or witnessed workplace violence against doctors or other medical workers in the last 5 years. Only 6.6% of respondents would encourage their offspring to become a doctor.

Among the 1202 respondents, there were 823 (68.47%) academic and 379 (31.53%) non-academic neurosurgeons. The two groups had no statistical difference in terms of gender, age, marital status, and job titles. However, a larger proportion of academic neurosurgeons were single compared to the non-academic (19.93% vs. 8.44% $p<0.01$), and the former preferred to have fewer children after marriage (Table 1). While the majority (91.93%) of academic neurosurgeons were working in public hospitals, nearly 18% of non-academic neurosurgeons chose to work in private medical facilities ($p<0.01$, Table 1). Both academic and non-academic neurosurgeons spent approximately 60 hours per week on clinical work (56.17±9.12 vs. 61.42±7.92 hours, $p<0.01$). For the academic neurosurgeons, they required additional 8.21±4.64 hours per week on teaching and research such as university lectures, lab work, clinical trials, paper writing, etc., making their average working hours significantly longer than that of the non-academic ($p<0.01$, Table 1). Accordingly, the average annual income of the academic neurosurgeons was statistically higher than that of their non-academic colleagues (11.37±4.29^10^4 RMB, 16,300±6,100 USD vs. 10.02±5.21^10^4 RMB,14,300±7,500 USD, $p<0.01$). The gap in income was also reflected by the difference in proportions of high-income individuals (Table 1). Some other notable difference included that the non-academic neurosurgeons had a higher risk of experiencing or witnessing workplace violence (44.06% vs. 35.12%, $p<0.01$). Additionally, it is worth noting that the academic neurosurgeons were less likely to encourage their child(ren) to become a doctor ($p<0.01$) (Table 1).

Career Burnout

Career Burnout was assessed by the 22-item MBI-HSS questionnaire and summarized in Table 2. Overall, 44.51% of responding neurosurgeons were burnout. There were 36.11% of respondents showing high levels of Emotional Exhaustion, 29.62% with high Depersonalization and 12.26% with a low sense of Personal Accomplishment (Table 2). Although the academic neurosurgeons had longer weekly working hours and more workload, the incidence of burnout was significantly lower among the academic neurosurgeons (37.91% vs. 58.84%, $p<0.01$). In fact, the academic neurosurgeons scored better in all three assessed dimensions ($p<0.01$, $p<0.01$, and $p<0.01$, respectively, Table 2). Additional analysis was performed to illustrate the difference in burnout rate among neurosurgeons with different job titles. Table 3 indicates that the non-academic neurosurgeons at all levels had higher burnout rates than their academic colleagues. In addition, for both academic and non-academic respondents, the senior/chief neurosurgeons were less likely being burnout than intern/resident or attending neurosurgeons (Table 3).

Job satisfaction

Job satisfaction was measured by JDI and the five subscales (Table 4). The mean JDI score for all surveyed neurosurgeons was 102.60±36.63. Previous studies have been conducted in other countries using JDI to measure job satisfaction. For example, Rahnavard et al., and Lee et al., reported a mean JDI between 175-190 of mental health professionals and nursing staff [20, 21]. A JDI of 102 of this study is significantly lower than the scores reported by other authors, indicating a lower level of job satisfaction. Interestingly, the academic neurosurgeons showed significantly higher scores (being more satisfied) when they were asked to comment on Work Itself, Promotion, and Supervision ($p<0.01$, $p<0.01$, and $p<0.01$, respectively, Table 4). There was no statistical difference in the comments on Pay and Coworker ($p=0.059$ and 0.45, respectively, Table 3).

Work engagement

The UWES scores indicated the difference in work engagement between the academic and non-academic neurosurgeons (Table 5). Overall, the academic neurosurgeons scored higher (being more enthusiastic for work) than their non-academic colleagues (p=0.015). For UWES subscales, academic neurosurgeons were more dedicated to work (p<0.01). Yet the academic and non-academic neurosurgeons showed no difference in the Vigor and Absorption assessment (p=0.057, 9=0.059, respectively, Table 5).

Multivariate analysis

Multivariate regression analyzation indicated that, for both academic and non-academic neurosurgeons, being divorced, having one (or the first) home-living child, working as attending doctors, prolonged working hours (≥71 hours per week), low annual income (<100,000 RMB, ~14,400 USD), and workplace violence were significantly related to professional burnout (Table 6). For non-academic neurosurgeons, working in public hospitals was an independent risk factor for burnout (OR 5.37, 95% CI 2.969-9.67, p<0.01). In addition, surgeons' age, number of home-living children, and job titles were associated with burnout among non-academic neurosurgeons but not the academic respondents (Table 6). Subgroup analysis also indicated that academic neurosurgeons may have a relatively lower expectation of income. While the annual income between 110,000-150,000 RMB (14,400-21,600 USD) was related to professional burnout among the academic neurosurgeons (OR 0.63, 95% CI 0.46-0.86, p<0.01), a similar association was only observed when the annual income exceeded 160,000 RMB (23,000 USD) among the non-academic respondents (OR 0.29, 95% CI 0.15-0.58, p<0.01, Table 6).

Discussion

There is no doubt that Chinese neurosurgery has made a remarkable improvement in the past decades [3, 4, 6]. On the stage of today's neurosurgery, the voice of the Chinese can often be heard. In spite of the fact that Chinese neurosurgery has shown progresses not only in the case numbers and operating techniques but also in the amount and quality of academic research, little attention has been paid to the working status of Chinese neurosurgical surgeons to date.

In this study, a national survey was conducted to address this issue. Our survey indicates that Chinese neurosurgeons are under great pressure. Vast workload, prolonged working hours, high incidence of burnout and low job satisfaction have been noted among all levels of neurosurgeons. Professional burnout has been previously investigated among neurosurgeons in the U.S. (27%-56.7% of neurosurgeons being burnout) [11, 13] and in Europe (one-quarter of neurosurgeons being burnout) [22]. A recent meta-analysis found that the global prevalence of burnout of residents was 51%[23]. However, this study did not report the prevalence of burnout of neurosurgery residents. In this study, the burnout ratio of Chinese neurosurgeons was 44.51%, which was similar to the results of the U.S. but significantly higher than that of Europe. An interesting finding is that, although the academic neurosurgeons have heavier workloads and longer working hours than the non-academic neurosurgeons, they are more satisfied with their jobs, more committed to the work, and less likely to experience professional burnout. The reasons for the phenomena are complex, and yet we speculate several possible explanations, discussed as follows.

First of all, the income gap may play an important role. Our survey indicated that one of the most apparent differences between Chinese academic and non-academic neurosurgeons is that the former had a higher annual income (Table 1). It has been demonstrated in multiple industries that pay is one of the most important contributors for job satisfaction, work engagement, and, consequently, professional burnout[13, 24-26]. Currently, Chinese tertiary hospitals are attracting an increasing number of patients due to reputations and skillful physicians. Under the principle of performance appraisal which has been widely accepted by Chinese health care facilities, academic neurosurgeons have good reasons to be paid better than those working in regional hospitals. However, it does not imply that neurosurgeons are individuals with high-income. On the contrary, although neurosurgeons are paid approximately 100,000 to 110,000 RMB (14,400-15,800 USD) annually, which is 1.11-1.22 times more than the average salary of Chinese urban employees (89,993 RMB, 13,000 USD, data from the National Bureau of Statistics of China, http://data.stats.gov.cn/easyquery.htm?cn=C01), neurosurgeons are actually underpaid considering their prolonged training, long working hours (nearly 70 hours per week), and vast workload.

Second, academic neurosurgeons may have better career development. As employees of university hospitals and national medical centers, academic neurosurgeons have more opportunities to get funding support and build collaborations, which is crucial for research breakthroughs and development of personal career. According to the records of WFNS (www.wfns.org), AANS (American Association of Neurological Surgeons, www.aans.org), and EANS (European Association of Neurosurgical Societies, www.eans.org), the three major organizations each holding an international neurosurgical conference annually, the majority of Chinese speakers or poster authors of those meetings came from tertiary hospitals. In addition, the database from ClinicalTrails (www.clinicaltrials.gov) and Chinese Clinical Trial Registry (ChiCTR, www.chictr.org.cn) indicates that the majority of multi-center projects are led or exclusively recruit partners from tertiary hospitals. The advantages in career development, especially the chance of getting support at a national level and the opportunities of setting international collaborations with world-leading research facilities, may provide academic neurosurgeons a sense of superiority, and consequently, have positive impacts on job satisfaction and engagement [27].

Thirdly, tertiary hospitals provide a safer work environment. During the last two decades, the deterioration of the doctor-patient relationship has become a major issue in the Chinese medical system. Chinese doctors have been threatened by a surge of workplace violence. In 2017, the Chinese Medical Doctor Association (CMDA) released the latest version of "*White paper on medical practice in China*", showing that 66% of Chinese physicians were involved in doctor-patient conflicts (www.cmda.net/u/cms/www/201807/06181247ffex.pdf). The increase of doctor-patient conflicts has a significant impact on physician burnout, mental health, job satisfaction, and drop-out [9, 28]. In our survey, nearly 40% of neurosurgeons have encountered workplace violence in the last five years. Nevertheless, the incidence among academic neurosurgeons was significantly lower than that among non-academic neurosurgeons. One possible explanation is that university teaching hospitals and national medical centers provide better security service than regional hospitals do. In addition, the public

holds the view that surgeons in tertiary hospitals are more skilled and better equipped. It is believed that academic neurosurgeons represent the highest level in this country, hence more respect and fewer conflicts are expected.

The gap of pay, career development, and safety between academic and non-academic neurosurgeons have attracted an increasing number of young talents to work in tertiary hospitals. If the gap continues to exist or even widens further, an inevitable consequence is that patients would prefer to choose tertiary hospitals even if their disorders could be well treated in regional hospitals. This trend would lead to an imbalance in medical resources and affect the quality of medical care. In order to solve the problem, in 2016 the Chinese authority initiated a new standardization training program requiring all Chinese neurosurgeons, particularly those working in regional hospitals, to finish an extra 4 years of specialist training. The intention of this reform is to enable all Chinese neurosurgeons to receive standardized training and to narrow their gap in skills and knowledge. In the meanwhile, the research management agencies, such as the Nature Science Foundation of China and many local foundations, have also provided increasing support for projects from regional hospitals.

This study has a few limitations. First of all, selection bias may exist during the process of the survey. There are approximately 11,000 registered neurosurgeons in China[5]. This is the largest group of neurosurgical specialists in the world. Although the number of 1202 respondents was similar to the U.S. study and significantly larger than studies in other countries [13, 22], the results of this study may only represent 16% of all Chinese neurosurgeons. Individuals who suffer from significant burnout or low morale were less likely to complete a voluntary survey. In other words, the survey may have provided more optimistic data. Moreover, the questionnaires were distributed electronically via smart-phone APPs and web pages, which may recruit more young respondents than for elder surgeons. Second, for easier understanding and analysis, we simply considered neurosurgeons working in tertiary hospitals as the academic and those in regional hospitals as the non-academic. However, researches in regional hospitals are actually not down to zero. The Chinese healthcare system requires every doctor to publish at least two

papers as one of the premise conditions for promotion, regardless of the type of hospital. In major cities such as Beijing and Shanghai, the conditions for promotion are more demanding, requesting publications in high standard international journals. Therefore, neurosurgeons in regional hospitals also conduct clinical or basic researches, although these researches are usually limited and under the help of tertiary hospitals. However, under the aforementioned new policy, it is a fact that some non-academic neurosurgeons were devoted to research and have made remarkable achievements. Although their number is limited, these "non-academic" neurosurgeons could stay as potential confounders in this anonymous survey. Finally, further studies are required to illustrate the difference in job satisfaction and work engagement among neurosurgeons of different titles. A comparison to other clinical specialists would also be interesting for future investigations.

Conclusion

This study reveals the working status of Chinese neurosurgeons. It also illustrates the difference between academic and the non-academic neurosurgeons in China. Our data suggests that Chinese neurosurgeons are under stress, particularly for those working in regional hospitals. We hope this study will promote reforms for better support and a safer working environment for Chinese neurosurgeons. We also hope this study may offer valuable information for medical students and young talents who would choose neurosurgery, a promising but challenging profession, as a career.

Fortunately, the Chinese authority recently has increasingly emphasized the legitimate rights and interests of medical workers. In addition, starting from 2018, it will be the August 19th of each year as the Chinese Physician's Day. All in all, having healthy and professionally satisfied physicians including neurosurgeons is the essential precondition for improved health care. The change may take a long time, but the future is promising.

Funding

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Competing interests

None declared.

Ethics approval

The Ethics Review Committee of Huashan Hospital, Fudan University approved the study design and the collection of the data through the questionnaire.

Data sharing statement

No additional data is available

Contributors

JY and YS drafted the manuscript and were involved in the interpretation of the data. JG and JC performed statistical analyses. JY, JC, and YS played a major role in questionnaire development. All the authors read and approved the final manuscript.

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Table 1. Demographic & practice characteristics of respondents

	All Neurosurgeons (n=1202)		Academic (n=823)		Non-academic (n=379)		p-value*
	n	%	n	%	n	%	
Gender							
Male	1117	92.93	757	91.98	360	94.99	0.069
Female	85	7.07	66	8.02	19	5.01	0.069
Age							
≤35	586	48.75	406	49.33	180	47.49	0.58
36-45	439	36.52	307	37.30	132	34.83	0.41
46-55	158	13.14	99	12.03	59	15.57	0.092
≥56	19	1.58	11	1.34	8	2.11	0.47
Marital status							
Married	956	79.53	630	76.55	326	86.02	**<0.01**
Unmarried	196	16.31	164	19.93	32	8.44	**<0.01**
Divorced	50	4.16	29	3.52	21	5.54	0.11
Number of kids (married only)							
0	80	8.37	74	11.75	6	1.84	**<0.01**
1	589	61.61	392	62.22	197	60.43	0.59
≥2	287	30.02	164	26.03	123	37.73	**<0.01**
Nature of current employer							
Public	1105	91.93	794	96.48	311	82.06	**<0.01**
Private	97	8.07	29	3.52	68	17.94	**<0.01**
Professional status							
Intern	36	3.00	25	3.04	11	2.90	0.99
Resident	336	27.95	241	29.28	95	25.07	0.13
Attending doctor	509	42.35	342	41.56	167	44.06	0.41
Senior/Chief	321	26.71	215	26.12	106	27.97	0.50
Working hours per week (hours, mean ±sd)							
Total	63.91±11.04	/	64.39±9.63	/	61.92±8.34	/	**<0.01**
Clinic	58.19±10.34	/	56.17±9.12	/	61.42±7.92	/	**<0.01**
Research	5.72±3.67	/	8.21±4.64	/	0.53±0.36	/	**<0.01**
Annual income (10,000RMB)							
<6	202	16.81	121	14.70	81	21.37	**<0.01**
6-10	384	31.95	231	28.07	153	40.37	**<0.01**
11-15	366	30.45	264	32.08	102	26.91	0.071
16-20	172	14.31	140	17.01	32	8.44	**<0.01**
≥20	78	6.49	67	8.14	11	2.90	**<0.01**
Experience or witness of workplace violence in the last 5 years							
Yes	456	37.94	289	35.12	167	44.06	**<0.01**
Encouraging child to become a doctor							
Yes	80	6.66	55	6.68	25	6.60	0.99
No	876	72.88	573	69.62	303	79.95	**<0.01**
Not sure	246	20.47	195	23.69	51	13.46	**<0.01**

* The p-values indicate the difference between the academic and non-academic neurosurgeons. A p-value less than 0.05 is considered as statistical significance.

Table 2. Burnout measured by MBI-HSS

Burnout Subscales	All Neurosurgeons (n=1202)		Academic (n=823)		Non-academic (n=379)		p-value*
	n	%	n	%	n	%	
Emotional Exhaustion							
Low	195	16.22	136	16.52	59	15.57	0.68
Intermediate	573	47.67	414	50.30	159	41.95	**<0.01**
High	434	36.11	273	33.17	161	42.48	**<0.01**
Depersonalization							
Low	543	45.17	394	47.87	149	39.31	**<0.01**
Intermediate	303	25.21	253	30.74	50	13.19	**<0.01**
High	356	29.62	176	21.39	180	47.49	**<0.01**
Personal Accomplishment							
Low	533	44.34	363	44.11	170	44.85	0.81
Intermediate	518	43.09	376	45.69	142	37.47	**<0.01**
High	151	12.56	84	10.21	67	17.68	**<0.01**
Burnout	535	44.51	312	37.91	223	58.84	**<0.01**

* The p-values indicate the difference between the academic and non-academic neurosurgeons. A p-value less than 0.05 is considered as statistical significance.

Table 3. Burnout measured by MBI-HSS among neurosurgeons with different job titles

	All neurosurgeons		Academic		Non-academic		p-value*
	n	Burnout, n(%)	n	Burnout, n(%)	n	Burnout, n(%)	
Intern/Resident	372	162(43.54)	266	108(40.60)	106	63(59.43)	**<0.01**
Attending doctor	509	253(49.71)	342	145(42.40)	167	115(68.86)	**<0.01**
Senior/Chief	321	120(37.38)# †	215	59(27.44)# †	106	45(42.45)# †	**<0.01**

* The p-values indicate the difference between the academic and non-academic neurosurgeons. A p-value less than 0.05 is considered as statistical significance.

There were statistic differences in the burnout rates between the group of Intern/Resident and the Senior/Chief neurosurgeons

† There were statistic differences in the burnout rate between the group of Attending doctor and the Senior/Chief neurosurgeons

Table 4. Job satisfaction measured by JDI

JDI Subscales	All Neurosurgeons (n=1202)		Academic (n=823)		Non-academic (n=379)		p-value*
	Mean	Sd	Mean	Sd	Mean	Sd	
JDI Score	102.60	36.63	107.04	36.48	92.95	35.12	**<0.01**
Work Itself	24.27	11.76	24.55	11.93	22.30	12.49	**<0.01**
Pay	7.44	4.22	7.60	4.09	7.11	4.84	0.059
Promotion	6.73	4.55	7.09	4.29	5.92	4.99	**<0.01**
Supervision	25.44	13.35	27.14	13.83	21.76	11.41	**<0.01**
Coworker	24.53	10.60	25.32	10.76	24.83	10.07	0.45

* The p-values indicate the difference between the academic and non-academic neurosurgeons. A p-value less than 0.05 is considered as statistical significance.

Table 5. Job engagement measured by UWES

UWES Subscales	All Neurosurgeons (n=1202)		Academic (n=823)		Non-academic (n=379)		p-value*
	Mean	Sd	Mean	Sd	Mean	Sd	
UWES Score	61.27	26.21	62.52	25.53	58.55	27.49	**0.015**
Vigor	22.04	9.48	22.39	9.37	21.28	9.69	0.059
Dedication	18.03	8.83	18.57	8.48	16.86	9.46	**<0.01**
Absorption	21.20	9.75	21.57	9.55	20.41	10.13	0.057

* The p-values indicate the difference between the academic and non-academic neurosurgeons. A p value less than 0.05 is considered as statistical significance.

Table 6. Multivariate analysis on burnout

	All Neurosurgeons (n=1202)			Academic(n=823)			Non-academic(n=379)		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p value
Gender									
Male	1.43	0.91-2.26	0.14	1.44	0.84-2.49	0.23	1.04	0.41-2.65	0.99
Age									
≤35	1.07	0.85-1.35	0.55	1.11	0.84-1.47	0.46	1.045	0.69-1.58	0.82
36-45	1.20	0.95-1.52	0.13	1.06	0.79-1.12	0.70	1.75	1.12-2.71	**0.013**
≥46	0.61	0.43-0.85	**<0.01**	0.70	0.45-1.08	0.10	0.39	0.23-0.69	**<0.01**
Marital status									
Married	0.71	0.54-0.94	**0.018**	0.54	0.39-0.75	**<0.01**	1.02	0.56-1.83	0.99
Unmarried	0.92	0.68-1.26	0.61	1.45	1.03-20.6	**0.033**	0.29	0.13-0.62	**<0.01**
Divorced	7.02	2.37-15.08	**<0.01**	4.53	1.98-10.37	**<0.01**	7.52	1.84-28.43	**<0.01**
Number of kids (married only)									
0	0.48	0.29-0.80	**<0.01**	0.78	0.46-1.33	0.43	0.17	0.075-0.38	**<0.01**
1	1.47	1.12-1.92	**<0.01**	1.16	0.83-1.63	0.39	2.46	1.56-3.98	**<0.01**
≥2	0.83	0.63-1.11	0.21	0.95	0.65-1.38	0.20	0.49	0.31-0.77	**<0.01**
Nature of current employer									
Public hospital	1.39	0.91-2.14	0.13	0.36	0.16-0.77	**0.010**	5.37	2.99-9.67	**<0.01**
Job titles									
Intern/resident	0.88	0.69-1.12	0.29	0.99	0.74-1.33	0.99	0.82	0.52-1.28	0.41
Attending doctor	1.40	1.12-1.76	**<0.01**	1.05	0.79-1.40	0.73	2.57	1.67-3.96	**<0.01**
Senior/Chief	0.74	0.57-0.97	**0.031**	0.94	0.67-1.32	0.71	0.41	0.25-0.64	**<0.01**
Working hours per week									
≤55	0.49	0.38-0.63	**<0.01**	0.59	0.33-0.61	**<0. 01**	0.68	0.43-1.08	0.10
56-70	0.63	0.49-0.81	**<0.01**	0.47	0.34-0.65	**<0.01**	0.99	0.64-1.55	0.99
≥71	3.12	2.43-3.99	**<0.01**	4.56	3.33-6.22	**<0.01**	1.39	0.91-2.12	0.13
Annual income (10,000RMB)									
<10	1.85	1.47-2.32	**<0.01**	1.82	1.37-2.43	**<0.01**	1.33	0.88-2.03	0.17
11-15	0.76	0.59-0.98	**0.033**	0.63	0.46-0.86	**<0.01**	1.32	0.82-2.11	0.24
≥16	0.55	0.41-0.74	**<0.01**	0.77	0.55-1.07	0.12	0.29	0.15-0.58	**<0.01**
Experience or witness of workplace violence in the last 5 years									
Yes	1.52	1.18-2.24	**<0.01**	1.42	1.15-2.07	**0.011**	2.03	1.50-3.25	**<0.01**

* A p-value less than 0.05 is considered as statistical significance.

STROBE Statement

Checklist of items that should be included in reports of observational studies

Section/Topic	Item No	Recommendation	Reported on Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	N/A
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	7

Section/Topic	Item No	Recommendation	Reported on Page No
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7-8
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	8-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-10
		(*b*) Report category boundaries when continuous variables were categorized	8-10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	10-11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13-14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-14
Other Information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

**Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.*

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Academic vs. non-academic neurosurgeons in China: a national cross-sectional study on workload, burnout, and engagement

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Academic vs. non-academic neurosurgeons in China: a national cross-sectional study on workload, burnout, and engagement

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Running Title: Academic vs. Non-academic neurosurgeons in China

Abstract

Objectives: Chinese neurosurgery has made great progress during the past decades, yet little is known about the working status of neurosurgeons. This study aimed to evaluate the difference between academic and non-academic neurosurgeons, focusing on their professional burnout, job satisfaction, and work engagement.

Design: Cross-sectional nationwide survey.

Study setting: The survey was conducted in China between 2017 and 2018.

Participants: A total number of 823 academic neurosurgeons and 379 non-academic neurosurgeons participated in this study.

Outcome measures: Professional burnout, job satisfaction, and work engagement were assessed using the Maslach Burnout Inventory, the Job Descriptive Index and the Utrecht Work Engagement Scale, respectively.

Results: The majority of respondents were male (92.93%), less than 45 years old (85.27%), and married (79.53%). Chinese neurosurgeons worked 63.91±11.04 hours per week, and approximately 45% experienced burnout. Compared with non-academic respondents, academic neurosurgeons had longer working hours ($p<0.01$), higher income ($p<0.01$), and were less willing to get married ($p<0.01$). In addition, they showed a lower degree of burnout ($p<0.01$), a higher level of job satisfaction ($p<0.01$) and were more enthusiastic at work ($p=0.015$). Multivariate regression analyses indicated that divorced (OR 7.02, 95% CI 2.37-15.08) and workplace violence (OR 1.52, 95% CI 1.18-2.24) were associated with burnout for both academic and non-academic respondents. Long working hours (≥71 hours per week) and low annual income (<100,000 RMB) were risk factors for burnout among academic neurosurgeons. For non-academic neurosurgical surgeons (age 36-45), working as attending doctors, serving in public hospitals, and having the first house-living child were all closely related to the incidence of burnout.

Conclusions: Chinese neurosurgeons are under significant stress particularly for the non-academic neurosurgeons. Offering better opportunities for training, promotion, higher income, and safer working environments could be solutions to relieve burnout and improve career satisfaction and engagement.

Registration: Chinese Clinical Trial Registry (ChiCTR1800014762).

Strengths and limitations of this study:

This is the first national cross-sectional survey to assess the working status of Chinese neurosurgeons.

Worldwide common questionnaires including MBI-HSS, JDI, and UEWS were applied in the survey. The results would facilitate a comparison to previous and future studies.

Subgroup analyses were performed to illustrate burnout levels among junior and senior neurosurgeons.

Despite a large number (1202) of respondents, the study covered approximately 16% of Chinese neurosurgeons. Selection bias may exist.

A comparison to other clinical specialists would also be interesting for future investigations.

Introduction

Chinese neurosurgery has a relatively short history. The first formal record of neurosurgical procedure could be traced back to 1950, when the first craniotomy operation was performed by Dr. Kefei Shan and Yuquan Shi in Shanghai [1]. At that time, Chinese neurosurgical facilities started with only a few pioneer surgeons and limited beds[1, 2]. A remarkable milestone in the development of Chinese neurosurgery was the foundation of the Chinese Neurosurgical Society (CNS) in 1986[3, 4]. To date, modern neurosurgical clinic centers have been established in many major cities, with some performing over 8,000 sophisticated operations annually[1, 4]. According to the World Federation of Neurosurgical Societies (WFNS) and the Chinese Neurosurgeon Society (CNS)[5], China has approximately 11,000 registered neurosurgeons, which is the largest group of neurosurgeons in the world. In addition, Chinese neurosurgery has made remarkable progress in academic research. It is indicated that China has contributed approximately 4.2% of published neurosurgical research in the world (ranked fifth in the world behind U.S, Japan, Germany, and U.K), and emerged as the only country among the top 5 with substantial growth of neurosurgical research productivity (121.9% ± 9.98% per year) [6].

Despite the remarkable achievement, to our knowledge, there have been few published studies revealing the working status of Chinese neurosurgeons. The training program and

career path of a neurosurgeon in China are different from that in the Western world. In China, the healthcare system involves hospitals of three levels. General practitioners usually work in level I hospitals, also known as community health centers. Level I hospitals provide primary health care and are not equipped with neurosurgical facilities. The Level II hospitals, also known as regional medical centers, recruit specialists including neurosurgeons. Routine neurosurgical operations can be performed in these hospitals. The level III (tertiary) hospitals are usually university teaching hospitals and national medical centers. Neurosurgeons working in tertiary hospitals are required to not only take care of complex cases (usually transferred from regional hospitals), but also conduct clinical/basic research, teaching, and tutoring. Therefore, the neurosurgical surgeons working in tertiary hospitals are usually considered academic neurosurgeons and those working in regional hospitals as the non-academic. For young doctors who are interested in neurosurgery, after graduation from medical school, they are recruited to work either in a regional or tertiary hospital and start their training as neurosurgeon residents. The updated (since 2003) training program requires a neurosurgeon resident to complete two stages (5-7 years in total) standardized training before they can apply for senior positions such as attending and then consulting neurosurgeons. Although young trainees may apply to work for a different hospital (e.g from a non-academic to academic center), the number of successful applicants is very limited. A brief introduction of the Chinese neurosurgery system and training system can be found elsewhere [4].

Due to the inherent difference of the academic and non-academic medical specialists in China, a natural belief holds that the academic neurosurgeons are under significant stress as a result of additional responsibilities. However, during our previous study to assess the working status of Chinese physicians from various specialties, subgroup analyses suggested that surgeons working in regional hospitals were actually more stressed (submitted and under review). Nevertheless, in-depth investigations could not be performed due to limited case numbers. Here we reported the results on a national survey on Chinese neurosurgeons. The focus of this study is to reveal the working status, as well as the difference between academic and non-academic of neurosurgeons. Detailed methods and results are described below.

Materials and Methods

Study Design and Questionnaires

From June 2017 to September 2018, a national online survey was conducted in mainland China using both smartphone apps and website visiting under the support of the East Institution of China Academy of Information and Communications Technology. This study was part of a two-phase national survey on the working and living status of Chinese physicians, which was approved and registered with the Chinese Clinical Trial Registry (ChiCTR1800014762). The Phase I investigation was conducted between June 2017 and February 2018, recruiting 1167 physicians of various specialties. This part focused on the comparison between specialties (submitted elsewhere and under review). The phase II investigation was conducted between March and September 2018, in which the working and living status of each specialty is further investigated. Answers from resident/attending/senior neurosurgeons in both phase I and II investigations were analyzed in this study. Potential respondents were invited to complete the online questionnaires via mailing lists of the Shanghai Medical Doctor Association, the national continuing education platform "Neurosurgery News", and the professional networks of the authors. Neurosurgeons were also invited during national or local conferences via two-dimensional barcodes scanning. An introduction of the research purpose and methods was provided at the beginning of the online survey. Informed consent was received electronically from each respondent. All answers were collected anonymously. To avoid repeated participation, each IP address was restricted to fill out the questionnaire once.

The questionnaire consisted of 147 closed-end questions, organized in sections including demographic and practice characteristics, professional burnout, job satisfaction, and work engagement. Most questions were derived from the well-established and standard scales (see below). A few questions were derived from previous studies [7-9] or were developed by the authors. Details for each section are described as follows.

Demographic and practice characteristics

Respondents were asked to provide gender, marital and family status, job titles, nature of employers, weekly working hours, annual income, experience of workplace violence, and whether a respondent would encourage his/her kid(s) to become a doctor. Neurosurgical respondents working in tertiary hospitals were considered academic neurosurgeons, and those from regional hospitals were considered as non-academic neurosurgeons.

Burnout

Professional burnout was measured by the 22-item Maslach Burnout Inventory-Human Services Survey (MBI-HSS). In previous studies on professional burnout, heterogeneities have been recognized regarding the different tools and questionnaire versions. However, the original 22-item version of MBI-HSS is still one of the most commonly used tools to measure burnout [10]. The 22 items coving three dimensions: Emotional Exhaustion (EE, 9 items), Depersonalization (DP, 5items), and Personal Accomplishments (PA, 8 items). Answers to each question were designed according to the frequency of a respondent's encountering situations on a 7-point scale, from "never" (0 points) to "daily" (6 points). MBI scores of each dimension were further graded as high, intermediate, or low (low EE≤18; high EE≥27; low DP≤5, high DP≥10; low PA≤33; high PA≥40) [11]. A respondent would be considered burnt out if he/she had high scores in the Emotional Exhaustion or Depersonalization assessment [11-13]. The internal consistency of the questionnaire was presented as Cronbach's α values for each section (0.91, 0.90, and 0.85, respectively).

Job satisfaction

The respondents' job satisfaction was assessed by the Index of Job Satisfaction (JDI). The JDI questionnaire contained questions on five independent dimensions, namely, Work Itself (22 items), Pay (9items), Promotion (7 items), Co-workers (11 items), and Supervision (14 items)[14, 15]. Each item was scored Yes=3, ?=1, and No=0, with negatively worded items being reverse-coded. A JDI score for each respondent was calculated as the sum of all his/her answers, with the scores of the Promotion and Pay sections being multiplied by 2. The Cronbach's α values of the 5 JDI subscales were 0.89, 0.94, 0.88, 0.90, and 0.87, respectively.

Work engagement

Work engagement was measured using the 17-item Utrecht Work Engagement Scale (UWES). The UWES had three subscales: Vigor (6 items), Dedication (5 items) and Absorption (6 items). All items were rated on a 7-point Likert scale (0-6). The sum of all items was used as a UWES score [16-18]. The internal consistency for the UWES questionnaire was presented as a Cronbach's α value of 0.85.

Data analysis

Data analysis was performed using SPSS 18 (SPSS Inc., Chicago, U.S.). Quantitative data were presented as means ± standard deviations (SD). Shapiro-Wilk W test and F test were performed for normality and homogeneity. Independent samples t-test, Wilcoxon rank-sum test, and one-way analysis of variance (ANOVA) were used for the quantitative data of independent groups. Chi-square and Fisher exact tests were used for nominal variables. Statistical significance was considered with a two-tailed p-value less than 0.05.

Patient and Public Involvement

No patients were involved in this study. The public has not been involved in the development of the research or in the study design. The study results will be disseminated to respondents via newsletters and publications.

Results

Demographic & practice characteristics of respondents

A total number of 1,202 neurosurgeons completed the survey. Considering the fact that approximately two-thirds of 11,000 registered neurosurgeons in China have received proper training and are active[19], the pool of responding neurosurgeons in this study may represent approximately 16% of Chinese neurosurgeons.

The demographic and practice characteristics of responding neurosurgeons were summarized in Table 1. Their mean age was 34.32±7.21 years, with a male to female ratio of 13.14:1. Among the respondents, 956 (79.53%) were married and 50 (4.16%)

were divorced. Approximately three-quarters of neurosurgeons had home-living children, and 23.87% (30.02% of the married) had more than one child. The majority (91.93%) of responding neurosurgeons worked in public hospitals. They worked an average of 63.91±11.04 hours a week, with an annual income of 11.13±4.85^10^4 RMB (approximately 16,000±6,990 USD). Interns, residents, attending doctors, and senior/chief neurosurgeons constituted 3.00%, 27.95%, 42.35%, and 26.71% of all respondents, respectively. Over one-third (37.94%) of surveyed neurosurgeons claimed that they had experienced or witnessed workplace violence against doctors or other medical workers in the last 5 years. Only 6.6% of respondents would encourage their offspring to become a doctor.

Among the 1202 respondents, there were 823 (68.47%) academic and 379 (31.53%) non-academic neurosurgeons. The two groups had no statistical difference in terms of gender, age, marital status, and job titles. However, a larger proportion of academic neurosurgeons were single compared to the non-academic (19.93% vs. 8.44% $p<0.01$), and the former preferred to have fewer children after marriage (Table 1). While the majority (91.93%) of academic neurosurgeons were working in public hospitals, nearly 18% of non-academic neurosurgeons chose to work in private medical facilities ($p<0.01$, Table 1). Both academic and non-academic neurosurgeons spent approximately 60 hours per week on clinical work (56.17±9.12 vs. 61.42±7.92 hours, $p<0.01$). For the academic neurosurgeons, they required additional 8.21±4.64 hours per week on teaching and research such as university lectures, lab work, clinical trials, paper writing, etc., making their average working hours significantly longer than that of the non-academic ($p<0.01$, Table 1). Accordingly, the average annual income of the academic neurosurgeons was statistically higher than that of their non-academic colleagues (11.37±4.29^10^4 RMB, 16,300±6,100 USD vs. 10.02±5.21^10^4 RMB,14,300±7,500 USD, $p<0.01$). The gap in income was also reflected by the difference in proportions of high-income individuals (Table 1). Some other notable difference included that the non-academic neurosurgeons had a higher risk of experiencing or witnessing workplace violence (44.06% vs. 35.12%, $p<0.01$). Additionally, it is worth noting that the academic neurosurgeons were less likely to encourage their child(ren) to become a doctor ($p<0.01$) (Table 1).

Career Burnout

Career Burnout was assessed by the 22-item MBI-HSS questionnaire and summarized in Table 2. Overall, 44.51% of responding neurosurgeons were burnout. There were 36.11% of respondents showing high levels of Emotional Exhaustion, 29.62% with high Depersonalization and 12.26% with a low sense of Personal Accomplishment (Table 2). Although the academic neurosurgeons had longer weekly working hours and more workload, the incidence of burnout was significantly lower among the academic neurosurgeons (37.91% vs. 58.84%, $p<0.01$). In fact, the academic neurosurgeons scored better in all three assessed dimensions ($p<0.01$, $p<0.01$, and $p<0.01$, respectively, Table 2). Additional analysis was performed to illustrate the difference in burnout rate among neurosurgeons with different job titles. Table 3 indicates that the non-academic neurosurgeons at all levels had higher burnout rates than their academic colleagues. In addition, for both academic and non-academic respondents, the senior/chief neurosurgeons were less likely being burnout than intern/resident or attending neurosurgeons (Table 3).

Job satisfaction

Job satisfaction was measured by JDI and the five subscales (Table 4). The mean JDI score for all surveyed neurosurgeons was 102.60±36.63. Previous studies have been conducted in other countries using JDI to measure job satisfaction. For example, Rahnavard et al., and Lee et al., reported a mean JDI between 175-190 of mental health professionals and nursing staff [20, 21]. A JDI of 102 of this study is significantly lower than the scores reported by other authors, indicating a lower level of job satisfaction. Interestingly, the academic neurosurgeons showed significantly higher scores (being more satisfied) when they were asked to comment on Work Itself, Promotion, and Supervision ($p<0.01$, $p<0.01$, and $p<0.01$, respectively, Table 4). There was no statistical difference in the comments on Pay and Coworker ($p=0.059$ and 0.45, respectively, Table 3).

Work engagement

The UWES scores indicated the difference in work engagement between the academic and non-academic neurosurgeons (Table 5). Overall, the academic neurosurgeons scored higher (being more enthusiastic for work) than their non-academic colleagues (p=0.015). For UWES subscales, academic neurosurgeons were more dedicated to work (p<0.01). Yet the academic and non-academic neurosurgeons showed no difference in the Vigor and Absorption assessment (p=0.057, 9=0.059, respectively, Table 5).

Multivariate analysis

Multivariate regression analyzation indicated that, for both academic and non-academic neurosurgeons, being divorced, having one (or the first) home-living child, working as attending doctors, prolonged working hours (≥71 hours per week), low annual income (<100,000 RMB, ~14,400 USD), and workplace violence were significantly related to professional burnout (Table 6). For non-academic neurosurgeons, working in public hospitals was an independent risk factor for burnout (OR 5.37, 95% CI 2.969-9.67, p<0.01). In addition, surgeons' age, number of home-living children, and job titles were associated with burnout among non-academic neurosurgeons but not the academic respondents (Table 6). Subgroup analysis also indicated that academic neurosurgeons may have a relatively lower expectation of income. While the annual income between 110,000-150,000 RMB (14,400-21,600 USD) was related to professional burnout among the academic neurosurgeons (OR 0.63, 95% CI 0.46-0.86, p<0.01), a similar association was only observed when the annual income exceeded 160,000 RMB (23,000 USD) among the non-academic respondents (OR 0.29, 95% CI 0.15-0.58, p<0.01, Table 6).

Discussion

There is no doubt that Chinese neurosurgery has made a remarkable improvement in the past decades [3, 4, 6]. On the stage of today's neurosurgery, the voice of the Chinese can often be heard. In spite of the fact that Chinese neurosurgery has shown progresses not only in the case numbers and operating techniques but also in the amount and quality of academic research, little attention has been paid to the working status of Chinese neurosurgical surgeons to date.

In this study, a national survey was conducted to address this issue. Our survey indicates that Chinese neurosurgeons are under great pressure. Vast workload, prolonged working hours, high incidence of burnout and low job satisfaction have been noted among all levels of neurosurgeons. Professional burnout has been previously investigated among neurosurgeons in the U.S. (27%-56.7% of neurosurgeons being burnout) [11, 13] and in Europe (one-quarter of neurosurgeons being burnout) [22]. A recent meta-analysis found that the global prevalence of burnout of residents was 51%[23]. However, this study did not report the prevalence of burnout of neurosurgery residents. In this study, the burnout ratio of Chinese neurosurgeons was 44.51%, which was similar to the results of the U.S. but significantly higher than that of Europe. An interesting finding is that, although the academic neurosurgeons have heavier workloads and longer working hours than the non-academic neurosurgeons, they are more satisfied with their jobs, more committed to the work, and less likely to experience professional burnout. The reasons for the phenomena are complex, and yet we speculate several possible explanations, discussed as follows.

First of all, the income gap may play an important role. Our survey indicated that one of the most apparent differences between Chinese academic and non-academic neurosurgeons is that the former had a higher annual income (Table 1). It has been demonstrated in multiple industries that pay is one of the most important contributors for job satisfaction, work engagement, and, consequently, professional burnout[13, 24-26]. Currently, Chinese tertiary hospitals are attracting an increasing number of patients due to reputations and skillful physicians. Under the principle of performance appraisal which has been widely accepted by Chinese health care facilities, academic neurosurgeons have good reasons to be paid better than those working in regional hospitals. However, it does not imply that neurosurgeons are individuals with high-income. On the contrary, although neurosurgeons are paid approximately 100,000 to 110,000 RMB (14,400-15,800 USD) annually, which is 1.11-1.22 times more than the average salary of Chinese urban employees (89,993 RMB, 13,000 USD, data from the National Bureau of Statistics of China, http://data.stats.gov.cn/easyquery.htm?cn=C01), neurosurgeons are actually underpaid considering their prolonged training, long working hours (nearly 70 hours per week), and vast workload.

Second, academic neurosurgeons may have better career development. As employees of university hospitals and national medical centers, academic neurosurgeons have more opportunities to get funding support and build collaborations, which is crucial for research breakthroughs and development of personal career. According to the records of WFNS (www.wfns.org), AANS (American Association of Neurological Surgeons, www.aans.org), and EANS (European Association of Neurosurgical Societies, www.eans.org), the three major organizations each holding an international neurosurgical conference annually, the majority of Chinese speakers or poster authors of those meetings came from tertiary hospitals. In addition, the database from ClinicalTrails (www.clinicaltrials.gov) and Chinese Clinical Trial Registry (ChiCTR, www.chictr.org.cn) indicates that the majority of multi-center projects are led or exclusively recruit partners from tertiary hospitals. The advantages in career development, especially the chance of getting support at a national level and the opportunities of setting international collaborations with world-leading research facilities, may provide academic neurosurgeons a sense of superiority, and consequently, have positive impacts on job satisfaction and engagement [27].

Thirdly, tertiary hospitals provide a safer work environment. During the last two decades, the deterioration of the doctor-patient relationship has become a major issue in the Chinese medical system. Chinese doctors have been threatened by a surge of workplace violence. In 2017, the Chinese Medical Doctor Association (CMDA) released the latest version of "*White paper on medical practice in China*", showing that 66% of Chinese physicians were involved in doctor-patient conflicts (www.cmda.net/u/cms/www/201807/06181247ffex.pdf). The increase of doctor-patient conflicts has a significant impact on physician burnout, mental health, job satisfaction, and drop-out [9, 28]. In our survey, nearly 40% of neurosurgeons have encountered workplace violence in the last five years. Nevertheless, the incidence among academic neurosurgeons was significantly lower than that among non-academic neurosurgeons. One possible explanation is that university teaching hospitals and national medical centers provide better security service than regional hospitals do. In addition, the public

holds the view that surgeons in tertiary hospitals are more skilled and better equipped. It is believed that academic neurosurgeons represent the highest level in this country, hence more respect and fewer conflicts are expected.

The gap of pay, career development, and safety between academic and non-academic neurosurgeons have attracted an increasing number of young talents to work in tertiary hospitals. If the gap continues to exist or even widens further, an inevitable consequence is that patients would prefer to choose tertiary hospitals even if their disorders could be well treated in regional hospitals. This trend would lead to an imbalance in medical resources and affect the quality of medical care. In order to solve the problem, in 2016 the Chinese authority initiated a new standardization training program requiring all Chinese neurosurgeons, particularly those working in regional hospitals, to finish an extra 4 years of specialist training. The intention of this reform is to enable all Chinese neurosurgeons to receive standardized training and to narrow their gap in skills and knowledge. In the meanwhile, the research management agencies, such as the Nature Science Foundation of China and many local foundations, have also provided increasing support for projects from regional hospitals.

This study has a few limitations. First of all, selection bias may exist during the process of the survey. There are approximately 11,000 registered neurosurgeons in China[5]. This is the largest group of neurosurgical specialists in the world. Although the number of 1202 respondents was similar to the U.S. study and significantly larger than studies in other countries [13, 22], the results of this study may only represent 16% of all Chinese neurosurgeons. Individuals who suffer from significant burnout or low morale were less likely to complete a voluntary survey. In other words, the survey may have provided more optimistic data. Moreover, the questionnaires were distributed electronically via smart-phone APPs and web pages, which may recruit more young respondents than for elder surgeons. Second, for easier understanding and analysis, we simply considered neurosurgeons working in tertiary hospitals as the academic and those in regional hospitals as the non-academic. However, researches in regional hospitals are actually not down to zero. The Chinese healthcare system requires every doctor to publish at least two

papers as one of the premise conditions for promotion, regardless of the type of hospital. In major cities such as Beijing and Shanghai, the conditions for promotion are more demanding, requesting publications in high standard international journals. Therefore, neurosurgeons in regional hospitals also conduct clinical or basic researches, although these researches are usually limited and under the help of tertiary hospitals. However, under the aforementioned new policy, it is a fact that some non-academic neurosurgeons were devoted to research and have made remarkable achievements. Although their number is limited, these "non-academic" neurosurgeons could stay as potential confounders in this anonymous survey. Finally, further studies are required to illustrate the difference in job satisfaction and work engagement among neurosurgeons of different titles. A comparison to other clinical specialists would also be interesting for future investigations.

Conclusion

This study reveals the working status of Chinese neurosurgeons. It also illustrates the difference between academic and the non-academic neurosurgeons in China. Our data suggests that Chinese neurosurgeons are under stress, particularly for those working in regional hospitals. We hope this study will promote reforms for better support and a safer working environment for Chinese neurosurgeons. We also hope this study may offer valuable information for medical students and young talents who would choose neurosurgery, a promising but challenging profession, as a career.

Fortunately, the Chinese authority recently has increasingly emphasized the legitimate rights and interests of medical workers. In addition, starting from 2018, it will be the August 19th of each year as the Chinese Physician's Day. All in all, having healthy and professionally satisfied physicians including neurosurgeons is the essential precondition for improved health care. The change may take a long time, but the future is promising.

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Competing interests

None declared.

Ethics approval

The Ethics Review Committee of Huashan Hospital, Fudan University approved the study design and the collection of the data through the questionnaire.

Data sharing statement

All data relevant to the study are included in the article or uploaded as supplementary information.

Contributors

JY and YS drafted the manuscript and were involved in the interpretation of the data. JG and JC performed statistical analyses. JY, JC, and YS played a major role in questionnaire development. All the authors read and approved the final manuscript.

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Table 1. Demographic & practice characteristics of respondents

	All Neurosurgeons (n=1202)		Academic (n=823)		Non-academic (n=379)		p-value*
	n	%	n	%	n	%	
Gender							
Male	1117	92.93	757	91.98	360	94.99	0.069
Female	85	7.07	66	8.02	19	5.01	0.069
Age							
≤35	586	48.75	406	49.33	180	47.49	0.58
36-45	439	36.52	307	37.30	132	34.83	0.41
46-55	158	13.14	99	12.03	59	15.57	0.092
≥56	19	1.58	11	1.34	8	2.11	0.47
Marital status							
Married	956	79.53	630	76.55	326	86.02	**<0.01**
Unmarried	196	16.31	164	19.93	32	8.44	**<0.01**
Divorced	50	4.16	29	3.52	21	5.54	0.11
Number of kids (married only)							
0	80	8.37	74	11.75	6	1.84	**<0.01**
1	589	61.61	392	62.22	197	60.43	0.59
≥2	287	30.02	164	26.03	123	37.73	**<0.01**
Nature of current employer							
Public	1105	91.93	794	96.48	311	82.06	**<0.01**
Private	97	8.07	29	3.52	68	17.94	**<0.01**
Professional status							
Intern	36	3.00	25	3.04	11	2.90	0.99
Resident	336	27.95	241	29.28	95	25.07	0.13
Attending doctor	509	42.35	342	41.56	167	44.06	0.41
Senior/Chief	321	26.71	215	26.12	106	27.97	0.50
Working hours per week (hours, mean ±sd)							
Total	63.91±11.04	/	64.39±9.63	/	61.92±8.34	/	**<0.01**
Clinic	58.19±10.34	/	56.17±9.12	/	61.42±7.92	/	**<0.01**
Research	5.72±3.67	/	8.21±4.64	/	0.53±0.36	/	**<0.01**
Annual income (10,000RMB)							
<6	202	16.81	121	14.70	81	21.37	**<0.01**
6-10	384	31.95	231	28.07	153	40.37	**<0.01**
11-15	366	30.45	264	32.08	102	26.91	0.071
16-20	172	14.31	140	17.01	32	8.44	**<0.01**
≥20	78	6.49	67	8.14	11	2.90	**<0.01**
Experience or witness of workplace violence in the last 5 years							
Yes	456	37.94	289	35.12	167	44.06	**<0.01**
Encouraging child to become a doctor							
Yes	80	6.66	55	6.68	25	6.60	0.99
No	876	72.88	573	69.62	303	79.95	**<0.01**
Not sure	246	20.47	195	23.69	51	13.46	**<0.01**

* The p-values indicate the difference between the academic and non-academic neurosurgeons. A p-value less than 0.05 is considered as statistical significance.

Table 2. Burnout measured by MBI-HSS

Burnout Subscales	All Neurosurgeons (n=1202)		Academic (n=823)		Non-academic (n=379)		p-value*
	n	%	n	%	n	%	
Emotional Exhaustion							
Low	195	16.22	136	16.52	59	15.57	0.68
Intermediate	573	47.67	414	50.30	159	41.95	**<0.01**
High	434	36.11	273	33.17	161	42.48	**<0.01**
Depersonalization							
Low	543	45.17	394	47.87	149	39.31	**<0.01**
Intermediate	303	25.21	253	30.74	50	13.19	**<0.01**
High	356	29.62	176	21.39	180	47.49	**<0.01**
Personal Accomplishment							
Low	533	44.34	363	44.11	170	44.85	0.81
Intermediate	518	43.09	376	45.69	142	37.47	**<0.01**
High	151	12.56	84	10.21	67	17.68	**<0.01**
Burnout	535	44.51	312	37.91	223	58.84	**<0.01**

* The p-values indicate the difference between the academic and non-academic neurosurgeons. A p-value less than 0.05 is considered as statistical significance.

Table 3. Burnout measured by MBI-HSS among neurosurgeons with different job titles

	All neurosurgeons		Academic		Non-academic		p-value*
	n	Burnout, n(%)	n	Burnout, n(%)	n	Burnout, n(%)	
Intern/Resident	372	162(43.54)	266	108(40.60)	106	63(59.43)	**<0.01**
Attending doctor	509	253(49.71)	342	145(42.40)	167	115(68.86)	**<0.01**
Senior/Chief	321	120(37.38)# †	215	59(27.44)# †	106	45(42.45)# †	**<0.01**

* The p-values indicate the difference between the academic and non-academic neurosurgeons. A p-value less than 0.05 is considered as statistical significance.

There were statistic differences in the burnout rates between the group of Intern/Resident and the Senior/Chief neurosurgeons

† There were statistic differences in the burnout rate between the group of Attending doctor and the Senior/Chief neurosurgeons

Table 4. Job satisfaction measured by JDI

JDI Subscales	All Neurosurgeons (n=1202)		Academic (n=823)		Non-academic (n=379)		p-value*
	Mean	Sd	Mean	Sd	Mean	Sd	
JDI Score	102.60	36.63	107.04	36.48	92.95	35.12	**<0.01**
Work Itself	24.27	11.76	24.55	11.93	22.30	12.49	**<0.01**
Pay	7.44	4.22	7.60	4.09	7.11	4.84	0.059
Promotion	6.73	4.55	7.09	4.29	5.92	4.99	**<0.01**
Supervision	25.44	13.35	27.14	13.83	21.76	11.41	**<0.01**
Coworker	24.53	10.60	25.32	10.76	24.83	10.07	0.45

* The p-values indicate the difference between the academic and non-academic neurosurgeons. A p-value less than 0.05 is considered as statistical significance.

Table 5. Job engagement measured by UWES

UWES Subscales	All Neurosurgeons (n=1202)		Academic (n=823)		Non-academic (n=379)		p-value*
	Mean	Sd	Mean	Sd	Mean	Sd	
UWES Score	61.27	26.21	62.52	25.53	58.55	27.49	**0.015**
Vigor	22.04	9.48	22.39	9.37	21.28	9.69	0.059
Dedication	18.03	8.83	18.57	8.48	16.86	9.46	**<0.01**
Absorption	21.20	9.75	21.57	9.55	20.41	10.13	0.057

* The p-values indicate the difference between the academic and non-academic neurosurgeons. A p value less than 0.05 is considered as statistical significance.

Table 6. Multivariate analysis on burnout

	All Neurosurgeons (n=1202)			Academic(n=823)			Non-academic(n=379)		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p value
Gender									
Male	1.43	0.91-2.26	0.14	1.44	0.84-2.49	0.23	1.04	0.41-2.65	0.99
Age									
≤35	1.07	0.85-1.35	0.55	1.11	0.84-1.47	0.46	1.045	0.69-1.58	0.82
36-45	1.20	0.95-1.52	0.13	1.06	0.79-1.12	0.70	1.75	1.12-2.71	**0.013**
≥46	0.61	0.43-0.85	**<0.01**	0.70	0.45-1.08	0.10	0.39	0.23-0.69	**<0.01**
Marital status									
Married	0.71	0.54-0.94	**0.018**	0.54	0.39-0.75	**<0.01**	1.02	0.56-1.83	0.99
Unmarried	0.92	0.68-1.26	0.61	1.45	1.03-20.6	**0.033**	0.29	0.13-0.62	**<0.01**
Divorced	7.02	2.37-15.08	**<0.01**	4.53	1.98-10.37	**<0.01**	7.52	1.84-28.43	**<0.01**
Number of kids (married only)									
0	0.48	0.29-0.80	**<0.01**	0.78	0.46-1.33	0.43	0.17	0.075-0.38	**<0.01**
1	1.47	1.12-1.92	**<0.01**	1.16	0.83-1.63	0.39	2.46	1.56-3.98	**<0.01**
≥2	0.83	0.63-1.11	0.21	0.95	0.65-1.38	0.20	0.49	0.31-0.77	**<0.01**
Nature of current employer									
Public hospital	1.39	0.91-2.14	0.13	0.36	0.16-0.77	**0.010**	5.37	2.99-9.67	**<0.01**
Job titles									
Intern/resident	0.88	0.69-1.12	0.29	0.99	0.74-1.33	0.99	0.82	0.52-1.28	0.41
Attending doctor	1.40	1.12-1.76	**<0.01**	1.05	0.79-1.40	0.73	2.57	1.67-3.96	**<0.01**
Senior/Chief	0.74	0.57-0.97	**0.031**	0.94	0.67-1.32	0.71	0.41	0.25-0.64	**<0.01**
Working hours per week									
≤55	0.49	0.38-0.63	**<0.01**	0.59	0.33-0.61	**<0. 01**	0.68	0.43-1.08	0.10
56-70	0.63	0.49-0.81	**<0.01**	0.47	0.34-0.65	**<0.01**	0.99	0.64-1.55	0.99
≥71	3.12	2.43-3.99	**<0.01**	4.56	3.33-6.22	**<0.01**	1.39	0.91-2.12	0.13
Annual income (10,000RMB)									
<10	1.85	1.47-2.32	**<0.01**	1.82	1.37-2.43	**<0.01**	1.33	0.88-2.03	0.17
11-15	0.76	0.59-0.98	**0.033**	0.63	0.46-0.86	**<0.01**	1.32	0.82-2.11	0.24
≥16	0.55	0.41-0.74	**<0.01**	0.77	0.55-1.07	0.12	0.29	0.15-0.58	**<0.01**
Experience or witness of workplace violence in the last 5 years									
Yes	1.52	1.18-2.24	**<0.01**	1.42	1.15-2.07	**0.011**	2.03	1.50-3.25	**<0.01**

* A p-value less than 0.05 is considered as statistical significance.

STROBE Statement

Checklist of items that should be included in reports of observational studies

Section/Topic	Item No	Recommendation	Reported on Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	N/A
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	7

Section/Topic	Item No	Recommendation	Reported on Page No
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7-8
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	8-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-10
		(*b*) Report category boundaries when continuous variables were categorized	8-10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	10-11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13-14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-14
Other Information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

**Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.*

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.