

Job Preferences for Social Medicine and Health care Management PhD Students in China: A Discrete Choice Experiment

Shimeng Liu

Fudan University School of Public Health

Yingyao Chen (✉ yychen@shmu.edu.cn)

Fudan University School of Public Health <https://orcid.org/0000-0002-3470-0748>

Shunping Li

Shandong University

Ningze Xu

Fudan University

Chengxiang Tang

Guangzhou University

Research

Keywords: Social medicine and health care management, PhD students, Job preferences, Discrete choice experiment

Posted Date: January 15th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-146018/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

1 **Job preferences for social medicine and health care management**

2 **PhD students in China: A discrete choice experiment**

3 Shimeng Liu^{1,2}, Yingyao Chen^{1,2*}, Shunping Li^{3,4}, Ningze Xu^{1,2}, Chengxiang Tang⁵

4 1. School of Public Health, Fudan University, Shanghai, 200032, China

5 2. NHC Key Laboratory of Health Technology Assessment (Fudan University), Shanghai,
6 200032, China.

7 3. Centre for Health Management and Policy Research, School of Public Health, Cheeloo College
8 of Medicine, Shandong University, Jinan 250012, China.

9 4. NHC Key Lab of Health Economics and Policy Research (Shandong University), Jinan 250012,
10 China.

11 5. School of Public Administration, Guangzhou University, Guangzhou 510006, China.

12

13 Shimeng Liu: mototo99@163.com

14 Yingyao Chen: yychen@shmu.edu.cn (*Correspondence author)

15 Shunping Li: lishunping@sdu.edu.cn

16 Ningze Xu: nzxu17@fudan.edu.cn

17 Chengxiang Tang: tang.chengxiang@gmail.com

18

19

20

21

22

23

24

Abstract

Background: The shortage of public health workforce and its uneven distribution between developed and underdeveloped areas still exist in China's health system. This study aimed to investigate PhD students majoring in social medicine and health care management (SMHCM)'s stated preferences when choosing a job, so as to inform policy-makers regarding alternative interventions to address recruitment and retention problems at underdeveloped areas.

Methods: The relative importance of 7 job attributes was assessed by conducting a web-based discrete choice experiment (DCE) survey on a sample of 193 SMHCM PhD students at different grades during October 20 and November 12, 2020. The 7 attributes were monthly income, location, housing, children's education, working environment, career promotion and *Bianzhi* (which refers to the authorized number of personnel (the number of established posts) in a party or government administrative organ).

Results: All 7 attributes were statistically significant with the expected sign and demonstrated the existence of preference heterogeneity. Monthly income, location and *Bianzhi* were of most concern for SMHCM PhD students when deciding their future jobs. Among the presented attributes, working environment was of least concern. For the sub-group analysis, the job in first-tier city was more likely to lead to a higher utility value for PhD students who were women, married, coming from urban area and has high annual family income. Compared with female PhD students, male PhD students were willing to pay more for a shorter time to get promoted.

Conclusions: Both monetary and non-monetary attributes were found to be significantly influential in affecting PhD students' preferences for choosing a job. Wider use of choice experiments can help improve the recruitment and retention of health workforce at disease control

1 system, especially in third-tier cities where resource constraints preclude the use of all strategies.

2 **Keywords:** Social medicine and health care management; PhD students; Job preferences; Discrete

3 choice experiment

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

1 **Introduction**

2 The pandemic of Coronavirus Disease 2019 (COVID-19) highlights the importance of early
3 detection of disease outbreaks, taking swift and decisive public health actions, and strengthening
4 public health systems ^[1]. Social medicine and health care management (SMHCM), as an
5 interdisciplinary specialty between medicine, social science and management science and is of a
6 particular need in battling against this pandemic ^[2] (The graduates can be employed by various
7 health institutions, such as hospitals, health inspection institutes, Center for Disease Control and
8 Prevention (CDC), government, academics and pharmaceutical companies., etc. and is one of the
9 major sources for public health workforce in China). However, the shortage of public health
10 workforce and its uneven distribution between developed and underdeveloped areas still exist in
11 China's health system. According to a survey conducted by Chinese CDC in 2020, the public health
12 workforce density varied significantly across 31 provinces and has decreased year by year, the
13 aggregate ratio of public health workforce to general population decreased from 1.47 to 1.42 per
14 10,000 from 2008 to 2017, consistently below the critical shortage threshold of 1.75 per 10,000
15 recommended by National Health Commission (NHC) ^[3]

16 High turnover of health professionals and lowest willingness to work at disease control system
17 among public health related graduates all contribute to the recruitment and retention problems at
18 CDC ^[4]. According to the statistics of the NHC, from 2009 to 2018, the number of health workforce
19 at hospitals increased by 58.07%, while the number of personnel at CDC decreased by 4.5% ^[5]. To
20 address those problems, there is an urgent need to carefully identify analytic questions that will help
21 carry out public health functions in the new era, alongside policy implications for an equitable
22 distribution of the public health workforce with a focus on the western region and low-low cluster

1 areas. Both existing public health workforce and PhD students majoring in SMHCM who will enter
2 into job market are important health workforce in the long run. Thus, to better address the
3 recruitment and retention issues and craft corresponding policy interventions, there is a need to
4 further investigate the nature and determinants of the SMHCM PhD students' job preferences.

5 Considering that a range of factors could influence SMHCM PhD students' motivation, an
6 appropriately selected combination of incentives would be needed to effectively attract and retain
7 SMHCM PhD students to work at CDC, especially in underdeveloped areas. But the development
8 of appropriate strategies first requires an understanding of factors influencing decisions to accept
9 and/or stay at a specific job post, on which strategies to improve job attractiveness and retention are
10 developed would therefore have the potential to be successful. Number of recent studies have used
11 discrete choice experiments (DCEs) to study the determinants of health-related students' job
12 preferences ^[6]. Rather than evaluating the decisions that students have actually made, this
13 methodology analyses the stated preferences of students for different job characteristics. It has also
14 been found that stated preferences derived from a DCE can adequately predict actual behavior in
15 the public health settings ^[7].

16 This study aims to elicit job preferences of SMHCM PhD students in China (whose career-related
17 decisions are crucial to the development of the health service in the future), and it presents the first
18 DCE evidence for this population group. Results from this study will inform policymakers to
19 develop more effective policies to improve job attractiveness and retention of a third-tier city job
20 position (underdeveloped areas in China) for SMHCM PhD students.

Sampling

In China, approximately 30 universities offer the SMHCM major ^[4]. In order to collect as many samples as possible, an anonymous web-based survey was conducted using the Sojump software during October 20th and November 12th, 2020. According to the rule of thumb proposed by Orme ^[8], the minimum sample size required for this study is 83. Considering the possibility of conducting further subgroup analyses, we designed to enroll a minimum of 150 respondents. Although this sample size is relatively small for a conjoint analysis ^[9,10], given the limited number of universities that provide SMHCM trainings for PhD students, the number of students who can state their preferences in this research is still reasonable.

Discrete choice experiment

Based on a well-tested theory of choice behavior, DCE is the most common type of ordinal preference method used in health economics and health services research ^[11]. In DCEs, students are expected to make trade-offs in a series of imperfect job scenarios with different attribute profiles. A DCE will assume that the job scenarios with the greatest utility will be chosen among a set of job choice. The DCE is considered to be a more realistic representation of actual decision-making as it allows for the estimation of overall preferences for any given combination of attributes and is shown to be one of the most sensitive methods to elicit preferences ^[12].

Selection of attributes for the choice experiment

The first step to design a DCE is to identify attributes and corresponding levels. We used qualitative research as well as a literature review to select attributes to be included in the DCE. Initially, ten attributes commonly adopted and suitable for the Chinese health system were identified through our previous research experience ^[13] and a literature review ^[14-16], which were monthly income, *Bianzhi*,

1 location, housing, children's education, working environment, career promotion, workload,
2 management style, training and career development opportunity. An in-depth interview was then
3 conducted with 7 SMHCM PhD students from Fudan university and Shandong University, which
4 suggested that the attribute of management style and workload could be removed. In addition, we
5 consulted two experts in the field of DCE and three experts in the field of public health for the
6 remaining attributes. After the consultation, we retained the attribute of career promotion, removed
7 the training and career development opportunity, and adjusted the level of monthly income from
8 15,000-30,000 CNY to 10,000-25,000 CNY. In sum, the final attributes and their levels (Table 1)
9 were determined based on our previous research experience, literature review, in-depth interview as
10 well as consultation with five experts in the fields of DCE and public health.

11 *Table 1 should appear at here*

12 **DCE design**

13 Once the attributes and attribute levels were defined, they were then combined into a set of carefully
14 selected scenarios (choice sets). We followed standard approaches for the design of the choice
15 experiment in order to achieve unbiased, statistical response efficiency^[17]. The DCE was based on
16 7 attributes. 3 of the 7 attributes were described in choice tasks by 3 response levels, three attributes
17 by 2 levels and one attribute by 4 levels, yielding a total of (e.g., $3 \times 3 \times 3 \times 2 \times 2 \times 2 \times 4$) 864 potential
18 combinations. Because the total number of comparisons ($[864 \times 863] / 2$) cannot be feasibly evaluated,
19 we developed an orthogonal and balanced designs to identify similar and efficient sets of profiles
20 among these profiles^[18, 19]. Applying the methods introduced by Huber and Zwerina^[20], DCE
21 macros for SAS (version 9.4) were used to select combinations for an orthogonal main effect design,
22 and the selected profiles were organized into the most D-efficient choice designs, given the design

parameters (Relative D-Eff: 77.9%). The design was evaluated based on the variance of parameters, confirming that the design was orthogonal. Finally, 36 choice sets were identified and were further divided into three blocks so as to minimize participants' cognitive burden. Within each version, a single choice set was duplicated to examine the internal consistency of participants. All participants were randomized to receive one of the 3 versions of the DCE questionnaire according to their month of birth. (Block 1: January to April; Block 2: May to August; Block 3: September to December). An example of the DCE choice set is provided in Table 2.

Table 2 should appear at here

Data collection

In addition to the DCE questions, the online questionnaire also contains questions related to students' sociodemographic characteristics, career planning, and family income. A ranking exercise was conducted prior to the DCE tasks to further examine the internal predictive validity of the DCE estimates, in which participants were asked to rank three attributes (within 7 attributes) from most important to least important with respect to their job preferences. At the end of the questionnaire, the respondents were given a task to indicate on a 5-point scale the level of difficulty of completing the 13 DCE choice tasks. The full questionnaire was piloted among SMHCM PhD students at Fudan University and Shandong university before data collection conducted between July and October of year 2020, aiming to examine the comprehensibility, acceptability, and validity of the questionnaire. A brief explanatory statement was given to respondents, which described the study and highlighted that their participation was voluntary and that no identifiable personal data would be collected. It is an anonymous survey so we did not require a written consent. A return questionnaire also indicates the implied consent which is commonly adopted in the anonymous online survey. Ethical approval

(Reference No.2020-10-0853) was obtained both for the consent procedure and for the study as a whole from the ethics review board of the school of public health, Fudan University, and the research adhered to the tenets of the Declaration of Helsinki.

Data analysis

We used STATA version 15.1 to clean and analyze the data. Descriptive statistics were reported for participants' socio-demographic characteristics, the ranking results and the 5-point scale score. The data from the DCE were analyzed within a random utility theory framework. The utility (U) associated with a particular job is made up of two components: the deterministic component v_{ni} (where is a function of observable characteristics) and the unobservable component ε_{ni} . The model of utility for an individual n associated with job i can be estimated as:

$$\begin{aligned} U_n &= v_{ni} + \varepsilon_{ni} \\ &= \beta_1 Location_{\text{Second tier city}} + \beta_2 Location_{\text{First tier city}} + \\ &\quad \beta_3 housing_{\text{Allowance}} + \beta_4 housing_{\text{Provided}} + \\ &\quad \beta_5 Children's education_{\text{Good}} + \beta_6 Promotion_{\text{3 year}} + \\ &\quad \beta_7 Promotion_{\text{1 year}} + \beta_8 Environment_{\text{1 year}} + \\ &\quad \beta_9 Bianzhi_{\text{Provided}} + \beta_{10} Monthly Income + \varepsilon_n \end{aligned}$$

Two econometric approaches were used to estimate this utility function, including the classical conditional logit model and a mixed logit model that could be used to capture potential unobservable preference heterogeneity^[21]. Conditional and mixed logit regression models were compared using the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), which are commonly used for model selection in random utility framework^[22, 23].

The DCE data were binary, where '1' indicates that the alternative plan was chosen and '0' means that the other alternative plan was chosen. Although most previous studies specify the coefficient

1 for monetary attribute in choice models to be fixed, it is often unrealistic to assume that all
2 participants have the same preferences regarding the monthly income of a job position ^[24]. In our
3 study, all attributes were dummy coded and specified as having a random component, except for
4 monthly income which was specified as a continuous variable in the models to facilitate the
5 calculation of willingness to pay (WTP), that is, the relative monetary value that students place on
6 various aspect of the job options. Through calculating the ratios of the coefficients between each
7 attribute level and the salary attribute, the marginal rate of substitution or WTP was calculated
8 $(-\frac{\beta_{(1,2\cdots9)}}{\beta_{10}})$ where β_{10} is the salary coefficient and $\beta_{(1,2\cdots9)}$ is the coefficient for attribute level 1,
9 2...9). The positive and negative results indicate theoretically to what extent the participants would
10 be willing to pay/to be compensated for an attribute level. Finally, we also conducted a simulation
11 study to understand to what extent the probability of choosing a given post changes as the levels of
12 the attributes are changed.

13 **Results**

14 A total of 193 individuals participated in the online survey, among which 26 were excluded because
15 their university does not have a SMHCM major, so we take them as invalid data. For internal
16 consistency, a choice test based on duplicated choice tasks among the remaining 167 participants
17 resulted in 14 (8.4%) participants failing the test. The detailed results reported below were based on
18 153 participants who passed the internal consistency tests. Meanwhile, a sensitivity analysis
19 including all 167 participants (Additional file 1: Table S1) was conducted and the results are
20 comparable to the results reported below.

21 **Respondents**

22 The sociodemographic characteristics are shown in Table 3. There were no significant differences

1 between those who failed versus who passed the internal consistency tests. The analysis sample
2 (n=153) had a mean age of 28.8 years (SD=4.5). Most of them were female (62.1%), coming from
3 urban areas (65.4%) and single (69.9%). Around 79.1% of the PhD students would do major-related
4 job after graduation while 18.9% hasn't make up their mind. For the '5-point scale' question, 61
5 respondents (39.9%) thought it was easy or very easy to complete the 13 DCE questions, 66
6 respondents (43.1%) thought it was normal, only 26 respondents (17.0%) thought it was difficult or
7 very difficult.

8 *Table 3 should appear at here*

9 **DCE results**

10 The AIC and BIC values suggested that the mixed logit estimates were preferable to the conditional
11 logit estimates for the analysis sample and the results from mixed logit model were not substantially
12 different from the conditional logit model. As such, we only report the preferred mixed logit
13 estimates in Table 4. The conditional logit estimates are presented in Additional file 2: Table S2.

14 A total of 153 respondents completed the DCE for a total of 3672 observations. The statistical
15 significance of all levels of each attribute indicates that all key characteristics identified in the DCE
16 design stage played a significant role in job choice. Results from the mixed logit model show that
17 respondents held strong preferences for first-tier city as opposed to third-tier city (β or relative utility
18 = 1.687; $p < 0.001$). SMHCM PhD students also exhibited strong preferences for provide housing
19 compared with no housing provide ($\beta = 1.129$; $p < 0.001$), as well as has *Bianzhi* compared with no
20 *Bianzhi* ($\beta = 1.045$; $p < 0.001$). SMHCM PhD students expressed a preference for 1 year to get
21 promoted ($\beta = 0.719$; $p < 0.001$), as well as good children education ($\beta = 0.555$; $p < 0.001$). Good

1 working environment only signs of a mild preference ($\beta = 0.401$; $p < 0.001$).

2 *Figure 1 should appear at hear*

3 *Table 4 should appear at here*

4 **Willingness to pay**

5 The willingness to pay analysis, carried out in order to calibrate the strength of SMHCM PhD
6 student's preferences to a single standard, quantified how much salary they were willing to sacrifice
7 in order to obtain a desired level of an attribute. This analysis revealed that students were willing to
8 pay 11767.8 CNY to attend a job in the first-tier city rather than the third-tier city. Students were
9 willing to pay 7873.5 CNY for the house rather than no house provide. In terms of *Bianzhi*, students
10 were willing to pay 7287.1 CNY to get a job with *Bianzhi*. The results of selective sub-group
11 analyses were presented in Tables 5-8 and Figure 2. For the subgroups, all seven attributes remained
12 statistically significant in influencing preferences. Focusing on the WTP estimates, it can be seen
13 that the job in first-tier city was more likely to lead to a higher utility value for respondents who
14 were women, married, coming from urban area and has high annual family income. In addition,
15 compared with female students, the male students were willing to pay more for a job with 1 year to
16 get promoted.

17 *Table 5-8 should appear at here*

18 *Figure 2 should appear at hear*

19 **Simulated preferences for job posting under various potential policy scenarios**

20 The simulation results are shown in Figure 3. The initial (baseline: 10000 CNY monthly income;
21 no housing; normal children's education; get career promotion after 5 year; no *Bianzhi*) probability

1 of taking a job in the third-tier city is 15.6%, hence the probability of taking job in the first-tier city
2 is 84.4%, the job in the first-tier city is thus preferred. For the single incentives, only increasing
3 monthly income from 10000 to 25000 CNY can make the probability of choosing the third-tier job
4 (61.4%) exceed the job in first-tier city (38.6%). For the given multiple incentives, the policy “②+
5 ③+⑤+⑥” was the most attractive one, as it can increase the probability of taking a third-tier city
6 job to 79.4%.

7 ***Figure 3 should appear at hear***

8 **Discussion**

9 We have used DCE data to quantify the preference of the final year undergraduate healthcare
10 administration students and to model the likely impact of different human resource strategies on
11 rural recruitment in China ^[13]. In the absence of data from rigorous evaluation studies, such analyses
12 provide useful insights into the potential effectiveness of different human resource policy
13 interventions. We hope the findings of this study will help inform policy-makers’ actions to
14 encourage the recruitment and retention of SMHCM PhD students at health system (for example,
15 CDC), especially in third-tier cities of China.

16 Our study shows that most of the PhD students prefer to find a job in the university or research
17 institution, only few students plan to work at CDC. Turnover is a common phenomenon both in the
18 national CDC and local CDC in China because of the low salary ^[4]. Our study confirms that financial
19 incentives are very important in persuading PhD students to choose a position in third-tier cities,
20 but only if they are fairly large. In our study, a 5000 CNY salary increase was relatively ineffective
21 (Fig. 3). Although higher salary has a large effect on preference for third-tier city positions, it is

1 often infeasible in the real world settings, for it may require significant financial investments upfront
2 which may deter policy-makers from implementing this intervention ^[25].

3 Among non-monetary attributes, working in the first-tier cities is the most important factor,
4 especially for students from urban areas. The results of ranking job posting attributes according to
5 their importance in Figure 1 confirmed the importance of working location again. The simulation
6 results in our study shows that for the single incentives, only increasing monthly income from 10000
7 to 25000 CNY can make the probability of choosing the third-tier city job exceed the job in first-
8 tier city. In China, living conditions in most of the third-tier city are still poor compared with first-
9 tier city in terms of infrastructure (e.g. telecommunications and transportation), schools for children
10 and employment opportunities for spouse ^[26]. Studies from other countries have reported that the
11 more centrally located the job, the more it will be preferred by health workers or graduate students
12 ^[27, 28]. In addition, our study also reveals that compared to students from rural areas, those from
13 urban areas shown a much stronger preference to work in the first-tier city rather than in third-tier
14 city. Therefore, attracting and retaining SMHCM PhD students with a rural background for third-
15 tier city would be a more feasible strategy.

16 In terms of housing, providing housing allowance is moderately effective, but providing housing
17 is a very powerful non-financial strategy. This shows the importance of providing housing for
18 SMHCM PhD students when choosing a job. Other study also showed similar results ^[29]. Influenced
19 by the traditional concept, most Chinese people think that ‘one does not have a home if one does
20 not own a house’. In addition, a series of welfare benefits attached to the house, such as children
21 education, pension, social services, etc., have exacerbated the current situation that ‘it is difficult to
22 own a room’ ^[30]. In recent years, although Chinese government has always adhered to the policy

1 that ‘houses are used for living, not for speculation’, and local governments have also implemented
2 a series of measures, such as restricting the purchase and loan of houses and increasing the supply
3 of affordable housing, the housing prices still exceed the affordability of ordinary office workers
4 ^[30]. Limited by the financial capacity, for the local governments of third-tier cities, the challenge is
5 not only to identify which single intervention is more likely to promote recruitment and retention of
6 SMHCM PhD students, but to identify the best combination of interventions which can be truly
7 implemented. It is often not possible in the real world to provide housing for the PhD students,
8 alternatively, a combination non-monetary combined with monetary incentives, such as housing
9 allowance combined with 15000 CNY and get career promotion after 1 year can achieve larger
10 impact than provide housing incentive only.

11 Contrary to our previous studies with health administration ^[13], nurse ^[14] or medical students ^[31]
12 which found that *Bianzhi* has the lowest utility in job preferences, *Bianzhi* is another important non-
13 monetary factor that influence the SMHCM PhD students job choice in this study. In China, *Bianzhi*
14 refers to the authorized number of personnel (the number of established posts) in a Party or
15 government administrative organ, a service organization or a working unit, a job with *Bianzhi* means
16 more stable ^[32]. This is perhaps because the respondents in this study were older, with an average
17 of 28.8 (while the average age of undergraduate healthcare administration students in our previous
18 study was 22.2), and some of them had started a family, so a job with *Bianzhi* may be more important
19 for them. In addition, the PhD students in this study are more likely to work in the university or
20 scientific research institution and governmental, for those departments, there is a big difference in
21 salary, welfare, health insurance, children’ education, and etc. between the job has *Bianzhi* or not.

22 Career promotion is another important nonmonetary factor, especially for male SMHCM PhD

1 students. Similar results have been obtained in other human resource DCE- based studies in low-
2 and middle-income countries ^[29, 33]. Snow et al ^[34] study indicates that the absence of senior posts
3 in underdeveloped areas is an important factor associated with the feeling of “professional
4 imprisonment” identified by those working in rural and remote posts. Developing clear career
5 paths for rural and remote areas posts and adopting strategies to increase public recognition are
6 strongly recommended strategies ^[35]. This is contrary to our previous study with undergraduate
7 healthcare administration students which found that the career development opportunities did not
8 appear to be as important as the other non-monetary attributes ^[12]. This is perhaps because the
9 SMHCM PhD student’s expectation of career achievement is generally higher than the
10 undergraduates. A survey of career expectations for PhD graduates carried by China association
11 for science and technology showed that development prospects are the main considerations of a
12 PhD graduate in obtaining employments ^[36].

13 The children’s education attribute was found to have slightly smaller effect than the work location,
14 housing or career promotion. It seems contrary to the study conducted in Nepal ^[37] in which children’s
15 education was found to be much stronger predictors of choice. It could be that most of the SMHCM
16 PhD students we studied had not started a family, so perhaps their future children’s education was
17 not among their main concern. The subgroup analysis in our study also strengthened the above
18 assumption which the married PhD students have a stronger preference for the children’s education
19 compared with the unmarried PhD students.

20 An unexpected finding from our study is the relatively lower utility of working environment in
21 job preferences. It was contrary to our previous studies which was strongly suggestive of a
22 preference for improved working environment ^[13]. In this study, working environment refers to

1 management support, the relationship between superior and subordinate, high-risk work
2 environments, and availability of equipment. We assumed that this may be related to the specificity
3 of our study population, because PhD students have a high expectation for their career achievement
4 and don't expect to find a job with poor working environment ^[36]. This finding is consistent with
5 the results of an earlier quantitative study in which working environment was not think as the major
6 contributing factors towards job choice for the PhD students in China ^[36]. Despite all this, we do not
7 recommend the government or policy-makers ignore the importance of working environment when
8 recruiting the SMHCM PhD students, for the reason that due to the high expectation for their future
9 career, a position with poor working environment may incur larger negative impact for their job
10 preferences.

11 The pandemic of COVID-19 highlights the importance of strengthening public health systems.
12 In the future, the demand for public health workforce in disease control system will increase. In
13 addition to our study, other studies also found that many public health graduates were unwilling to
14 devote themselves to CDC ^[3,38]. To address potential challenge of human resources shortage in the
15 disease control system of China, further qualitative research such as in-depth interviews and focus
16 group discussions involving SMHCM PhD students is required to determine the specific reasons
17 why they are unwilling to work at CDC.

18 There are several limitations in this study. The first limitation stems from the fact that a choice
19 experiment does not offer the universe of attributes because the choice task becomes difficult and
20 respondents are less willing to critically appraise each attribute as the list grows. Not all potentially
21 important attributes, such as workload, were assessed. Second, DCEs are based on stated
22 preferences and not on actual behaviors. The existing literature suggests that response in choice

1 experiments predicts behavior, but this association is far from perfect. As a result, though choice
2 experiments can efficiently narrow the field of candidate interventions, evidence of SMHCM PhD
3 students' behavior may still be needed in many circumstances. Finally, unlike our previous studies,
4 the respondents in this study were not limited to the final year SMHCM PhD students. Though job
5 preferences may vary between PhD students at different grades, given the limited sample size, we
6 were unable to examine this difference.

7 **Conclusions**

8 Although China has conducted a series of DCE-based studies on graduates, the respondents are
9 mainly undergraduate graduates ^[13,14,31,39]. To the best of our knowledge, this is the first study using
10 DCE methodology to investigate job preferences of PhD students internationally. The SMHCM
11 PhD students are in their early stages of career preparation, so the results of this study will be more
12 effective to inform policy-makers regarding the design of recruitment and retention policies. Both
13 monetary and non-monetary attributes were found to be significantly influential in affecting students'
14 job preferences. Wider use of choice experiments can help improve the recruitment and retention of
15 health workforce at disease control system, especially in the third-tier cities where resource
16 constraints preclude the use of all strategies.

17

18

19

20

21

1 **Abbreviations**

2 COVID-19: Coronavirus Disease 2019; SMHCM: Social Medicine and Health Care Management;
3 CDC: Center for Disease Control and Prevention; DCE: Discrete Choice Experiment; SD: Standard
4 Deviation; SE: Standard Error; WTP: Willingness to Pay.

5 **Acknowledgements**

6 The authors thank all the participants for their time and effort. Responsibility for any remaining
7 errors lies solely with the authors.

8 **Funding**

9 All meetings, time invested, travel, etc. was funded by the individuals. The project had no financial
10 support.

11 **Availability of data and materials**

12 The data used and/or analyzed during the study are available from the corresponding author on
13 reasonable request.

14 **Authors' contributions**

15 SML, YYC, designed the study. SML, YYC, SPL and CXT collected the data. SML, YYC
16 completed the data analyses. SML wrote the manuscript. SML, YYC, SPL, NZX and CXT edited
17 the manuscript. All authors have read and approved the final manuscript.

18 **Ethics approval and consent to participate**

19 Ethical approval (Reference No.2020-10-0853) was obtained both for the consent procedure and for
20 the study as a whole from the ethics review board of the school of public health, Fudan University,
21 and the research adhered to the tenets of the Declaration of Helsinki.

22 **Consent for publication**

23 Not applicable.

24 **Competing interests**

25 The authors declare that they have no competing interests.

26 **Author details**

27 ¹School of Public Health, Fudan University, Shanghai, 200032, China. ²NHC Key Laboratory of
28 Health Technology Assessment (Fudan University), Shanghai, 200032, China. ³Centre for Health
29 Management and Policy Research, School of Public Health, Cheeloo College of Medicine,
30 Shandong University, Jinan 250012, China. ⁴NHC Key Lab of Health Economics and Policy
31 Research (Shandong University), Jinan 250012, China. ⁵School of Public Administration,
32 Guangzhou University, Guangzhou 510006, China.

33

References

- [1] Zeng W, Li G, Turbat V, Hu G, Ahn H, Shen J. Optimizing preventive medicine to bridge the gap between clinical medicine and public health for disease control in China: A lesson from COVID-19. *Prev Med.* 2020; 143:106324.
- [2] Liang WN, Hu Z, Wang YD. Health Care Administration [In Chinese]. 4st ed. BeiJing: People's Medical Publishing House Press; 2017.
- [3] Li YQ, Chen H, Guo HY. Examining Inequality in the Public Health Workforce Distribution in the Centers for Disease Control and Prevention (CDCs) System in China, 2008-2017. *Biomed Environ Sci.* 2020; 33(5):374-383.
- [4] How to improve public health personnel training [In Chinese]. China education daily. 25 March, 2020. 4th edition.
- [5] National Health Commission of the People's Republic of China. Statistical bulletin of health development in China (2009-2018) [In Chinese]. <http://www.nhc.gov.cn/wjw/gongb/list.shtml>. (Accessed 22 November 2020)
- [6] Lagarde M, Blaauw D. A review of the application and contribution of discrete choice experiments to inform human resources policy interventions. *Hum Resour Health.* 2009; 7:62.
- [7] Salampessy BH, Veldwijk J, Jantine Schuit A, van den Brekel-Dijkstra K, Neslo RE, Ardine de Wit G, et al. The Predictive Value of Discrete Choice Experiments in Public Health: An Exploratory Application. *Patient.* 2015; 8(6):521–9.
- [8] ORME BK. Getting started with conjoint analysis: strategies for product design and pricing research. 3rd edition. Madison: Research Publishers LLC, 2014: 1-234.
- [9] Marshall D, Bridges JF, Hauber B, Cameron R, Donnalley L, Fyie K, et al. Conjoint Analysis Applications in Health - How are Studies being Designed and Reported?: An Update on Current Practice in the Published Literature between 2005 and 2008. *Patient.* 2010;3(4):249-56.
- [10] de Bekker-Grob EW, Donkers B, Jonker MF, Stolk EA. Sample size requirements for discrete-choice experiments in healthcare: a practical guide. *Patient.* 2015;8(5):373–84.
- [11] Louviere JJ, Hensher DA, Swait JD. Stated choice methods: analysis and applications Cambridge: Cambridge University Press; 2000.
- [12] Louviere JJ, Lancsar E. Choice experiments in health: the good, the bad, the ugly and toward a brighter future. *Health Econ Policy Law.* 2009; 4(Pt 4):527-46.
- [13] Liu S, Li S, Li Y, Wang H, Zhao J, Chen G. Job preferences for healthcare administration students in China: A discrete choice experiment. *PLoS One.* 2019;14(1):e0211345.
- [14] Liu T, Li S, Yang R, Liu S, Chen G. Job preferences of undergraduate nursing students in eastern China: a discrete choice experiment. *Hum Resour Health.* 2019;17(1):1.
- [15] Mandeville KL, Lagarde M, Hanson K. The use of discrete choice experiments to inform health workforce policy: a systematic review. *BMC Health Serv Res.* 2014; 14:367.

- 1 [16] Ryan M, Kolstad J, Rockers P, Dolea C. How to Conduct a Discrete Choice Experiment for
2 Health Workforce Recruitment and Retention in Remote and Rural Areas: A User Guide with Case
3 Studies. Geneva: World Health Organization, World Bank, and CapacityPlus; 2012.
- 4 [17] Reed Johnson F, Lancsar E, Marshall D, Kilambi V, Mühlbacher A, Regier DA, et al.
5 Constructing experimental designs for discrete-choice experiments: report of the ISPOR conjoint
6 analysis experimental design good research practices task force. *Value Health*. 2013; 16(1):3-13.
- 7 [18] Kuhfeld WF. Experimental design, choice, conjoint, and graphical techniques. *Marketing*
8 *research methods in SAS*. Cary, NC, USA: SAS Institute Inc; 2005.
- 9 [19] Ryan M. A role for conjoint analysis in technology assessment in health care?. *Int J Technol*
10 *Assess Health Care*. 1999;15(03):443–57.
- 11 [20] Huber J, Zwerina K. The importance of utility balance in efficient choice designs. *J Mark Res*.
12 1996; 307–17.
- 13 [21] McFadden D, Train K. Mixed MNL models for discrete response. *J Appl Econ*. 2000;
14 15(5):447–70.
- 15 [22] Hauber AB, González JM, Groothuis-Oudshoorn CG, Prior T, Marshall DA, Cunningham C,
16 et al. Statistical Methods for the Analysis of Discrete Choice Experiments: A Report of the ISPOR
17 Conjoint Analysis Good Research Practices Task Force. *Value in health*. 2016; 19(4):300–15.
- 18 [23] Hensher DA. Accounting for scale heterogeneity within and between pooled data sources.
19 *Transp Res Pt A-Policy Pract*. 2012; 46(3):480–6.
- 20 [24] Hole AR, Kolstad JR. Mixed logit estimation of willingness to pay distributions: a comparison
21 of models in preference and WTP space using data from a health-related choice experiment. *Empir*
22 *Econ*. 2012; 42(2):445–69.
- 23 [25] WHO Guidelines Approved by the Guidelines Review Committee. Increasing Access to Health
24 Workers in Remote and Rural Areas Through Improved Retention: Global Policy
25 Recommendations. Geneva: World Health Organization; 2010.
- 26 [26] Zhang W, Jing WM, Wang YJ. What Determines the Talent Attractiveness of First-tier Cities?
27 Based on the Random Forest Algorithm of Influential Factors [In Chinese]. *Science and Technology*
28 *Management Research*. 2017; 37(22):99-108.
- 29 [27] Honda A, Vio F. Incentives for non-physician health professionals to work in the rural and
30 remote areas of Mozambique--a discrete choice experiment for eliciting job preferences. *Hum*
31 *Resour Health*. 2015; 13:23.
- 32 [28] Girardi SN, Carvalho CL, Maas LW, Araujo JF, Massote AW, Stralen ACSV, et, al. Preferences
33 for work in primary care among medical students in Minas Gerais State, Brazil: evidence from a
34 discrete choice experiment. *Cad Saude Publica*. 2017; 33(8):e00075316.
- 35 [29] Rockers PC, Jaskiewicz W, Kruk ME, Phathamavong O, Vangkonevilay P, Paphassarang C,
36 et al. Differences in preferences for rural job postings between nursing students and practicing
37 nurses: evidence from a discrete choice experiment in Lao People's Democratic Republic. *Hum*
38 *Resour Health*. 2013; 11:22.

- [30] Lin M. Pressure and anxiety of young people in contemporary China [In Chinese]. People's Tribune. 2019; (33):78-80.
- [31] Liu S, Li S, Yang R, Liu T, Chen G. Job preferences for medical students in China: A discrete choice experiment. *Medicine (Baltimore)*. 2018; 97(38):e12358.
- [32] Brodsgaard KE. Institutional reform and the Bianzhi system in China. *China Q*. 2002(170):361–86.
- [33] Blaauw D, Erasmus E, Pagaiya N, Tangcharoensathien V, Mullei K, Mudhune S, et al. Policy interventions that attract nurses to rural areas: a multicountry discrete choice experiment. *Bull World Health Organ*. 2010; 88(5):350-6.
- [34] Snow RC, Asabir K, Mutumba M, Koomson E, Gyan K, Dzodzomenyo M, et al. Key factors leading to reduced recruitment and retention of health professionals in remote areas of Ghana: a qualitative study and proposed policy solutions. *Hum Resour Health*. 2011; 9(13).
- [35] Edson C. Arau' joa, Akiko Maeda. How to Recruit and Retain Health Workers in Rural and Remote Areas in Developing Countries: A Guidance Note. World Bank: 2013.
- [36] The Editorial Department of Science and Technology Review. An Analysis of Career Expectations for PhD Graduates [In Chinese]. *Science and Technology Review*. 2008; 12:19-22.
- [37] Gautam B, Sapkota VP, Wagle RR. Employment preferences of obstetricians and gynecologists to work in the district hospitals: evidence from a discrete choice experiment in Nepal. *Hum Resour Health*. 2019;17(1):96.
- [38] Qi X, Wang Y, Xia L, Meng Y, Li Y, Yu S, et al. Cross-sectional survey on public health informatics workforce in China: issues, developments and the future. *Public Health*, 2015; 129, 1459–64.
- [39] Wu D, Shi Y, Wu S. Aspects prioritized by nursing undergraduates during choosing a position in grassroots medical institutions analyzed based on the discrete choice experiment [In Chinese]. *Chinese General Practice*, 2017; 20(30):3759-62.

1 **Figure legend**

2 Figure 1 Ranking job posting attributes according to their importance

3 Figure 2 Willingness to pay estimation for subgroup population

4 Figure 3 Simulated preferences for job posting under various potential policy scenarios. Changes in
5 the probabilities of taking a job, third-tier city versus first-tier city, as conditions in the third-tier city
6 job improve

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

26

27

28

29

30

Table 1 Attributes and attribute levels

Attribute	level	Description
Monthly income	10000 CNY	-----
	15000 CNY	
	20000 CNY	
	25000 CNY	
Working location	First-tier city	Represents the larger cities, like Beijing, Shanghai, Shenzhen, Guangzhou
	Second-tier city	Represents the medium-sized cities, like Qingdao, Xiamen
	Third-tier city	Represents the minor cities, like Weifang, Luoyang
Housing	No housing provision	-----
	Housing allowance provided	
	Housing provided	
Children' education condition	Normal	-----
	Good	
Career Promotion	1 year later	-----
	3 year later	
	5 year later	
Working environment	Common	Refers to management support, the relationship between superior and subordinate, amenities (such as regular bus, canteen and lounge), high-risk work environments and availability of equipment.
	Better	
	None	
<i>Bianzhi</i>	Offer	<i>Bianzhi</i> refers to the authorized number of personnel (the number of established posts) in a Party or government administrative organ (<i>jiguan</i>), a service organization (<i>shiye danwei</i>) or a working unit (<i>qiye</i>)

According to the Organisation for Economic Co-operation and Development (OECD) data (<https://data.oecd.org/conversion/exchange-rates.htm>), the average annual exchange rate between US\$ and CNY in 2019 was: US\$1 = CNY 6.908.

Table 2 Example combination of choice: Which of these jobs would you prefer?

Attributes/levels	Job 1	Job 2
Monthly income	25000 CNY	10000 CNY
Working location	Second-tier city	First-tier city
Housing	House provided	No house provided
Children' education condition	Normal	Good
Career Promotion	3 year	1 year
Working environment	Common	Better
<i>Bianzhi</i>	Offer	None
Which of these jobs would you prefer?		

Table 3 Respondent characteristics

	Full sample: n = 167		Analysis sample: n = 153		Excluded sample: n = 14		χ^2 (P-value)
	n	%	n	%	n	%	
Age(year), Mean \pm SD	28.8	4.5	28.8	4.5	29.1	3.5	
Gender							0.026(0.871)
Male	63	37.7	58	37.9	5	35.7	
Female	104	62.3	95	62.1	9	64.3	
Birthplace							
Rural	59	35.3	53	34.6	6	42.9	
Urban	108	64.7	100	65.4	8	57.1	
Marital status							0.529(0.912)
Unmarried	118	70.7	107	69.9	11	78.6	
Married	48	28.7	45	29.4	3	21.4	
Divorced/widow	1	0.6	1	0.7	0	0	
Monthly consumption (CNY)							3.465(0.629)
<1500	33	19.8	29	19.0	4	28.6	
1500-2500	70	41.9	65	42.5	5	35.7	
2500-3500	23	13.8	21	13.7	2	14.3	
3500-4500	14	8.4	14	9.2	0	0	
4500-5500	4	2.4	3	2.0	1	7.1	
>5500	23	13.8	21	13.7	2	14.3	
Annual family income (CNY)							2.865(0.826)
<50000	29	17.4	25	16.3	4	28.6	
50000-100000	39	23.4	36	23.5	3	21.4	
100000-150000	37	22.2	33	21.6	4	28.6	
150000-200000	22	13.2	21	13.7	1	7.1	
200000-250000	12	7.2	11	7.2	1	7.1	
250000-300000	8	4.8	8	5.2	0	0	
>300000	20	12.0	19	12.4	1	7.1	
Will you take a job related to your major after graduation?							0.971(0.615)
Yes	131	78.4	121	79.1	10	71.4	
No	3	1.8	3	2.0	0	0	
Not sure	33	19.8	29	18.9	4	28.6	
Career planning (multiple-choice: Times was selected)							
University or scientific research institution			126				
Hospital			63				
CDC			18				
Government agency			71				
Pharmaceutical company			39				
Others			6				

Table 4 Mixed logit estimates and WTP (n = 153)

Attributes and levels	β	SE	SD	SE	WTP (CNY)	95%CI	
Working location (ref: Third-tier city)							
Second-tier city	1.187***	0.165	1.054***	0.210	8282.2	6173.6	10818.3
First-tier city	1.687***	0.239	2.328***	0.315	11767.8	8637.1	15744.6
Housing (ref: No housing provision)							
Housing allowance	0.568***	0.135	0.051	0.203	3962.0	2194.3	5814.8
Housing provided	1.129***	0.159	-0.552**	0.220	7873.5	5879.8	10287.4
Condition for children’s education (ref: Normal)							
Good	0.555***	0.101	0.510**	0.170	3872.5	2500.1	5441.5
Career Promotion (ref: 5 year)							
3 year	0.320***	0.123	-0.040	0.224	2229.4	561.8	4030.6
1 year	0.719***	0.141	-0.666***	0.189	5016.8	3151.4	7135.0
Working environment (ref: Common)							
Better	0.401***	0.098	-0.234	0.236	2794.4	1499.1	4215.3
Bianzhi (ref: None)							
Offer	1.045***	0.132	-0.871**	0.155	7287.1	5558.1	9386.4
Income	0.0001434***	0.0000156	-0.000087**	0.0000168			
LR chi2(10)		177.08					
Number of observations		3672					
Log likelihood		-907.420					
AIC		1854.84					
BIC		1979.01					

* $P < 0.10$; ** $P < 0.05$; *** $P < 0.01$

Table 5 Subgroup analyses: Gender

Attributes and levels	Male (n=58)				Female (n=95)			
	β	SE	SD	SE	β	SE	SD	SE
Working location (ref: Third-tier city)								
Second-tier city	0.961***	0.281	1.119***	0.338	1.408***	0.218	-1.059***	0.241
First-tier city	1.397***	0.396	2.552***	0.511	2.097***	0.318	2.162***	0.340
Housing (ref: No housing provision)								
Housing allowance	0.498**	0.221	-0.0170	0.280	.670***	0.180	-0.140	0.332
Housing provided	1.024***	0.243	0.350	0.381	1.271***	0.223	0.855***	0.214
Condition for children's education (ref: Normal)								
Good	0.518***	0.164	0.279	0.412	0.601**	0.137	0.678***	0.187
Career Promotion (ref: 5 year)								
3 year	0.369*	0.207	-0.001	0.373	0.352**	0.160	0.033	0.272
1 year	0.953***	0.262	0.732**	0.336	0.692***	0.177	0.636**	0.291
Working environment (ref: Common)								
Better	0.425***	0.162	-0.069	0.450	0.450***	0.129	0.164	0.318
Bianzhi (ref: None)								
Offer	0.909***	0.241	1.002***	0.299	1.237***	0.172	-0.770***	0.172
Income	0.0001663***	0.0000291	-0.000109***	0.0000289	0.0001391***	0.0000188	0.0000857***	0.0000215
Log likelihood		-342.410				-552.949		
LR chi2(10)		82.99				103.75		
Number of observations		1392				2280		

* $P < 0.10$; ** $P < 0.05$; *** $P < 0.01$

Table 6 Subgroup analyses: Marital status

Attributes and levels	Unmarried (n=107)				Married (n=45)			
	β	SE	SD	SE	β	SE	SD	SE
Working location (ref: Third-tier city)								
Second-tier city	1.156***	0.200	1.082***	0.242	3.665***	1.218	-5.226**	2.129
First-tier city	1.654***	0.280	2.149***	0.324	7.713***	2.935	10.249**	3.985
Housing (ref: No housing provision)								
Housing allowance	0.623***	0.161	-0.019	0.204	2.115*	0.979	-1.107	0.675
Housing provided	0.969***	0.180	-0.609**	0.237	5.189***	1.904	2.175**	0.983
Condition for children's education (ref: Normal)								
Good	0.446***	0.111	0.408*	0.211	2.806***	1.055	1.470**	0.619
Career Promotion (ref: 5 year)								
3 year	0.126	0.140	-0.176	0.237	2.645**	1.059	1.423	0.896
1 year	0.608***	0.162	-0.672***	0.247	2.798***	0.925	3.467**	1.384
Working environment (ref: Common)								
Better	0.364***	0.115	0.288	0.283	1.518**	0.680	-2.067*	1.110
Bianzhi (ref: None)								
Offer	0.999***	0.142	0.597***	0.167	4.085**	1.588	5.422**	2.205
Income	0.0001506***	0.000019	0.0000937***	0.0000193	.0003818***	.0001431	0.000447**	0.0001792
Log likelihood		-637.526				-244.655		
LR chi2(10)		115.39				84.65		
Number of observations		2568				1080		

* $P < 0.10$; ** $P < 0.05$; *** $P < 0.01$

Table 7 Subgroup analyses: Birthplace

Attributes and levels	Rural (n=53)				Urban (n=100)			
	β	SE	SD	SE	β	SE	SD	SE
Working location (ref: Third-tier city)								
Second-tier city	0.705***	0.257	-0.993***	0.366	1.628***	0.266	1.390***	0.313
First-tier city	0.980***	0.334	1.781***	0.422	2.416***	0.387	2.977***	0.496
Housing (ref: No housing provision)								
Housing allowance	0.648**	0.231	-0.124	0.354	0.575***	0.190	-0.262	0.355
Housing provided	1.281***	0.282	-0.638	0.398	1.160***	0.220	0.622**	0.243
Condition for children's education (ref: Normal)								
Good	0.604***	0.196	0.485*	0.283	0.633***	0.139	-0.556***	0.198
Career Promotion (ref: 5 year)								
3 year	-0.047	0.208	0.122	0.415	0.554***	0.168	0.157	0.265
1 year	0.585**	0.271	1.006***	0.300	0.844***	0.183	-0.562**	0.264
Working environment (ref: Common)								
Better	0.588***	0.184	0.294	0.378	0.360***	0.132	-0.039	0.420
Bianzhi (ref: None)								
Offer	0.878***	0.229	0.979***	0.283	1.288***	0.192	-0.902***	0.195
Income	.0001826***	.0000343	-0.0001095***	0.0000295	0.0001463***	0.0000219	-0.0000841***	0.0000217
Log likelihood		-326.313				-405.08163		
LR chi2(10)		52.29				81.67		
Number of observations		1272				2400		

* $P < 0.10$; ** $P < 0.05$; *** $P < 0.01$

Table 8 Subgroup analyses: Annual family income

Attributes and levels	≤150000 CNY (n=94)				>150000 CNY (n=59)			
	β	SE	SD	SE	β	SE	SD	SE
Working location (ref: Third-tier city)								
Second-tier city	0.705***	0.257	1.066***	0.271	1.650***	0.310	1.101***	0.324
First-tier city	0.980***	0.334	2.399***	0.384	2.674***	0.484	2.341***	0.480
Housing (ref: No housing provision)								
Housing allowance	0.648**	0.231	-0.070	0.285	0.789***	0.235	-0.118	0.339
Housing provided	1.281***	0.282	-0.592**	0.294	1.063***	0.281	-0.604*	0.340
Condition for children's education (ref: Normal)								
Good	0.604***	0.196	-0.404	0.276	0.606***	0.183	-0.756***	0.271
Career Promotion (ref: 5 year)								
3 year	-0.047	0.208	0.104	0.267	0.507**	0.208	0.214	0.500
1 year	0.585**	0.271	0.711***	0.234	1.028***	0.252	0.879**	0.346
Working environment (ref: Common)								
Better	0.588***	0.184	0.408	0.239	0.418**	0.164	0.011	0.342
Bianzhi (ref: None)								
Offer	0.878***	0.229	1.024***	0.210	1.125***	0.217	0.674***	0.232
Income	0.0001826***	0.0000343	-0.0001037***	0.000024	0.0001223***	0.0000234	0.0000756***	0.0000239
Log likelihood		-555.680				-336.266		
LR chi2(10)		118.24				59.84		
Number of observations		2256				1416		

* $P < 0.10$; ** $P < 0.05$; *** $P < 0.01$

Figures

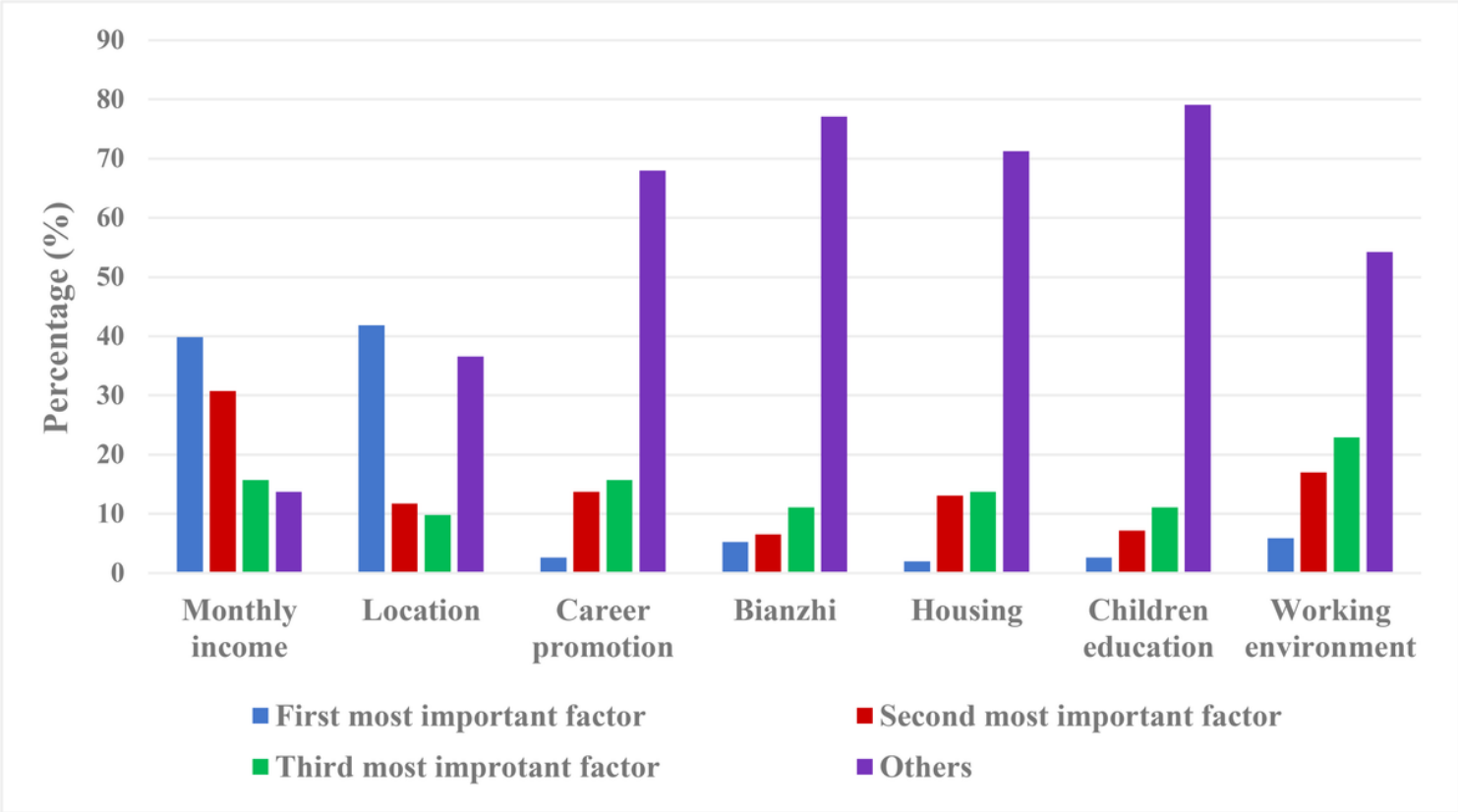


Figure 1

Ranking job posting attributes according to their importance

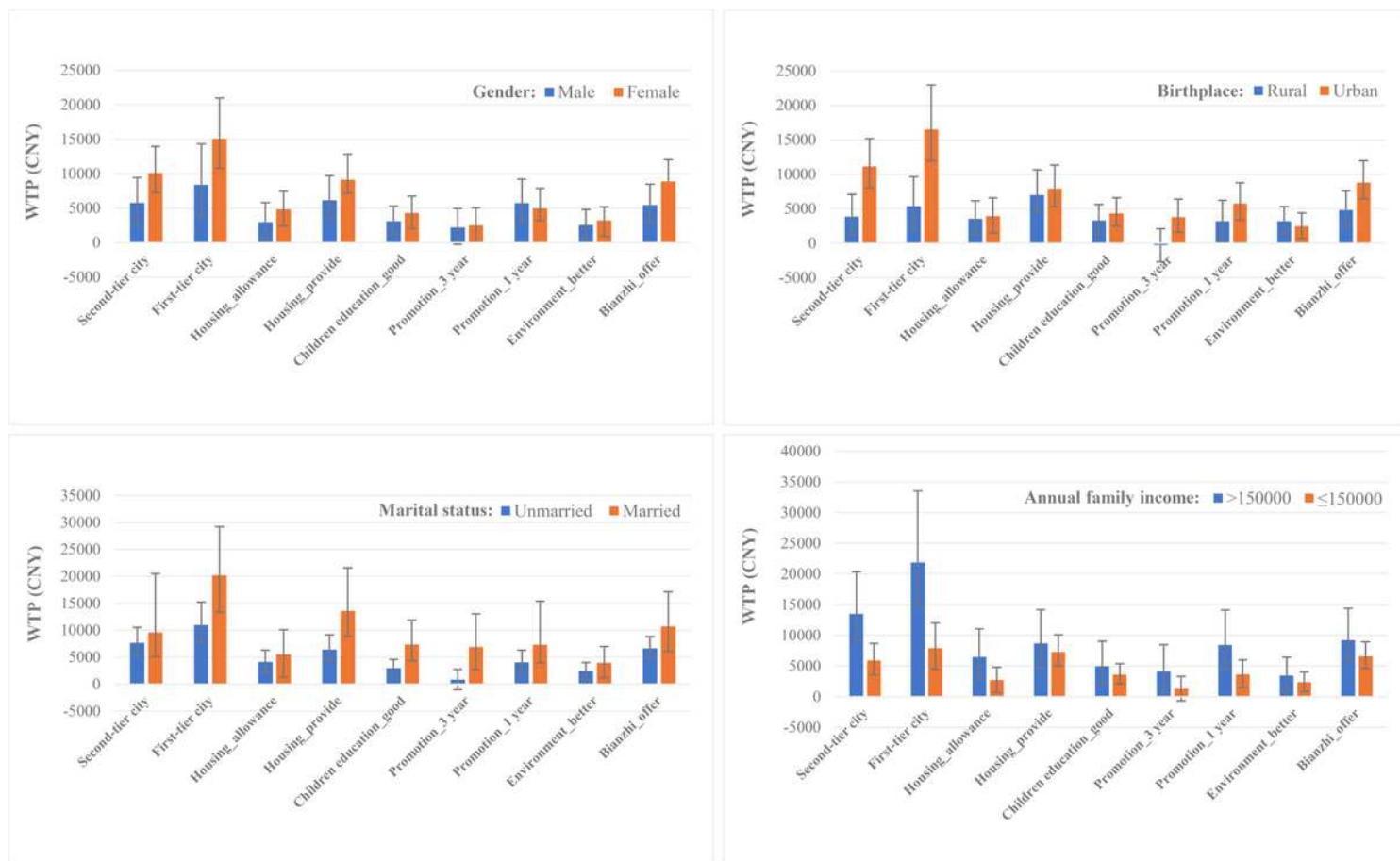


Figure 2

Willingness to pay estimation for subgroup population

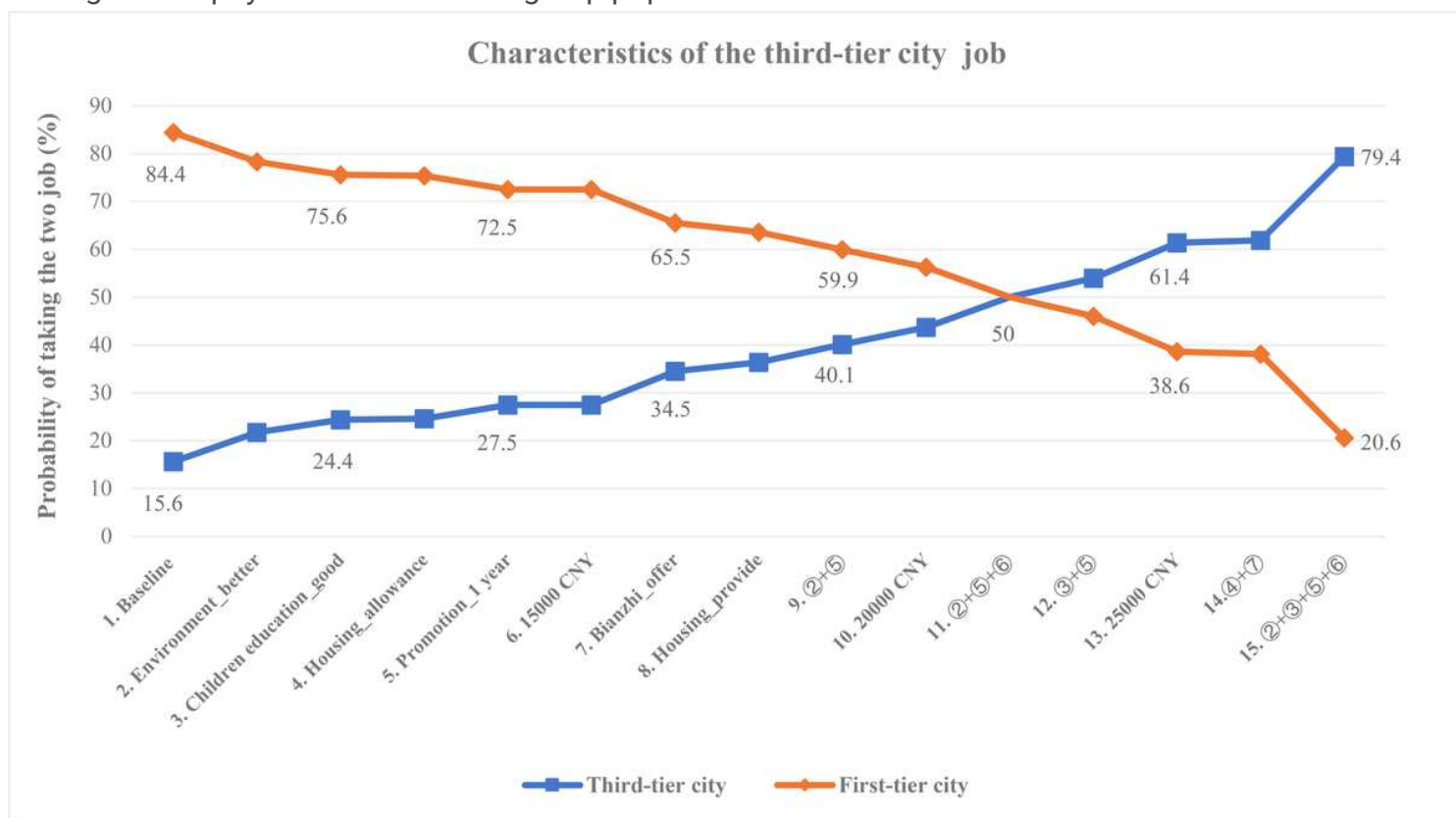


Figure 3

Simulated preferences for job posting under various potential policy scenarios. Changes in the probabilities of taking a job, third-tier city versus first-tier city, as conditions in the third-tier city job improve

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [renamed15901.docx](#)
- [renamedd0324.docx](#)