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More or less, what had the appraisal for hospitals brought to job satisfaction of healthcare professionals? A cross-sectional survey in China

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More or less, what had the appraisal for hospitals brought to job satisfaction of healthcare professionals?

A cross-sectional survey in China

ABSTRACT

Objective The purpose of this study is to measure the effectiveness of appraisals for hospitals (i.e., performance appraisal for public tertiary hospitals, PAPTH) and examined its impact on job satisfaction of healthcare professionals in Chinese public tertiary hospitals.

Design A cross-sectional study.

Setting Nine public tertiary hospitals across three economic regions in China.

Participants A total of 13211 hospital employees in public tertiary hospitals in August 2020, China and 8417 fully answered questionnaires from doctors and nurses were included in the main analysis. Male made up 18.64% and doctors constituted 28.15%.

Results This study found that PAPTH played a positive role on job satisfaction of healthcare professionals after. A “more effective” PAPTH working environment improved 9.57 points (CI: 8.99 – 10.16) of job satisfaction scores with other conditions unchanged. This finding showed robustness in a series of sensitivity analysis.

Conclusion The finding would provide ideas and inspiration for enhancing the job satisfaction of healthcare professionals, especially in the design of macro-level policies targeted towards organizations.

Key words Job satisfaction; healthcare professionals; appraisals for hospitals; inverse probability-of-treatment weighting.

Strengths and limitation of this study

- Past studies have shown positive impact of performance appraisal for hospitals in reducing health care costs and improving health care quality, but research on its impact on healthcare professionals’ job satisfaction is limited.
- This study collected relative sufficient potential confounders (such as sociodemographic characteristics, depression status of participants and hospital characteristics) and excluded their effects with the Inverse probability-of-treatment weighting (IPTW) method.
- Though a large sample have been analyzed, we didn’t include healthcare professionals in all positions but only doctors and nurses, which may lead to a lack of extrapolation.

INTRODUCTION

The job satisfaction of healthcare professionals is widely concerned, for its impact on physician outcomes (e.g., turnover, performance and mental health) and healthcare outcomes (e.g., quality of care, patient outcomes and costs)¹⁻⁴. Hoppock (1935) defined job satisfaction as any combination of psychological, physiological and environmental conditions that encourage employees to be satisfied or happy with their job⁵. Different personal attributes and working environment which consists of job characteristics, physical working conditions and social working conditions may affect workers' job satisfaction⁶. As for healthcare professionals, aside from personal factors like age, gender, marital status, position, and education background, abundant evidence have shown that work environment factors had significant impact on job satisfaction, including income, working shift, leadership, job autonomy, and collegial support⁷⁻¹¹.

Health policies have been considered as a type of practice environment which influence the job satisfaction of healthcare professionals^{3 12} and prior literature have proven that the impact of hospital mergers on staff job satisfaction and psychological status in the NHS^{13 14}. The Performance Appraisal for Public Tertiary Hospitals (PAPTH) in China was initially launched in 2019. It annually evaluated and rated more than 2400 top hospitals which were funded by the government based on 5 dimensions: medical quality of the hospital, operation efficiency of the hospital, sustainable development of the hospital, satisfaction of patients, and job satisfaction of

healthcare professionals. The PAPTH aimed to promote transitions of the development mode and the management mode of public tertiary hospitals to a more efficient and quality-oriented direction through the performance appraisal for hospitals ¹⁵. So far, the appraisal results of the PAPTH were considered as an essential basis for policy support for the development of hospitals, financial input from the government, the amount of performance compensation of healthcare professionals, and the income of the hospitals.

During the implementation of PAPTH, hospitals are the recipients and are pushed to be more efficient and quality-oriented. Financial and nonfinancial incentives from PAPTH motivated tertiary hospitals to benchmark weaknesses through each appraisal dimension and improve their performance, profoundly reforming working settings and social environment with adaptive policies in hospitals ^{12 16}. It's noted that healthcare professionals were affected directly by this hospital-level adaptive policies.

However, there were ambiguous results about the impact of health policies on job satisfaction of healthcare professionals. Altered everyday work activities and organizational culture caused by job arrangements may bring more stress, less job security, and less job autonomy to healthcare professionals through strict regulations and higher requirements ¹⁷⁻¹⁹. Meanwhile, some opposing views ²⁰ pointed out that a robust satisfaction is based on internal values more than external

changes, and there was no significant or persistent impact of healthcare reforms on doctors' job satisfaction. As for the individual level, healthcare professionals may feel the coexistence of support and pressure during the PAPTH policy implementation: on the one hand, PAPTH aimed to achieve better medical quality, higher operation efficiency of hospital, more sustainable development of hospitals and more satisfied patients, offering positive working conditions to satisfy healthcare professionals; on the other hand, there also could exist more stressful work tasks and higher work requirements on healthcare professionals in hospitals due to the pressure from the annual hospital ranking, for the relationship between the ranking and governmental funding. For instance, higher quality of health records and medical care encouraged by PAPTH may impose more stress on healthcare professionals and affect their job satisfaction negatively²¹⁻²³. In this case, what macro health policies like PAPTH, which do not take healthcare professionals as targets but aim at organizational changes, have brought to healthcare professionals and its effect on job satisfaction of healthcare professionals needs to be further studied.

This study aimed to figure out the effect of PAPTH as an environmental factor on job satisfaction of healthcare professionals. We hypothesized that healthcare professionals tended to hold higher job satisfaction in a "more effective" PAPTH working environment, and defined "more effective" by the extent to the improvement in working environment by PAPTH. Firstly, the PAPTH-induced improvement in working environment were measured in 5 dimensions of PAPTH (i.e., medical

quality of hospital, operation efficiency of hospital, sustainable development of hospital and satisfaction of patients) based on the evaluation of healthcare professionals. Then, we constructed the Inverse probability-of-treatment weighting (IPTW) method to clarify the disparities in job satisfaction of healthcare professionals among the two working settings. At last, we compared the differences of job satisfaction with a series of weighted linear regression models between different working environment.

METHODS

Study design and population

This is a quantitative study that used data from a nationwide cross-sectional sampling survey conducted in tertiary public general hospitals in China in August 2020. To ensure the representativeness of the samples across hospitals with different social backgrounds and baseline performance, hospitals were selected in consideration of economical regions and PAPTH ratings for 2018 (based on data prior to the implementation of PAPTH). Firstly, three provinces were selected from three regions (“Eastern region”, “Central region” and “Western region”)¹. Then three hospitals were selected respectively from each province, stratified by performance ratings (“fair”,

¹ In China, regions were divided into “western region”, “central region” and “eastern region” according to their level of economic development from low to high.

“good” and “excellent”). Participants included all hospital employees on duty during the investigation period. Through an electronic questionnaire, participants submitted their responses directly to the cloud server, and the data were confidential to managers to ensure the authenticity of this survey and the response rate.

In total, we received 13211 questionnaires across 9 public tertiary hospitals in 3 provinces in China, from which 10012 doctors and nurses were distinguished according to participants’ responses (detailed in the supplementary materials). Considering the essential roles of doctors and nurses in the delivery of healthcare, this study focused on the changes of job satisfaction of doctors and nurses, but also reported results for healthcare professionals of all positions in the sensitivity analyses for robustness. Finally, responses without missing value from 8417 doctors and nurses (84.07% in 10012) were included in the statistical analysis. Based on responses to the improvement of working environment, the exposure group included participants who positioned themselves in a “more effective” PAPTH working environment, while the control group included the remaining participants. After excluding confounding of hospital characteristics and personal characteristics by IPTW approach, this study estimated the average treated/causal effect of exposure (i.e., the “more effective” PAPTH working environment) on job satisfaction (**Figure 1**).

Study Measures

Outcome variable: Job satisfaction

The Minnesota Satisfaction Questionnaire (MSQ) (short-form) ²⁴ was used to measure healthcare professionals' job satisfaction. The instrument asked respondents to rate their satisfaction of their present job in 20 aspects which were divided in intrinsic scale (including item 1-4, 7-11, 15-16, 20) and extrinsic scale (including item 5-6, 12-14, 17-19). Responds were made on a 5-point scale from 1 (*very dissatisfied*) to 5 (*very satisfied*). The total score with a range of 20 to 100 was calculated for each participant. The intrinsic and extrinsic subscales were used as outcome measures in the explorational analysis. The Cronbach's α value of MSQ in this survey was 0.966. (Table S1 in supplementary materials)

Exposure variable: The "more effective" PAPTH

The "more effective" PAPTH working environment was defined according to the evaluation of participants on the extent to which PAPTH improved the working environment. Participants rated the improvement in 5 appraisal dimensions of PAPTH with a 5-point scale from 0 (*no improvement*) to 4 (*significant improvement*). Responses that reported "unclear" in any dimension were considered as missing value (less than 7.07% in each dimension). The total score was calculated for each participant and a total score more than 18 point (the 75th percent quantile) was considered to indicate a "more effective" environment. Those participants who worked in a "more effective" environment were assigned to 1 (exposed group) while others were assigned to 0 (control group).

The Cronbach's α value was 0.970. (**Table S2** in supplementary materials)

Covariates

We selected covariates based on a priori knowledge of potential factors of job satisfaction and the improvement observed of the PPATH, including age group, gender (male or female), marital status (never married or other conditions), position (doctor or nurse), education level (below undergraduate, undergraduate, master's degree or doctoral degree), technical title (not have, primary title, intermediate title, vice senior or senior), administrative position (have or not have), department (internal medicine, surgical or other departments), region (east, center or west), performance rating of the hospital (fair, good or excellent), the increased attention to the working environment (more or less), the depression status of participants (at risk or none). All information were derived from responses to survey questions.

The increased attention to the PPATH of participants were measured by 5 aspects of PPATH's indicators (**Table S3** in the supplementary materials). Responds were made on a 5-point scale from 0 (*no increasement*) to 4 (*significant increasement*). Participants who reported as "never concern" in any dimension were marked as missing responds (less than 6.05% in each dimension). A higher total score indicated more increased attention of participants on the working environment. Scores less than 9 (the 25th quantile) were considered as less increased attention. The Cronbach's α value

was 0.927.

The depression status of participants were measured by the Center for Epidemiological Studies-Depression Scale with 20 items ²⁵. Each of 20 symptoms has a 4-point option, ranging from 0 (*rarely or none of the time*) to 3 (*all of the time*). Four of the items (4, 8, 12, 16) were reversely scored. Total scores range from 0 to 60, with higher scores indicating greater depressive symptoms. We identified individuals at risk for depression with cut-off scores of 16 or greater ²⁶. The Cronbach's α value of the Center for Epidemiological Studies-Depression Scale was 0.926.

The Self-Rating Anxiety Scale²⁷ measuring levels of anxiety among healthcare professionals had 20 items. Participants described how often they felt or behaved in anxiety-related ways during the past week, and their responds were made on a 4-point scale from 1 (*none or almost none*) to 4 (*almost all the time*). Five of the items (5, 9, 13, 17, and 19) were reverse scored. The scores of all items were summed up as a raw score, then the standard score was calculated by multiplying the raw score times 1.25. A higher standard score ranging from 25 to 100 indicated a higher possibility of anxiety. We identified individuals at risk for anxiety disorder with cut-off scores of 50 or greater²⁸. The Cronbach's α coefficients of the Self-Rating Anxiety Scale was 0.877.

Data analysis

Descriptive analysis and difference significance test

Standard descriptive statistics were used to characterize participants who worked in a “more effective” environment and who did not. In comparisons between groups, the chi-square test and one-way ANOVA analysis were performed on the categorical variables and continuous variables as appropriate.

Inverse probability treatment weighting

IPTW used propensity scores to create a weight for each participant so that the baseline characteristics of participants are balanced. By weighting each individual on the his/her weighting we simulated a pseudo-population in which there was not association between baseline observed covariates and the treatment (i.e., “more effective” PAPTH environment).

To increase statistical efficiency and attain better coverage of confidence intervals, stabilized weight was calculated²⁹:

$$w_i = \frac{P(T_i = t_i)}{P(T_i = t | C_i = c_i)},$$

where T denotes the working environment with $t=1$ for “more effective” and $t=0$ for “less effective”, i represents participants and C indicates a set of potential confounders. The numerator equals to the crude probability of exposure and the dominator equals to the probability of exposure conditioned with set C .

We chose the traditional strategy of controlled trial-and-error re-specification of the weight-estimating equation in the determination of set C . Though the exchangeability assumption requires enough joint predictors of exposure and outcome (i.e., confounders) in the estimation of the dominator, the addition of non-confounding variables may introduce selection bias due to collider stratification, violate the possibility assumption and decrease the statistical efficiency. To achieve a better trade-off, a backward selection was performed.

Figure 2 showed the procedure of the construction of weights. The optimal set C containing less covariates would produce optimal weights which possessed a distribution with a mean close to 1 and a narrower range, and facilitated a better balance of all covariates³⁰. The primitive set C in the specification 1 would contain all covariates which showed imbalance (standardized difference in proportion > 0.1) at the baseline and affect the probability of T under the consideration of domain knowledge. The standardized differences in proportion were calculated as follow³¹:

$$\text{Standardized difference in proportion} = \frac{\hat{p}_{\text{exposed}} - \hat{p}_{\text{control}}}{\sqrt{\frac{\hat{p}_{\text{exposed}}(1 - \hat{p}_{\text{exposed}}) + \hat{p}_{\text{control}}(1 - \hat{p}_{\text{control}})}{2}}}$$

where $\hat{p}_{\text{exposed}}$ and $\hat{p}_{\text{control}}$ denote the sample prevalence of the exposure(T) in exposed and control groups, respectively.

Extreme weights would be addressed through truncation at the 1st and 99th percentiles in the process

of constructing³². Remaining imbalance after weighed would be addressed in the further regression adjustment^{33 34}.

The weighted linear regressions

The average treatment effect of the “more effective” PPATH working environment on job satisfaction was estimated in the pseudo-population by linear regression models. All models took the “more effective” PPATH working environment as the treatment and job satisfaction as the outcome. A robust “sandwich” variance estimator was used to solve the lack of independence among participants due to IPTW³⁵.

The primary analysis (Model 1) incorporated all the variables that distributed unevenly after IPTW. Alternatively, we compared the IPTW approach against standard stepwise multivariate regression analysis in Model 2. Subgroup analysis were planned to draw exploratory conclusions of interests with Bonferroni corrections.

R version 4.2.1 was used for data analysis. R package “cobalt” version 4.4.1 was used to assess the covariate balance. R package “MASS”³⁶ version 7.3.58.1 and “lme4”³⁷ version 1.1.30 was used to construct the stepwise regression models and the linear mixed-effects model respectively. R package “sandwich” version 3.0.2 were used for robust estimation of standard error³⁸. All tests

were two sided with type I error rates of 0.05.

RESULTS

Characteristics of participants at baseline

Table S4 in the supplementary materials summarized the sociodemographic characteristics of participants. The average age of 8417 participants was 34.02 ± 8.30 years, and male made up 18.64%. Most of participants had been married previously and doctors constituted 28.15%. According to the definition of “more effective”, 2224 (26.42%) participants reported a “more effective” PAPTH working environment with a score greater than 18 for working environment improvement.

Differences in the distribution of covariates existed at baseline between the “more effective” and “less effective” PAPTH working environment (**Figure 3**). People who evaluated greater improvement were younger, more likely to be female, nurses and never married. Besides, they experienced lower-level education such as below undergraduate and undergraduate. As for hospital characteristics, they were more likely to come from central and eastern regions and hospitals with higher performance rating.

IPTW weights and balance diagnosis

This study obtained the optimal stabilized weights through “Specification 3_99trunc”. The optimal set *C* included age groups, gender, education level, marital status, technical title, position and the depression status of healthcare professionals, as well as the performance rating of hospitals. The mean stabilized weight was equal to 0.99, while the standard deviation was equal to 0.31. The minimum and maximum weights were 0.53 and 2.70, respectively (**Table S5**).

The IPTW performed well at balancing the baseline covariates. The groups became more comparable for the most of baseline covariates, with standardized differences in proportion less than 10% for most covariates, except for the increased attention to working environment and the region (**Figure 3; Table S4**). We considered the impact of those remaining imbalance by putting the increased attention to working environment of healthcare professionals and the region into outcome models (described below).

The impact of PAPTH on job satisfaction

Table 1 showed that the influence of the “more effective” PAPTH working environment on job satisfaction was nearly 10-point arise in MSQ score (9.57, 95% CI 8.99 – 10.16) in the primary analysis (Model 1). Results of the standard multivariate regression analyses closely agreed with that for the IPTW approach described above (9.92, 95% CI 9.42 – 10.42).

The positive effect of the “more effective” PPATH working environment on job satisfaction in different regions presented as V-shaped in Model 3. Among all regions, the “more effective” PPATH working setting improved MSQ score the most in the central region, about 2.04 points higher than eastern region and about 3.50 points higher than the western region.

For population with different increased attention, the average difference in job satisfaction decreased from the group with more increased attention to less increased attention (9.60, 95%CI 9.01- 10.19 to 8.27, 95%CI 2.57- 13.96).

Sensitive analysis

A series of sensitivity analysis were conducted to test the robustness of findings (**Table 2**). First, we defined “more effective” with different thresholds in Model 5-6 (i.e., 50th percentile and the mean + SD). Second, we used linear mixed-effects models in weighted population to estimate the impact of the “more effective” working environment by taking the effect of region as random effect (Model 7). At last, we expanded the sample size to medical personnel of all positions (Model 8). Balance diagnosis for new weights in the sensitivity analysis were presented in the **Figure S1** in the supplementary materials. Results in **Table 2** were broadly consistent with those reported in **Table 1**, indicating the robust impact of the “more effective” PPATH on job satisfaction of healthcare professionals.

DISCUSSION

The “more effective” PAPTH induced higher job satisfaction

By means of IPTW to reduce selective bias, our results offered a clue that macro health policies like PAPTH played positive role on job satisfaction of healthcare professionals. Doctors and nurses, who worked in settings where PAPTH motivated better, would experience an approximately 10 points (12.5% of the range of MSQ score) advancement in job satisfaction on average.

This encouraging finding triggered us to figure out which aspect of job satisfaction were more increased. Intrinsic job satisfaction indicated the contentment with the type of work the employee were doing, while extrinsic job satisfaction encompassed the working environments such as salary, coworkers and management ³⁹. We compared the target effects on intrinsic and extrinsic MSQ score as exploring analysis based on Model 2. It turned out that the “more effective” PAPTH working setting increased about 5.46 points of intrinsic MSQ score (9.10% of the range) and 4.46 points of extrinsic MSQ score (11.15% of the range). The higher proportion of increase in extrinsic MSQ scores in our exploratory results supported our hypothesis and conclusions, implying that a “more effective” PAPTH working environment improved more job satisfaction of doctors and nurses.

PAPTH was supposed to promote hospitals to improve the physical and social working conditions,

and to offer higher medical quality and better management. Our results demonstrated that expected positive impact to some extent. As a plausible explanation of our findings, policies which provide a flexible practice environment with adequate staffing and resources, which provide opportunities for healthcare professionals to participate in the hospital's policies and governance, and which reflect positively on their work and performance, may facilitate the job satisfaction of healthcare professionals^{40 41}.

Hospitals from the western region had a higher demand for support in improving job satisfaction

Through subgroup analysis, this study measured the target impact among regions with different economic conditions. Comparing the greater increase in job satisfaction in hospitals located in the central and eastern regions, the effect of environmental improvements in western hospitals (with poor economic development) appeared to be less sufficient in advancing of job satisfaction. Our results called for greater support or benefits from PAPTH to increase the job satisfaction of healthcare professionals in western regions than other regions, aside from working settings.

Negative responses of healthcare professionals diminish the effect of “more effective” PAPTH on job satisfaction

The responses of those who are affected by what is implemented exert considerable influence on

the implementation process of policies⁴². Model 4 showed our interest in the response of healthcare professionals to PAPTH through subgroup analysis. Our results showed that when the samples were restricted to participants who had less increased attention to the working environment, the effect of “more effective” PAPTH declined about 1.30 points in the mean MSQ score and was accompanied with greater variation, whereas the result in the opposite subgroup remained consistent with the primary analysis in **Table 1**.

During the implementation of policies, it is noted that the level of involvement of recipients, as well as service organizations and street-level bureaucrats, may influence the confidence in, and support of, the policy decisions and improve the chances for successful implementation^{43 44}. We considered the less increased attention to the working environment as a type of negative response from healthcare professionals, indicating a lower level of engagement. From the perspective of implementation science, our findings highlighted the necessity of improving responses of healthcare professionals to develop, execute, and evaluate large-scale healthcare policies, such as the attention, understanding, recognition and the support of the policy.

A collaborative scheme to motivate healthcare professionals

Motivators of healthcare professionals are diverse^{12 45 46}. China had carried out a variety of reforms targeted at individual level to stimulate the vitality of healthcare professionals, such as reforms in

the performance management, promotion system, compensation system, etc. However, comparing similar studies in recent years, we only observed slight improvement of the MSQ score of healthcare professionals in tertiary hospitals of China ^{47 48}. This study found that the hospital improvements pursued by PAPTH also improved staff satisfaction, calling for a collaborative motivating scheme which takes both the individual level and the working environment level into account.

The operational efficiency and the sustainable development of hospitals were breakthroughs to amplify the positive effect of an improved environment on job satisfaction. After reviewing healthcare professionals' evaluation of PAPTH-induced improvements in the working environment, it was found that the dimension of the operational efficiency and the sustainable development of hospital presented lower scores, whereas the medical quality and satisfaction of patients scored high scores (**Table S2**). In the past, public tertiary hospitals in China had made more efforts to achieve the mission of the medical and public health services provision¹⁵, but less improvements had been showed in the managerial area. This study denoted that more efforts were called for on the operational efficiency and the sustainable development of public tertiary hospitals in future. Optimizing the flow of patients for a better coordination among human and material resources, distributive justice for more retention of healthcare personnel may help the improvement ^{49 50}.

Limitation

Despite the size and findings of the study, it has limitations. Firstly, we didn't analyze medical personnel in all positions, leading to the lack of generalizability in the whole healthcare professionals. Secondly, though applied IPTW and matching, there still existed potential confounding factors, such as the personal preference of healthcare professionals, income of healthcare professionals, regional customs and culture. Thirdly, this study only confirmed the positive effects of PAPTH on job satisfaction, and further research is needed to find which aspects of working environment improved by PAPTH increased more job satisfaction and which aspects of job satisfaction were more increased.

CONCLUSION

We observed that the PAPTH, even though targeted towards hospitals for implementation, played a positive role not only on working environments in public tertiary hospitals but also on healthcare professionals. The results showed that a working environment with more proactive responses to macro policies can lead to a greater increase in job satisfaction. Besides, less individual addition on working environments lowered the enhancement of job satisfaction. Findings in this research indicated the impact of macro-level policies on individual job satisfaction, as well as the

moderating effect of individual attention on this impact. There was an influence pathway outside of design, whereby policies promoted hospital improvements, which subsequently increased staff motivation. Therefore, this study called for a collaborative motivating scheme and a comprehensive policy design which takes into account both the individual level and the working environment level.

List of abbreviations

PAPTH=The performance appraisal for public tertiary hospitals
IPTW=Inverse probability-of-treatment weighting

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Contributors

Conception or design of the work: GHL, KYS, YYX and CSS
Data collection: KYS, GHL, CSS
Data analysis and interpretation: XYL and MJL
Drafting the article: XYL and MJL
Critical revision of the article: XYL, MJL, YYX, DSB, GHL
All authors contributed to the submitted version and approved the final manuscript.

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Competing interests

None declared.

Ethics approval and consent to participate

This survey received ethical approval from the Ethics Committee of the School of Public Health, Shanghai Jiao Tong University School of Medicine, China on February 20, 2020, and record number SJUPN-202008 using the National Statement on Ethical Conduct in Human Research. Informed consents were written for each participant to read and sign before moving on to filling the questionnaires.

Data availability statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

References

1. Coomber B, Barriball KL. Impact of job satisfaction components on intent to leave and turnover for hospital-based nurses: a review of the research literature. *Int J Nurs Stud* 2007;44(2):297-314. doi: 10.1016/j.ijnurstu.2006.02.004 [published Online First: 20060424]
2. Williams ES, Skinner AC. Outcomes of physician job satisfaction: a narrative review, implications, and

- directions for future research. *Health Care Manage Rev* 2003;28(2):119-39. doi: 10.1097/00004010-200304000-00004
3. Brady KJS, Kazis LE, Sheldrick RC, et al. Selecting physician well-being measures to assess health system performance and screen for distress: Conceptual and methodological considerations. *Curr Probl Pediatr Adolesc Health Care* 2019;49(12):100662. doi: 10.1016/j.cppeds.2019.100662 [published Online First: 20190925]
4. McHugh MD, Kutney-Lee A, Cimiotti JP, et al. Nurses' widespread job dissatisfaction, burnout, and frustration with health benefits signal problems for patient care. *Health Aff (Millwood)* 2011;30(2):202-10. doi: 10.1377/hlthaff.2010.0100
5. Hoppock R. Job satisfaction. New York: Harper 1935:303.
6. Raziq A, Maulabakhsh R. Impact of Working Environment on Job Satisfaction. *Procedia Economics and Finance* 2015;23:717-25. doi: 10.1016/s2212-5671(15)00524-9
7. Lu H, Zhao Y, While A. Job satisfaction among hospital nurses: A literature review. *Int J Nurs Stud* 2019;94:21-31. doi: 10.1016/j.ijnurstu.2019.01.011 [published Online First: 20190210]
8. Cummings GG, MacGregor T, Davey M, et al. Leadership styles and outcome patterns for the nursing workforce and work environment: A systematic review. *INTERNATIONAL JOURNAL OF NURSING STUDIES* 2010;47(3):363-85. doi: 10.1016/j.ijnurstu.2009.08.006
9. Shanafelt TD, Gorringer G, Menaker R, et al. Impact of organizational leadership on physician burnout and satisfaction. *Mayo Clin Proc* 2015;90(4):432-40. doi: 10.1016/j.mayocp.2015.01.012

- [published Online First: 20150318]
10. Bofo IM. The effects of workplace respect and violence on nurses' job satisfaction in Ghana: a cross-sectional survey. *Hum Resour Health* 2018;16(1):6. doi: 10.1186/s12960-018-0269-9 [published Online First: 20180115]
11. Zhou H, Han X, Zhang J, et al. Job Satisfaction and Associated Factors among Medical Staff in Tertiary Public Hospitals: Results from a National Cross-Sectional Survey in China. *Int J Environ Res Public Health* 2018;15(7) doi: 10.3390/ijerph15071528 [published Online First: 20180719]
12. Chandler CI, Chonya S, Mtei F, et al. Motivation, money and respect: a mixed-method study of Tanzanian non-physician clinicians. *Soc Sci Med* 2009;68(11):2078-88. doi: 10.1016/j.socscimed.2009.03.007 [published Online First: 20090328]
13. Lim KK. Impact of hospital mergers on staff job satisfaction: a quantitative study. *Hum Resour Health* 2014;12:70. doi: 10.1186/1478-4491-12-70 [published Online First: 20141212]
14. Cortvriend P. Change management of mergers: the impact on NHS staff and their psychological contracts. *Health Serv Manage Res* 2004;17(3):177-87. doi: 10.1258/0951484041485593
15. Li Y, He W, Yang L, et al. A historical review of performance appraisal of public hospitals in China from the perspective of historical institutionalism. *Front Public Health* 2022;10:1009780. doi: 10.3389/fpubh.2022.1009780 [published Online First: 20221010]
16. Franco LM, Bennett S, Kanfer R. Health sector reform and public sector health worker motivation: a conceptual framework. *Soc Sci Med* 2002;54(8):1255-66. doi: 10.1016/s0277-9536(01)00094-6

17. Nalla MK, Kang W. Organizational Climate, Perceived Citizen Support, and Job Satisfaction of Police Officers: Findings from the Post-Grand Reform Era in South Korea. *Asian Journal of Criminology* 2012;7(2):153-71. doi: 10.1007/s11417-012-9127-1

18. Manyazewal T, Matlakala MC. Beyond patient care: the impact of healthcare reform on job satisfaction in the Ethiopian public healthcare sector. *Hum Resour Health* 2017;15(1):10. doi: 10.1186/s12960-017-0188-1 [published Online First: 20170203]

19. Alameddine M, Bauer JM, Richter M, et al. Trends in job satisfaction among German nurses from 1990 to 2012. *J Health Serv Res Po* 2016;21(2):101-08. doi: 10.1177/1355819615614045

20. Aasland OG, Rosta J, Nylenna M. Healthcare reforms and job satisfaction among doctors in Norway. *Scand J Public Health* 2010;38(3):253-8. doi: 10.1177/1403494810364559 [published Online First: 20100309]

21. Shanafelt TD, Dyrbye LN, Sinsky C, et al. Relationship Between Clerical Burden and Characteristics of the Electronic Environment With Physician Burnout and Professional Satisfaction. *Mayo Clinic Proceedings* 2016;91(7):836-48. doi: 10.1016/j.mayocp.2016.05.007

22. Friedberg MW, Chen PG, Van Busum KR, et al. Factors Affecting Physician Professional Satisfaction and Their Implications for Patient Care, Health Systems, and Health Policy. *Rand Health Q* 2014;3(4):1-1.

23. Trivellas P, Reklitis P, Platis C. The effect of job related stress on employees' satisfaction: A survey in Health Care. *Procd Soc Behv* 2013;73:718-26. doi: 10.1016/j.sbspro.2013.02.110

24. Weiss DJ, Dawis RV, England GW, et al. Manual for the Minnesota Satisfaction Questionnaire: Minnesota studies in vocational rehabilitation. *Minneapolis: Industrial Relations Center, University of Minnesota* 1967
25. Radloff LS. The CES-D Scale: A Self-Report Depression Scale for Research in the General Population. *Applied Psychological Measurement* 1977;1(3):385-401. doi: 10.1177/014662167700100306
26. Lewinsohn PM, Seeley JR, Roberts RE, et al. Center for Epidemiologic Studies Depression Scale (CES-D) as a screening instrument for depression among community-residing older adults. *Psychol Aging* 1997;12(2):277-87. doi: 10.1037//0882-7974.12.2.277
27. Zung WW. A rating instrument for anxiety disorders. *Psychosomatics* 1971;12(6):371-9. doi: 10.1016/S0033-3182(71)71479-0
28. Dunstan DA, Scott N. Norms for Zung's Self-rating Anxiety Scale. *BMC Psychiatry* 2020;20(1):90. doi: 10.1186/s12888-019-2427-6 [published Online First: 20200228]
29. van der Wal WM, Geskus RB. ipw: An R Package for Inverse Probability Weighting. *Journal of Statistical Software* 2011;43(13):1 - 23. doi: 10.18637/jss.v043.i13
30. Cole SR, Hernan MA. Constructing inverse probability weights for marginal structural models. *Am J Epidemiol* 2008;168(6):656-64. doi: 10.1093/aje/kwn164 [published Online First: 20080805]
31. Austin PC, Stuart EA. Moving towards best practice when using inverse probability of treatment weighting (IPTW) using the propensity score to estimate causal treatment effects in observational studies. *Stat Med* 2015;34(28):3661-79. doi: 10.1002/sim.6607 [published Online First: 20150803]

32. Aitken Z, Simpson JA, Bentley R, et al. Disability acquisition and mental health: effect modification by demographic and socioeconomic characteristics using data from an Australian longitudinal study. *BMJ Open* 2017;7(9):e016953. doi: 10.1136/bmjopen-2017-016953
33. Milner A, Aitken Z, Krnjacki L, et al. Perceived fairness of pay among people with and without disabilities: a propensity score matched analysis of working Australians. *Scand J Work Environ Health* 2015;41(5):451-9. doi: 10.5271/sjweh.3515 [published Online First: 20150717]
34. Weighted Regression Estimators of Causal Effects. In: Winship C, Morgan SL, eds. Counterfactuals and Causal Inference: Methods and Principles for Social Research. 2 ed. Cambridge: Cambridge University Press 2014:226-64.
35. Chesnaye NC, Stel VS, Tripepi G, et al. An introduction to inverse probability of treatment weighting in observational research. *Clin Kidney J* 2022;15(1):14-20. doi: 10.1093/ckj/sfab158 [published Online First: 20210826]
36. Venables WN, Ripley BD. Modern Applied Statistics with S. Fourth ed. New York: Springer 2002.
37. Bates D, Machler M, Bolker BM, et al. Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software* 2015;67(1):1-48. doi: 10.18637/jss.v067.i01
38. Long JS, Ervin LH. Using Heteroscedasticity Consistent Standard Errors in the Linear Regression Model. *The American Statistician* 2000;54(3):217-24. doi: 10.1080/00031305.2000.10474549
39. Jones LK. Job satisfaction. In Encyclopedia of career change and work issues. Phoenix: The Oryx Press 1992.

40. Atefi N, Abdullah KL, Wong LP, et al. Factors influencing registered nurses perception of their overall job satisfaction: a qualitative study. *Int Nurs Rev* 2014;61(3):352-60. doi: 10.1111/inr.12112
41. Alnuaimi K, Ali R, Al-Younis N. Job satisfaction, work environment and intent to stay of Jordanian midwives. *Int Nurs Rev* 2020;67(3):403-10. doi: 10.1111/inr.12605 [published Online First: 20200728]
42. Nilsen P, Stahl C, Roback K, et al. Never the twain shall meet?--a comparison of implementation science and policy implementation research. *Implement Sci* 2013;8:63. doi: 10.1186/1748-5908-8-63 [published Online First: 20130610]
43. Perla RJ, Bradbury E, Gunther-Murphy C. Large-scale improvement initiatives in healthcare: a scan of the literature. *J Healthc Qual* 2013;35(1):30-40. doi: 10.1111/j.1945-1474.2011.00164.x [published Online First: 20110914]
44. Bullock HL, Lavis JN, Wilson MG, et al. Understanding the implementation of evidence-informed policies and practices from a policy perspective: a critical interpretive synthesis. *Implementation Science* 2021;16(1) doi: 10.1186/s13012-021-01082-7
45. Willis-Shattuck M, Bidwell P, Thomas S, et al. Motivation and retention of health workers in developing countries: a systematic review. *BMC Health Serv Res* 2008;8:247. doi: 10.1186/1472-6963-8-247 [published Online First: 20081204]
46. Scheurer D, McKean S, Miller J, et al. U.S. physician satisfaction: a systematic review. *J Hosp Med* 2009;4(9):560-8. doi: 10.1002/jhm.496

47. Wang M, Hu C, Huang M, et al. The effect of emotional clarity and attention to emotion on job satisfaction: A mediating role of emotion regulation among Chinese medical staff. *Asian Journal of Social Psychology* 2019;22(3):316-24. doi: 10.1111/ajsp.12365

48. Liu D, Wu Y, Jiang F, et al. Gender Differences in Job Satisfaction and Work-Life Balance Among Chinese Physicians in Tertiary Public Hospitals. *Front Public Health* 2021;9:635260. doi: 10.3389/fpubh.2021.635260 [published Online First: 20210510]

49. Miranda MA, Salvatierra S, Rodriguez I, et al. Characterization of the flow of patients in a hospital from complex networks. *Health Care Manag Sci* 2020;23(1):66-79. doi: 10.1007/s10729-018-9466-2 [published Online First: 20190103]

50. Chen D, Lin Q, Yang T, et al. Distributive Justice and Turnover Intention Among Medical Staff in Shenzhen, China: The Mediating Effects of Organizational Commitment and Work Engagement. *Risk Manag Healthc Policy* 2022;15:665-76. doi: 10.2147/RMHP.S357654 [published Online First: 20220414]

Tables

Table 1 The impact of a “more effective” PAPTH working environment on job satisfaction of healthcare professionals using a series of linear regressions.

Model ^a	Weighting	Sample size	A “more effective” PAPTH working environment				
			Coefficient	95%CI	<i>p</i> -value ^e	Adj. <i>p</i> -value ^f	<i>p</i> -value
Model 1 ^b (Primary analysis)	The optimal weights	8417	9.57	(8.99, 10.1)	***	NA	
Model 2 ^c (Standard multivariate regression)	None	8417	9.92	(9.42, 10.4)	***	NA	
Model 3 ^b (Subgroup analysis of region)	The optimal weights	1504 (West)	7.67	(5.65, 9.70)	***	***	
		2519 (Center)	11.17	(10.10, 12.24)	***	***	
		4394 (East))	9.13	(8.39, 9.86)	***	***	
Model 4 ^b (Subgroup analysis of increased attention to the PAPTH)	The optimal weights	6412 (More)	9.60	(9.01, 10.1)	***	***	
		2005 (Less)	8.27	(2.57, 13.9)	***	***	

- Note:** PAPTH, the performance appraisal for public tertiary hospitals; CI, confidence interval.
- a. Outcome variables in all the models above was the job satisfaction of healthcare professionals.
 - b. Model 1, model 3 and model 4 included the “more effective” PAPTH, region, and the increased attention to the working environment as independent variables.
 - c. Model 2 remained the “more effective” PAPTH, gender, age group, position, anxiety status, depressive status, administrative position and the increased concern to PAPTH of healthcare professionals, as well as the region and the performance rating of hospitals.
 - d. The confidence intervals were estimated by the robust variance estimator “sandwich”.
 - e. $p<0.05$; ** $p<0.01$; *** $p<0.001$
 - f. Bonferroni corrections of p -value were applied in the subgroup analysis in model 3 and model 4.

Table 2 Sensitivity analysis of the impact of a “more effective” PAPTH working environment on job satisfaction of healthcare professionals.

Model	Design	A “more effective” PAPTH working environment		
		Coefficient	95%CI	<i>p-value</i> ^d
Model 1	Primary analysis	9.57	(8.99, 10.15)	***
Model 5^a	Different threshold: 50 th percentile (≥ 14); Sample size = 8417	8.14	(7.62, 8.66)	***
Model 6^a	Different threshold: Mean + standard deviation (≥ 18.45); Sample size = 8417	9.83	(9.21, 10.45)	***
Model 7	Different outcome models with the random effect of province; Sample size = 8417	9.30	(7.36, 11.24)	***
Model 8^{ac}	Different population including whole medical personnel of all position; Sample size = 11138	9.51	(9.00, 10.01)	***

Note: CI, confidence interval.

- Weights in model 5, model 6 and model 8 were constructed in line with the primary analysis (that is, the same equilibrium of weighted population had been achieved and the weights were also truncated at the 99th percentile).
- The confidence intervals of model 5, model 6 and model 8 were estimated by the robust variance estimator “sandwich”.
- After coding the variables, 11138 fully answered responses (84.31% in 13211) from participants in all position were included in the model 8.
- *** $p < 0.001$

Figures

Figure 1 Causal diagram depicting potential confounders of the association between the “more effective” PAPTH working environment and job satisfaction.

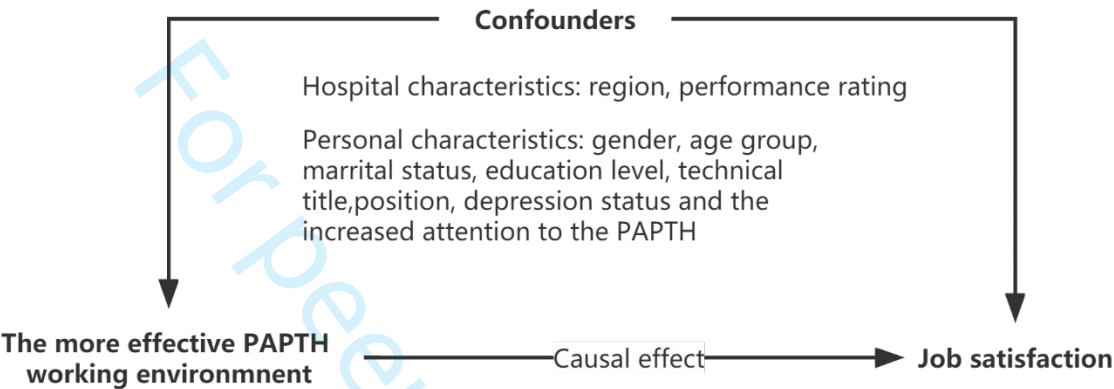


Figure 2 Schematic presentation of the overall steps followed in the analysis. ATE, the average treatment effect

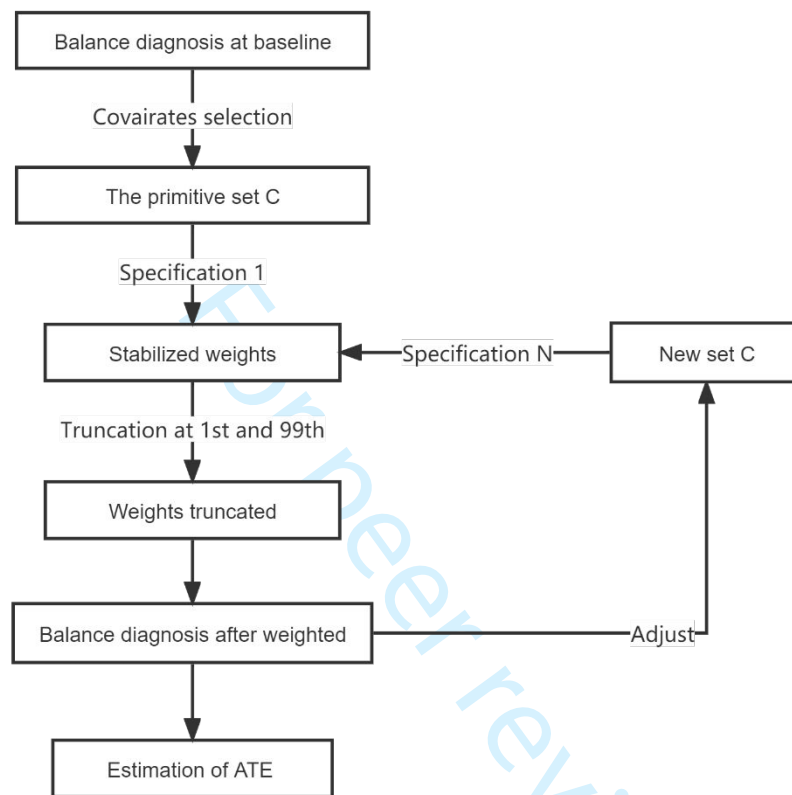
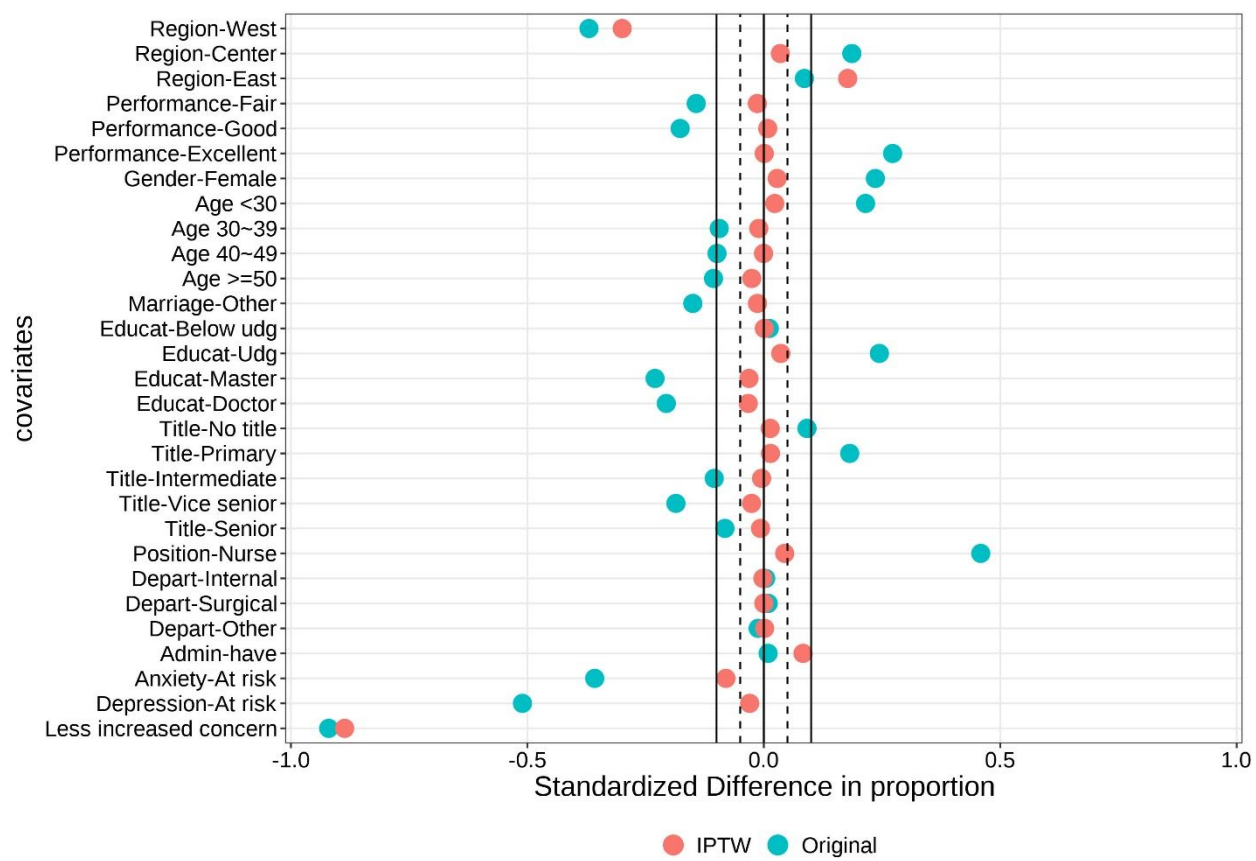


Figure 3 Standardized differences in proportion between population working in and not in a “more effective” PAPTH environment for each baseline covariate before and after IPTW.



The solid lines indicate the 10% differences which reflect good balance of confounders; each layer of a binary variable had a standardized difference in proportion with equal value but opposite directions, so only one of them was shown in the figure; IPTW, inverse probability-of-treatment weighting; Performance, the performance rating of hospitals; Marriage - Other, marital status other than never married; Educat - Below udg, education level - below undergraduate; Educat - Udg, education level - undergraduate; Title, technical title; Depart, department; Admin, administrative position.

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Supplementary materials

Table S1 The job satisfaction scores (Mean $\pm$ Standard deviation).
On my present job, this is how I feel about.....

Items	Score	Rank	Score
1. Being able to keep busy all the time	3.65 $\pm$ 0.80	17	
2. The chance to work alone on the job	3.95 $\pm$ 0.65	6	
3. The chance to do different things from time to time	3.75 $\pm$ 0.75	16	
4. The chance to be “somebody” in the community	3.97 $\pm$ 0.64	4	
5. The way my boss handles his/her workers	3.83 $\pm$ 0.78	12	
6. The competence of my supervisor in making decisions	3.84 $\pm$ 0.79	10	
7. Being able to do things that don't go against my conscience	4.11 $\pm$ 0.70	1	
8. The way my job provides for steady employment	4.03 $\pm$ 0.68	2	
9. The chance to do things for other people	3.96 $\pm$ 0.67	5	
10. The chance to tell people what to do	3.60 $\pm$ 0.76	19	
11. The chance to do something that makes use of my abilities	3.93 $\pm$ 0.69	7	
12. The way company policies are put into practice	3.81 $\pm$ 0.76	13	

Items	Score	Rank of score
13. My pay and the amount of work I do	3.41±1.01	20
14. The chances for promotion on this job	3.62±0.86	18
15. The freedom to use my own judgment	3.84±0.71	11
16. The chance to try my own methods of doing the job	3.77±0.75	15
17. The working conditions	3.78±0.79	14
18. The way my co-workers get along with each other	4.02±0.68	3
19. The praise I get for doing a good job	3.88±0.74	8
20. The feeling of accomplishment I get from the job	3.88±0.74	9

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Table S2 Improvements in the working environment resulting from PAPTH. (Mean $\pm$ Standard deviation).

In your opinion, after the implementation of the performance appraisal of public tertiary hospitals, how did you promote in these aspects of your hospital?

Items	Score
1. Medical quality of hospital	2.57 $\pm$ 1.16
2. Operational efficiency of hospital	2.50 $\pm$ 1.20
3. Sustainable development of hospital	2.55 $\pm$ 1.18
4. Satisfaction of inpatients	2.59 $\pm$ 1.20
5. Satisfaction of outpatients	2.63 $\pm$ 1.20
Average score	2.57 $\pm$ 0.05
Total score	12.84 $\pm$ 5.61

PAPTH, the performance appraisal for public tertiary hospitals

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Table S3 The increased attention to the PAPTH of participants (Mean ± Standard deviation).

In your opinion, after the implementation of the performance appraisal of public tertiary hospitals, how do you pay attention to the following aspects of the hospital?

Items	Score
1. Medical quality of hospital	2.62±1.21
2. Operational efficiency of hospital	2.39±1.25
3. Sustainable development of hospital	2.47±1.22
4. Satisfaction of inpatients	2.62±1.22
5. Satisfaction of outpatients	2.72±1.20
Total score	12.81±5.36

PAPTH, the performance appraisal for public tertiary hospitals

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Table S4 Distributions of the individual characteristics and hospital characteristics before and after IPTW.

		Before IPTW				After IPTW	
	Level	Overall (N=8417)	Less effective (N=6193)	More effective (N=2224)	STD	More effective (N=2163.1)	STD
Age --mean (SD)		34.02 (8.30)	34.50 (8.33)	32.71 (8.04)	-0.22	32.41 (8.334)	-0.02
Age group--n (%)	<30	3078 (36.57)	2094 (33.81)	984 (44.24)	0.22	884 (37.70)	0.02
	30~39	3626 (43.08)	2744 (44.31)	882 (39.66)	-0.09	900 (42.54)	-0.01
	40~49	1217 (14.46)	951 (15.36)	266 (11.96)	-0.10	335 (14.45)	0.00
	≥50	496 (5.89)	404 (6.52)	92 (4.14)	-0.11	155 (5.31)	-0.03
Gender--n (%)	Male	1569 (18.64)	1297 (20.94)	272 (12.23)	-0.24	335 (17.56)	-0.03
	Female	6848 (81.36)	4896 (79.06)	1952 (87.77)	0.24	1783.33 (82.44)	0.03
Marital status--n (%)	Never married	2503 (29.74)	1728 (27.90)	775 (34.85)	0.15	666.1 (30.35)	0.01
	Other conditions	5914 (70.26)	4465 (72.10)	1449 (65.15)	-0.15	1506.70 (69.65)	-0.01
Position--n (%)	Doctor	2369 (28.15)	2054 (33.17)	315 (14.16)	-0.46	500.4 (26.37)	-0.04
	Nurse	6048 (71.85)	4139 (66.83)	1909 (85.84)	0.46	1592.67 (73.63)	0.04
Education--n (%)	Below undergraduate	920 (10.93)	671 (10.83)	249 (11.20)	0.01	266.6 (10.94)	0.00
	Undergraduate	6076 (72.19)	4298 (69.40)	1778 (79.95)	0.24	1595.02 (73.74)	0.04
	Master's degree	1034 (12.28)	876 (14.15)	158 (7.10)	-0.23	255.1 (11.33)	-0.03
Technical title--n (%)	Doctoral degree	387 (4.60)	348 (5.62)	39 (1.75)	-0.21	86.27 (3.99)	-0.03
	Not have	548 (6.51)	365 (5.89)	183 (8.23)	0.09	148.76 (6.88)	0.01
	Primary title	3989 (47.39)	2787 (45.00)	1202 (54.05)	0.18	1039.15 (48.04)	0.01
	Intermediate title	2789 (33.14)	2132 (34.43)	657 (29.54)	-0.10	712.48 (32.94)	0.00

Before IPTW						After IPTW	
	Level	Overall (N=8417)	Less effective (N=6193)	More effective (N=2224)	STD	More effective (N=2163.1)	STD
Administrative position--n (%)	Vice senior	749 (8.90)	632 (10.21)	117 (5.26)	-0.19	85 (8.22)	-0.03
	Senior	342 (4.06)	277 (4.47)	65 (2.92)	-0.08	6 (3.92)	-0.01
	Not have	7676 (91.20)	5652 (91.26)	2024 (91.01)	-0.01	1930.94 (89.27)	-0.08
	Have	741 (8.80)	541 (8.74)	200 (8.99)	0.01	20 (10.73)	0.08
Department--n (%)	Internal medicine	2275 (27.03)	1671 (26.98)	604 (27.16)	0.00	59 (27.01)	0.00
	Surgical	2449 (29.10)	1795 (28.98)	654 (29.41)	0.01	60 (29.02)	0.00
	Other	3693 (43.88)	2727 (44.03)	966 (43.44)	-0.01	99 (43.97)	0.00
Region--n (%)	West	1504 (17.87)	1318 (21.28)	186 (8.36)	-0.37	62 (9.55)	-0.30
	Center	2519 (29.93)	1712 (27.64)	807 (36.29)	0.19	61 (30.57)	0.03
	East	4394 (52.20)	3163 (51.07)	1231 (55.35)	0.09	1295.16 (59.88)	0.18
Performance rating--n (%)	Fair	1122 (13.33)	902 (14.56)	220 (9.89)	-0.14	28 (12.88)	-0.01
	Good	3826 (45.46)	2958 (47.76)	868 (39.03)	-0.18	93 (45.94)	0.01
	Excellent	3469 (41.21)	2333 (37.67)	1136 (51.08)	0.27	80 (41.18)	0.00
Depression status --n(%)	None	4376 (51.99)	2820 (45.54)	1556 (69.96)	0.51	1154.29 (53.36)	0.03
	At risk	4041 (48.01)	3373 (54.46)	668 (30.04)	-0.51	1008.81 (46.64)	-0.03
Anxiety status -- n(%)	None	5846 (69.45)	4046 (65.33)	1800 (80.94)	0.36	1567.78 (72.48)	0.08
	At risk	2571 (30.55)	2147 (34.67)	424 (19.06)	-0.36	595 (27.52)	-0.08
Increased attention to working	More	6412 (76.18)	4210 (67.98)	2202 (99.01)	0.92	2138.49 (98.86)	0.89

Before IPTW						After IPTW	
	Level	Overall (N=8417)	Less effective (N=6193)	More effective (N=2224)	STD	More effective (N=2163.1)	STD
environment --n(%)							
	Less	2005 (23.82)	1983 (32.02)	22 (0.99)	-0.92	1 (1.14)	-0.89
Job satisfaction -- mean (SD)		76.61 (11.69)	73.03 (9.90)	86.58 (10.43)	1.33	86 (10.65)	1.14
Intrinsic job satisfaction -- mean (SD)		46.43 (6.66)	44.49 (5.72)	51.84 (6.09)	1.25	46 (6.20)	1.07
Extrinsic job satisfaction-- mean (SD)		30.18 (5.36)	28.54 (4.62)	34.74 (4.59)	1.35	34 (4.71)	1.14

Note:

PAPTH, the performance appraisal for public tertiary hospitals; IPTW, inverse probability treatment weighting; SD, standard deviation; STD, Standardized differences in proportion or mean.

Table S5 The construction of inverse probability weights under a series of models.

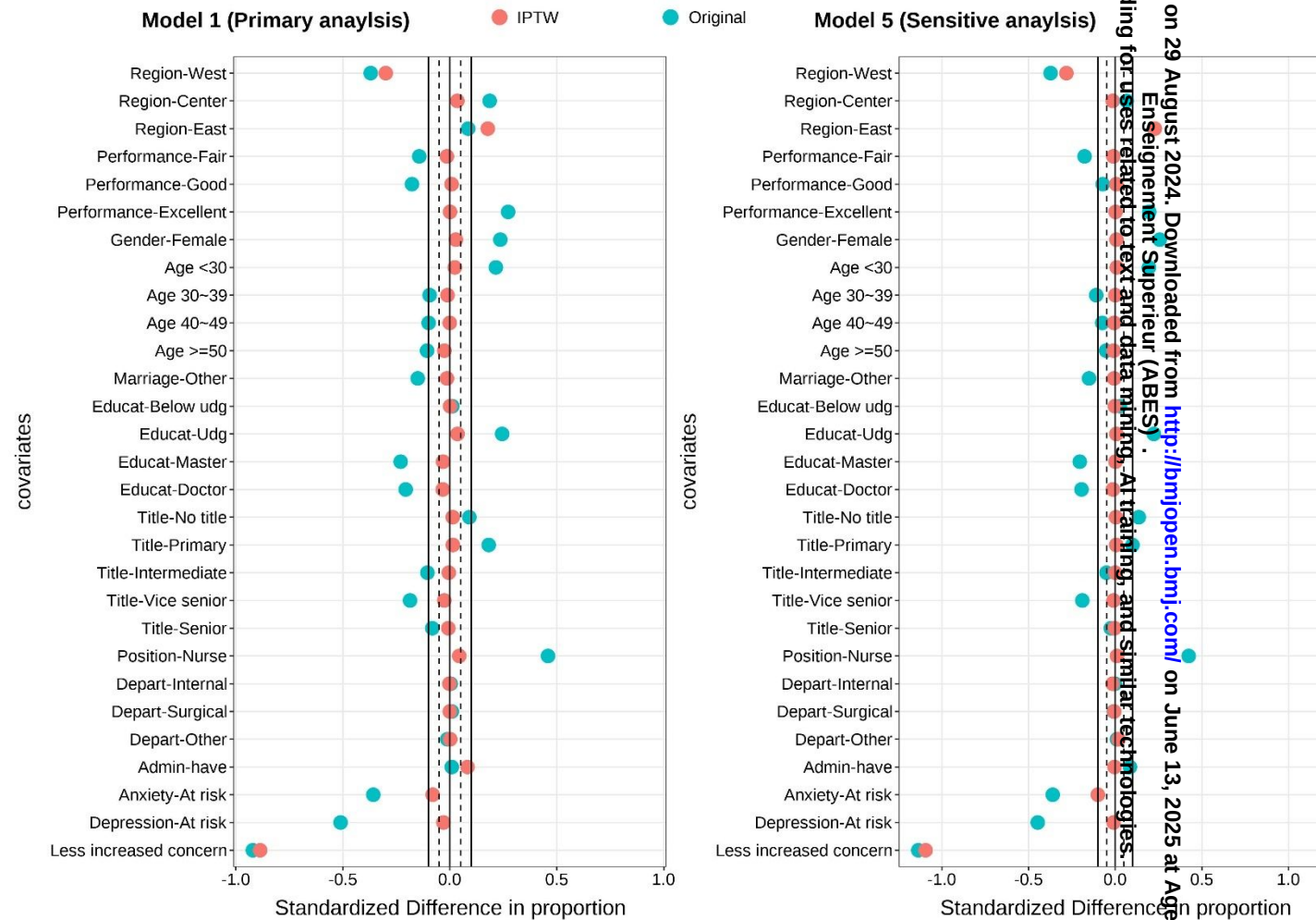
Specification ^a	Description of set <i>C</i>	Estimated weights		Variables that are newly distributed after being weighted
		Mean (SD)	Minimum-maximum	
1	The primitive set <i>C</i> ^b	1.01(1.92)	0.42-137.95	
1_99trunc	Truncated weights from specification 1	0.94(0.32)	0.46-1.92	Increased attention to APATH
2	Set <i>C</i> = The primitive set <i>C</i> minus the region	1.00(1.47)	0.44-74.63	
2_99trunc	Truncated weights from specification 2	0.94(0.31)	0.47-1.93	Region and the increased attention to the PAPATH
3	Set <i>C</i> = The primitive set <i>C</i> minus region and the increased attention to the PAPATH	1.00(0.38)	0.49-7.07	
3_99trunc (Optimal)	Truncated weights from specification 3	0.99(0.31)	0.53-2.70	Region and the increased attention to the PAPATH

Note: PAPATH, the performance appraisal for public tertiary hospitals; SD, standard deviation.

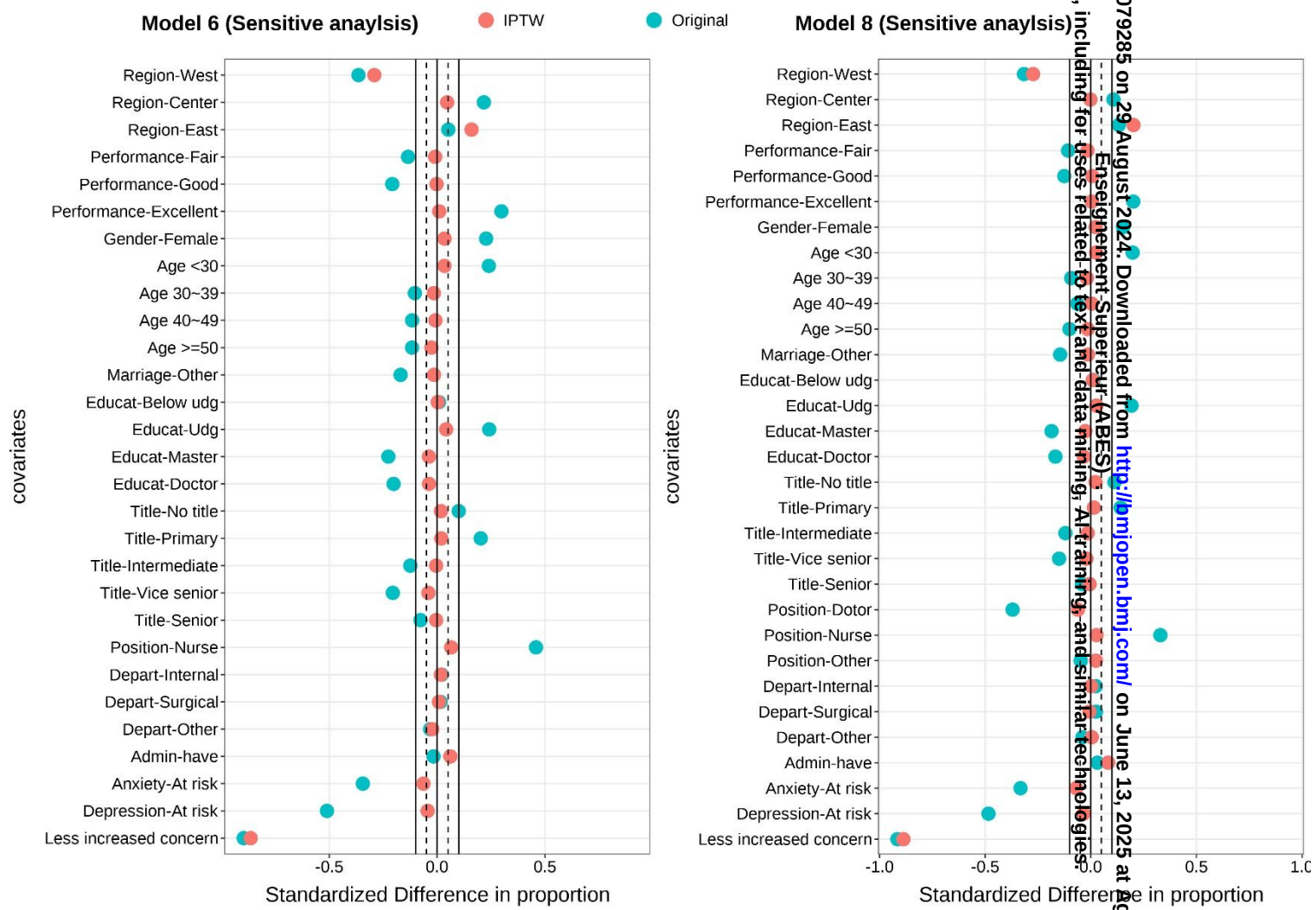
a. Numerator in all the specifications above equals the probability of lower effectiveness in the baseline population. All truncations were performed at the 1st and 99th percentile.

b. The primitive set *C* includes category terms for age group, gender, marital status, education level, technical title, position, the increased attention to working environment, the depression status, region and the performance rating of hospitals. The administrative position, the department and the anxiety status were excluded from the primitive set *C* because the standardized differences in proportion were less than 10% or statistically insignificant impact on the “more effective” PAPATH in multivariate analysis.

Figure S1 The balance diagnosis for baseline variables before and after IPTW in the primary analysis and sensitive analysis.



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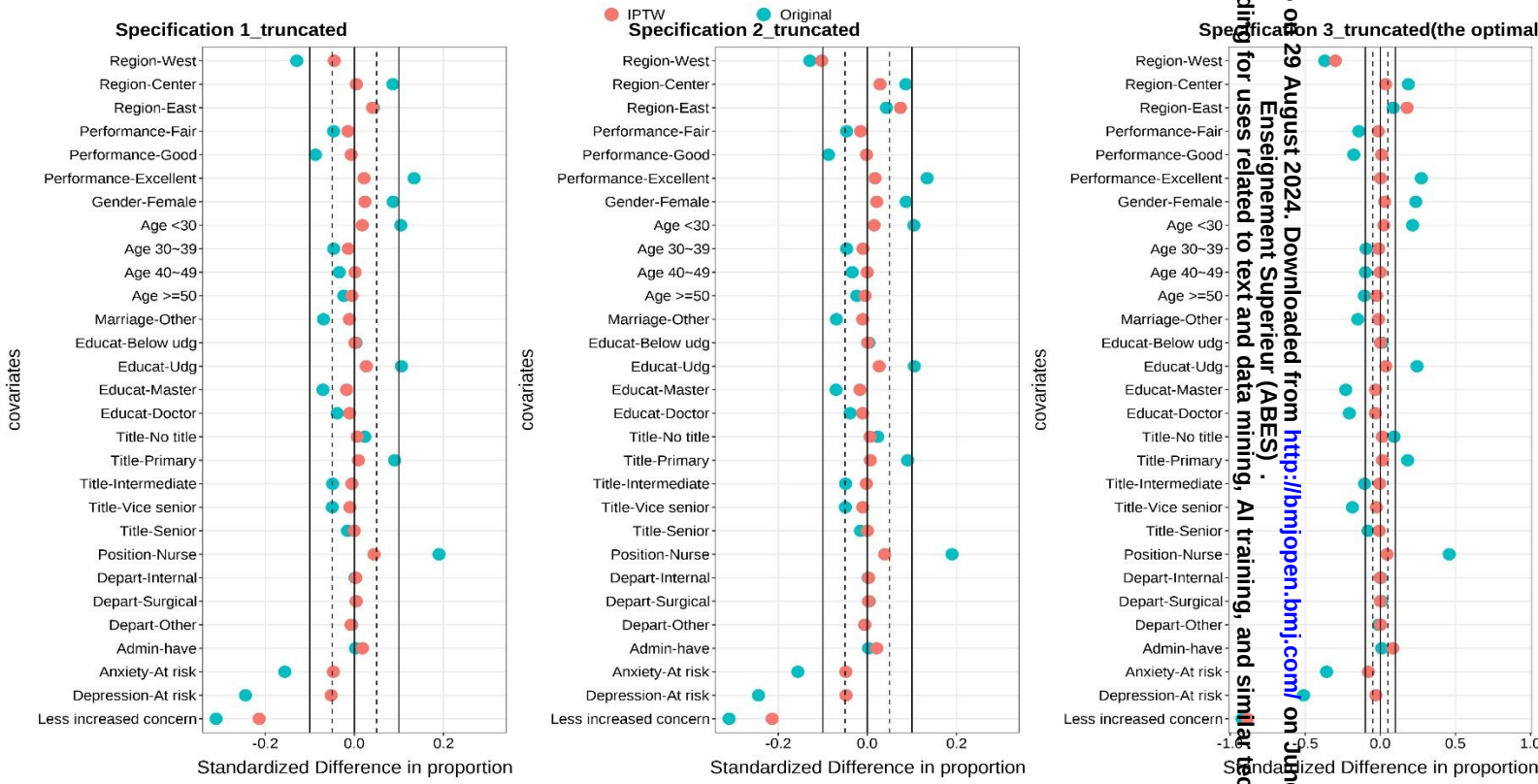


Note: IPTW, inverse probability-of-treatment weighting; Performance, the performance rating of hospitals; Marriage - Other, marital status other than never married; Educat - Below udg, education level - below undergraduate; Educat - Udg, education level - undergraduate; Title, technical title; Depart, department; Admin, administrative position

1. The solid lines indicate the 10% differences which reflect good balance of confounders;
2. Each layer of a dichotomous variable had a standardized difference in proportion with equal value but opposite directions, so only one of them was shown in the figure.

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Figure S2 The balance diagnosis for baseline variables before and after IPTW in the construction of weights



Note: IPTW, inverse probability-of-treatment weighting; Performance, the performance rating of hospital; Marriage - Other, marital status other than never married; Educat - Below udg, education level - below undergraduate; Educat - Udg, education level - undergraduate; Title, technical title; Depart, department; Admin, administrative position

1. The solid lines indicate the 10% differences which reflect good balance of confounders;
2. Each layer of a dichotomous variable had a standardized difference in proportion with equal value but opposite directions, so only one of them was shown in the figure.

The principle of distinguishing doctors and nurses from all positions.

We asked every participant about main positions, specific department and administrative position and distinguished doctors and nurses from all positions mainly according to their responses of main position. However, some participants might be classified into a different position category than their self-orientation. For example, participant who reported as both a doctor and other position (such as a nurse or public health personnel) was identified as a doctor (81 in 13211, 0.61%), participant who self-reported as both a nurse and other position (such as a public health personnel or administrative personnel but not a doctor) was identified as a nurse (46 in 13211, 0.35%).

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cross-sectional studies

Section/Topic	Item #	Recommendation	Reported on page #
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	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-10
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	7-10
Bias	9	Describe any efforts to address potential sources of bias	11-13
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-10
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	10-13
		(b) Describe any methods used to examine subgroups and interactions	12-13
		(c) Explain how missing data were addressed	8-9
		(d) If applicable, describe analytical methods taking account of sampling strategy	6
		(e) Describe any sensitivity analyses	13
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	13
		(b) Give reasons for non-participation at each stage	Not applicable
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13-14
		(b) Indicate number of participants with missing data for each variable of interest	8-9
Outcome data	15*	Report numbers of outcome events or summary measures	Not applicable
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	15
		(b) Report category boundaries when continuous variables were categorized	7-10
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	15-16
Discussion			
Key results	18	Summarise key results with reference to study objectives	16-20
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	20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16-20
Generalisability	21	Discuss the generalisability (external validity) of the study results	20
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	22

*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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More or less, what had the appraisal for hospitals brought to job satisfaction of healthcare professionals? A cross-sectional survey in China

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More or less, what had the appraisal for hospitals brought to job satisfaction of healthcare professionals?

A cross-sectional survey in China

ABSTRACT

Objective The purpose of this study is to evaluate the effectiveness of hospital appraisals, specifically the Performance Appraisal for Tertiary Public Hospitals (PATPH), and to examine its impact on the job satisfaction of healthcare professionals in Chinese tertiary public hospitals.

Design A cross-sectional study.

Setting Nine tertiary public hospitals across three economic and geographic regions in China.

Participants In August 2020, a total of 13,211 hospital employees were surveyed, with 8,417 fully completed questionnaires provided by doctors and nurses forming the primary dataset for analysis. Of these respondents, males comprised 18.64% and doctors constituted 28.15%.

Results This study revealed that PATPH had a positive impact on the job satisfaction of healthcare professionals. A “more effective” PATPH working environment resulted in an improvement of 9.57 points (95% *CI*: 8.99 - 10.16) in job satisfaction scores, controlling for all other variables. The finding persisted consistently through a series of sensitive analyses.

Conclusion The findings offered insights and inspiration for improving the job satisfaction of healthcare professionals, especially in the development of macro-level policies targeted towards organizational enhancement.

Key words Job satisfaction; healthcare professionals; appraisals for hospitals; inverse probability-of-treatment weighting.

Strengths and limitation of this study

- Previous studies have demonstrated positive effects of hospital performance appraisals in reducing healthcare costs and improving healthcare quality. However, there is limited research exploring its impact on the job satisfaction of healthcare professionals.
- This study collected a substantial amount of potential confounding variables, including sociodemographic characteristics, the depression status of participants, and hospital characteristics. All of these variables were accounted for in the analyses, and their effects would be mitigated using the Inverse Probability-of-Treatment Weighting (IPTW) method.
- While a large sample was analyzed in this study, it is important to note that only doctors and nurses were included among healthcare professionals, potentially limiting the generalizability of findings to other healthcare positions.

INTRODUCTION

The job satisfaction of healthcare professionals is widely concerned, for its impact on physician outcomes (e.g., turnover, performance and mental health) and healthcare outcomes (e.g., quality of care, patient outcomes and costs)¹⁻⁴. Hoppock (1935) defined job satisfaction as any combination of psychological, physiological, and environmental conditions that encourage employees to be satisfied or happy with their job⁵. Different personal attributes and working environments which consist of job characteristics, physical working conditions, and social working conditions, may affect workers' job satisfaction⁶. As for healthcare professionals, aside from personal factors such as age, gender, marital status, position, and education background, abundant evidence suggests that work environment factors significantly influence job satisfaction. These factors include income, working shifts, leadership quality, job autonomy, and collegial support⁷⁻¹¹.

Health policies have been considered as a type of practice environment which influence the job satisfaction of healthcare professionals^{3 12}. Prior literature has proven that the impact of hospital mergers on staff job satisfaction and psychological status in the National Health Service^{13 14}. The Performance Appraisal for Tertiary Public Hospitals (PATPH) in China was initially launched in 2019. It annually evaluated and rated more than 2400 top hospitals which were funded by the government based on 5 dimensions: medical quality of the hospital, operation efficiency of the

hospital, sustainable development of the hospital, satisfaction of patients, and job satisfaction of healthcare professionals. The PATPH seeks to promote transitions in both the developmental and the managerial approaches of tertiary public hospitals towards more efficient and quality-driven paradigms ¹⁵. So far, the performance appraisals conducted under the PATPH serve as a crucial determinant for various facets of policy formulation, including government support for hospital development, financial allocations, remuneration for healthcare professionals based on performance, and hospital revenue.

Throughout the implementation of PATPH, hospitals have been the recipients of initiatives aimed at enhancing efficiency and quality. The provision of financial and non-financial incentives, which are propelled by PATPH, has motivated tertiary public hospitals to identify and address weaknesses across various appraisal dimensions, thereby improving overall performance. This process has led to significant reforms in working environments and social settings within hospitals through the implementation of adaptive policies ^{12 16}. Hence, healthcare professionals have been directly impacted by these adaptive policies at the hospital level.

There were ambiguous results about the impact of health policies on the job satisfaction of healthcare professionals. Resulting from alterations in job arrangements, changes in everyday work activities and organizational culture may lead to heightened stress, decreased job security,

and reduced job autonomy among healthcare professionals due to stringent regulations and increased requirements¹⁷⁻¹⁹. However, contrary perspectives have²⁰ highlighted that a strong sense of satisfaction stems primarily from internal values rather than external changes. Furthermore, they argue that healthcare reforms have not shown any significant or persistent impact on doctors' job satisfaction.

At the individual level, healthcare professionals may experience a combination of support and pressure during the implementation of PATPH. On the one hand, PATPH aims to enhance medical quality, improve hospital operational efficiency, promote sustainable hospital development, and ensure patient satisfaction, thereby offering favorable working conditions to satisfy healthcare professionals. On the other hand, healthcare professionals may also face more demanding work tasks and higher work requirements due to the pressure from annual hospital rankings, which are linked to governmental funding. For instance, the emphasis on improving the quality of health records and medical care as encouraged by PATPH may place additional stress on healthcare professionals and potentially diminish their job satisfaction²¹⁻²³. In such case, it becomes essential to conduct further research on the impact of macro health policies like PATPH, which primarily target organizational changes rather than healthcare professionals, on the well-being of healthcare professionals and their job satisfaction.

This study aimed to investigate the impact of PATPH as an environmental factor on the job satisfaction of healthcare professionals. Initially, we assessed the PATPH-induced improvements in the working environment across five dimensions (i.e., medical quality of hospital, operation efficiency of hospital, sustainable development of hospital, satisfaction of inpatients, and satisfaction of outpatients) based on evaluations provided by healthcare professionals. Subsequently, we constructed the Inverse Probability-of-Treatment Weighting (IPTW) method to clarify the disparities in job satisfaction among healthcare professionals in two working settings: the “more effective” and the “less effective” PATPH working environment. Finally, we compared the differences in job satisfaction using a series of weighted linear regression models between different working environments.

METHODS

Study design and population

This quantitative study used data sourced from a nationwide cross-sectional sampling survey conducted in tertiary public general hospitals across China in August 2020. To ensure the representativeness of the samples across hospitals with diverse social backgrounds and baseline performance levels, hospitals were selected in consideration of their geographical locations with economical regions and their performance ratings according to the PATPH for the year 2018 (prior to the implementation of PATPH).

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7 Firstly, three provinces were selected, each representing one of three major regions in China:
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9 Eastern region, Central region, and Western region. Subsequently, three hospitals were selected
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11 from each province, stratified based on their performance ratings categorized as “fair”, “good”,
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13 and “excellent”.
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20 Participants included all hospital employees on duty during the investigation period. Utilizing an
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22 electronic questionnaire, participants directly submitted their responses to a cloud server. Strict
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24 confidentiality measures were implemented to ensure the authenticity of this survey data and
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26 maintain in a high response rate.
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33 In total, we received 13,211 questionnaires from 9 tertiary public hospitals across 3 provinces in
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35 China, accounting for about 35.45% of the total number of all employees. Among these, 10,012
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37 were completed by doctors and nurses, as indicated by participants’ responses (further details
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39 about the principle of distinguishing were provided in the Supplement). The proportion of doctors
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41 and nurses in 13211 responses (i.e., 75.79%) closely mirrors the ratio of doctors and nurses to total
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43 hospital staff in tertiary hospitals, which is 72.71% according to the 2021 China Health Statistical
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45 Yearbook. Considering the essential roles of doctors and nurses in healthcare delivery, this study
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51 focused on the changes in job satisfaction among doctors and nurses. Additionally, results for
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healthcare professionals across all positions were also reported in the sensitive analysis to ensure robustness.

Subsequently, responses without missing value from 8,417 doctors and nurses (representing 84.07% of the total 10,012) were included in statistical analyses. Participants were categorized into two groups based on their responses regarding the improvement of the working environment: the exposure group comprised individuals who perceived themselves to be in a “more effective” PATPH working environment, while the control group encompassed the remaining participants. Employing the IPTW approach to mitigate confounding effects arising from hospital and personal characteristics, this study estimated the average treated effect of exposure (i.e., the “more effective” PATPH working environment) on job satisfaction. The relationship among all the variables studied was adequately illustrated graphically in **Figure S1** in the Supplement.

Patient and Public Involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Measurements

Outcome variable: Job satisfaction

The Minnesota Satisfaction Questionnaire (MSQ) (short-form)²⁴ was used to measure healthcare professionals' job satisfaction. The instrument asked respondents to rate their satisfaction of their present job in 20 aspects which were divided in intrinsic scale (including item 1-4, 7-11, 15-16, 20) and extrinsic scale (including item 5-6, 12-14, 17-19). Responds were made on a 5-point scale from 1 (*very dissatisfied*) to 5 (*very satisfied*). The total score with a range of 20 to 100 was calculated for each participant. The intrinsic and extrinsic subscales were used as outcome measures in the explorational analysis. The Cronbach's α value of MSQ in this survey was 0.966. (Table S1 in the Supplement)

Exposure variable: The "more effective" PATPH

The determination of a "more effective" PATPH working environment was based on participants' assessments of the extent to which PATPH improved various aspects of the working environment. Participants rated the improvement across five dimensions of PATPH using a 5-point scale, ranging from 0 (*no improvement*) to 4 (*significant improvement*). Responses indicating "unclear" in any dimension were treated as missing values, constituting less than 7.07% in each dimension. For each participant, a total score was calculated by summing their ratings across all five dimensions (i.e., medical quality of hospital, operation efficiency of hospital, sustainable development of hospital, satisfaction of inpatients and satisfaction of outpatients). A total score exceeding 18 points (the 75th quantile) was deemed indicative of a "more effective" environment.

Participants falling into this category were assigned to the exposed group (assigned a value 1), while those who did not meet this criterion were assigned to the control group (assigned a value of 0). The Cronbach’s α value was 0.970. (**Table S2** in the Supplement)

Covariates

We selected covariates based on a priori knowledge of potential factors influencing job satisfaction. These covariates included age group, gender (male or female), marital status (never married or other conditions), position (doctor or nurse), education level (below undergraduate, undergraduate, master’s degree, or doctoral degree), technical title (not have, primary title, intermediate title, vice senior, or senior), administrative position (have or not have), department (internal medicine, surgical, or other departments), region (east, center, or west), performance rating of the hospital (fair, good, or excellent), increased attention to the working environment (more or less), depression status of participants (at risk or none). All this information was derived from responses to survey questions and was considered as potential covariates in the analysis.

The increased attention to the working environment among participants was measured by five aspects of PATPH’s indicators (i.e., medical quality of hospital, operation efficiency of hospital, sustainable development of hospital, satisfaction of inpatients and satisfaction of outpatients; see **Table S3** in the Supplement). Responses were elicited on a 5-point scale, ranging from 0 (*no*

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4 *increase*) to 4 (*significant increase*). Participants who reported “never concern” in any
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7 dimension were classified as missing respondents, constituting less than 6.05% in each dimension.
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9 A higher total score indicated a great level of increased attention among participants toward the
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11 working environment. Scores less than 9 (representing the 25th quantile) were considered
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13 indicative of less increased attention. The Cronbach’s α value was 0.927.
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20 The depression status of participants was measured using the Center for Epidemiological Studies-
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22 Depression Scale (CES-D) consisting of 20 items ²⁵. Each item has a 4-point response scale,
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24 ranging from 0 (*indicating rarely or none of the time*) to 3 (*indicating all of the time*). Four items
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26 (4, 8, 12, 16) were reversely scored. Total scores ranged from 0 to 60, with higher scores indicating
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28 greater presence of depressive symptoms. Individuals at risk for depression were identified using
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30 a cut-off score of 16 or higher ²⁶. The Cronbach’s α value of the CES-D was 0.926.
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38 The levels of anxiety among healthcare professionals were assessed using the Self-Rating Anxiety
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40 Scale (SAS)²⁷, comprising 20 items. Participants reported the frequency of anxiety-related feelings
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42 or behaviors experienced during the past week, with responses recorded on a 4-point scale ranging
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44 from 1 (*none or almost none*) to 4 (*almost all the time*). Five items (5, 9, 13, 17, and 19) were
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46 reverse-scored. The raw scores for all items were summed to calculate a total raw score, which
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48 was then multiplied by 1.25 to obtain the standard score. A higher standard score, ranging from 25
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to 100, indicated a greater likelihood of experiencing anxiety. Individuals at risk for anxiety disorder were identified using a cut-off score of 50 or higher²⁸. The Cronbach's α coefficients of the SAS was 0.877.

Data analysis

Descriptive analysis and difference significance test

Standard descriptive statistics were used to characterize participants who worked in a “more effective” environment and those who did not. For categorical variables, frequencies and percentages were reported, while continuous variables were summarized using means and standard deviations. To compare differences between groups, the chi-square test was utilized for categorical variables, examining whether there were significant associations between groups and each categorical variable. For continuous variables, one-way analysis of variance (ANOVA) was conducted to assess the significance of differences in means between groups.

Inverse probability treatment weighting

The Inverse Probability-of-Treatment Weighting (IPTW) method leveraged propensity scores to generate a weight for each participant, aiming to achieve balance in baseline characteristics across groups. By assigning weights to individuals based on their propensity scores, we created a pseudo-population in which there was no association between baseline observed covariates and the

treatment (i.e., the “more effective” PATPH environment). This weighting approach allowed us to mitigate potential confounding effects arising from differences in baseline characteristics between participants exposed to the “more effective” PATPH environment and those who were not.

To enhance statistical efficiency and improve the coverage of confidence intervals, stabilized weights were calculated using the formula²⁹:

$$w_i = \frac{P(T_i = t_i)}{P(T_i = t | C_i = c_i)},$$

where w_i represents the stabilized weight for participant i . T denotes the working environment, with $t=1$ for “more effective” and $t=0$ for “less effective”, i represents participants. C indicates a set of potential confounders. The numerator represents the crude probability of exposure, i.e., the probability of being exposed to the “more effective” working environment. The denominator represents the probability of exposure conditioned on the set of potential confounders (i.e., the set C).

We chose the traditional strategy of controlled trial-and-error re-specification of the weight-estimating equation in the determination of set C . The exchangeability assumption requires enough joint predictors of exposure and outcome (i.e., confounders) in the estimation of the dominator. However, the addition of non-confounding variables may introduce selection bias due to collider stratification, potentially violating the possibility assumption and diminishing statistical efficiency.

To achieve a better balance between these considerations, we conducted a backward selection process to include potential confounders.

Figure 1 showed the procedure for the constructing weights. The optimal set of potential confounders C should contain fewer covariates, resulting in weights with a distribution characterized by a mean close to 1 and a narrower range. These criteria would facilitate better balance across all covariates³⁰. The primitive set C in the specification 1 would contain all covariates which showed imbalance (standardized difference in proportion > 0.1) at the baseline and affect the probability of T under the consideration of domain knowledge. The standardized differences in proportion were calculated as follow³¹:

$$\text{Standardized difference in proportion} = \frac{\hat{p}_{exposed} - \hat{p}_{control}}{\sqrt{\frac{\hat{p}_{exposed}(1 - \hat{p}_{exposed}) + \hat{p}_{control}(1 - \hat{p}_{control})}{2}}}$$

where $\hat{p}_{exposed}$ and $\hat{p}_{control}$ denote the sample prevalence of the exposure(T) in exposed and control groups, respectively.

Extreme weights would be addressed through truncation at the 1st and 99th percentiles in the process of constructing³². Remaining imbalance after weighed would be addressed in the further regression adjustment^{33 34}.

The weighted linear regressions

The average treatment effect of the “more effective” PATPH working environment on job satisfaction was estimated in the pseudo-population using linear regression models. In these models, the “more effective” PATPH working environment was treated as the treatment variable, while job satisfaction served as the outcome variable. To account for the lack of independence among participants due to IPTW, a robust “sandwich” variance estimator was employed³⁵.

In the primary analysis (Model 1), we included all variables that exhibited uneven distributions after IPTW. Alternatively, in Model 2, we compared the IPTW approach against a standard stepwise multivariate regression analysis. This comparison allows us to evaluate the performance and effectiveness of the IPTW method in adjusting for confounding compared to traditional regression modeling techniques. Additionally, subgroup analyses were conducted in Model 3 and Model 4 to investigate potential variations in treatment effects across different regions and levels of increased attention towards the working environment, respectively. Bonferroni corrections were applied in multiple comparisons.

Sensitive analysis

A series of sensitive analysis were conducted to test the robustness of the findings (**Table 2**). Firstly, we defined “more effective” with different thresholds in Model 5-6 (i.e., the 50th percentile

and the mean + SD). Secondly, linear mixed-effects models were applied to the weighted population to estimate the impact of the “more effective” working environment, with the region treated as a random effect (Model 7). Lastly, the sample size was expanded to include medical personnel of all positions in Model 8.

R version 4.2.1 was used for data analysis. R package “cobalt” was used to assess the covariate balance. R package “MASS”³⁶ and “lme4”³⁷ was used to construct the stepwise regression models and the linear mixed-effects model respectively. R package “sandwich” were used for robust estimation of standard error³⁸. All tests were two sided with type I error rates of 0.05.

RESULTS

Characteristics of participants at baseline

Table S4 in the supplementary materials summarized the sociodemographic characteristics of participants. The average age of 8,417 participants was 34.02 ± 8.30 years, and male made up 18.64%. Most of participants had been married previously and doctors constituted 28.15%. According to the definition of “more effective”, 2,224 (26.42%) participants reported a “more effective” PATPH working environment with a score greater than 18 for working environment improvement. The characteristics of the “more effective” and the “less effective” group of people were also displayed separately in Table S4. Differences in the distribution of covariates existed at

baseline between the “more effective” and “less effective” PATPH working environments (**Figure 2**).

IPTW weights and balance diagnosis

After several attempts in specifications, this study obtained the optimal stabilized weights using “Specification 3_99trunc” (see **Table S5** and **Figure S2** in the Supplement). The optimal set of covariates, denoted as the optimal set *C*, included age groups, gender, education level, marital status, technical title, position, depression status of healthcare professionals, and hospital performance ratings. The mean stabilized weight was 0.99, with a standard deviation of 0.31. The minimum and maximum weights were 0.53 and 2.70, respectively.

The IPTW performed effectively in balancing of the baseline covariates. Following IPTW adjustment, the groups increased comparability across most baseline covariates, with standardized differences in proportion being less than 10%. However, there remained residual imbalance in the covariates related to the increased attention to the working environment and the region (**Figure 2**; **Table S4**). We addressed the impact of this remaining imbalance by incorporating the two variables into the outcome models (as described below).

Impact of PATPH on job satisfaction

Table 1 showed the impact of the “more effective” PATPH working environment on job satisfaction, demonstrating a nearly 10-point increase in MSQ score (9.57, 95% *CI* 8.99 - 10.16) in the primary analysis (Model 1). Results obtained from the multivariate regression analysis closely aligned with that derived from the IPTW approach (9.92, 95% *CI* 9.42 - 10.42).

The positive effect of the “more effective” PATPH working environment on job satisfaction across regions exhibited a V-shaped pattern in Model 3. Among all regions, the impact of the “more effective” PATPH working environment on MSQ score was most pronounced in the central region, with an increase of approximately 2.04 points compared to the eastern region and about 3.50 points compared to the western region.

Among populations with varying levels of increased attention to the working environment, the average difference in job satisfaction decreased from the group with higher levels of attention to that of those with lower levels. Specifically, the average difference in job satisfaction was 9.60 (95% *CI* 9.01- 10.19) for individuals with higher levels of increased attention to the working environment, compared to 8.27 (95% *CI* 2.57- 13.96) for individuals with lower levels of increased attention to the working environment.

Sensitive analysis

The results in **Table 2** were broadly consistent with those reported in **Table 1**, indicating the robust impact of the “more effective” PATPH on the job satisfaction of healthcare professionals. Balance diagnoses for baseline variables before and after IPTW in the sensitive analysis (Model 5-8 in **Table 2**) were presented in **Figure S3** in the Supplements.

DISCUSSION

The “More Effective” PATPH Induced Higher Job Satisfaction

Utilizing IPTW to reduce selective bias, our findings offered a clue that macro health policies such as PATPH played positive roles in enhancing the job satisfaction of healthcare professionals. Doctors and nurses working in environments where PATPH were more effective, experienced an average advancement of approximately 10 points in job satisfaction (equivalent to 12.5% of the range of MSQ score).

This encouraging finding prompted us to investigate which aspects of job satisfaction were predominantly affected. Intrinsic job satisfaction indicated the contentment with the nature of ones’ work, while extrinsic job satisfaction encompassed factors such as salary, coworkers and management ³⁹. Conducting exploratory analyses based on Model 2, we found that the “more effective” PATPH working environment increased intrinsic MSQ score by approximately 5.46 points (equivalent to 9.10% of the range) and extrinsic MSQ score by approximately 4.46 points

(equivalent to 11.15% of the range). The higher proportion of increase in extrinsic MSQ scores in our exploratory results supported our conclusions, implying that a “more effective” PATPH working environment led to greater job satisfaction among doctors and nurses.

PATPH aims to incentivize hospitals to enhance physical and social working conditions, to provide higher medical quality and to improve management. Our findings demonstrated that these anticipated positive impacts were realized to some extent. Plausible explanations for our findings included implemented policies that foster a flexible practice environment with adequate staffing and resources, increased opportunities for healthcare professionals to participate in hospital policies and governance, and more recognition of healthcare professionals’ contributions to work and performance^{40 41}.

Hospitals in the Western Region Exhibit a Higher Demand for Support in Improving Job Satisfaction

Through subgroup analyses, this study evaluated the specific impact among regions characterized by varying economic conditions. When comparing the increase in job satisfaction motivated by PATPH, results in the Central and Eastern regions showed notable improvements. Nevertheless, in Western hospitals, which generally have lower levels of economic development, the impact of environmental improvements on job satisfaction seemed relatively limited. Our finding

underscored the necessity for greater support or benefits from PATPH to increase the job satisfaction of healthcare professionals in Western regions, in addition to improvements in working settings.

Negative Attitude of Healthcare Professionals Diminish the Effect of the “more effective” PATPH on Job Satisfaction

The responses of affected individuals exert considerable influence on the implementation process of policies⁴². Model 4 showed our interest in the response of healthcare professionals to PATPH through subgroup analyses. Our findings revealed that when the analysis was restricted to participants with less attention to the working environment, the effect of a “more effective” PATPH declined by approximately 1.30 points in mean MSQ score, accompanied by greater variation. Conversely, the results in the other subgroup, which consists of participants with more increased attention to the working environment, remained consistent with the primary analysis.

During the implementation of policies, it is noted that the involvement level of recipients, service organizations, and street-level bureaucrats may influence confidence in and support of policy decisions, thereby enhancing the chances for successful implementation^{43 44}. We interpreted the less attention to the working environment as a form of negative response from healthcare professionals, indicating a lower engagement level. From an implementation science perspective,

our findings highlighted the importance of improving healthcare professionals’ responses to effectively develop, implement, and evaluate large-scale healthcare policies. This includes fostering attention, understanding, recognition, and support for the policy among healthcare professionals.

A Collaborative Scheme to Enhance Motivation among Healthcare Professionals

Motivating healthcare professionals is a multifaceted endeavor, with various factors influencing their satisfaction^{12 45 46}. In China, several reforms have been implemented at the individual level to boost the enthusiasm of healthcare professionals, such as reforms in the performance management, promotion system, compensation system, etc. However, despite these efforts, recent studies have shown only marginal improvements in the job satisfaction among healthcare professionals in tertiary hospitals in China^{47 48}. Our study shed light on the potential for the improvements in staff satisfaction pursued by PATPH in hospitals settings, calling for a collaborative motivational scheme that considers both individual-level and environment-level factors.

Enhancing operational efficiency and promoting sustainable development in hospitals are critical elements for maximizing the positive effect of an improved environment on job satisfaction.

Comparing to higher scores of medical quality and patient satisfaction in the healthcare professionals' evaluation of PATPH-induced improvements, the operational efficiency and the sustainable development of hospitals scored lower. This is consistent with the historical focus on the provision of medical and public health services in Chinese public hospitals, with fewer efforts directed towards improvements in managerial areas¹⁵. Our finding emphasized the importance of intensifying efforts towards improving operational efficiency and promoting sustainable development in tertiary public hospitals in the future. To achieve this, collaborative efforts are need to optimize patient flow and enhance coordination among human and material resources. Additionally, ensuring distributive justice to enhance the retention of healthcare personnel is also crucial.^{49 50}.

Limitation

Despite the scope and findings of this study, several limitations should be acknowledged. Firstly, our analyses did not include medical personnel in all positions, potentially limiting the generalizability of our finding to broader population of healthcare professionals. Secondly, the original population of this survey was not equally distributed by covariates. However, we employed IPTW method to diminish the effect of confounders successfully; Thirdly, despite employing IPTW and matching techniques, residual confounding factors may still exist, such as individual preferences of healthcare professionals, income disparities among healthcare

professionals, regional customs and cultures. Fourthly, our study primarily focused on confirming the overall positive effects of PATPH on job satisfaction. Further research is needed to find which aspects of working environment improved by PATPH contributed to increased job satisfaction, and which aspects of job satisfaction were more affected.

CONCLUSION

Our study demonstrated that the PATPH, while targeting hospital implementation, had a broader positive impact not only on the working environments of tertiary public hospitals but also on healthcare professionals themselves. We observed that a working environment with more proactive responses to macro policies can lead to a greater increase in job satisfaction. Besides, less individual addition to working environments is linked to lower enhancements in job satisfaction. Findings in this research indicated the impact of macro-level policies on individual job satisfaction, as well as the moderating effect of individual attention on this impact. We identified an influence pathway beyond policy design, whereby policies promoting hospital improvements subsequently increase staff motivation. Thus, our study advocated for the implementation of a collaborative motivating scheme which takes both individual-level and environment-level factors into account. Such an approach is essential for maximizing the positive impact of macro-level policies on healthcare professionals’ job satisfaction and overall well-being.

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List of abbreviations

PATPH=The Performance Appraisal for Tertiary Public Hospitals

IPTW=Inverse Probability-of-Treatment Weighting

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Contributorship Statement

Conception or design of the work: LGH, SCS and XYY

Data collection: SKY, XSQ, LGH, SCS and BDS

Data analysis and interpretation: LXY, LMJ and SCS

Drafting the article: LXY and LMJ

Critical revision of the article: LXY, LMJ, XSQ, SCS and LGH

All authors contributed to the submitted version and approved the final manuscript.

All those designated as authors met all ICMJE criteria for authorship, and all who meet the ICMJE criteria were identified as authors.

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Competing interests

None declared.

Ethics approval and consent to participate

This survey received ethical approval from the Ethics Committee of the School of Public Health, Shanghai Jiao Tong University School of Medicine, China on February 20, 2020, and record number SJUPN-202008 using the National Statement on Ethical Conduct in Human Research. Informed consents were written for each participant to read and sign before moving on to filling the questionnaires.

Data availability statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

References

1. Coomber B, Barriball KL. Impact of job satisfaction components on intent to leave and turnover for hospital-based nurses: a review of the research literature. *Int J Nurs Stud* 2007;44(2):297-314. doi: 10.1016/j.ijnurstu.2006.02.004 [published Online First: 20060424]
2. Williams ES, Skinner AC. Outcomes of physician job satisfaction: a narrative review, implications, and directions for future research. *Health Care Manage Rev* 2003;28(2):119-39. doi: 10.1097/00004010-200304000-00004
3. Brady KJS, Kazis LE, Sheldrick RC, et al. Selecting physician well-being measures to assess health system performance and screen for distress: Conceptual and methodological considerations. *Curr Probl Pediatr Adolesc Health Care* 2019;49(12):100662. doi: 10.1016/j.cppeds.2019.100662 [published Online First: 20190925]
4. McHugh MD, Kutney-Lee A, Cimiotti JP, et al. Nurses' widespread job dissatisfaction, burnout, and frustration with health benefits signal problems for patient care. *Health Aff (Millwood)* 2011;30(2):202-10. doi: 10.1377/hlthaff.2010.0100
5. Hoppock R. Job satisfaction. New York: Harper 1935:303.
6. Raziq A, Maulabakhsh R. Impact of Working Environment on Job Satisfaction. *Procedia Economics and*

Finance 2015;23:717-25. doi: 10.1016/s2212-5671(15)00524-9

7. Lu H, Zhao Y, While A. Job satisfaction among hospital nurses: A literature review. *Int J Nurs Stud* 2019;94:21-31. doi: 10.1016/j.ijnurstu.2019.01.011 [published Online First: 20190210]

8. Cummings GG, MacGregor T, Davey M, et al. Leadership styles and outcome patterns for the nursing workforce and work environment: A systematic review. *INTERNATIONAL JOURNAL OF NURSING STUDIES* 2010;47(3):363-85. doi: 10.1016/j.ijnurstu.2009.08.006

9. Shanafelt TD, Gorringer G, Menaker R, et al. Impact of organizational leadership on physician burnout and satisfaction. *Mayo Clin Proc* 2015;90(4):432-40. doi: 10.1016/j.mayocp.2015.01.012 [published Online First: 20150318]

10. Bofo IM. The effects of workplace respect and violence on nurses' job satisfaction in Ghana: a cross-sectional survey. *Hum Resour Health* 2018;16(1):6. doi: 10.1186/s12960-018-0269-9 [published Online First: 20180115]

11. Zhou H, Han X, Zhang J, et al. Job Satisfaction and Associated Factors among Medical Staff in Tertiary Public Hospitals: Results from a National Cross-Sectional Survey in China. *Int J Environ Res Public Health* 2018;15(7) doi: 10.3390/ijerph15071528 [published Online First: 20180719]

12. Chandler CI, Chonya S, Mtei F, et al. Motivation, money and respect: a mixed-method study of Tanzanian non-physician clinicians. *Soc Sci Med* 2009;68(11):2078-88. doi: 10.1016/j.socscimed.2009.03.007 [published Online First: 20090328]

13. Lim KK. Impact of hospital mergers on staff job satisfaction: a quantitative study. *Hum Resour Health*

- 2014;12:70. doi: 10.1186/1478-4491-12-70 [published Online First: 20141212]
14. Cortvriend P. Change management of mergers: the impact on NHS staff and their psychological contracts. *Health Serv Manage Res* 2004;17(3):177-87. doi: 10.1258/0951484041485593
15. Li Y, He W, Yang L, et al. A historical review of performance appraisal of public hospitals in China from the perspective of historical institutionalism. *Front Public Health* 2022;10:1009780. doi: 10.3389/fpubh.2022.1009780 [published Online First: 20221010]
16. Franco LM, Bennett S, Kanfer R. Health sector reform and public sector health worker motivation: a conceptual framework. *Soc Sci Med* 2002;54(8):1255-66. doi: 10.1016/s0277-9536(01)00094-6
17. Nalla MK, Kang W. Organizational Climate, Perceived Citizen Support, and Job Satisfaction of Police Officers: Findings from the Post-Grand Reform Era in South Korea. *Asian Journal of Criminology* 2012;7(2):153-71. doi: 10.1007/s11417-012-9127-1
18. Manyazewal T, Matlakala MC. Beyond patient care: the impact of healthcare reform on job satisfaction in the Ethiopian public healthcare sector. *Hum Resour Health* 2017;15(1):10. doi: 10.1186/s12960-017-0188-1 [published Online First: 20170203]
19. Alameddine M, Bauer JM, Richter M, et al. Trends in job satisfaction among German nurses from 1990 to 2012. *J Health Serv Res Po* 2016;21(2):101-08. doi: 10.1177/1355819615614045
20. Aasland OG, Rosta J, Nylenna M. Healthcare reforms and job satisfaction among doctors in Norway. *Scand J Public Health* 2010;38(3):253-8. doi: 10.1177/1403494810364559 [published Online First: 20100309]

21. Shanafelt TD, Dyrbye LN, Sinsky C, et al. Relationship Between Clerical Burden and Characteristics of the Electronic Environment With Physician Burnout and Professional Satisfaction. *Mayo Clinic Proceedings* 2016;91(7):836-48. doi: 10.1016/j.mayocp.2016.05.007

22. Friedberg MW, Chen PG, Van Busum KR, et al. Factors Affecting Physician Professional Satisfaction and Their Implications for Patient Care, Health Systems, and Health Policy. *Rand Health Q* 2014;3(4):1-1.

23. Trivellas P, Reklitis P, Platis C. The effect of job related stress on employees' satisfaction: A survey in Health Care. *Procd Soc Behv* 2013;73:718-26. doi: 10.1016/j.sbspro.2013.02.110

24. Weiss DJ, Dawis RV, England GW, et al. Manual for the Minnesota Satisfaction Questionnaire: Minnesota studies in vocational rehabilitation. *Minneapolis: Industrial Relations Center, University of Minnesota* 1967

25. Radloff LS. The CES-D Scale: A Self-Report Depression Scale for Research in the General Population. *Applied Psychological Measurement* 1977;1(3):385-401. doi: 10.1177/014662167700100306

26. Lewinsohn PM, Seeley JR, Roberts RE, et al. Center for Epidemiologic Studies Depression Scale (CES-D) as a screening instrument for depression among community-residing older adults. *Psychol Aging* 1997;12(2):277-87. doi: 10.1037//0882-7974.12.2.277

27. Zung WW. A rating instrument for anxiety disorders. *Psychosomatics* 1971;12(6):371-9. doi: 10.1016/S0033-3182(71)71479-0

28. Dunstan DA, Scott N. Norms for Zung's Self-rating Anxiety Scale. *BMC Psychiatry* 2020;20(1):90. doi:

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- 10.1186/s12888-019-2427-6 [published Online First: 20200228]
29. van der Wal WM, Geskus RB. ipw: An R Package for Inverse Probability Weighting. *Journal of Statistical Software* 2011;43(13):1 - 23. doi: 10.18637/jss.v043.i13
30. Cole SR, Hernan MA. Constructing inverse probability weights for marginal structural models. *Am J Epidemiol* 2008;168(6):656-64. doi: 10.1093/aje/kwn164 [published Online First: 20080805]
31. Austin PC, Stuart EA. Moving towards best practice when using inverse probability of treatment weighting (IPTW) using the propensity score to estimate causal treatment effects in observational studies. *Stat Med* 2015;34(28):3661-79. doi: 10.1002/sim.6607 [published Online First: 20150803]
32. Aitken Z, Simpson JA, Bentley R, et al. Disability acquisition and mental health: effect modification by demographic and socioeconomic characteristics using data from an Australian longitudinal study. *BMJ Open* 2017;7(9):e016953. doi: 10.1136/bmjopen-2017-016953
33. Milner A, Aitken Z, Krnjacki L, et al. Perceived fairness of pay among people with and without disabilities: a propensity score matched analysis of working Australians. *Scand J Work Environ Health* 2015;41(5):451-9. doi: 10.5271/sjweh.3515 [published Online First: 20150717]
34. Weighted Regression Estimators of Causal Effects. In: Winship C, Morgan SL, eds. Counterfactuals and Causal Inference: Methods and Principles for Social Research. 2 ed. Cambridge: Cambridge University Press 2014:226-64.
35. Chesnaye NC, Stel VS, Tripepi G, et al. An introduction to inverse probability of treatment weighting in observational research. *Clin Kidney J* 2022;15(1):14-20. doi: 10.1093/ckj/sfab158 [published

Online First: 20210826]

36. Venables WN, Ripley BD. Modern Applied Statistics with S. Fourth ed. New York: Springer 2002.

37. Bates D, Machler M, Bolker BM, et al. Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software* 2015;67(1):1-48. doi: 10.18637/jss.v067.i01

38. Long JS, Ervin LH. Using Heteroscedasticity Consistent Standard Errors in the Linear Regression Model. *The American Statistician* 2000;54(3):217-24. doi: 10.1080/00031305.2000.10474549

39. Jones LK. Job satisfaction. In Encyclopedia of career change and work issues. Phoenix: The Oryx Press 1992.

40. Atefi N, Abdullah KL, Wong LP, et al. Factors influencing registered nurses perception of their overall job satisfaction: a qualitative study. *Int Nurs Rev* 2014;61(3):352-60. doi: 10.1111/inr.12112

41. Alnuaimi K, Ali R, Al-Younis N. Job satisfaction, work environment and intent to stay of Jordanian midwives. *Int Nurs Rev* 2020;67(3):403-10. doi: 10.1111/inr.12605 [published Online First: 20200728]

42. Nilsen P, Stahl C, Roback K, et al. Never the twain shall meet?--a comparison of implementation science and policy implementation research. *Implement Sci* 2013;8:63. doi: 10.1186/1748-5908-8-63 [published Online First: 20130610]

43. Perla RJ, Bradbury E, Gunther-Murphy C. Large-scale improvement initiatives in healthcare: a scan of the literature. *J Healthc Qual* 2013;35(1):30-40. doi: 10.1111/j.1945-1474.2011.00164.x [published Online First: 20110914]

44. Bullock HL, Lavis JN, Wilson MG, et al. Understanding the implementation of evidence-informed policies and practices from a policy perspective: a critical interpretive synthesis. *Implementation Science* 2021;16(1) doi: 10.1186/s13012-021-01082-7
45. Willis-Shattuck M, Bidwell P, Thomas S, et al. Motivation and retention of health workers in developing countries: a systematic review. *BMC Health Serv Res* 2008;8:247. doi: 10.1186/1472-6963-8-247 [published Online First: 20081204]
46. Scheurer D, McKean S, Miller J, et al. U.S. physician satisfaction: a systematic review. *J Hosp Med* 2009;4(9):560-8. doi: 10.1002/jhm.496
47. Wang M, Hu C, Huang M, et al. The effect of emotional clarity and attention to emotion on job satisfaction: A mediating role of emotion regulation among Chinese medical staff. *Asian Journal of Social Psychology* 2019;22(3):316-24. doi: 10.1111/ajsp.12365
48. Liu D, Wu Y, Jiang F, et al. Gender Differences in Job Satisfaction and Work-Life Balance Among Chinese Physicians in Tertiary Public Hospitals. *Front Public Health* 2021;9:635260. doi: 10.3389/fpubh.2021.635260 [published Online First: 20210510]
49. Miranda MA, Salvatierra S, Rodriguez I, et al. Characterization of the flow of patients in a hospital from complex networks. *Health Care Manag Sci* 2020;23(1):66-79. doi: 10.1007/s10729-018-9466-2 [published Online First: 20190103]
50. Chen D, Lin Q, Yang T, et al. Distributive Justice and Turnover Intention Among Medical Staff in Shenzhen, China: The Mediating Effects of Organizational Commitment and Work Engagement.

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Tables

Table 1 The impact of a “more effective” PATPH working environment on job satisfaction of healthcare professionals using a series of linear regressions.

Model ^a	Weighting	Sample size	A “more effective” PATPH working environment			
			Coefficient	95% CI	<i>p</i> -value ^e	Adj. <i>p</i> -value ^f
Model 1 ^b (Primary analysis)	The optimal weights	8417	9.57	(8.99, 10.1)	***	NA
Model 2 ^c (Multivariate regression)	None	8417	9.92	(9.42, 10.4)	***	NA
Model 3 ^b (Subgroup analysis of region)	The optimal weights	1504 (West)	7.67	(5.65, 9.70)	***	***
		2519 (Center)	11.17	(10.10, 12.24)	***	***
		4394 (East))	9.13	(8.39, 9.86)	***	***
Model 4 ^b (Subgroup analysis of increased attention to the working environment)	The optimal weights	6412 (More)	9.60	(9.01, 10.1)	***	***

2005 (Less)	8.27	(2.57, 13.99)	***	***
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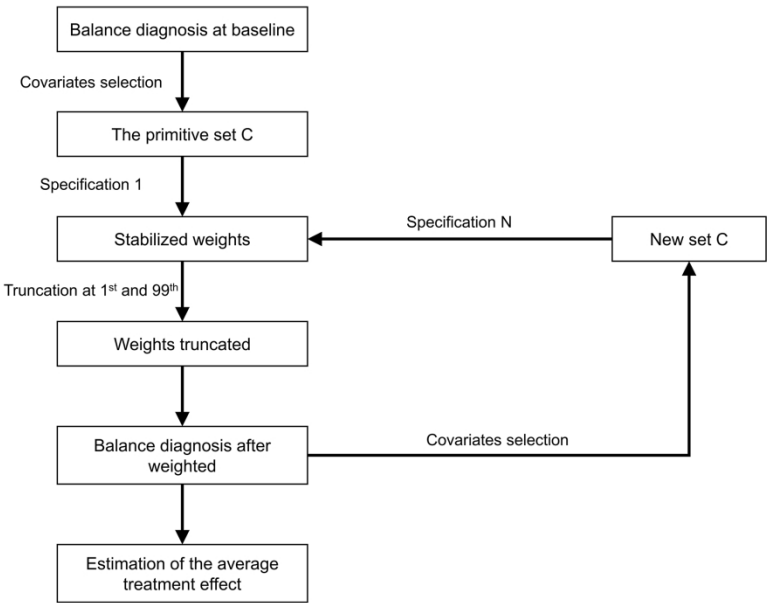
- Note:** PATPH, the performance appraisal for tertiary public hospitals; CI, confidence interval.
- a. Outcome variables in all the models above was the job satisfaction of healthcare professionals.
 - b. Model 1, model 3 and model 4 included the “more effective” PATPH, region, and the increased attention to the working environment as independent variables.
 - c. Model 2 remained the “more effective” PATPH, gender, age group, position, anxiety status, depression status, administrative position and the increased concern to PATPH of healthcare professionals, as well as the region and the performance rating of hospitals.
 - d. The confidence intervals were estimated by the robust variance estimator “sandwich”.
 - e. $p<0.05$; ** $p<0.01$; *** $p<0.001$
 - f. Bonferroni corrections of p -value were applied in the subgroup analysis in model 3 and model 4.

Table 2 Sensitive analysis of the impact of a “more effective” PATPH working environment on job satisfaction of healthcare professionals.

Model	Design	A “more effective” PATPH working environment		
		Coefficient	95% CI	<i>p-value</i> ^d
Model 1	Primary analysis	9.57	(8.99, 10.15)	***
Model 5^a	Different threshold: 50 th percentile (≥ 14); Sample size = 8417	8.14	(7.62, 8.66)	***
Model 6^a	Different threshold: Mean + standard deviation (≥ 18.45); Sample size = 8417	9.83	(9.21, 10.45)	***
Model 7	Different outcome models with the random effect of province; Sample size = 8417	9.30	(7.36, 11.24)	***
Model 8^{ac}	Different population including whole medical personnel of all position; Sample size = 11138	9.51	(9.00, 10.01)	***

Note: CI, confidence interval.

- Weights in model 5, model 6 and model 8 were constructed in line with the primary analysis (that is, the same equilibrium of weighted population had been achieved and the weights were also truncated at the 99th percentile).
- The confidence intervals of model 5, model 6 and model 8 were estimated by the robust variance estimator “sandwich”.
- After coding the variables, 11138 fully answered responses (84.31% in 13211) from participants in all position were included in the model 8.
- *** $p < 0.001$

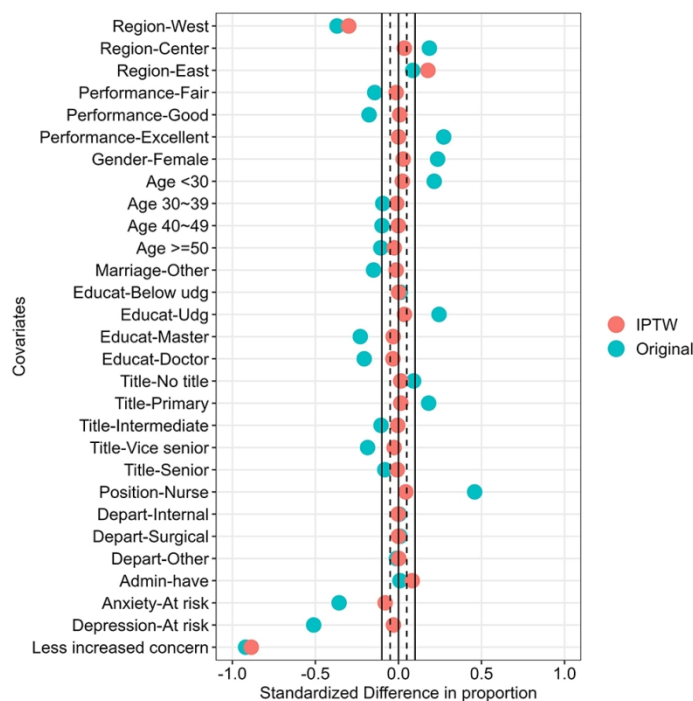


Note: PATPH, the performance appraisal for tertiary public hospitals

Figure 1 Schematic presentation of the overall steps followed in the analysis.

Schematic presentation of the overall steps followed in the analysis.

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Note:

- The solid lines indicate the 10% differences which reflect good balance of confounders; each layer of a binary variable had a standardized difference in proportion with equal value but opposite directions, so only one of them was shown in the figure;
- PATPH, the performance appraisal for tertiary public hospitals; IPTW, inverse probability-of-treatment weighting; Performance, the performance rating of hospitals; Marriage - Other, marital status other than never married; Educat - Below udg, education level - below undergraduate; Educat - Udg, education level - undergraduate; Title, technical title; Depart, department; Admin, administrative position.

Figure 2 Standardized differences in proportion between population working in and not in a “more effective” PATPH environment for each baseline covariate before and after IPTW.

Standardized differences in proportion between population working in and not in a “more effective” PATPH environment for each baseline covariate before and after IPTW

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Supplementary materials

Table S1 The job satisfaction scores (Mean ± Standard deviation).

On my present job, this is how I feel about.....

Items	Score	Rank	Score
1. Being able to keep busy all the time	3.65±0.80	17	
2. The chance to work alone on the job	3.95±0.65	6	
3. The chance to do different things from time to time	3.75±0.75	16	
4. The chance to be “somebody” in the community	3.97±0.64	4	
5. The way my boss handles his/her workers	3.83±0.78	12	
6. The competence of my supervisor in making decisions	3.84±0.79	10	
7. Being able to do things that don't go against my conscience	4.11±0.70	1	
8. The way my job provides for steady employment	4.03±0.68	2	
9. The chance to do things for other people	3.96±0.67	5	
10. The chance to tell people what to do	3.60±0.76	19	
11. The chance to do something that makes use of my abilities	3.93±0.69	7	

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Items	Score	Rank of score
12. The way company policies are put into practice	3.81±0.76	13
13. My pay and the amount of work I do	3.41±1.01	20
14. The chances for promotion on this job	3.62±0.86	18
15. The freedom to use my own judgment	3.84±0.71	11
16. The chance to try my own methods of doing the job	3.77±0.75	15
17. The working conditions	3.78±0.79	14
18. The way my co-workers get along with each other	4.02±0.68	3
19. The praise I get for doing a good job	3.88±0.74	8
20. The feeling of accomplishment I get from the job	3.88±0.74	9

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Table S2 Improvements in the working environment resulting from the Performance Appraisal for Tertiary Public Hospitals (Mean $\pm$ Standard deviation).

In your opinion, after the implementation of the Performance Appraisal of Tertiary Public Hospitals, how did you promote in these aspects of your hospital?

Items	Score
1. Medical quality of hospital	2.57 $\pm$ 1.16
2. Operational efficiency of hospital	2.50 $\pm$ 1.20
3. Sustainable development of hospital	2.55 $\pm$ 1.18
4. Satisfaction of inpatients	2.59 $\pm$ 1.20
5. Satisfaction of outpatients	2.63 $\pm$ 1.20
Average score	2.57 $\pm$ 0.05
Total score	12.84 $\pm$ 5.61

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Table S3 The increased attention of participants to the working environment after the implementation of the performance Appraisal of Tertiary Public Hospitals (Mean $\pm$ Standard deviation).

In your opinion, after the implementation of the Performance Appraisal of Tertiary Public Hospitals, how do you pay attention to the following aspects of the hospital?

Items	Score
1. Medical quality of hospital	2.62 $\pm$ 1.21
2. Operational efficiency of hospital	2.39 $\pm$ 1.25
3. Sustainable development of hospital	2.47 $\pm$ 1.22
4. Satisfaction of inpatients	2.62 $\pm$ 1.22
5. Satisfaction of outpatients	2.72 $\pm$ 1.20
Total score	12.81 $\pm$ 5.36

Table S4 Distributions of the individual characteristics and hospital characteristics before and after IPTW

Characteristics	Level	Overall (N=8417)	Before IPTW			After IPTW		
			Less effective (N=6193)	More effective (N=2224)	STD	Less effective (N=2163.1)	More effective (N= 2163.1)	STD
Age --mean (SD)		34.02 (8.30)	34.50 (8.33)	32.71 (8.04)	-0.22	34.03 (8.33)	33.82 (8.33)	-0.02
Age group--n (%)	<30	3078 (36.57)	2094 (33.81)	984 (44.24)	0.22	2263.74 (36.8)	815.44 (37.70)	0.02
	30~39	3626 (43.08)	2744 (44.31)	882 (39.66)	-0.09	2665.66 (43.7)	920.20 (42.54)	-0.01
	40~49	1217 (14.46)	951 (15.36)	266 (11.96)	-0.10	895.53 (14.7)	312.60 (14.45)	0.00
	≥50	496 (5.89)	404 (6.52)	92 (4.14)	-0.11	364.07 (5.8)	114.85 (5.31)	-0.03
Gender--n (%)	Male	1569 (18.64)	1297 (20.94)	272 (12.23)	-0.24	1151.24 (19.0)	379.77 (17.56)	-0.03
	Female	6848 (81.36)	4896 (79.06)	1952 (87.77)	0.24	5037.76 (82.0)	1783.33 (82.44)	0.03
Marital status--n (%)	Never married	2503 (29.74)	1728 (27.90)	775 (34.85)	0.15	1839.56 (29.2)	656.39 (30.35)	0.01
	Other conditions	5914 (70.26)	4465 (72.10)	1449 (65.15)	-0.15	4349.43 (70.8)	1506.70 (69.65)	-0.01
Position--n (%)	Doctor	2369 (28.15)	2054 (33.17)	315 (14.16)	-0.46	1745.06 (28.0)	570.42 (26.37)	-0.04
	Nurse	6048 (71.85)	4139 (66.83)	1909 (85.84)	0.46	4443.94 (71.0)	1592.67 (73.63)	0.04
Education--n (%)	Below undergraduate	920 (10.93)	671 (10.83)	249 (11.20)	0.01	675.07 (10.1)	236.69 (10.94)	0.00
	Undergraduate	6076 (72.19)	4298 (69.40)	1778 (79.95)	0.24	4467.73 (72.9)	1595.02 (73.74)	0.04
	Master's degree	1034 (12.28)	876 (14.15)	158 (7.10)	-0.23	761.06 (12.0)	245.12 (11.33)	-0.03
	Doctoral degree	387 (4.60)	348 (5.62)	39 (1.75)	-0.21	285.13 (4.1)	86.27 (3.99)	-0.03
Technical title--n (%)	Not have	548 (6.51)	365 (5.89)	183 (8.23)	0.09	404.23 (6.3)	148.76 (6.88)	0.01

Characteristics	Level	Overall (N=8417)	Before IPTW			After IPTW		
Administrative position--n (%)	Primary title	3989 (47.39)	2787 (45.00)	1202 (54.05)	0.18	2929.88 (77.4)	1039.15 (48.04)	0.01
	Intermediate title	2789 (33.14)	2132 (34.43)	657 (29.54)	-0.10	2052.33 (33.6)	712.48 (32.94)	0.00
	Vice senior	749 (8.90)	632 (10.21)	117 (5.26)	-0.19	551.58 (11)	177.85 (8.22)	-0.03
	Senior	342 (4.06)	277 (4.47)	65 (2.92)	-0.08	250.98 (6)	84.86 (3.92)	-0.01
	Not have	7676 (91.20)	5652 (91.26)	2024 (91.01)	-0.01	5670.48 (82)	1930.94 (89.27)	-0.08
	Have	741 (8.80)	541 (8.74)	200 (8.99)	0.01	518.52 (8)	232.16 (10.73)	0.08
	Internal medicine	2275 (27.03)	1671 (26.98)	604 (27.16)	0.00	1676.60 (29)	584.16 (27.01)	0.00
	Surgical	2449 (29.10)	1795 (28.98)	654 (29.41)	0.01	1796.07 (22)	627.73 (29.02)	0.00
Department--n (%)	Other departments	3693 (43.88)	2727 (44.03)	966 (43.44)	-0.01	2716.33 (39)	951.21 (43.97)	0.00
	West	1504 (17.87)	1318 (21.28)	186 (8.36)	-0.37	1238.77 (20)	206.62 (9.55)	-0.30
	Center	2519 (29.93)	1712 (27.64)	807 (36.29)	0.19	1791.68 (28)	661.32 (30.57)	0.03
	East	4394 (52.20)	3163 (51.07)	1231 (55.35)	0.09	3158.55 (51)	1295.16 (59.88)	0.18
Performance rating--n (%)	Fair	1122 (13.33)	902 (14.56)	220 (9.89)	-0.14	825.00 (13)	278.62 (12.88)	-0.01
	Good	3826 (45.46)	2958 (47.76)	868 (39.03)	-0.18	2818.14 (55)	993.75 (45.94)	0.01
	Excellent	3469 (41.21)	2333 (37.67)	1136 (51.08)	0.27	2545.86 (41)	890.72 (41.18)	0.00
Depression status --n(%)	None	4376 (51.99)	2820 (45.54)	1556 (69.96)	0.51	3214.03 (51)	1154.29 (53.36)	0.03
	At risk	4041 (48.01)	3373 (54.46)	668 (30.04)	-0.51	2974.97 (48)	1008.81 (46.64)	-0.03
Anxiety status --n(%)	None	5846 (69.45)	4046 (65.33)	1800 (80.94)	0.36	4269.35 (68)	1567.78 (72.48)	0.08
	At risk	2571 (30.55)	2147 (34.67)	424 (19.06)	-0.36	1919.64 (31)	595.32 (27.52)	-0.08
Increased attention to	More	6412 (76.18)	4210 (67.98)	2202 (99.01)	0.92	4268.40 (68)	2138.49 (98.86)	0.89

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Characteristics	Level	Overall (N=8417)	Before IPTW				After IPTW		
working environment --n(%)	Less	2005 (23.82)	1983 (32.02)	22 (0.99)	-0.92	1920.60 (23.33)	24.61 (1.14)	-0.89	
Job satisfaction -- mean (SD)		76.61 (11.69)	73.03 (9.90)	86.58 (10.43)	1.33	73.56 (10.77)	85.10 (10.65)	1.14	
Intrinsic job satisfaction -- mean (SD)		46.43 (6.66)	44.49 (5.72)	51.84 (6.09)	1.25	44.76 (6.10)	51.06 (6.20)	1.07	
Extrinsic job satisfaction-- mean (SD)		30.18 (5.36)	28.54 (4.62)	34.74 (4.59)	1.35	28.80 (4.60)	34.04 (4.71)	1.14	

Note:

IPTW, inverse probability treatment weighting; SD, standard deviation; STD, Standardized differences in proportion or mean.

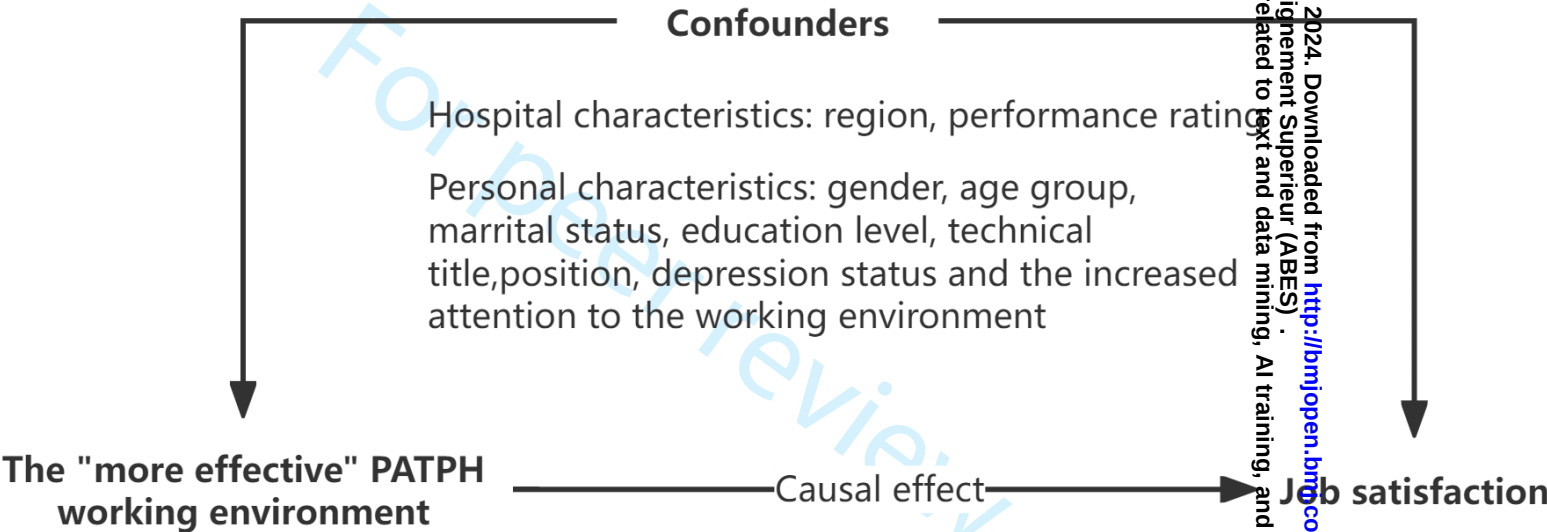
Table S5 The construction of inverse probability weights under a series of models.

Specification ^a	Description of set <i>C</i>	Estimated weights		Variables that are unevenly distributed after weighted
		Mean (SD)	Minimum-maximum	
1	The primitive set <i>C</i> ^b	1.01(1.92)	0.42-137.95	
1_99trunc	Truncated weights from specification 1	0.94(0.32)	0.46-1.92	Increased attention to working environment
2	Set <i>C</i> = The primitive set <i>C</i> minus the region	1.00(1.47)	0.44-74.63	
2_99trunc	Truncated weights from specification 2	0.94(0.31)	0.47-1.93	Region and the increased attention to the working environment
3	Set <i>C</i> = The primitive set <i>C</i> minus region and the increased attention to the working environment	1.00(0.38)	0.49-7.07	
3_99trunc (Optimal)	Truncated weights from specification 3	0.99(0.31)	0.53-2.70	Region and the increased attention to the working environment

Note: PATPH, the performance appraisal for tertiary public hospitals; SD, standard deviation.

- Numerator in all the specifications above equals the probability of lower effectiveness in the baseline population. All truncations were performed at the 1st and 99th percentile.
- The primitive set *C* includes category terms for age group, gender, marital status, education level, technical title, position, the increased attention to working environment, the depression status, region and the performance rating of hospitals. The administrative position, the department and the anxiety status were excluded from the primitive set *C* because the standardized differences in proportion were less than 10% or statistically insignificant impact on the “more effective” PATPH in multivariate analysis.

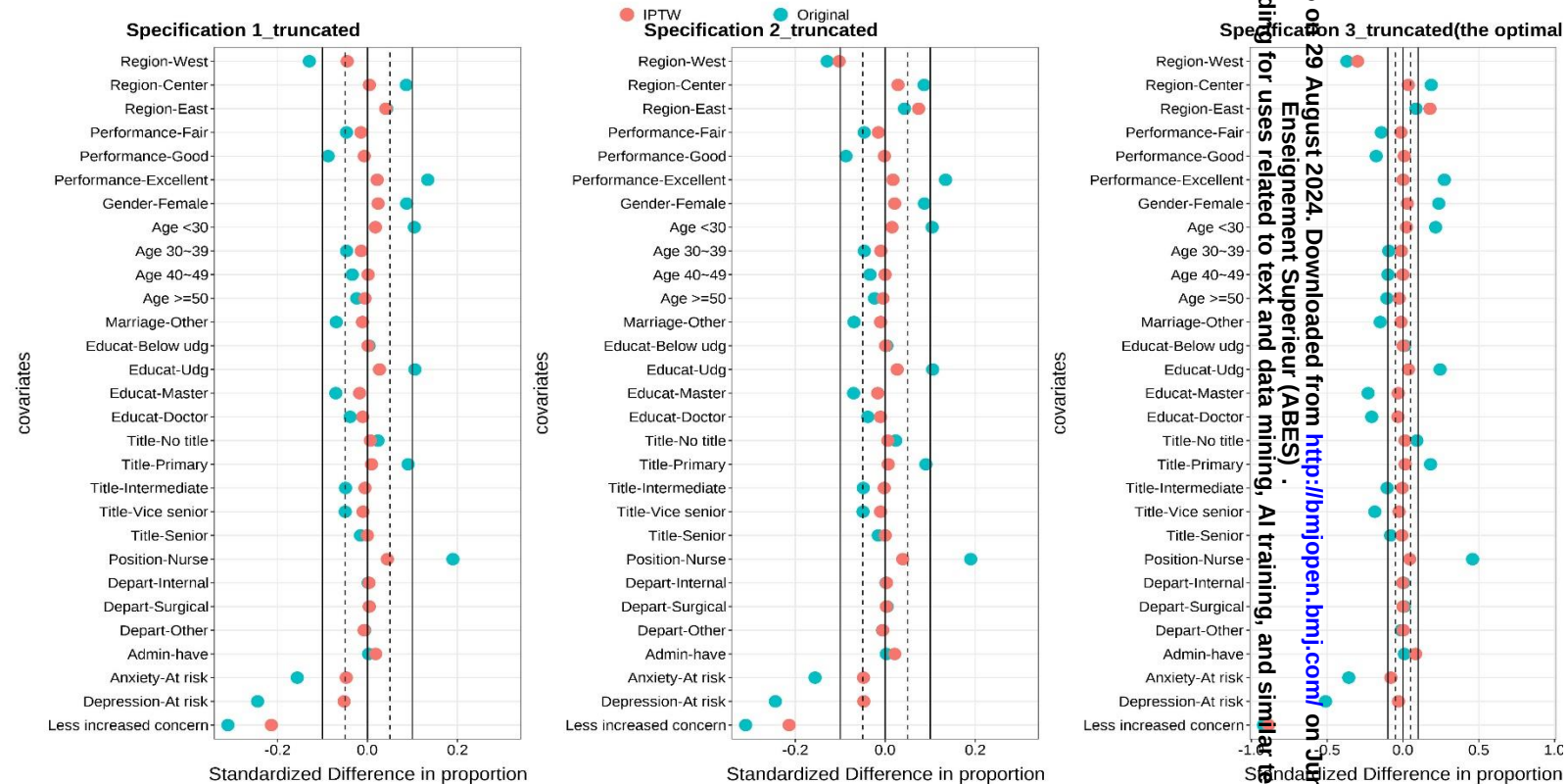
Figure S1 Causal diagram depicting potential confounders of the association between the “more effective” PATPH working environment and job satisfaction.



Note: PATPH, the performance appraisal for tertiary public hospitals

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Including for uses related to text and data mining, AI training, and similar technologies.

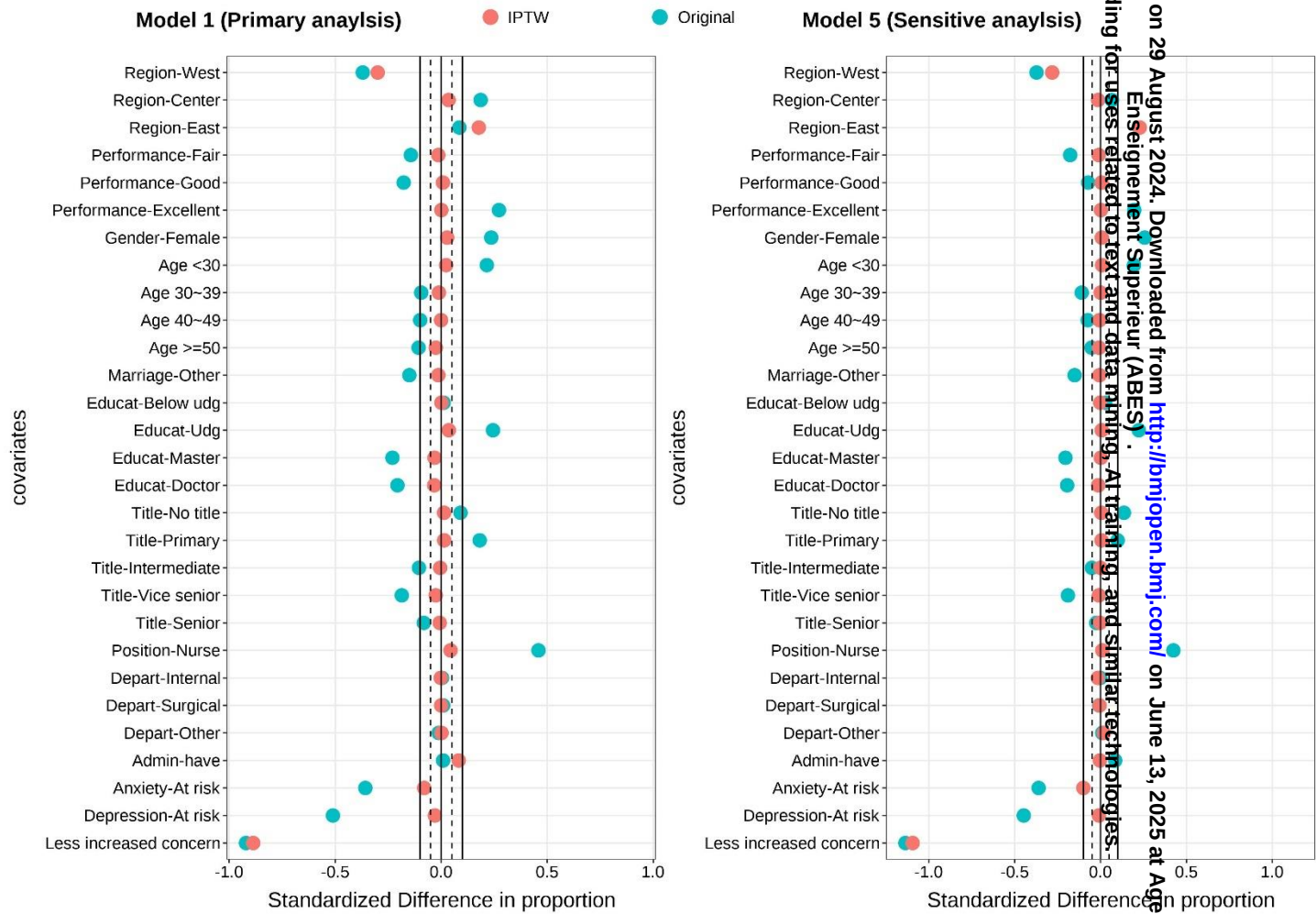
Figure S2 The balance diagnosis for baseline variables before and after IPTW in the construction of weights

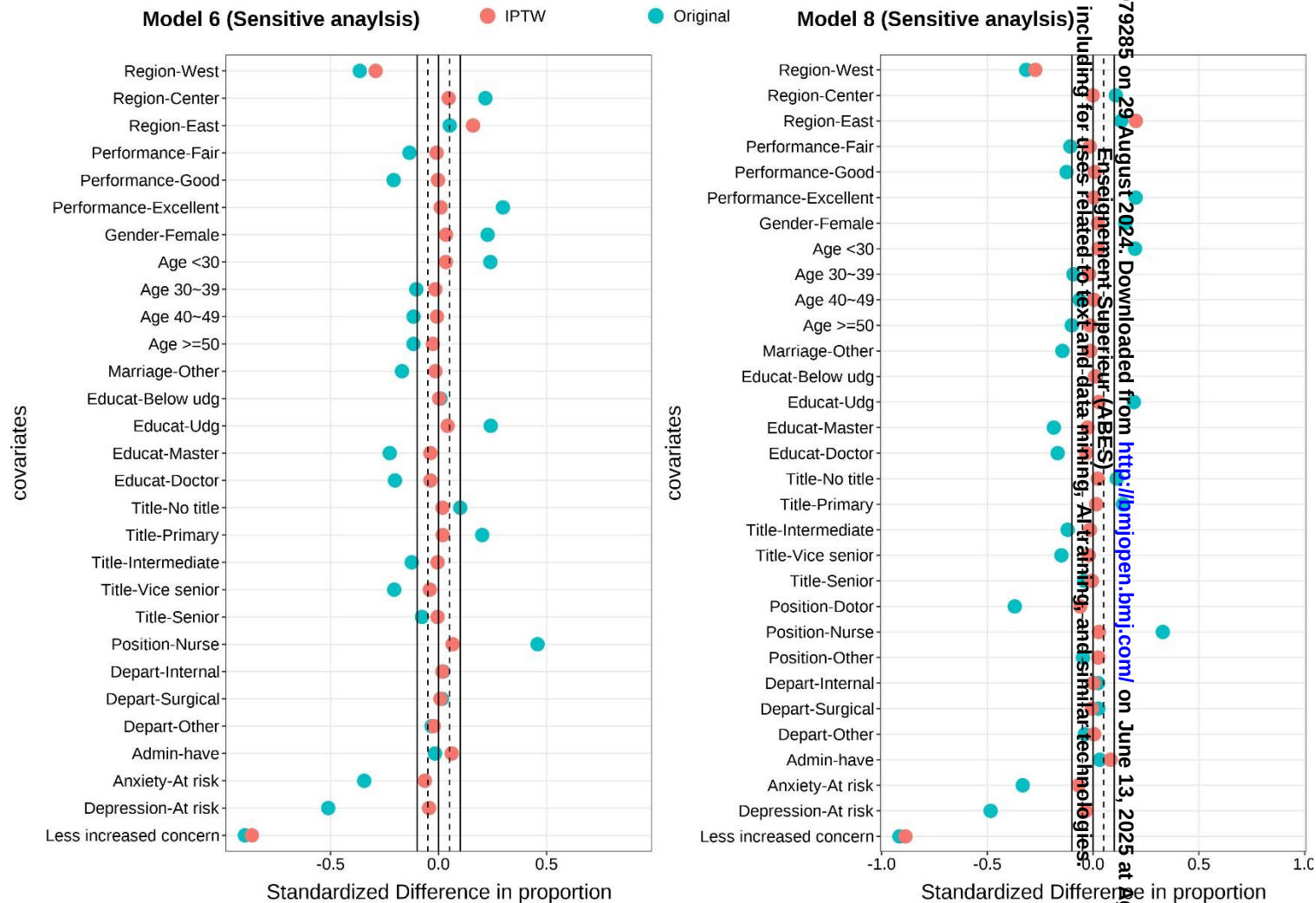


Note: IPTW, inverse probability-of-treatment weighting; Performance, the performance rating of hospital; Marriage - Other, marital status other than never married; Educat - Below udg, education level - below undergraduate; Educat - Udg, education level - undergraduate; Title, technical title; Depart, department; Admin, administrative position

- The solid lines indicate the 10% differences which reflect good balance of confounders;
- Each layer of a dichotomous variable had a standardized difference in proportion with equal value but opposite directions, so only one of them was shown in the figure.

Figure S3 The balance diagnosis for baseline variables before and after IPTW in the primary analysis and sensitive analysis.





Note: IPTW, inverse probability-of-treatment weighting; Performance, the performance rating of hospitals; Marriage - Other, marital status other than never married; Educat - Below udg, education level - below undergraduate; Educat - Udg, education level - undergraduate; Title, technical title; Depart, department; Admin, administrative position

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- a. The solid lines indicate the 10% differences which reflect good balance of confounders;
- b. Each layer of a dichotomous variable had a standardized difference in proportion with equal value but in opposite directions, so only one of them was shown in the figure.

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The principle of distinguishing doctors and nurses from all positions.

We asked every participant about main positions, specific department and administrative position and distinguished doctors and nurses from all positions mainly according to their responses of main position. However, some participants might be classified into a different position category than their self-orientation. For example, participant who reported as both a doctor and other position (such as a nurse or public health personnel) was identified as a doctor (81 in 13211, 0.61%), participant who self-reported as both a nurse and other position (such as a public health personnel or administrative personnel but not a doctor) was identified as a nurse (46 in 13211, 0.35%).

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cross-sectional studies

Section/Topic	Item #	Recommendation	Reported on page #
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	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-10
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	7-10
Bias	9	Describe any efforts to address potential sources of bias	11-13
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-10
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	10-13
		(b) Describe any methods used to examine subgroups and interactions	12-13
		(c) Explain how missing data were addressed	8-9
		(d) If applicable, describe analytical methods taking account of sampling strategy	6
		(e) Describe any sensitivity analyses	13
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	13
		(b) Give reasons for non-participation at each stage	Not applicable
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13-14
		(b) Indicate number of participants with missing data for each variable of interest	8-9
Outcome data	15*	Report numbers of outcome events or summary measures	Not applicable
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	15
		(b) Report category boundaries when continuous variables were categorized	7-10
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	15-16
Discussion			
Key results	18	Summarise key results with reference to study objectives	16-20
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	20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16-20
Generalisability	21	Discuss the generalisability (external validity) of the study results	20
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	22

*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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What Has the Appraisal for Hospitals Brought to Job Satisfaction of Healthcare Professionals? A Cross-Sectional Survey in China

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What Has the Appraisal for Hospitals Brought to Job Satisfaction of Healthcare Professionals?

A Cross-Sectional Survey in China

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4 **ABSTRACT**

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7 **Objective** The purpose of this study is to evaluate the effectiveness of hospital appraisals,

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9 specifically the Performance Appraisal for Tertiary Public Hospitals (PATPH), and to examine its

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11 impact on the job satisfaction of healthcare professionals in tertiary public hospitals in China.

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14 **Design** A cross-sectional study using a multistage sampling method. Improvements induced by

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16 PATPH in the working environment, job satisfaction, and other covariates were measured. A series

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18 of weighted linear regressions with weights from the Inverse Probability-of-Treatment Weighting

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20 (IPTW) method were used to examine the effect of PATPH on job satisfaction.

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25 **Setting** Nine tertiary public hospitals across three economic and geographic regions in China.

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27 **Participants** In August 2020, a total of 13,211 hospital employees were surveyed, and 8,417

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29 doctors and nurses fully completed questionnaires forming the primary dataset for analysis. Of

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31 these respondents, males comprised 18.64% and doctors constituted 28.15%.

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35 **Results** This study revealed that PATPH had a positive impact on the job satisfaction of healthcare

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37 professionals. A “more effective” PATPH working environment resulted in an improvement of

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39 9.57 points (95% *CI*: 8.99 - 10.16) in job satisfaction scores, controlling for all other variables.

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41 The finding persisted consistently through a series of sensitivity analyses.

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45 **Conclusion** The findings offered insights and inspiration for improving the job satisfaction of

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47 healthcare professionals, especially in the development of macro-level policies targeted towards

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49 organizational enhancement.

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53 **Key words** Job satisfaction; healthcare professionals; appraisals for hospitals; inverse probability-

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of-treatment weighting.

Strengths and limitation of this study

- Previous studies have demonstrated positive effects of hospital performance appraisals in reducing healthcare costs and improving healthcare quality. However, there is limited research exploring its impact on the job satisfaction of healthcare professionals.
- This study collected a substantial amount of potential confounding variables, including sociodemographic characteristics, the depression status of participants, and hospital characteristics. All of these variables were accounted for in the analyses, and their effects would be mitigated using the Inverse Probability-of-Treatment Weighting (IPTW) method.
- While a large sample was analyzed in this study, it is important to note that only doctors and nurses were included among healthcare professionals, potentially limiting the generalizability of findings to other healthcare positions.

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4 **INTRODUCTION**

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6 The job satisfaction of healthcare professionals is widely concerned, for its impact on physician

7 outcomes (e.g., turnover, performance and mental health) and healthcare outcomes (e.g., quality

8 of care, patient outcomes and costs)¹⁻⁴. Hoppock (1935) defined job satisfaction as any

9 combination of psychological, physiological, and environmental conditions that encourage

10 employees to be satisfied or happy with their job ⁵. Different personal attributes and working

11 environments which consist of job characteristics, physical working conditions, and social working

12 conditions, may affect workers' job satisfaction ⁶. As for healthcare professionals, aside from

13 personal factors such as age, gender, marital status, position, and education background, abundant

14 evidence suggests that work environment factors significantly influence job satisfaction. These

15 factors include income, working shifts, leadership quality, job autonomy, and collegial support ⁷⁻

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Health policies have been considered as a type of practice environment which influence the job

satisfaction of healthcare professionals ^{3 12}. Prior literature has proven that the impact of hospital

mergers on staff job satisfaction and psychological status in the National Health Service ^{13 14}. The

Performance Appraisal for Tertiary Public Hospitals (PATPH) in China was initially launched in

2019. It annually evaluated and rated more than 2400 top hospitals which were funded by the

government based on 5 dimensions: medical quality of the hospital, operation efficiency of the

hospital, sustainable development of the hospital, satisfaction of patients, and job satisfaction of

healthcare professionals. The PATPH seeks to promote transitions in both the developmental and the managerial approaches of tertiary public hospitals towards more efficient and quality-driven paradigms¹⁵. So far, the performance appraisals conducted under the PATPH serve as a crucial determinant for various facets of policy formulation, including government support for hospital development, financial allocations, remuneration for healthcare professionals based on performance, and hospital revenue.

Throughout the implementation of PATPH, hospitals have been the recipients of initiatives aimed at enhancing efficiency and quality. The provision of financial and non-financial incentives, which are propelled by PATPH, has motivated tertiary public hospitals to identify and address weaknesses across various appraisal dimensions, thereby improving overall performance. This process has led to significant reforms in working environments and social settings within hospitals through the implementation of adaptive policies^{12 16}. Hence, healthcare professionals have been directly impacted by these adaptive policies at the hospital level.

This study aimed to investigate the impact of PATPH as an environmental factor on the job satisfaction of healthcare professionals. There were ambiguous results about the impact of health policies on the job satisfaction of healthcare professionals. Resulting from alterations in job arrangements, changes in everyday work activities and organizational culture may lead to heightened stress, decreased job security, and reduced job autonomy among healthcare

professionals due to stringent regulations and increased requirements ¹⁷⁻¹⁹. However, contrary perspectives ²⁰ have highlighted that a strong sense of satisfaction stems primarily from internal values rather than external changes. Furthermore, they argue that healthcare reforms have not shown any significant or persistent impact on doctors' job satisfaction.

At the individual level, healthcare professionals may experience a combination of support and pressure during the implementation of PATPH. On the one hand, PATPH aims to enhance medical quality, improve hospital operational efficiency, promote sustainable hospital development, and ensure patient satisfaction, thereby offering favorable working conditions to satisfy healthcare professionals. On the other hand, healthcare professionals may also face more demanding work tasks and higher work requirements due to the pressure from annual hospital rankings, which are linked to governmental funding. For instance, the emphasis on improving the quality of health records and medical care as encouraged by PATPH may place additional stress on healthcare professionals and potentially diminish their job satisfaction ²¹⁻²³. In such case, it becomes essential to conduct further research on the impact of macro health policies like PATPH, which primarily target organizational changes rather than healthcare professionals, on the well-being of healthcare professionals and their job satisfaction.

METHODS

Study design and population

This quantitative study used data sourced from a nationwide cross-sectional multistage sampling survey conducted in tertiary public general hospitals across China in August 2020. According to the economic development level and geographic region, we divided 23 provinces and 5 autonomous regions of China into eastern, central, and western regions. In the first stage, we randomly selected one provincial administrative region from each region. In the second stage, to ensure the representativeness among hospitals with different performance levels, 1 tertiary public hospital was randomly selected as a sample hospital within each rank of the provincial administrative regions according to the performance appraisal of tertiary public hospitals in 2019 (excellent, good, and general). The 3 representative hospitals were located in each of the provinces.

Participants included all hospital employees on duty during the investigation period. Utilizing an electronic questionnaire, participants directly submitted their responses to a cloud server. Strict confidentiality measures were implemented to ensure the authenticity of this survey data and maintain in a high response rate.

In total, we received 13,211 questionnaires from 9 tertiary public hospitals across 3 provinces in China, accounting for about 35.45% of the total number of all employees. Considering the essential roles of doctors and nurses in healthcare delivery, this study focused on the changes in job satisfaction among doctors and nurses. Additionally, results for healthcare professionals across all

positions were also reported in the sensitivity analysis to ensure robustness. Among all of the responses, 10,012(75.79%) were identified as doctors and nurses (further details about the principle of distinguishing were provided in the Supplement). The proportion of doctors and nurses in 13211 responses closely mirrors 72.71%, the ratio of doctors and nurses to total hospital staff in tertiary hospitals according to the 2021 China Health Statistical Yearbook, supporting the representativeness of the sample.

Subsequently, 8,417 responses without missing value from 10,012 doctors and nurses (representing 84.07% of 10,012) were included in statistical analyses. Participants were categorized into two groups based on their responses regarding the improvement of the working environment: the exposure group comprised individuals who perceived themselves to be in a “more effective” PATPH working environment, while the control group encompassed the remaining participants. Employing the IPTW approach to mitigate confounding effects arising from hospital and personal characteristics, this study estimated the average treated effect of exposure (i.e., the “more effective” PATPH working environment) on job satisfaction. The relationship among all the variables studied was adequately illustrated graphically in the Supplement.

Patient and Public Involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination

plans of our research.

Measurements

Outcome variable: Job satisfaction

The Minnesota Satisfaction Questionnaire (MSQ) (short-form) ²⁴ was used to measure healthcare professionals' job satisfaction. The instrument asked respondents to rate their satisfaction of their present job in 20 aspects which were divided in intrinsic scale (including item 1-4, 7-11, 15-16, 20) and extrinsic scale (including item 5-6, 12-14, 17-19). Responds were made on a 5-point scale from 1 (*very dissatisfied*) to 5 (*very satisfied*). The total score with a range of 20 to 100 was calculated for each participant. The intrinsic and extrinsic subscales were used as outcome measures in the explorational analysis. The Cronbach's α value of MSQ in this survey was 0.966.

(Table S1 in the Supplement)

Exposure variable: The "more effective" PATPH

The determination of a "more effective" PATPH working environment was based on participants' assessments of the extent to which PATPH improved various aspects of the working environment. Participants rated the improvement across five dimensions of PATPH using a 5-point scale, ranging from 0 (*no improvement*) to 4 (*significant improvement*). Responses indicating "unclear" in any dimension were treated as missing values, constituting less than 7.07% in each dimension. For each participant, a total score was calculated by summing their ratings across all five

dimensions (i.e., medical quality of hospital, operation efficiency of hospital, sustainable development of hospital, satisfaction of inpatients and satisfaction of outpatients). A total score exceeding 18 points (the 75th quantile) was deemed indicative of a “more effective” environment. Participants falling into this category were assigned to the exposed group (assigned a value 1), while those who did not meet this criterion were assigned to the control group (assigned a value of 0). The Cronbach’s α value was 0.970. (**Table S2** in the Supplement)

Covariates

We selected covariates based on a priori knowledge of potential factors influencing job satisfaction. These covariates included age group, gender (male or female), marital status (never married or other conditions), position (doctor or nurse), education level (below undergraduate, undergraduate, master’s degree, or doctoral degree), technical title (not have, primary title, intermediate title, vice senior, or senior), administrative position (have or not have), department (internal medicine, surgical, or other departments), region (east, center, or west), performance rating of the hospital (fair, good, or excellent), increased attention to the working environment (more or less), depression status of participants (at risk or none). All this information was derived from responses to survey questions and was considered as potential covariates in the analysis.

The increased attention to the working environment among participants was measured by five aspects of PATPH’s indicators (i.e., medical quality of hospital, operation efficiency of hospital,

sustainable development of hospital, satisfaction of inpatients and satisfaction of outpatients). Responses were elicited on a 5-point scale, ranging from 0 (*no increase*) to 4 (*significant increase*). Participants who reported “never concern” in any dimension were classified as missing respondents, constituting less than 6.05% in each dimension. A higher total score indicated a great level of increased attention among participants toward the working environment. Scores less than 9 (representing the 25th quantile) were considered indicative of less increased attention. The Cronbach’s α value was 0.927. (**Table S3** in the Supplement)

The depression status of participants as one of the covariates, was measured using the Center for Epidemiological Studies-Depression Scale (CES-D) consisting of 20 items²⁵. Each item has a 4-point response scale, ranging from 0 (*indicating rarely or none of the time*) to 3 (*indicating all of the time*). Four items (4, 8, 12, 16) were reversely scored. Total scores ranged from 0 to 60, with higher scores indicating greater presence of depressive symptoms. Individuals at risk for depression were identified using a cut-off score of 16 or higher²⁶. The Cronbach’s α value of the CES-D was 0.926.

The levels of anxiety among healthcare professionals as one of the covariates, were assessed using the Self-Rating Anxiety Scale (SAS)²⁷, comprising 20 items. Participants reported the frequency of anxiety-related feelings or behaviors experienced during the past week, with responses recorded on a 4-point scale ranging from 1 (*none or almost none*) to 4 (*almost all the time*). Five items (5,

9, 13, 17, and 19) were reverse-scored. The raw scores for all items were summed to calculate a total raw score, which was then multiplied by 1.25 to obtain the standard score. A higher standard score, ranging from 25 to 100, indicated a greater likelihood of experiencing anxiety. Individuals at risk for anxiety disorder were identified using a cut-off score of 50 or higher²⁸. The Cronbach's α coefficients of the SAS was 0.877.

Figure S1 in the Supplement depicted the causal relationship between the exposure variable and the outcome variable, while also displaying all potential confounding variables measured in this study.

Data analysis

The Inverse Probability-of-Treatment Weighting (IPTW) method was applied to mitigate potential confounding effects arising from differences in baseline characteristics between participants exposed to the “more effective” PATPH environment and those who were not (differences in baseline were displayed in Figure 1). This method leveraged propensity scores to generate a weight for each participant, assigned weights to individuals based on their propensity scores, and created a pseudo-population in which there was no association between baseline observed covariates and the treatment. Subsequently, weighted linear regression analyses were used to estimate the average treatment effect of the “more effective” PATPH working environment on job satisfaction in the pseudo-population.

In detail, this study encompassed three steps: (1) Calculate the IPTW weight of each sample based on the propensity score of each sample. (2) Examine the balance of baseline variables before and after applying the IPTW weights through standardized differences. (3) Employ weighted linear regressions to estimate the outcome to mitigate the influence of confounding variables on the results. Figure 2 displayed the entire procedure of weight construction, balance diagnosis and the estimation.

Inverse probability treatment weighting

To enhance statistical efficiency and improve the coverage of confidence intervals, stabilized weights were calculated using the formula²⁹:

$$w_i = \frac{P(T_i=t_i)}{P(T_i=t|C_i=c_i)},$$

where w_i represents the stabilized weight for participant i . T denotes the working environment, with $t=1$ for “more effective” and $t=0$ for “less effective”, i represents participants. C indicates a set of potential confounders. The numerator represents the crude probability of exposure, i.e., the probability of being exposed to the “more effective” working environment. The denominator represents the probability of exposure conditioned on the set of potential confounders (i.e., the set C).

We chose the traditional strategy of controlled trial-and-error re-specification of the weight-

estimating equation in the determination of set C . The exchangeability assumption requires enough joint predictors of exposure and outcome (i.e., confounders) in the estimation of the dominator. However, the addition of non-confounding variables may introduce selection bias due to collider stratification, potentially violating the possibility assumption and diminishing statistical efficiency. To achieve a better balance between these considerations, we conducted a backward selection process to include potential confounders.

The optimal set of potential confounders C should contain fewer covariates, resulting in weights with a distribution characterized by a mean close to 1 and a narrower range. These criteria would facilitate better balance across all covariates³⁰. The primitive set C in the specification 1 would contain all covariates which showed imbalance (standardized difference in proportion >0.1) at the baseline and affect the probability of T under the consideration of domain knowledge. The standardized differences in proportion were calculated as follow³¹:

Standardized difference in proportion

$$= \frac{\hat{p}_{exposed} - \hat{p}_{control}}{\sqrt{\frac{\hat{p}_{exposed}(1 - \hat{p}_{exposed}) + \hat{p}_{control}(1 - \hat{p}_{control})}{2}}}$$

where $\hat{p}_{exposed}$ and $\hat{p}_{control}$ denote the sample prevalence of the exposure(T) in exposed and control groups, respectively.

Extreme weights would be addressed through truncation at the 1st and 99th percentiles in the

process of constructing³². Remaining imbalance after weighed would be addressed in the further regression adjustment^{33 34}.

The weighted linear regressions

In weighted linear regressions, the “more effective” PATPH working environment was treated as the treatment variable, while job satisfaction served as the outcome variable. To account for the lack of independence among participants due to IPTW, a robust “sandwich” variance estimator was employed³⁵.

In the primary analysis (Model 1), we included all variables that exhibited uneven distributions after IPTW. Alternatively, in Model 2, we compared the IPTW approach against a standard stepwise multivariate regression analysis. This comparison allows us to evaluate the performance and effectiveness of the IPTW method in adjusting for confounding compared to traditional regression modeling techniques. Additionally, subgroup analyses were conducted in Model 3 and Model 4 to investigate potential variations in treatment effects across different regions and levels of increased attention towards the working environment, respectively. Bonferroni corrections were applied in multiple comparisons.

Sensitivity analysis

A series of sensitivity analyses were conducted to test the robustness of the findings. Firstly, we

defined “more effective” with different thresholds in Model 5-6 (i.e., the 50th percentile and the mean + SD). Secondly, linear mixed-effects models were applied to the weighted population to estimate the impact of the “more effective” working environment, with the region treated as a random effect (Model 7). Lastly, the sample size was expanded to include medical personnel of all positions in Model 8.

R version 4.2.1 was used for data analysis. R package “cobalt” was used to assess the covariate balance. R package “MASS”³⁶ and “lme4”³⁷ was used to construct the stepwise regression models and the linear mixed-effects model respectively. R package “sandwich” were used for robust estimation of standard error³⁸. All tests were two sided with type I error rates of 0.05.

Descriptive analysis and difference significance test

Standard descriptive statistics were used to characterize participants who worked in a “more effective” environment and those who did not. For categorical variables, frequencies and percentages were reported, while continuous variables were summarized using means and standard deviations. To compare differences between groups, the chi-square test was utilized for categorical variables, examining whether there were significant associations between groups and each categorical variable. For continuous variables, one-way analysis of variance (ANOVA) was conducted to assess the significance of differences in means between groups.

RESULTS

Characteristics of participants at baseline

The average age of 8,417 participants was 34.02 ± 8.30 years, and male made up 18.64%. Most of participants had been married previously and doctors constituted 28.15%. According to the definition of “more effective”, 2,224 (26.42%) participants reported a “more effective” PATPH working environment with a score greater than 18 for working environment improvement. Differences in the distribution of covariates existed at baseline between the “more effective” and “less effective” PATPH working environments (**Figure 1**). **Table S4** in the Supplement summarized the sociodemographic characteristics of participants. The characteristics of the “more effective” and the “less effective” group of people were also displayed separately in **Table S4**.

IPTW weights and balance diagnosis

After several attempts in specifications, this study obtained the optimal stabilized weights using “Specification 3_99trunc” (see **Table S5** in the Supplement for detailed process and see Figure S2 for balance diagnoses throughout the entire construction). The optimal set of covariates, denoted as the optimal set *C*, included age groups, gender, education level, marital status, technical title, position, depression status of healthcare professionals, and hospital performance ratings. The mean stabilized weight was 0.99, with a standard deviation of 0.31. The minimum and maximum weights were 0.53 and 2.70, respectively.

The IPTW performed effectively in balancing of the baseline covariates. Following IPTW adjustment, the groups increased comparability across most baseline covariates, with standardized differences in proportion being less than 10%. However, there remained residual imbalance in the covariates related to the increased attention to the working environment and the region (**Figure 1**). We addressed the impact of this remaining imbalance by incorporating the two variables into the outcome models (as described below).

Impact of PATPH on job satisfaction

Table 1 showed the impact of the “more effective” PATPH working environment on job satisfaction, demonstrating a nearly 10-point increase in MSQ score (9.57, 95% *CI* 8.99 - 10.16) in the primary analysis (Model 1). Results obtained from the multivariate regression analysis closely aligned with that derived from the IPTW approach (9.92, 95% *CI* 9.42 - 10.42).

The positive effect of the “more effective” PATPH working environment on job satisfaction across regions exhibited a V-shaped pattern in Model 3. Among all regions, the impact of the “more effective” PATPH working environment on MSQ score was most pronounced in the central region, with an increase of approximately 2.04 points compared to the eastern region and about 3.50 points compared to the western region.

Among populations with varying levels of increased attention to the working environment, the

average difference in job satisfaction decreased from the group with higher levels of attention to that of those with lower levels. Specifically, the average difference in job satisfaction was 9.60 (95% *CI* 9.01- 10.19) for individuals with higher levels of increased attention to the working environment, compared to 8.27 (95% *CI* 2.57- 13.96) for individuals with lower levels of increased attention to the working environment.

Sensitivity analysis

The results in **Table 2** were broadly consistent with those reported in **Table 1**, indicating the robust impact of the “more effective” PATPH on the job satisfaction of healthcare professionals. Balance diagnoses for baseline variables before and after IPTW in the sensitivity analyses were presented in Figure S3 in the Supplement.

DISCUSSION

The “More Effective” PATPH Induced Higher Job Satisfaction

Utilizing IPTW to reduce selective bias, our findings offered a clue that macro health policies such as PATPH played positive roles in enhancing the job satisfaction of healthcare professionals. Doctors and nurses working in environments where PATPH were more effective, experienced an average advancement of approximately 10 points in job satisfaction (equivalent to 12.5% of the range of MSQ score).

This encouraging finding prompted us to investigate which aspects of job satisfaction were predominantly affected. Intrinsic job satisfaction indicated the contentment with the nature of ones’ work, while extrinsic job satisfaction encompassed factors such as salary, coworkers and management ³⁹. Conducting exploratory analyses based on Model 2, we found that the “more effective” PATPH working environment increased intrinsic MSQ score by approximately 5.46 points (equivalent to 9.10% of the range) and extrinsic MSQ score by approximately 4.46 points (equivalent to 11.15% of the range). The higher proportion of increase in extrinsic MSQ scores in our exploratory results supported our conclusions, implying that a “more effective” PATPH working environment led to greater job satisfaction among doctors and nurses.

PATPH aims to incentivize hospitals to enhance physical and social working conditions, to provide higher medical quality and to improve management. Our findings demonstrated that these anticipated positive impacts were realized to some extent. Plausible explanations for our findings included implemented policies that foster a flexible practice environment with adequate staffing and resources, increased opportunities for healthcare professionals to participate in hospital policies and governance, and more recognition of healthcare professionals’ contributions to work and performance ^{40 41}.

Hospitals in the Western Region Exhibit a Higher Demand for Support in Improving Job Satisfaction

Through subgroup analyses, this study evaluated the specific impact among regions characterized by varying economic conditions. When comparing the increase in job satisfaction motivated by PATPH, results in the Central and Eastern regions showed notable improvements. Nevertheless, in Western hospitals, which generally have lower levels of economic development, the impact of environmental improvements on job satisfaction seemed relatively limited. Our finding underscored the necessity for greater support or benefits from PATPH to increase the job satisfaction of healthcare professionals in Western regions, in addition to improvements in working settings.

Negative Attitude of Healthcare Professionals Diminish the Effect of the “more effective” PATPH on Job Satisfaction

The responses of affected individuals exert considerable influence on the implementation process of policies ⁴². Model 4 showed our interest in the response of healthcare professionals to PATPH through subgroup analyses. Our findings revealed that when the analysis was restricted to participants with less attention to the working environment, the effect of a “more effective” PATPH declined by approximately 1.30 points in mean MSQ score, accompanied by greater variation. Conversely, the results in the other subgroup, which consists of participants with more increased attention to the working environment, remained consistent with the primary analysis.

During the implementation of policies, it is noted that the involvement level of recipients, service

organizations, and street-level bureaucrats may influence confidence in and support of policy decisions, thereby enhancing the chances for successful implementation^{43 44}. We interpreted the less attention to the working environment as a form of negative response from healthcare professionals, indicating a lower engagement level. From an implementation science perspective, our findings highlighted the importance of improving healthcare professionals' responses to effectively develop, implement, and evaluate large-scale healthcare policies. This includes fostering attention, understanding, recognition, and support for the policy among healthcare professionals.

A Collaborative Scheme to Enhance Motivation among Healthcare Professionals

Motivating healthcare professionals is a multifaceted endeavor, with various factors influencing their satisfaction^{12 45 46}. In China, several reforms have been implemented at the individual level to boost the enthusiasm of healthcare professionals, such as reforms in the performance management, promotion system, compensation system, etc. However, despite these efforts, recent studies have shown only marginal improvements in the job satisfaction among healthcare professionals in tertiary hospitals in China^{47 48}. Our study shed light on the potential for the improvements in staff satisfaction pursued by PATPH in hospitals settings, calling for a collaborative motivational scheme that considers both individual-level and environment-level factors.

Enhancing operational efficiency and promoting sustainable development in hospitals are critical elements for maximizing the positive effect of an improved environment on job satisfaction. Comparing to higher scores of medical quality and patient satisfaction in the healthcare professionals' evaluation of PATPH-induced improvements, the operational efficiency and the sustainable development of hospitals scored lower. This is consistent with the historical focus on the provision of medical and public health services in Chinese public hospitals, with fewer efforts directed towards improvements in managerial areas¹⁵. Our finding emphasized the importance of intensifying efforts towards improving operational efficiency and promoting sustainable development in tertiary public hospitals in the future. To achieve this, collaborative efforts are need to optimize patient flow and enhance coordination among human and material resources. Additionally, ensuring distributive justice to enhance the retention of healthcare personnel is also crucial.^{49 50}.

Limitation

Despite the scope and findings of this study, several limitations should be acknowledged. Firstly, our analyses did not include medical personnel in all positions, potentially limiting the generalizability of our finding to broader population of healthcare professionals. Secondly, the original population of this survey was not equally distributed by covariates. However, we employed IPTW method to diminish the effect of confounders successfully; Thirdly, despite

employing IPTW and matching techniques, residual confounding factors may still exist, such as individual preferences of healthcare professionals, income disparities among healthcare professionals, regional customs and cultures. Fourthly, our study primarily focused on confirming the overall positive effects of PATPH on job satisfaction. Further research is needed to find which aspects of working environment improved by PATPH contributed to increased job satisfaction, and which aspects of job satisfaction were more affected.

CONCLUSION

Our study demonstrated that the PATPH, while targeting hospital implementation, had a broader positive impact not only on the working environments of tertiary public hospitals but also on healthcare professionals themselves. We observed that a working environment with more proactive responses to macro policies can lead to a greater increase in job satisfaction. Besides, less individual addition to working environments is linked to lower enhancements in job satisfaction. Findings in this research indicated the impact of macro-level policies on individual job satisfaction, as well as the moderating effect of individual attention on this impact. We identified an influence pathway beyond policy design, whereby policies promoting hospital improvements subsequently increase staff motivation. Thus, our study advocated for the implementation of a collaborative motivating scheme which takes both individual-level and environment-level factors into account. Such an approach is essential for maximizing the positive

impact of macro-level policies on healthcare professionals' job satisfaction and overall well-being.

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List of abbreviations

PATPH=The Performance Appraisal for Tertiary Public Hospitals

IPTW=Inverse Probability-of-Treatment Weighting

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Contributorship Statement

Conception or design of the work: LGH, SCS and XYY

Data collection: SKY, XSQ, LGH, SCS and BDS

Data analysis and interpretation: LXY, LMJ and SCS

Drafting the article: LXY and LMJ

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All authors contributed to the submitted version and approved the final manuscript. LGH is the guarantor.

All those designated as authors met all ICMJE criteria for authorship, and all who meet the ICMJE criteria were identified as authors.

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Competing interests

None declared.

Ethics approval and consent to participate

This survey received ethical approval from the Ethics Committee of the School of Public Health, Shanghai Jiao Tong University School of Medicine, China on February 20, 2020, and record number SJUPN-202008 using the National Statement on Ethical Conduct in Human Research. Informed consents were written for each participant to read and sign before moving on to filling the questionnaires.

Data availability statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

References

1. Coomber B, Barriball KL. Impact of job satisfaction components on intent to leave and turnover for hospital-based nurses: a review of the research literature. *Int J Nurs Stud* 2007;44(2):297-314. doi:

10.1016/j.ijnurstu.2006.02.004 [published Online First: 20060424]

2. Williams ES, Skinner AC. Outcomes of physician job satisfaction: a narrative review, implications, and directions for future research. *Health Care Manage Rev* 2003;28(2):119-39. doi: 10.1097/00004010-200304000-00004

3. Brady KJS, Kazis LE, Sheldrick RC, et al. Selecting physician well-being measures to assess health system performance and screen for distress: Conceptual and methodological considerations. *Curr Probl Pediatr Adolesc Health Care* 2019;49(12):100662. doi: 10.1016/j.cppeds.2019.100662 [published Online First: 20190925]

4. McHugh MD, Kutney-Lee A, Cimiotti JP, et al. Nurses' widespread job dissatisfaction, burnout, and frustration with health benefits signal problems for patient care. *Health Aff (Millwood)* 2011;30(2):202-10. doi: 10.1377/hlthaff.2010.0100

5. Hoppock R. Job satisfaction. New York: Harper 1935:303.

6. Raziq A, Maulabakhsh R. Impact of Working Environment on Job Satisfaction. *Procedia Economics and Finance* 2015;23:717-25. doi: 10.1016/s2212-5671(15)00524-9

7. Lu H, Zhao Y, While A. Job satisfaction among hospital nurses: A literature review. *Int J Nurs Stud* 2019;94:21-31. doi: 10.1016/j.ijnurstu.2019.01.011 [published Online First: 20190210]

8. Cummings GG, MacGregor T, Davey M, et al. Leadership styles and outcome patterns for the nursing workforce and work environment: A systematic review. *INTERNATIONAL JOURNAL OF NURSING STUDIES* 2010;47(3):363-85. doi: 10.1016/j.ijnurstu.2009.08.006

9. Shanafelt TD, Gorringer G, Menaker R, et al. Impact of organizational leadership on physician burnout

- and satisfaction. *Mayo Clin Proc* 2015;90(4):432-40. doi: 10.1016/j.mayocp.2015.01.012
[published Online First: 20150318]
10. Bofo IM. The effects of workplace respect and violence on nurses' job satisfaction in Ghana: a cross-sectional survey. *Hum Resour Health* 2018;16(1):6. doi: 10.1186/s12960-018-0269-9 [published Online First: 20180115]
11. Zhou H, Han X, Zhang J, et al. Job Satisfaction and Associated Factors among Medical Staff in Tertiary Public Hospitals: Results from a National Cross-Sectional Survey in China. *Int J Environ Res Public Health* 2018;15(7) doi: 10.3390/ijerph15071528 [published Online First: 20180719]
12. Chandler CI, Chonya S, Mtei F, et al. Motivation, money and respect: a mixed-method study of Tanzanian non-physician clinicians. *Soc Sci Med* 2009;68(11):2078-88. doi: 10.1016/j.socscimed.2009.03.007 [published Online First: 20090328]
13. Lim KK. Impact of hospital mergers on staff job satisfaction: a quantitative study. *Hum Resour Health* 2014;12:70. doi: 10.1186/1478-4491-12-70 [published Online First: 20141212]
14. Cortvriend P. Change management of mergers: the impact on NHS staff and their psychological contracts. *Health Serv Manage Res* 2004;17(3):177-87. doi: 10.1258/0951484041485593
15. Li Y, He W, Yang L, et al. A historical review of performance appraisal of public hospitals in China from the perspective of historical institutionalism. *Front Public Health* 2022;10:1009780. doi: 10.3389/fpubh.2022.1009780 [published Online First: 20221010]
16. Franco LM, Bennett S, Kanfer R. Health sector reform and public sector health worker motivation: a conceptual framework. *Soc Sci Med* 2002;54(8):1255-66. doi: 10.1016/s0277-9536(01)00094-6

17. Nalla MK, Kang W. Organizational Climate, Perceived Citizen Support, and Job Satisfaction of Police Officers: Findings from the Post-Grand Reform Era in South Korea. *Asian Journal of Criminology* 2012;7(2):153-71. doi: 10.1007/s11417-012-9127-1

18. Manyazewal T, Matlakala MC. Beyond patient care: the impact of healthcare reform on job satisfaction in the Ethiopian public healthcare sector. *Hum Resour Health* 2017;15(1):10. doi: 10.1186/s12960-017-0188-1 [published Online First: 20170203]

19. Alameddine M, Bauer JM, Richter M, et al. Trends in job satisfaction among German nurses from 1990 to 2012. *J Health Serv Res Po* 2016;21(2):101-08. doi: 10.1177/1355819615614045

20. Aasland OG, Rosta J, Nylenna M. Healthcare reforms and job satisfaction among doctors in Norway. *Scand J Public Health* 2010;38(3):253-8. doi: 10.1177/1403494810364559 [published Online First: 20100309]

21. Shanafelt TD, Dyrbye LN, Sinsky C, et al. Relationship Between Clerical Burden and Characteristics of the Electronic Environment With Physician Burnout and Professional Satisfaction. *Mayo Clinic Proceedings* 2016;91(7):836-48. doi: 10.1016/j.mayocp.2016.05.007

22. Friedberg MW, Chen PG, Van Busum KR, et al. Factors Affecting Physician Professional Satisfaction and Their Implications for Patient Care, Health Systems, and Health Policy. *Rand Health Q* 2014;3(4):1-1.

23. Trivellas P, Reklitis P, Platis C. The effect of job related stress on employees' satisfaction: A survey in Health Care. *Procd Soc Behv* 2013;73:718-26. doi: 10.1016/j.sbspro.2013.02.110

24. Weiss DJ, Dawis RV, England GW, et al. Manual for the Minnesota Satisfaction Questionnaire:

- Minnesota studies in vocational rehabilitation. *Minneapolis: Industrial Relations Center, University of Minnesota* 1967
25. Radloff LS. The CES-D Scale: A Self-Report Depression Scale for Research in the General Population. *Applied Psychological Measurement* 1977;1(3):385-401. doi: 10.1177/014662167700100306
26. Lewinsohn PM, Seeley JR, Roberts RE, et al. Center for Epidemiologic Studies Depression Scale (CES-D) as a screening instrument for depression among community-residing older adults. *Psychol Aging* 1997;12(2):277-87. doi: 10.1037//0882-7974.12.2.277
27. Zung WW. A rating instrument for anxiety disorders. *Psychosomatics* 1971;12(6):371-9. doi: 10.1016/S0033-3182(71)71479-0
28. Dunstan DA, Scott N. Norms for Zung's Self-rating Anxiety Scale. *BMC Psychiatry* 2020;20(1):90. doi: 10.1186/s12888-019-2427-6 [published Online First: 20200228]
29. van der Wal WM, Geskus RB. ipw: An R Package for Inverse Probability Weighting. *Journal of Statistical Software* 2011;43(13):1 - 23. doi: 10.18637/jss.v043.i13
30. Cole SR, Hernan MA. Constructing inverse probability weights for marginal structural models. *Am J Epidemiol* 2008;168(6):656-64. doi: 10.1093/aje/kwn164 [published Online First: 20080805]
31. Austin PC, Stuart EA. Moving towards best practice when using inverse probability of treatment weighting (IPTW) using the propensity score to estimate causal treatment effects in observational studies. *Stat Med* 2015;34(28):3661-79. doi: 10.1002/sim.6607 [published Online First: 20150803]
32. Aitken Z, Simpson JA, Bentley R, et al. Disability acquisition and mental health: effect modification by demographic and socioeconomic characteristics using data from an Australian longitudinal study.

BMJ Open 2017;7(9):e016953. doi: 10.1136/bmjopen-2017-016953

33. Milner A, Aitken Z, Krnjacki L, et al. Perceived fairness of pay among people with and without disabilities: a propensity score matched analysis of working Australians. *Scand J Work Environ Health* 2015;41(5):451-9. doi: 10.5271/sjweh.3515 [published Online First: 20150717]

34. Weighted Regression Estimators of Causal Effects. In: Winship C, Morgan SL, eds. Counterfactuals and Causal Inference: Methods and Principles for Social Research. 2 ed. Cambridge: Cambridge University Press 2014:226-64.

35. Chesnaye NC, Stel VS, Tripepi G, et al. An introduction to inverse probability of treatment weighting in observational research. *Clin Kidney J* 2022;15(1):14-20. doi: 10.1093/ckj/sfab158 [published Online First: 20210826]

36. Venables WN, Ripley BD. Modern Applied Statistics with S. Fourth ed. New York: Springer 2002.

37. Bates D, Machler M, Bolker BM, et al. Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software* 2015;67(1):1-48. doi: 10.18637/jss.v067.i01

38. Long JS, Ervin LH. Using Heteroscedasticity Consistent Standard Errors in the Linear Regression Model. *The American Statistician* 2000;54(3):217-24. doi: 10.1080/00031305.2000.10474549

39. Jones LK. Job satisfaction. In Encyclopedia of career change and work issues. Phoenix: The Oryx Press 1992.

40. Atefi N, Abdullah KL, Wong LP, et al. Factors influencing registered nurses perception of their overall job satisfaction: a qualitative study. *Int Nurs Rev* 2014;61(3):352-60. doi: 10.1111/inr.12112

41. Alnuaimi K, Ali R, Al-Younis N. Job satisfaction, work environment and intent to stay of Jordanian

- midwives. *Int Nurs Rev* 2020;67(3):403-10. doi: 10.1111/inr.12605 [published Online First: 20200728]
42. Nilsen P, Stahl C, Roback K, et al. Never the twain shall meet?--a comparison of implementation science and policy implementation research. *Implement Sci* 2013;8:63. doi: 10.1186/1748-5908-8-63 [published Online First: 20130610]
43. Perla RJ, Bradbury E, Gunther-Murphy C. Large-scale improvement initiatives in healthcare: a scan of the literature. *J Healthc Qual* 2013;35(1):30-40. doi: 10.1111/j.1945-1474.2011.00164.x [published Online First: 20110914]
44. Bullock HL, Lavis JN, Wilson MG, et al. Understanding the implementation of evidence-informed policies and practices from a policy perspective: a critical interpretive synthesis. *Implementation Science* 2021;16(1) doi: 10.1186/s13012-021-01082-7
45. Willis-Shattuck M, Bidwell P, Thomas S, et al. Motivation and retention of health workers in developing countries: a systematic review. *BMC Health Serv Res* 2008;8:247. doi: 10.1186/1472-6963-8-247 [published Online First: 20081204]
46. Scheurer D, McKean S, Miller J, et al. U.S. physician satisfaction: a systematic review. *J Hosp Med* 2009;4(9):560-8. doi: 10.1002/jhm.496
47. Wang M, Hu C, Huang M, et al. The effect of emotional clarity and attention to emotion on job satisfaction: A mediating role of emotion regulation among Chinese medical staff. *Asian Journal of Social Psychology* 2019;22(3):316-24. doi: 10.1111/ajsp.12365
48. Liu D, Wu Y, Jiang F, et al. Gender Differences in Job Satisfaction and Work-Life Balance Among

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Chinese Physicians in Tertiary Public Hospitals. *Front Public Health* 2021;9:635260. doi: 10.3389/fpubh.2021.635260 [published Online First: 20210510]

49. Miranda MA, Salvatierra S, Rodriguez I, et al. Characterization of the flow of patients in a hospital from complex networks. *Health Care Manag Sci* 2020;23(1):66-79. doi: 10.1007/s10729-018-9466-2 [published Online First: 20190103]

50. Chen D, Lin Q, Yang T, et al. Distributive Justice and Turnover Intention Among Medical Staff in Shenzhen, China: The Mediating Effects of Organizational Commitment and Work Engagement. *Risk Manag Healthc Policy* 2022;15:665-76. doi: 10.2147/RMHP.S357654 [published Online First: 20220414]

Tables

Table 1 The impact of a “more effective” PATPH working environment on job satisfaction of healthcare professionals using a series of linear regressions.

Model ^a	Weighting	Sample size	A “more effective” PATPH working environment				
			Coefficient	95% CI	<i>p</i> -value ^e	Adj. <i>p</i> -value ^f	<i>p</i> -value
Model 1 ^b (Primary analysis)	The optimal weights	8417	9.57	(8.99, 10.1)	***	NA	
Model 2 ^c (Multivariate regression)	None	8417	9.92	(9.42, 10.4)	***	NA	
Model 3 ^b (Subgroup analysis of region)	The optimal weights	1504 (West)	7.67	(5.65, 9.70)	***	***	
		2519 (Center)	11.17	(10.10, 12.24)	***	***	
		4394 (East))	9.13	(8.39, 9.86)	***	***	
Model 4 ^b (Subgroup analysis of increased attention to the working environment)	The optimal weights	6412 (More)	9.60	(9.01, 10.1)	***	***	
		2005 (Less)	8.27	(2.57, 13.9)	***	***	

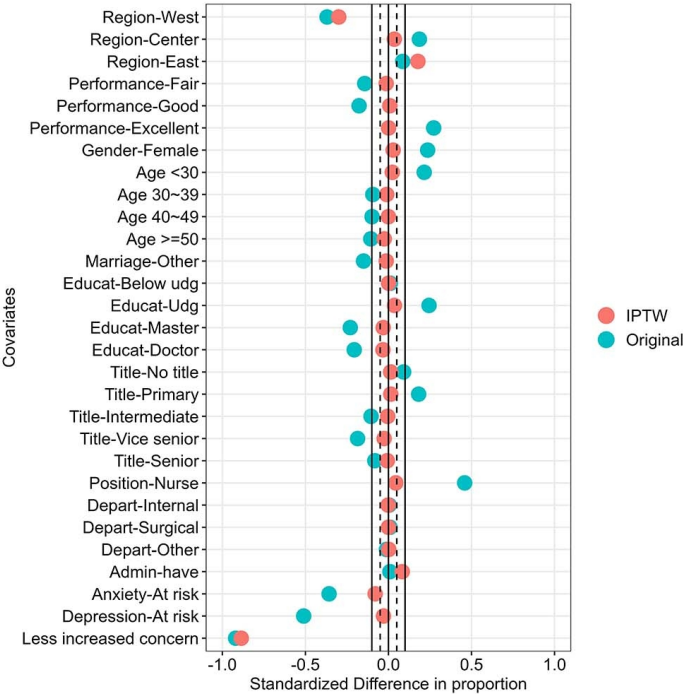
- Note:** PATPH, the performance appraisal for tertiary public hospitals; CI, confidence interval.
- a. Outcome variables in all the models above was the job satisfaction of healthcare professionals.
 - b. Model 1, model 3 and model 4 included the “more effective” PATPH, region, and the increased concern to the working environment as independent variables.
 - c. Model 2 remained the “more effective” PATPH, gender, age group, position, anxiety status, depressive status, administrative position and the increased concern to PATPH of healthcare professionals, as well as the region and the performance rating of hospitals.
 - d. The confidence intervals were estimated by the robust variance estimator “sandwich”.
 - e. $p<0.05$; ** $p<0.01$; *** $p<0.001$
 - f. Bonferroni corrections of p -value were applied in the subgroup analysis in model 3 and model 4.

Table 2 Sensitivity analyses of the impact of a “more effective” PATPH working environment on job satisfaction of healthcare professionals.

Model	Design	A “more effective” PATPH working environment		
		Coefficient	95% CI	<i>p-value</i> ^d
Model 1	Primary analysis	9.57	(8.99, 10.15)	***
Model 5^a	Different threshold: 50 th percentile (≥ 14); Sample size = 8417	8.14	(7.62, 8.66)	***
Model 6^a	Different threshold: Mean + standard deviation (≥ 18.45); Sample size = 8417	9.83	(9.21, 10.45)	***
Model 7	Different outcome models with the random effect of province; Sample size = 8417	9.30	(7.36, 11.24)	***
Model 8^{ac}	Different population including whole medical personnel of all position; Sample size = 11138	9.51	(9.00, 10.01)	***

Note: CI, confidence interval.

- Weights in model 5, model 6 and model 8 were constructed in line with the primary analysis (that is, the same equilibrium of weighted population had been achieved and the weights were also truncated at the 99th percentile).
- The confidence intervals of model 5, model 6 and model 8 were estimated by the robust variance estimator “sandwich”.
- After coding the variables, 11138 fully answered responses (84.31% in 13211) from participants in all position were included in the model 8.
- *** $p < 0.001$

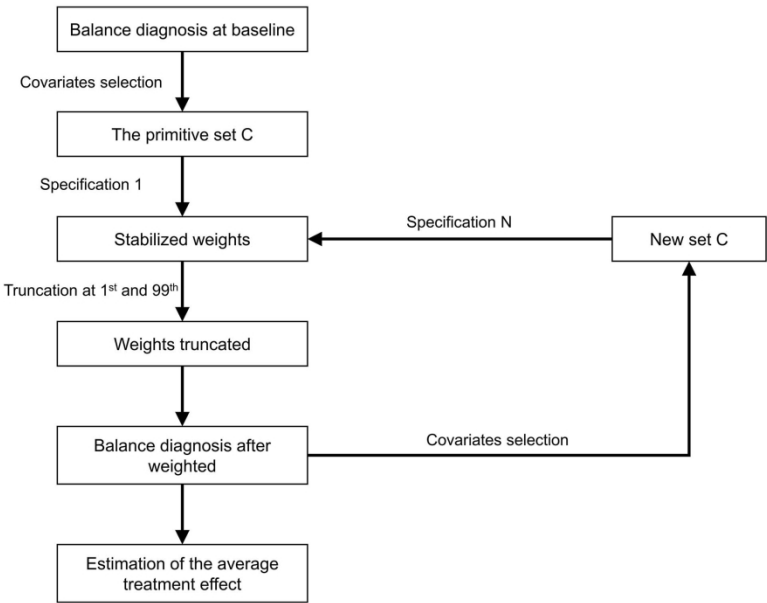


Note:
a. The solid lines indicate the 10% differences which reflect good balance of confounders; each layer of a binary variable had a standardized difference in proportion with equal value but opposite directions, so only one of them was shown in the figure;
b. PATPH, the performance appraisal for tertiary public hospitals; IPTW, inverse probability-of-treatment weighting; Performance, the performance rating of hospitals; Marriage - Other, marital status other than never married; Educat - Below udg, education level - below undergraduate; Educat - Udg, education level - undergraduate; Title, technical title; Depart, department; Admin, administrative position.

Figure 1 Standardized differences in proportion between population working in and not in a “more effective” PATPH environment for each baseline covariate before and after IPTW.

Standardized differences in proportion between population working in and not in a “more effective” PATPH environment for each baseline covariate before and after IPTW.

499x499mm (72 x 72 DPI)



Note: PATPH, the performance appraisal for tertiary public hospitals

Figure2 Schematic presentation of the overall steps followed in the analysis.

Schematic presentation of the overall steps followed in the analysis.

881x734mm (72 x 72 DPI)

Table S1 The job satisfaction scores (Mean $\pm$ Standard deviation).*On my present job, this is how I feel about.....*

Items	Score	Rank of score
1. Being able to keep busy all the time	3.65 $\pm$ 0.80	17
2. The chance to work alone on the job	3.95 $\pm$ 0.65	6
3. The chance to do different things from time to time	3.75 $\pm$ 0.75	16
4. The chance to be “somebody” in the community	3.97 $\pm$ 0.64	4
5. The way my boss handles his/her workers	3.83 $\pm$ 0.78	12
6. The competence of my supervisor in making decisions	3.84 $\pm$ 0.79	10
7. Being able to do things that don't go against my conscience	4.11 $\pm$ 0.70	1
8. The way my job provides for steady employment	4.03 $\pm$ 0.68	2
9. The chance to do things for other people	3.96 $\pm$ 0.67	5
10. The chance to tell people what to do	3.60 $\pm$ 0.76	19
11. The chance to do something that makes use of my abilities	3.93 $\pm$ 0.69	7
12. The way company policies are put into practice	3.81 $\pm$ 0.76	13
13. My pay and the amount of work I do	3.41 $\pm$ 1.01	20

Items	Score	Rank of score
14. The chances for promotion on this job	3.62±0.86	18
15. The freedom to use my own judgment	3.84±0.71	11
16. The chance to try my own methods of doing the job	3.77±0.75	15
17. The working conditions	3.78±0.79	14
18. The way my co-workers get along with each other	4.02±0.68	3
19. The praise I get for doing a good job	3.88±0.74	8
20. The feeling of accomplishment I get from the job	3.88±0.74	9

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Table S2 Improvements in the working environment resulting from the Performance Appraisal for Tertiary Public Hospitals (Mean $\pm$ Standard deviation).

In your opinion, after the implementation of the Performance Appraisal of Tertiary Public Hospitals, how did you promote in these aspects of your hospital?

Items	Score
1. Medical quality of hospital	2.57 $\pm$ 1.16
2. Operational efficiency of hospital	2.50 $\pm$ 1.20
3. Sustainable development of hospital	2.55 $\pm$ 1.18
4. Satisfaction of inpatients	2.59 $\pm$ 1.20
5. Satisfaction of outpatients	2.63 $\pm$ 1.20
Average score	2.57 $\pm$ 0.05
Total score	12.84 $\pm$ 5.61

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Table S3 The increased attention of participants to the working environment after the implementation of the performance Appraisal of Tertiary Public Hospitals (Mean $\pm$ Standard deviation).

In your opinion, after the implementation of the Performance Appraisal of Tertiary Public Hospitals, how do you pay attention to the following aspects of the hospital?

Items	Score
1. Medical quality of hospital	2.62 $\pm$ 1.21
2. Operational efficiency of hospital	2.39 $\pm$ 1.25
3. Sustainable development of hospital	2.47 $\pm$ 1.22
4. Satisfaction of inpatients	2.62 $\pm$ 1.22
5. Satisfaction of outpatients	2.72 $\pm$ 1.20
Total score	12.81 $\pm$ 5.36

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Table S4 Distributions of the individual characteristics and hospital characteristics before and after IPTW

Characteristics	Level	Overall (N=8417)	Before IPTW			After IPTW		
			Less effective (N=6193)	More effective (N=2224)	STD	Less effective (N=2163.1)	More effective (N= 2163.1)	STD
Age --mean (SD)		34.02 (8.30)	34.50 (8.33)	32.71 (8.04)	-0.22	34.03 (8.33)	33.82 (8.33)	-0.02
Age group--n (%)	<30	3078 (36.57)	2094 (33.81)	984 (44.24)	0.22	2263.74 (33.81)	815.44 (37.70)	0.02
	30~39	3626 (43.08)	2744 (44.31)	882 (39.66)	-0.09	2665.66 (44.31)	920.20 (42.54)	-0.01
	40~49	1217 (14.46)	951 (15.36)	266 (11.96)	-0.10	895.53 (15.36)	312.60 (14.45)	0.00
	≥50	496 (5.89)	404 (6.52)	92 (4.14)	-0.11	364.07 (6.52)	114.85 (5.31)	-0.03
Gender--n (%)	Male	1569 (18.64)	1297 (20.94)	272 (12.23)	-0.24	1151.24 (20.94)	379.77 (17.56)	-0.03
	Female	6848 (81.36)	4896 (79.06)	1952 (87.77)	0.24	5037.76 (79.06)	1783.33 (82.44)	0.03
Marital status--n (%)	Never married	2503 (29.74)	1728 (27.90)	775 (34.85)	0.15	1839.56 (27.90)	656.39 (30.35)	0.01
	Other conditions	5914 (70.26)	4465 (72.10)	1449 (65.15)	-0.15	4349.43 (72.10)	1506.70 (69.65)	-0.01
Position--n (%)	Doctor	2369 (28.15)	2054 (33.17)	315 (14.16)	-0.46	1745.06 (33.17)	570.42 (26.37)	-0.04
	Nurse	6048 (71.85)	4139 (66.83)	1909 (85.84)	0.46	4443.94 (66.83)	1592.67 (73.63)	0.04
Education--n (%)	Below undergraduate	920 (10.93)	671 (10.83)	249 (11.20)	0.01	675.07 (10.83)	236.69 (10.94)	0.00
	Undergraduate	6076 (72.19)	4298 (69.40)	1778 (79.95)	0.24	4467.73 (69.40)	1595.02 (73.74)	0.04
	Master's degree	1034 (12.28)	876 (14.15)	158 (7.10)	-0.23	761.06 (14.15)	245.12 (11.33)	-0.03
	Doctoral degree	387 (4.60)	348 (5.62)	39 (1.75)	-0.21	285.13 (5.62)	86.27 (3.99)	-0.03
Technical title--n (%)	Not have	548 (6.51)	365 (5.89)	183 (8.23)	0.09	404.23 (5.89)	148.76 (6.88)	0.01

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Administrative position--n (%)	Primary title	3989 (47.39)	2787 (45.00)	1202 (54.05)	0.18	2929.88 (17.44)	1039.15 (48.04)	0.01
	Intermediate title	2789 (33.14)	2132 (34.43)	657 (29.54)	-0.10	2052.33 (33.36)	712.48 (32.94)	0.00
	Vice senior	749 (8.90)	632 (10.21)	117 (5.26)	-0.19	551.58 (8.81)	177.85 (8.22)	-0.03
	Senior	342 (4.06)	277 (4.47)	65 (2.92)	-0.08	250.98 (4.06)	84.86 (3.92)	-0.01
	Not have	7676 (91.20)	5652 (91.26)	2024 (91.01)	-0.01	5670.48 (91.22)	1930.94 (89.27)	-0.08
	Have	741 (8.80)	541 (8.74)	200 (8.99)	0.01	518.52 (8.38)	232.16 (10.73)	0.08
	Internal medicine	2275 (27.03)	1671 (26.98)	604 (27.16)	0.00	1676.60 (27.09)	584.16 (27.01)	0.00
	Surgical	2449 (29.10)	1795 (28.98)	654 (29.41)	0.01	1796.07 (29.12)	627.73 (29.02)	0.00
	Other departments	3693 (43.88)	2727 (44.03)	966 (43.44)	-0.01	2716.33 (43.99)	951.21 (43.97)	0.00
	West	1504 (17.87)	1318 (21.28)	186 (8.36)	-0.37	1238.77 (21.22)	206.62 (9.55)	-0.30
Region--n (%)	Center	2519 (29.93)	1712 (27.64)	807 (36.29)	0.19	1791.68 (28.55)	661.32 (30.57)	0.03
	East	4394 (52.20)	3163 (51.07)	1231 (55.35)	0.09	3158.55 (51.33)	1295.16 (59.88)	0.18
	Fair	1122 (13.33)	902 (14.56)	220 (9.89)	-0.14	825.00 (13.33)	278.62 (12.88)	-0.01
Performance rating--n (%)	Good	3826 (45.46)	2958 (47.76)	868 (39.03)	-0.18	2818.14 (45.33)	993.75 (45.94)	0.01
	Excellent	3469 (41.21)	2333 (37.67)	1136 (51.08)	0.27	2545.86 (41.14)	890.72 (41.18)	0.00
	None	4376 (51.99)	2820 (45.54)	1556 (69.96)	0.51	3214.03 (51.33)	1154.29 (53.36)	0.03
Depression status --n(%)	At risk	4041 (48.01)	3373 (54.46)	668 (30.04)	-0.51	2974.97 (48.77)	1008.81 (46.64)	-0.03
	None	5846 (69.45)	4046 (65.33)	1800 (80.94)	0.36	4269.35 (68.88)	1567.78 (72.48)	0.08
Anxiety status --n(%)	At risk	2571 (30.55)	2147 (34.67)	424 (19.06)	-0.36	1919.64 (31.22)	595.32 (27.52)	-0.08
	More	6412 (76.18)	4210 (67.98)	2202 (99.01)	0.92	4268.40 (68.77)	2138.49 (98.86)	0.89
Increased attention to working								

environment --n(%)	Less	2005 (23.82)	1983 (32.02)	22 (0.99)	-0.92	1920.60 (31.13)	24.61 (1.14)	-0.89
Job satisfaction -- mean (SD)		76.61 (11.69)	73.03 (9.90)	86.58 (10.43)	1.33	73.56 (9.17)	85.10 (10.65)	1.14
Intrinsic job satisfaction -- mean (SD)		46.43 (6.66)	44.49 (5.72)	51.84 (6.09)	1.25	44.76 (6.10)	51.06 (6.20)	1.07
Extrinsic job satisfaction-- mean (SD)		30.18 (5.36)	28.54 (4.62)	34.74 (4.59)	1.35	28.80 (4.10)	34.04 (4.71)	1.14

Note:

IPTW, inverse probability treatment weighting; SD, standard deviation; STD, Standardized differences in proportion or mean.

Table S5 The construction of inverse probability weights under a series of models.

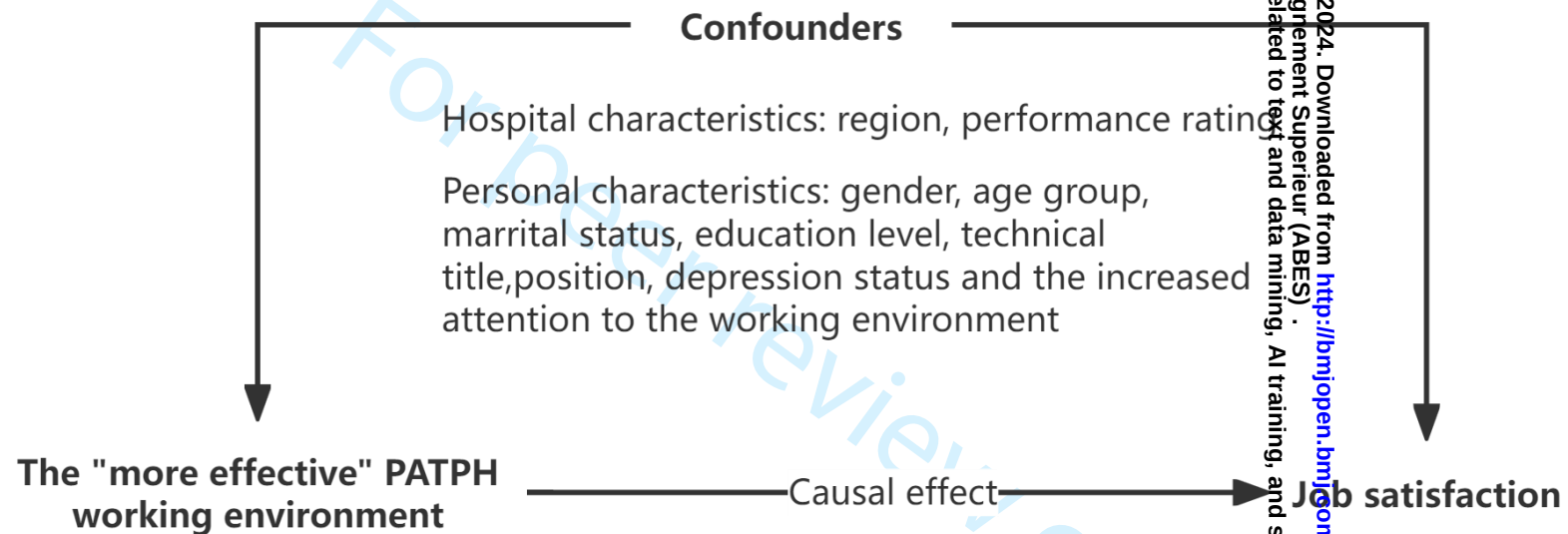
Specification ^a	Description of set <i>C</i>	Estimated weights	
		Mean (SD)	Minimum-maximum
1	The primitive set <i>C</i> ^b	1.01(1.92)	0.42-137.95
1_99trunc	Truncated weights from specification 1	0.94(0.32)	0.46-1.92
2	Set <i>C</i> = The primitive set <i>C</i> minus the region	1.00(1.47)	0.44-74.63
2_99trunc	Truncated weights from specification 2	0.94(0.31)	0.47-1.93
3	Set <i>C</i> = The primitive set <i>C</i> minus region and the increased attention to the working environment	1.00(0.38)	0.49-7.07
3_99trunc (Optimal)	Truncated weights from specification 3	0.99(0.31)	0.53-2.70

Note: PATPH, the performance appraisal for tertiary public hospitals; SD, standard deviation.

a. Numerator in all the specifications above equals the probability of lower effectiveness in the baseline population. All truncations were performed at the 1st and 99th percentile.

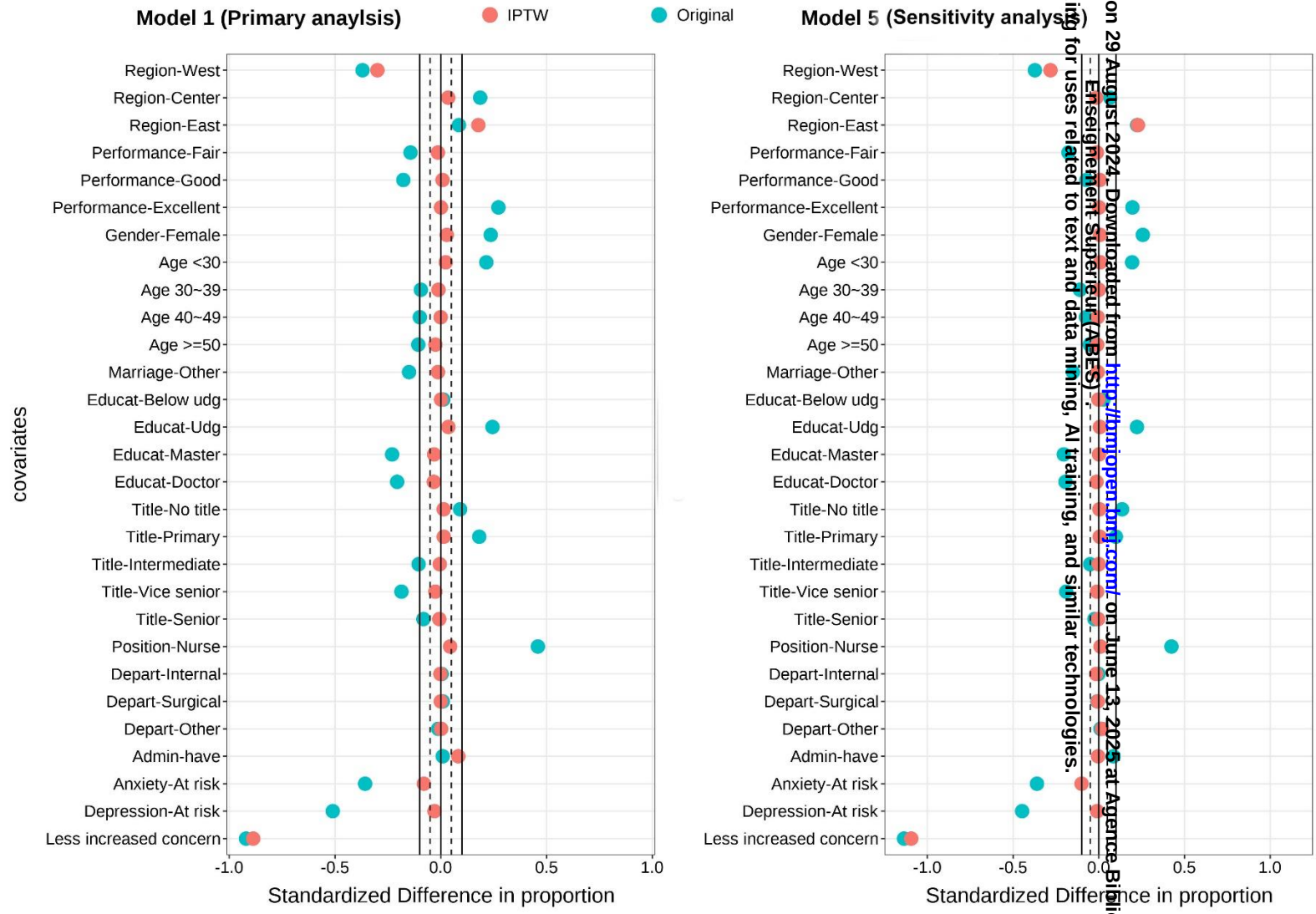
b. The primitive set *C* includes category terms for age group, gender, marital status, education level, technical title, position, the increased attention to working environment, the depression status, region and the performance rating of hospitals. The administrative position, the department and the anxiety status were excluded from the primitive set *C* because the standardized differences in proportion were less than 10% or statistically insignificant impact on the “more effective” PATPH in multivariate analysis.

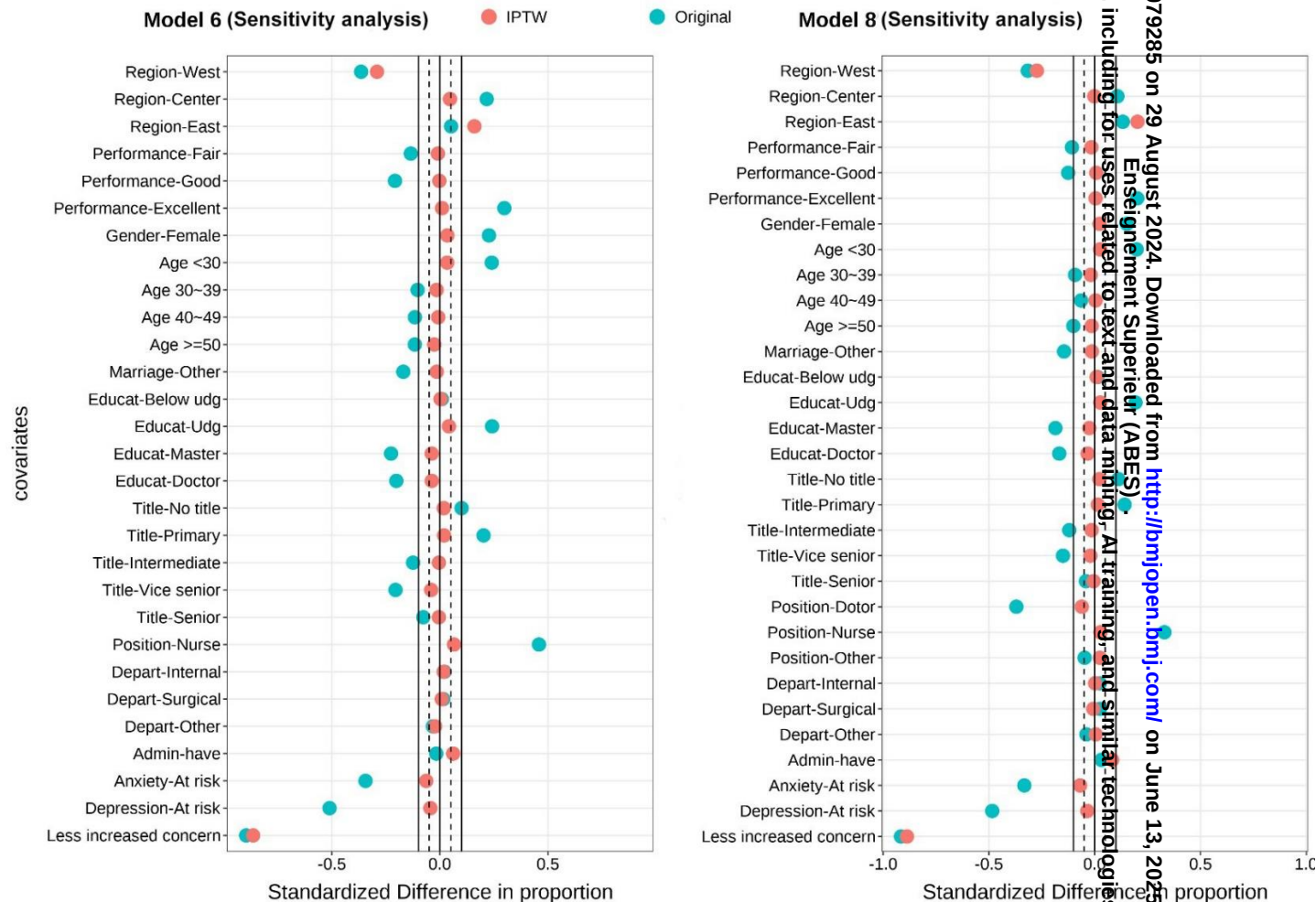
Figure S1 The causal relationship and potential confounders: the impact of a “more effective” PATPH working environment on job satisfaction .



Note: PATPH, the performance appraisal for tertiary public hospitals

Figure S2 The balance diagnoses for baseline variables before and after IPTW in the primary analysis and sensitivity analysis.





Note: IPTW, inverse probability-of-treatment weighting; Performance, the performance rating of hospitals; Marriage - Other, marital status other than never married; Educat - Below udg, education level - below undergraduate; Educat - Udg, education level - undergraduate; Title, technical title; Depart, department; Admin, administrative position

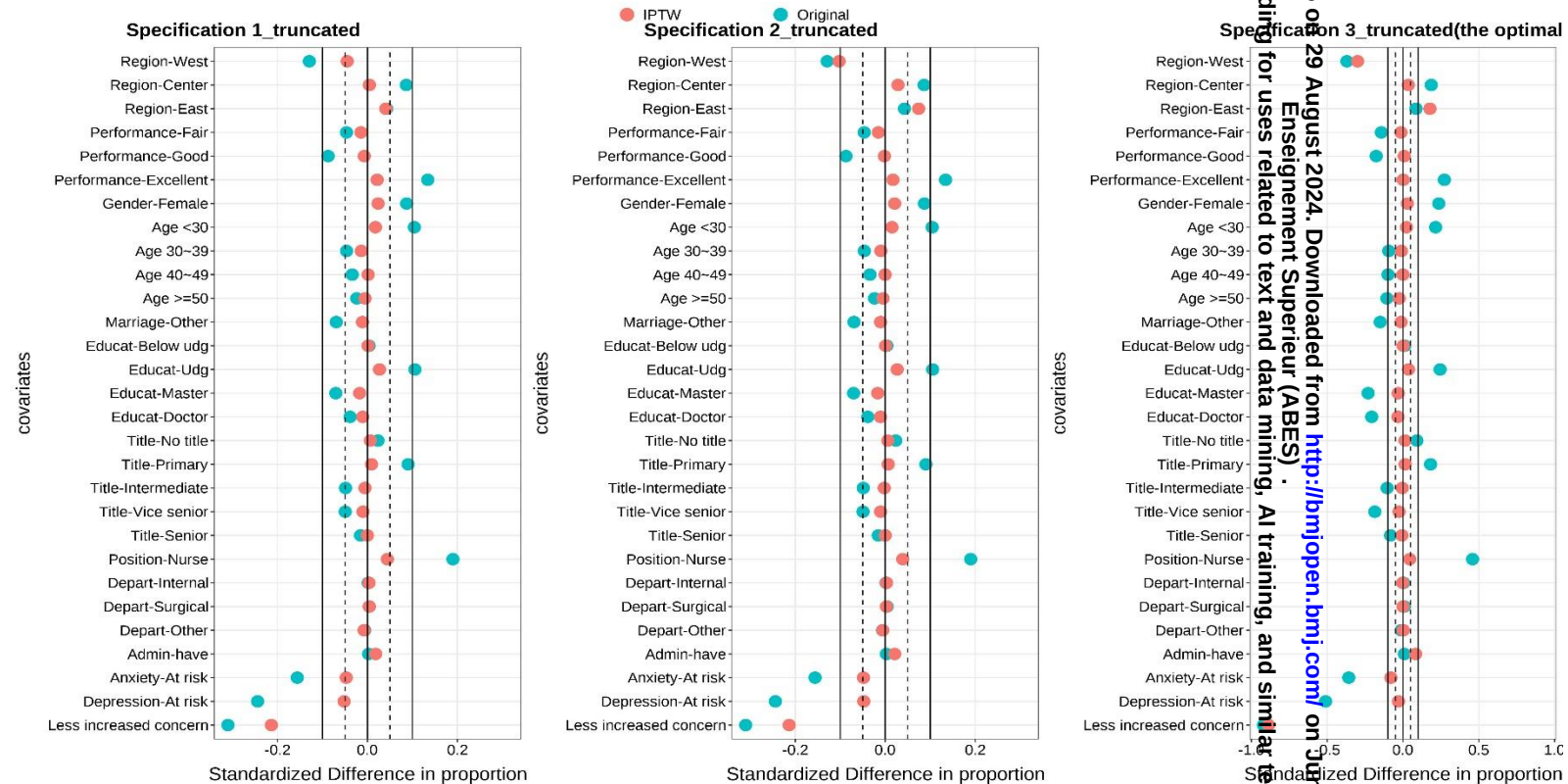
a. The solid lines indicate the 10% differences which reflect good balance of confounders;

b. Each layer of a dichotomous variable had a standardized difference in proportion with equal value but opposite directions, so only

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one of them was shown in the figure.

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Figure S3 The balance diagnoses for baseline variables before and after IPTW in the construction of weights

Note: IPTW, inverse probability-of-treatment weighting; Performance, the performance rating of hospital; Marriage - Other, marital status other than never married; Educat - Below udg, education level - below undergraduate; Educat - Udg, education level - undergraduate; Title, technical title; Depart, department; Admin, administrative position

- The solid lines indicate the 10% differences which reflect good balance of confounders;
- Each layer of a dichotomous variable had a standardized difference in proportion with equal value but opposite directions, so only one of them was shown in the figure.

The principle of distinguishing doctors and nurses from all positions.

We asked every participant about main positions, specific department and administrative position and distinguished doctors and nurses from all positions mainly according to their responses of main position. However, some participants might be classified into a different position category than their self-orientation. For example, participant who reported as both a doctor and other position (such as a nurse or public health personnel) was identified as a doctor (81 in 13211, 0.61%), participant who self-reported as both a nurse and other position (such as a public health personnel or administrative personnel but not a doctor) was identified as a nurse (46 in 13211, 0.35%).

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cross-sectional studies

Section/Topic	Item #	Recommendation	Reported on page #
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	4
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-11
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	8-11
Bias	9	Describe any efforts to address potential sources of bias	11-13
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-11
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	11-13
		(b) Describe any methods used to examine subgroups and interactions	12-13
		(c) Explain how missing data were addressed	8-9
		(d) If applicable, describe analytical methods taking account of sampling strategy	6
		(e) Describe any sensitivity analyses	13
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	13
		(b) Give reasons for non-participation at each stage	Not applicable
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13-14
		(b) Indicate number of participants with missing data for each variable of interest	8-9
Outcome data	15*	Report numbers of outcome events or summary measures	Not applicable
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	15
		(b) Report category boundaries when continuous variables were categorized	7-10
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	15-16
Discussion			
Key results	18	Summarise key results with reference to study objectives	16-20
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	20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16-20
Generalisability	21	Discuss the generalisability (external validity) of the study results	20
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	22

*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.