

BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open

Factors Influencing Subspecialty Choice Among Medical Students: A Systematic Review and Meta-analysis

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-022097
Article Type:	Research
Date Submitted by the Author:	03-Feb-2018
Complete List of Authors:	<p>Yang, Yahan; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology; Sun Yat-Sen University, Zhongshan School of Medicine</p> <p>Li, Jiawei; Sun Yat-Sen University, Zhongshan School of Mathematics</p> <p>Wu, Xiaohang; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology</p> <p>Wang, Jinghui; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology</p> <p>Li, Wangting; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology</p> <p>Zhu, Yi; University of Miami School of Medicine, Department of Molecular and Cellular Pharmacology; Sun Yat-Sen University Zhongshan Ophthalmic Center, Cataract</p> <p>Chen, Chuan; State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic Center, Sun Yat-sen University; University of Miami School of Medicine, Department of Molecular and Cellular Pharmacology</p> <p>Lin, Haotian; State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic Center, Sun Yat-sen University, Cataract</p>
Keywords:	Medical students, Career choice, Meta-analysis

SCHOLARONE™
Manuscripts

1
2
3
4 **Title Page**
5
6

7 **Factors Influencing Subspecialty Choice Among Medical Students: A Systematic**
8
9 **Review and Meta-analysis**
10

11
12 Yahan Yang, M.D.^{1,2}; Jiawei Li, M.D.³; Xiaohang Wu, M.D.¹; Jinghui Wang, M.D.¹;
13
14 Wangting Li, M.D.¹; Yi Zhu, M.D.^{1,4}; Chuan Chen, M.D.^{1,4}; Haotian Lin, M.D., Ph.
15
16 D^{1#}
17
18
19
20
21

22 **Institution:** 1. State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic
23
24 Center, Sun Yat-sen University, Guangzhou, Guangdong, 510060, People's Republic
25
26 of China
27

28
29
30 2. Zhongshan School of Medicine, Sun Yat-sen University, Guangzhou, China
31

32
33 3. Zhongshan School of Mathematics, Sun Yat-sen University, Guangzhou, China
34

35
36 4. Department of Molecular and Cellular Pharmacology, University of Miami Miller
37
38 School of Medicine, Miami, Florida 33136, USA.
39
40
41
42

43
44 **#Editorial Correspondence:**
45

46
47 Prof. Haotian Lin
48

49
50 Zhongshan Ophthalmic Center, Sun Yat-sen University
51
52

1
2
3
4 Xian Lie South Road 54#
5

6
7 Guangzhou, China, 510060.
8

9
10 Telephone number: +86-020-87330493
11

12
13 Fax: +86-020-87333271
14

15
16 E-mail: haot.lin@hotmail.com
17

18
19 Word count for text: 2947
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53

ABSTRACT

Objective To characterize the contributing factors that affect medical students' subspecialty choice and to estimate the extent of influence of individual factors on the students' decision-making process.

Design Systematic review and meta-analysis.

Methods A systematic search of the Cochrane Library, ERIC, Web of Science, CNKI and PubMed databases was conducted for studies published between January 1977 and October 2016. Information concerning study characteristics, influential factors, and the extent of their influence (EOI) was extracted independently by two trained investigators. EOI is the percentage level that describes how much each of the factors influenced students' choice of subspecialty. The estimates were pooled using a random-effects meta-analysis model due to the between-study heterogeneity.

Results Data were extracted from 72 studies (881,502 individuals). Overall, the factors influencing medical students' choice of subspecialty training mainly included academic interests (74.87%), competencies (55.15%), controllable lifestyles or flexible work schedules (53.06%), patient service orientation (49.35%), medical teachers or mentors (46.93%), career opportunities (44.00%), workload or working hours (37.92%), income (35.25%), length of training (32.30%), prestige (31.29%), advice from others (28.24%), and student debt (15.33%), with significant between-study heterogeneity

($P < 0.0001$). Subgroup analyses revealed that the EOI of academic interests was higher in developed countries than that in developing countries (79.30% [95% confidence interval (CI), 70.09%; 86.24%] vs. 60.41% [95% CI, 43.44%; 75.19%]; $Q = 3.37$ $P = 0.02$). The EOI value of prestige was lower in developed countries than that in developing countries (24.45% [95% CI, 19.46%; 30.25%] vs. 48.02% [95% CI, 32.40%; 64.03%]; $Q = 4.31$ $P = 0.01$).

Conclusions This systematic review and meta-analysis provided a quantitative evaluation of the top 12 influencing factors associated with medical students' choice of subspecialty. Our findings provide the basis for the development of specific, effective strategies to optimize the distribution of physicians among different departments by modifying these influencing factors.

Systematic review registration PROSPERO CRD42017053781.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- Our research emphasize that a reliable estimate of the factors associated with medical students' subspecialty choice is critical to obtaining a better understanding of students' perceptions, and the findings of the present study can facilitate the development of intervention strategies tailored to the needs of various healthcare systems.
- A large number of studies conducted in varied populations have been included.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- The differences in the characteristics of country, survey years, specialty, the type of data used and sample size across studies represent a major limitation of our study.

KEYWORDS Medical students, career choice, meta-analysis

For peer review only

Introduction

Medical students' choice of subspecialty represents the process that students' majored in medicine decide to choose a medical specialty, such as pediatrics and surgery, and their sub-discipline, such as nephrology and neurosurgery. With the development of the social economy and the improvement in people's living standards, the demand for physicians continues to increase; however, an imbalance in the supply of physicians in different subspecialties has become a growing concern in both developed and developing countries.^{1 2} Some subspecialties, such as family medicine and palliative medicine,^{3 4} are experiencing a desperate shortage of physicians, whereas other subspecialties, such as cardiology, ophthalmology and ear, nose and throat (ENT) surgery, require several years of training before admission due to intense competition.^{5 6}

Specialty choice is the product of a complex interconnection of student expectation, department expectation, and competition for available spots, and student choice is where the choice begins.⁷ Previous studies have suggested that medical students' choice of subspecialty is essential to the maintenance of an adequate medical workforce and a balanced development of the medical system.^{8 9} However, the influencing factors underlying students' subspecialty choice have not been systemically reviewed. Recent changes in the training and practice environment may influence medical students' career choice.¹⁰ Additionally, the variability in preferences over time and in students' attitudes towards career choices can further complicate this assessment. For example, a study in the UK indicated that half of the

1
2
3
4 medical students made a definitive subspecialty choice during their first year of
5
6 medical school.¹¹ However, students were prone to changing their subspecialty
7
8 preference during medical school and internship.¹² Notably, students may also reject
9
10 certain subspecialties during their medical school training, even those they have
11
12 previously seriously considered.¹³ Therefore, identifying the factors that influence
13
14 students' choice of subspecialty will enable a better understanding of the current
15
16 shortage/overload of physicians in specific fields and contribute to policy-building
17
18 and decision-making to improve the training and recruitment of students in the future.
19
20

21
22 We thus conducted a systematic review and a meta-analysis to investigate the
23
24 influencing factors and the extent of their influence on the choice of subspecialty
25
26 training among medical students. More specifically, we focused on the following
27
28 questions. First, can we gain a better understanding of students' preferences for
29
30 medical specialty according to the primary influencing factor? Second, do the
31
32 subgroups according to world region and survey years examined in this study differ
33
34 significantly with regard to the weight that students place on the identified
35
36 influencing factor?
37
38

39 40 **Methods**

41 42 **Search Strategy and Study Eligibility**

43
44 Cross-sectional studies published between January 1977 and October 2016 that
45
46 reported on factors influencing medical students' choice of subspecialty were
47
48 identified using the Cochrane Library, Medline, Web of Science, CNKI and ERIC
49
50
51
52

1
2
3
4 databases. Articles were screened by title, abstract and reference list, and by
5
6 correspondence with study investigators using the approach recommended by the
7
8 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)
9
10 guidelines (**Fig. S1**).¹⁴ Potentially relevant papers were first identified by reviewing
11
12 the titles and abstracts, and the full text of each retrieved article was then assessed.
13
14 The search strategy is shown in **Methods S1**. Studies were included if they reported
15
16 data on medical students, were published in peer-reviewed journals, and used a
17
18 validated method to assess the extent of a factor's influence on the choice of
19
20 subspecialty.
21
22

23 24 **Data Extraction and Quality Assessment**

25
26
27 The following information was independently extracted from each article by 2 trained
28
29 investigators (Y.Y. and J.L.) using a standardized form: study design, geographic
30
31 location, years of survey, journal, sample size, average age of the participants, the
32
33 number and percentage of male participants, and the influencing factors and the
34
35 extent of their influence. Each study may involve one or several influencing factors.
36
37 The Newcastle-Ottawa Scale (NOS) recommended by the Agency for Healthcare
38
39 Research and Quality (AHRQ), available at
40
41 http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp, were used to assess
42
43 the quality of the studies. All discrepancies were resolved via discussion and
44
45 consensus.
46
47
48
49

50 **Statistical Analysis**

1
2
3
4 As considerable heterogeneity was expected because of the multiple sources of
5
6 variances, a random effects meta-analysis model was used to estimate the influencing
7
8 factors and the extent of their influence.¹⁵ Between-study heterogeneity was assessed
9
10 using the I^2 statistic, which was calculated to describe the percentage of total
11
12 variation caused by heterogeneity across studies, with $\geq 50\%$ indicating considerable
13
14 heterogeneity.^{16 17} Potential sources of heterogeneity were identified using
15
16 meta-regression.¹⁸ Subgroup analyses were performed for each factor in the studies in
17
18 developed countries vs. developing countries and studies conducted before 2010 vs.
19
20 after 2010. The EOI value of competencies in developing countries was not
21
22 statistically significant (81.21% [95% CI, 75.27%; 86.51%], $P=0.1436$), and no
23
24 studies on the influence of student debt in developing countries were found. The
25
26 Q-test based on the analysis of variance was used to compare the subgroups, with a
27
28 significance threshold of 5%.¹⁹ The influence of individual studies on the overall EOI
29
30 value was explored by serially excluding each study in a sensitivity analysis.
31
32 Publication bias was investigated using a funnel plot test and Egger's test.^{20 21} All
33
34 analyses were performed using R (version 3.3.1, The R Foundation, Vienna, Austria).
35
36 The statistical tests were 2-sided with a significance threshold of $P<0.05$.
37
38
39
40
41

42 **Results**

43 **Study Characteristics**

44
45 Seventy-two studies involving a total of 881,502 individuals were included in the
46
47 present research (**Table 1**). Thirty-three studies were conducted in North America, 23
48
49 in Europe, 6 in Asia, 5 in Oceania, 3 in Africa, and 2 in South America. The median
50
51
52
53
54

1
2
3
4 number of participants per study was 254.5 (range 37-29,227). Thirteen studies
5
6 included students who had already selected subspecialties, whereas 59 did not. The
7
8 influencing factors for subspecialty choice were classified according to 17 aspects,
9
10 including academic interests, controllable lifestyle or flexible work schedule (defined
11
12 as flexibility that allows physicians to control the number of hours devoted to
13
14 practicing the specialty), competencies, patient service orientation, medical teachers
15
16 or mentors, career opportunities, workload or working hours (characterized by the
17
18 physician's time spent on professional responsibilities), income, prestige, length of
19
20 training, advice from others (advice from family, friends, and other students), student
21
22 debt, experience with the subject, working environment, personality, gender and job
23
24 security. The influencing factors were ranked according to the frequency of
25
26 occurrence and each factor was identified when at least 5 papers were available
27
28 describing it. Personality and gender are common factors that affect the choice of
29
30 subspecialty among medical students, but most of the relevant literature has not
31
32 reported on the extent of these factors' influence. Moreover, the funnel plots were
33
34 clearly asymmetrical with regard to experience with the subject, the working
35
36 environment and job variety, indicating the existence of publication bias. Thus, the
37
38 analysis of the remaining 12 influencing factors were shown in this paper. Quality
39
40 assessment scores for the included studies are listed in **Table 1**. None of the studies
41
42 received a point for the second AHRQ Quality Indicator, which requires studies to list
43
44 the inclusion and exclusion criteria for exposed and unexposed subjects (cases and
45
46 controls) or refer to previous publications, since no comparison studies were
47
48 referenced in the analyzed articles. For the remaining 10 criteria, 6 studies received 9
49
50
51
52
53

1
2
3
4 points, 8 studies received 8 points, 17 studies received 7 points, 32 studies received 6
5
6 points, 7 studies received 5 points and 2 studies received 4 points (scores for
7
8 individual studies are presented in **Table S1**).
9

10 11 **Primary Analysis**

12
13
14 A meta-analysis was performed on the 12 influencing factors (**Table 2**): academic
15 interests (**Fig. S2**), competencies (**Fig. S3**), controllable lifestyle or flexible work
16 schedule (**Fig. S4**), patient service orientation (**Fig. S5**), medical teachers or mentors
17 (**Fig. S6**), career opportunities (**Fig. S7**), workload or working hours (**Fig. S8**),
18 income (**Fig. S9**), length of training (**Fig. S10**), prestige (**Fig. S11**), advice from
19 others (**Fig. S12**) and student debt (**Fig. S13**). All the factors were significant with
20 evidence of between-study heterogeneity ($P < 0.0001$). A sensitivity analysis, in which
21 the meta-analysis was serially repeated after the exclusion of each study,
22 demonstrated that no individual study affected the overall extent of a factor's
23 influence.
24
25
26
27
28
29
30
31
32
33
34
35
36

37 **Meta-regression and Subgroup Analysis**

38
39
40 Using common instructions when at least 5 studies were available and at least 2
41 studies were in each comparator subgroup, four categorical covariates were identified
42 as potential sources of heterogeneity by examining the studies conducted in the
43 United States (US) vs. the studies conducted in other countries, the studies conducted
44 before 2010 vs. those conducted after 2010, the studies concerning subspecialty only
45 vs. those that were not specific to a subspecialty, and the studies with a sample size
46
47
48
49
50
51
52

1
2
3
4 <200 vs. the studies with a sample size ≥ 200 (**Table 3**). Some of the heterogeneities
5
6 observed among the 12 factors can be partially explained by country, survey years,
7
8 specialty and sample size.
9

10
11 EOI values were further analyzed by subgroup (**Table S2**) according to world region
12
13 (**Fig. 1**) and survey year (**Fig. 2**). The EOI value of academic interests in developed
14
15 countries was higher than that in developing countries (79.30% [95% CI, 70.09%;
16
17 86.24%] vs. 60.41% [95% CI, 43.44%; 75.19%]; $Q=3.37$ $P=0.02$). Conversely, a
18
19 lower EOI value of prestige was found in studies conducted in developed countries
20
21 than in developing countries (24.45% [95% CI, 19.46%; 30.25%] vs. 48.02% [95%
22
23 CI, 32.40%; 64.03%]; $Q=4.31$ $P=0.01$). No statistically significant subgroup
24
25 differences in the EOI values of the other influencing factors were noted between
26
27 developed countries and developing countries. In addition, no statistically significant
28
29 differences in the EOI values of the influencing factors were observed when
30
31 subgroup analysis was performed by survey year.
32
33
34
35

36 **Assessment of Publication Bias**

37
38
39 We generated a funnel plot with proportion as the abscissa and standard error as the
40
41 ordinate. A visual inspection of the funnel plots revealed minimal asymmetry among
42
43 the various influencing factors (**Fig. S14**), and the results were concentrated in the
44
45 narrow upper part of the graph. However, there was evidence of small study effect in
46
47 the meta-analysis of “patient service orientation” (Egger’s test $P=0.02$).
48
49

50 **Discussion**

Implications

This systematic review and meta-analysis involved 72 studies with 881,502 medical students. Twelve influencing factors were analyzed. These factors can be classified into two categories: economic factors and non-economic factors. We found that the EOI of the economic factors, including income (35.25%) and student debt (15.33%), may not depend on the region's level of economic development. However, income remained a major influencing factor in the process of choosing a subspecialty. In the US, 15% of full-time family medicine physicians earned less than \$100,000 in 2004, which is significantly less than the income earned by invasive cardiologists (median income=\$427,815), neurosurgeons (median income=\$211,094), and orthopedists (median income=\$335,646).²² This economic inequality made family medicine less attractive to medical school graduates.²³ Benefits such as health insurance and tuition reimbursement have been shown to be the most common economic incentives used to attract applicants.²⁴

The non-economic factors can be divided into individual factors, specialty-related factors and others. First, individual factors, including academic interest and competencies, have a considerable impact on students' subspecialty choice, with EOI values of 74.87% and 55.15%, respectively. In addition, in the subgroup analysis, although academic interests were less influential in developing countries than in developed countries (79.30% [95% CI, 70.09%; 86.24%] vs. 60.41% [95% CI, 43.44%; 75.19%]; $Q=3.37$ $P=0.02$), they were still the most influential of the 12 factors regardless of regional economic level. These findings indicate that

1
2
3
4 subspecialties with a shortage of manpower may attract more students by increasing
5
6 students' interests and improving the quality of education. Previous studies indicated
7
8 that early subspecialty exposure in medical education may arouse students' academic
9
10 interest and improve their clinical competence.^{23 25} For example, an elective
11
12 extracurricular program designed to facilitate early contact with family medicine
13
14 physicians was found to significantly improve students' interest and clinical skills,
15
16 especially communication skills, in family medicine.²⁶ Furthermore, dispelling myths
17
18 and espousing the positive aspects of a discipline may provide a better understanding
19
20 of certain subspecialties; this approach could also be effective in increasing students'
21
22 academic interest.²⁷ For instance, family medicine is often considered a discipline
23
24 that requires less professional skills and knowledge. This misconception demotivates
25
26 students from choosing family medicine as their future career subspecialty, and this
27
28 trend may eventually lead to a shortage of family physicians.²⁷ Eliminating such
29
30 prejudices may help students pay greater attention to the areas in short supply and
31
32 restore their interests in other specialties.
33
34
35

36
37
38 Second, the specialty-related factors included controllable lifestyle/flexible work
39
40 schedule (EOI of 53.06%), career opportunities (EOI of 44.00%), workload (EOI of
41
42 37.92%) and training length (EOI of 32.30%). Of these factors, lifestyle varied
43
44 between different areas. Additionally, although certain specialties, such as general
45
46 surgery, seem to have an adequate number of surgeons on a per capita basis in the US,
47
48 there is still a poor geographic distribution within the surgical workforce according to
49
50 the type of surgical practice.²⁸ The inflexible lifestyle is a common reason that
51
52
53

1
2
3
4 students perceive surgery to be less attractive.²⁸ Reorganization of expected work
5
6 hours within shared practices and the increased use of physician extenders and
7
8 technologies such as electronic medical records may give physicians more flexibility
9
10 in work schedules.²⁹ Moreover, providing promotion opportunities and shortening the
11
12 length of training are possible strategies to recruit new staff in subspecialties that
13
14 require a long period of post-graduate residency training, such as neurosurgery.³⁰

15
16
17
18 Finally, other factors such as service orientation (EOI of 49.35%), medical teachers
19
20 or mentors (EOI of 46.93%), prestige (EOI of 31.29%), and advice from others (EOI
21
22 of 28.24%) also contribute to the decision-making process of medical students. For
23
24 example, the desire to care for patients with end-stage diseases contributed to the
25
26 decision to enter palliative medicine in 86% of the medical students.⁴ Additionally,
27
28 exposure to mentors in a particular clinical field such as internal medicine has been
29
30 strongly associated with medical students' choice of clinical field.³¹ Moreover,
31
32 improving the occupational prestige of areas such as family medicine, pathology, and
33
34 radiology may help reshape the distribution of the workforce.^{25 32 33}

35
36
37
38 In our study, several findings are especially noteworthy. First, interest was far more
39
40 important than income in deciding subspecialty. In our study, interest was the
41
42 top-ranked influencing factor (EOI of 74.87%) of subspecialty choice, while income
43
44 was ranked lower (EOI of 35.25%). This finding argues against the possible default
45
46 belief that raising physician's wages alone could solve the uneven distribution of
47
48 clinicians among subspecialties. Our findings highlight that cultivating and
49
50 stimulating students' professional interests may help improve the maldistribution of
51
52

1
2
3
4 medical resources in a more efficient and cost-saving manner.
5
6

7 Second, improving abilities in a certain subspecialty of interest can greatly affect
8 medical students' professional choice. In our study, competencies ranked second in
9 influence, which may reflect the impact of admission conditions on students' choice
10 of subspecialty. Hence, to reduce the risk that students are restricted to the
11 subspecialty of their interest due to a lack of personal skills, medical education
12 should focus more on enhancing students' personal competencies in addition to their
13 academic interests.
14
15
16
17
18
19
20
21
22

23 Third, balancing medical resources is a complex process in practical terms, as the
24 influencing factors are not mutually exclusive. The shortage of physicians in certain
25 subspecialties may increase physician workload, resulting in less time for teaching.
26 Hence, the quality of teaching cannot be guaranteed, and students may tend to avoid
27 choosing these subspecialties, thus worsening the imbalance in the medical
28 workforce. Additionally, some of the 12 factors identified are not amenable to
29 practical interventions. For example, prestige cannot be immediately increased using
30 interventional strategies.³² Overall, effective strategies must be multi-pronged and
31 incorporate several different aspects, and maldistribution in the workforce should not
32 be tackled through a simple adjustment of one influencing factor.
33
34
35
36
37
38
39
40
41
42
43
44

45 **Interpretations of the results of this meta-analysis**

46
47
48 Our meta-regression stratified by the study-level characteristics found that country,
49 survey years, subspecialty and sample size may contribute to the heterogeneity
50
51
52

1
2
3
4 between studies. There was no significant difference in the sensitivity analysis, which
5 indicated that the results of the meta-analysis were convincing. The funnel plots and
6
7 Egger's tests revealed that most of the publication bias was small ($P>0.05$), except
8
9 for the meta-analysis of "patient service orientation". Moreover, the majority of the
10
11 studies collected in the database were from developed countries rather than
12
13 developing countries.
14
15

16 17 18 **Limitations**

19
20 Several limitations should be considered when interpreting the findings of this study.
21
22 First, the students involved in our study included medical students at different stages
23
24 of their medical education. Students' perception about different subspecialties may
25
26 change during medical training. For example, compared to an intern, a freshman
27
28 student may place greater emphasis on income and prestige when considering a
29
30 career choice.³⁴ Second, our meta-analysis summarized the data from different
31
32 geographic regions around the world, and the general conclusions may not be
33
34 appropriate to guide policy development in each region. Enhanced effort is needed to
35
36 develop specific intervention strategies according to the specific medical career grade,
37
38 economic level, religious beliefs, healthcare system, educational system and endemic
39
40 diseases of different countries and regions. Third, the surveys in the various studies
41
42 were also conducted using different methods. Most of the questionnaires used a
43
44 Likert scale. Therefore, when we converted the results to a percentage representing
45
46 the extent of a factor's influence, the Likert scale items were treated as interval
47
48 data.³⁵⁻³⁷ Consequently, there may have been differences in the conversion process.
49
50
51
52

1
2
3
4 Fourth, a secondary meta-analysis of longitudinal studies may better reflect changes
5
6 in influencing factors and the extent of their influence over time. Finally, the analysis
7
8 relied on aggregated published data. A multicenter prospective study would provide a
9
10 more accurate estimate of the influencing factors and the extent of their influence on
11
12 medical students' choice of subspecialty.
13
14

15 **Conclusion**

16
17
18 In conclusion, this systematic review and meta-analysis provided a summary
19
20 evaluation of 12 influencing factors and the extent of their influence on the choice of
21
22 subspecialty training among medical students. Understanding students' attitudes
23
24 toward their subspecialty decision-making process could provide the basis for
25
26 developing strategies to increase the attractiveness of subspecialties experiencing a
27
28 shortage of manpower, thereby balancing the distribution of medical recourses.
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4 **Contributors:** Haotian Lin contributed to the conceptualising and design of the study,
5
6 and to research funding, coordinated the research and oversaw the project. Yahan
7
8 Yang, Jiawei Li and Xiaohang Wu contributed to data collection and interpretation,
9
10 and to data analysis. Jinghui Wang, Yi Zhu, Chuan Chen and Wangting Li contributed
11
12 to the design of the study. All authors contributed to the drafting and revision of the
13
14 paper and approved the final manuscript for publication.
15
16

17
18 **Funding:** The principal investigator of this study (Haotian Lin) is currently
19
20 supported by the Pearl River Scholar Program of Guangdong Province, the
21
22 Outstanding Young Teacher Cultivation Projects in Guangdong Province
23
24 (YQ2015006), and the Guangdong Provincial Natural Science Foundation for
25
26 Distinguished Young Scholars of China (2014A030306030). These sponsors and
27
28 funding organizations had no role in the design or performance of this study.
29
30

31
32 **Competing Interests:** The authors declare no competing financial interests.
33
34

35 **Data sharing:** No additional data available.
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

References

1. Zurn P, Dal Poz MR, Stilwell B, et al. Imbalance in the health workforce. *Hum Resour Health* 2004;2(1):13. doi: 10.1186/1478-4491-2-13
2. Diallo K, Zurn P, Gupta N, et al. Monitoring and evaluation of human resources for health: an international perspective. *Hum Resour Health* 2003;1(1):3. doi: 10.1186/1478-4491-1-3
3. Bodenheimer T. Primary care--will it survive? *N Engl J Med* 2006;355(9):861-4. doi: 10.1056/NEJMp068155
4. LeGrand SB, Heintz JB. Palliative Medicine Fellowship: A Study of Resident Choices. *Journal of Pain and Symptom Management* 2012;43(3):558-68. doi: 10.1016/j.jpainsymman.2011.04.018
5. Kim YY, Kim UN, Kim YS, et al. Factors associated with the specialty choice of Korean medical students: a cross-sectional survey. *Human Resources for Health* 2016;14:8. doi: 10.1186/s12960-016-0141-8
6. McNally SA. Competition ratios for different specialties and the effect of gender and immigration status. *J R Soc Med* 2008;101(10):489-92. doi: 10.1258/jrsm.2008.070284
7. Reed VA, Jernstedt GC, Reber ES. Understanding and improving medical student specialty choice: a synthesis of the literature using decision theory as a referent. *Teach Learn Med* 2001;13(2):117-29. doi: 10.1207/S15328015TLM1302_7
8. Al-Ansari SS, Khafagy MA. FACTORS AFFECTING THE CHOICE OF HEALTH SPECIALTY BY MEDICAL GRADUATES. *Journal of Family & Community Medicine* 2015;13(3):119-23.
9. Leduc N, Vanasse A, Scott I, et al. The career decision-making process of medical students and residents and the choice of specialty and practice location: how does Postgraduate Medical Education fit in? 2011
10. Delamothe T. Modernising Medical Careers: final report. *BMJ* 2008;336(7635):54-55.
11. Goldacre MJ, Laxton L, Harrison EM, et al. Early career choices and successful career progression in surgery in the UK: prospective cohort studies. *Bmc Surgery* 2010;10:11. doi: 10.1186/1471-2482-10-32
12. Weissman C, Zisk-Rony RY, Schroeder JE, et al. Medical specialty considerations by medical students early in their clinical experience. *Isr J Health Policy Res* 2012;1(1):13. doi: 10.1186/2045-4015-1-13
13. Jackson C, Ball J, Hirsh W, et al. Informing choices: the need for career advice in medical training. *Cambridge: National institute for careers Education and Counseling* 2003
14. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *J Clin Epidemiol* 2009;62(10):1006-12. doi: 10.1016/j.jclinepi.2009.06.005
15. Borenstein M, Hedges LV, Higgins JP, et al. A basic introduction to fixed-effect and random-effects models for meta-analysis. *Res Synth Methods* 2010;1(2):97-111. doi: 10.1002/jrsm.12
16. Higgins JP, Thompson SG, Deeks JJ, et al. Measuring inconsistency in meta-analyses. *BMJ* 2003;327(7414):557-60. doi: 10.1136/bmj.327.7414.557
17. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med* 2002;21(11):1539-58. doi: 10.1002/sim.1186
18. Sterne JA, Juni P, Schulz KF, et al. Statistical methods for assessing the influence of study characteristics on treatment effects in 'meta-epidemiological' research. *Stat Med* 2002;21(11):1513-24. doi: 10.1002/sim.1184

19. Borenstein M, Hedges LV, Higgins J, et al. Criticisms of meta-analysis. *Introduction to meta-analysis* 2009;377-87.
20. Egger M, Davey Smith G, Schneider M, et al. Bias in meta-analysis detected by a simple, graphical test. *BMJ* 1997;315(7109):629-34.
21. Sterne JA, Egger M. Funnel plots for detecting bias in meta-analysis: guidelines on choice of axis. *J Clin Epidemiol* 2001;54(10):1046-55.
22. Bodenheimer T, Berenson RA, Rudolf P. The primary care-specialty income gap: why it matters. *Annals of internal medicine* 2007;146(4):301-6.
23. Bodenheimer T, Pham HH. Primary care: current problems and proposed solutions. *Health Aff (Millwood)* 2010;29(5):799-805. doi: 10.1377/hlthaff.2010.0026
24. Association AH. The hospital workforce shortage: Immediate and future. *Trend Watch* 2001;3(2):1-8.
25. Compton MT, Frank E, Elon L, et al. Changes in US medical students' specialty interests over the course of medical school. *Journal of General Internal Medicine* 2008;23(7):1095-100. doi: 10.1007/s11606-008-0579-z
26. Indyk D, Deen D, Fornari A, et al. The influence of longitudinal mentoring on medical student selection of primary care residencies. *BMC medical education* 2011;11(1):27.
27. Gill H, McLeod S, Duerksen K, et al. Factors influencing medical students' choice of family medicine Effects of rural versus urban background. *Canadian Family Physician* 2012;58(11):E649-E57.
28. Richardson JD. Workforce and lifestyle issues in general surgery training and practice. *Archives of surgery (Chicago, Ill : 1960)* 2002;137(5):515-20.
29. Newton DA, Grayson MS, Thompson LF. The variable influence of lifestyle and income on medical students' career specialty choices: data from two U.S. medical schools, 1998-2004. *Academic medicine : journal of the Association of American Medical Colleges* 2005;80(9):809-14.
30. Orrico K. Ensuring an adequate neurosurgical workforce for 21st century. *Surgeons Aaon* 2012
31. Wright SM, Wong A, Newill CA. The impact of role models on medical students. *Journal of General Internal Medicine* 1997;12(1):53-56.
32. Glazer GM, Ruiz-Wibbelsmann JA. Decades of perceived mediocrity: prestige and radiology. *Radiology* 2011;260(2):311-16.
33. Schwartzbaum AM, McGrath JH, Rothman RA. The perception of prestige differences among medical subspecialties. *Soc Sci Med* 1973;7(5):365-71.
34. Parsa S, Aghazadeh A, Nejatiasafa AA, et al. Freshmen versus Interns' Specialty Interests. *Archives of Iranian Medicine* 2010;13(6):509-15.
35. Komorita SS. Attitude Content, Intensity, and the Neutral Point on a Likert Scale. *J Soc Psychol* 1963;61:327-34. doi: 10.1080/00224545.1963.9919489
36. Baggaley AR, Hull AL. The effect of nonlinear transformations on a Likert scale. *Eval Health Prof* 1983;6(4):483-91.
37. Norman G. Likert scales, levels of measurement and the "laws" of statistics. *Advances in health sciences*

- education : theory and practice 2010;15(5):625-32. doi: 10.1007/s10459-010-9222-y
38. Smith F, Lambert TW, Goldacre MJ. Factors influencing junior doctors' choices of future specialty: trends over time and demographics based on results from UK national surveys. *Journal of the Royal Society of Medicine* 2015;108(10):396-405. doi: 10.1177/0141076815599674
39. Cochran A, Melby S, Neumayer LA. An Internet-based survey of factors influencing medical student selection of a general surgery career. *American Journal of Surgery* 2005;189(6):742-46. doi: 10.1016/j.amjsurg.2005.03.019
40. Hauer KE, Durning SJ, Kernan WN, et al. Factors associated with medical students' career choices regarding internal medicine. *Jama-Journal of the American Medical Association* 2008;300(10):1154-64. doi: 10.1001/jama.300.10.1154
41. Johnson AL, Sharma J, Chinchilli VM, et al. Why do medical students choose orthopaedics as a career? *The Journal of bone and joint surgery American volume* 2012;94(11):e78. doi: 10.2106/jbjs.k.00826 [published Online First: 2012/05/29]
42. Kiolbassa K, Miksch A, Hermann K, et al. Becoming a general practitioner - Which factors have most impact on career choice of medical students? *Bmc Family Practice* 2011;12:7. doi: 10.1186/1471-2296-12-25
43. Klingensmith ME, Cogbill TH, Luchette F, et al. Factors Influencing the Decision of Surgery Residency Graduates to Pursue General Surgery Practice Versus Fellowship. *Annals of Surgery* 2015;262(3):449-55. doi: 10.1097/sla.0000000000001435
44. Lee JY, Kerbl DC, McDougall EM, et al. Medical Students Pursuing Surgical Fields Have No Greater Innate Motor Dexterity than Those Pursuing Nonsurgical Fields. *Journal of Surgical Education* 2012;69(3):360-63. doi: 10.1016/j.jsurg.2011.11.005
45. Macdonald C, Cawood T. Factors influencing career decisions in internal medicine. *Internal Medicine Journal* 2012;42(8):918-23. doi: 10.1111/j.1445-5994.2012.02793.x
46. Paiva RE, Vu NV, Verhulst SJ. The effect of clinical experiences in medical school on specialty choice decisions. *J Med Educ* 1982;57(9):666-74.
47. Ni Chroinin D, Cronin E, Cullen W, et al. Would you be a geriatrician? Student career preferences and attitudes to a career in geriatric medicine. *Age Ageing* 2013;42(5):654-7. doi: 10.1093/ageing/af093 [published Online First: 2013/08/07]
48. Rogers LQ, Fincher RM, Lewis LA. Factors influencing medical students to choose primary care or non-primary care specialties. *Academic medicine : journal of the Association of American Medical Colleges* 1990;65(9 Suppl):S47-8.
49. Abendroth J, Schnell U, Lichte T, et al. Motives of former interns in general practice for speciality-choice--results of a cross-sectional study among graduates 2007 to 2012. *GMS Zeitschrift für medizinische Ausbildung* 2014;31(1):Doc11. doi: 10.3205/zma000903 [published Online First: 2014/02/28]
50. Alawad A, Khan WS, Abdelrazig YM, et al. Factors considered by undergraduate medical students when selecting specialty of their future careers. *Pan African Medical Journal* 2015;20:6. doi: 10.11604/pamj.2015.20.102.4715
51. Azizzadeh A, McCollum CH, Miller CC, 3rd, et al. Factors influencing career choice among medical students interested in surgery. *Curr Surg* 2003;60(2):210-3. doi: 10.1016/s0149-7944(02)00679-7 [published Online First: 2004/02/20]

- 1
2
3
4 52. Celenza A, Bharath J, Scop J. Improving the attractiveness of an emergency medicine career to medical
5 students: An exploratory study. *Emergency Medicine Australasia* 2012;24(6):625-33. doi:
6 10.1111/j.1742-6723.2012.01607.x
7
8 53. Dolan-Evans E, Rogers GD. Barriers for students pursuing a surgical career and where the Surgical Interest
9 Association can intervene. *Anz Journal of Surgery* 2014;84(6):406-11. doi: 10.1111/ans.12521
10
11 54. Boyd JS, Clyne B, Reinert SE, et al. Emergency Medicine Career Choice: A Profile of Factors and Influences
12 from the Association of American Medical Colleges (AAMC) Graduation Questionnaires. *Academic*
13 *Emergency Medicine* 2009;16(6):544-49. doi: 10.1111/j.1553-2712.2009.00385.x
14
15 55. Egerton EA. Choice of career of doctors who graduated from Queen's University, Belfast in 1977. *Med Educ*
16 1985;19(2):131-7.
17
18 56. Diderichsen S, Johansson EE, Verdonk P, et al. Few gender differences in specialty preferences and
19 motivational factors: a cross-sectional Swedish study on last-year medical students. *Bmc Medical*
20 *Education* 2013;13:8. doi: 10.1186/1472-6920-13-39
21
22 57. Ferrari S, Reggianini C, Mattei G, et al. International Study of Student Career Choice in Psychiatry
23 (ISoSCCiP): Results from Modena, Italy. *International Review of Psychiatry* 2013;25(4):450-59. doi:
24 10.3109/09540261.2013.804402
25
26 58. Freire MDM, Jordao LMR, Ferreira ND, et al. Motivation Towards Career Choice of Brazilian Freshman
27 Students in a Fifteen-Year Period. *Journal of Dental Education* 2011;75(1):115-21.
28
29 59. Buddeberg-Fischer B, Klaghofer R, Abel T, et al. Swiss residents' speciality choices--impact of gender,
30 personality traits, career motivation and life goals. *BMC Health Serv Res* 2006;6:137. doi:
31 10.1186/1472-6963-6-137
32
33 60. Dorsey ER, Jarjoura D, Rutecki GW. The influence of controllable lifestyle and sex on the specialty choices of
34 graduating U.S. medical students, 1996-2003. *Academic medicine : journal of the Association of*
35 *American Medical Colleges* 2005;80(9):791-6. [published Online First: 2005/08/27]
36
37 61. Ekenze SO, Ugwumba FO, Obi UM, et al. Undergraduate Surgery Clerkship and the Choice of Surgery as a
38 Career: Perspective from a Developing Country. *World Journal of Surgery* 2013;37(9):2094-100. doi:
39 10.1007/s00268-013-2073-y
40
41 62. Barikani A, Afaghi M, Barikani F, et al. Perception of the medical students on their future career in Qazvin
42 University of Medical Sciences. *Global journal of health science* 2012;4(4):176-80. doi:
43 10.5539/gjhs.v4n4p176 [published Online First: 2012/09/18]
44
45 63. Bittaye M, Odukogbe AT, Nyan O, et al. Medical students' choices of specialty in The Gambia: the need for
46 career counseling. *BMC Med Educ* 2012;12:72. doi: 10.1186/1472-6920-12-72
47
48 64. Bonura EM, Lee ES, Ramsey K, et al. Factors Influencing Internal Medicine Resident Choice of Infectious
49 Diseases or Other Specialties: A National Cross-sectional Study. *Clinical Infectious Diseases*
50 2016;63(2):155-63. doi: 10.1093/cid/ciw263
51
52 65. Al-Fouzan R, Al-Ajlan S, Marwan Y, et al. Factors affecting future specialty choice among medical students in
53 Kuwait. *Medical Education Online* 2012;17:7. doi: 10.3402/meo.v17i0.19587
54
55 66. AlKot MM, Gouda MA, KhalafAllah MT, et al. Family Medicine in Egypt From Medical Students'
56 Perspective: A Nationwide Survey. *Teaching and Learning in Medicine* 2015;27(3):264-73. doi:
57 10.1080/10401334.2015.1044654
58
59
60

- 1
2
3
4 67. Borges NJ, Manuel RS, Duffy RD, et al. Influences on specialty choice for students entering person-oriented
5 and technique-oriented specialties. *Medical Teacher* 2009;31(12):1086-88. doi:
6 10.3109/01421590903183787
7
8 68. Budd S, Kelley R, Day R, et al. Student attitudes to psychiatry and their clinical placements. *Medical Teacher*
9 2011;33(11):E586-E92. doi: 10.3109/0142159x.2011.610836
10
11 69. Corrigan MA, Shields CJ, Redmond HP. Factors influencing surgical career choices and advancement in
12 Ireland and Britain. *World Journal of Surgery* 2007;31(10):1921-29. doi: 10.1007/s00268-007-9175-3
13
14 70. Davis CR, Trevatt AEJ, McGoldrick RB, et al. How to train plastic surgeons of the future. *Journal of Plastic*
15 *Reconstructive and Aesthetic Surgery* 2016;69(8):1134-40. doi: 10.1016/j.bjps.2016.05.001
16
17 71. Deutsch T, Lippmann S, Frese T, et al. Who wants to become a general practitioner? Student and curriculum
18 factors associated with choosing a GP career - a multivariable analysis with particular consideration of
19 practice-orientated GP courses. *Scandinavian Journal of Primary Health Care* 2015;33(1):47-53. doi:
20 10.3109/02813432.2015.1020661
21
22 72. Gardner SP, Roberts-Thomson KF. The effect of a change in selection procedures on students' motivation to
23 study dentistry. *Australian Dental Journal* 2014;59(1):2-8. doi: 10.1111/adj.12141
24
25 73. Dias MS, Sussman JS, Durham S, et al. Perceived benefits and barriers to a career in pediatric neurosurgery: a
26 survey of neurosurgical residents Clinical article. *Journal of Neurosurgery-Pediatrics*
27 2013;12(5):422-33. doi: 10.3171/2013.5.peds12597
28
29 74. Goltz CJ, Bachusz RC, Mancini E, et al. Medical Student Career Survey-Vascular Surgery Awareness
30 Initiative. *Annals of Vascular Surgery* 2013;27(2):225-31. doi: 10.1016/j.avsg.2012.02.012
31
32 75. Gupta NB, Khadilkar SV, Bangar SS, et al. Neurology as career option among postgraduate medical students.
33 *Annals of Indian Academy of Neurology* 2013;16(4):478-82. doi: 10.4103/0972-2327.120427
34
35 76. Hanzlick R, Prahlow JA, Denton S, et al. Selecting forensic pathology as a career - A survey of the post with
36 an eye on the future. *American Journal of Forensic Medicine and Pathology* 2008;29(2):114-22. doi:
37 10.1097/PAF.0b013e318174f0a9
38
39 77. Harris MC, Marx J, Gallagher PR, et al. General vs subspecialty pediatrics - Factors leading to residents'
40 career decisions over a 12-year period. *Archives of Pediatrics & Adolescent Medicine*
41 2005;159(3):212-16. doi: 10.1001/archpedi.159.3.212
42
43 78. Hauer KE, Fagan MJ, Kernan W, et al. Internal medicine clerkship directors' perceptions about student interest
44 in internal medicine careers. *Journal of General Internal Medicine* 2008;23(7):1101-04. doi:
45 10.1007/s11606-008-0640-y
46
47 79. Labiris G, Vamvakerou V, Tsolakaki O, et al. Perceptions of Greek medical students regarding medical
48 profession and the specialty selection process during the economic crisis years. *Health Policy*
49 2014;117(2):203-09. doi: 10.1016/j.healthpol.2014.04.009
50
51 80. Lambert TW, Goldacre MJ, Bron AJ. Career choices for ophthalmology made by newly qualified doctors in
52 the United Kingdom, 1974-2005. *Bmc Ophthalmology* 2008;8:9. doi: 10.1186/1471-2415-8-3
53
54 81. Shah HH, Jhaveri KD, Sparks MA, et al. Career Choice Selection and Satisfaction among US Adult
55 Nephrology Fellows. *Clinical Journal of the American Society of Nephrology* 2012;7(9):1513-20. doi:
56 10.2215/cjn.01620212
57
58 82. Lefevre JH, Roupret M, Kerneis S, et al. Career choices of medical students: a national survey of 1780
59
60

- students. *Medical Education* 2010;44(6):603-12. doi: 10.1111/j.1365-2923.2010.03707.x
83. Vicente B, Rosel L. Challenges for psychiatric recruitment and training in Chile. *International Review of Psychiatry* 2013;25(4):413-18. doi: 10.3109/09540261.2013.822348
84. Wiesenfeld L, Abbey S, Takahashi SG, et al. Choosing Psychiatry as a Career: Motivators and Deterrents at a Critical Decision-Making Juncture. *Canadian Journal of Psychiatry-Revue Canadienne De Psychiatrie* 2014;59(8):450-54.
85. Lam CYY, Cheung CSY, Hui ASY. Factors influencing the career interest of medical graduates in obstetrics and gynaecology in Hong Kong: a cross-sectional questionnaire survey. *Hong Kong Medical Journal* 2016;22(2):138-43.
86. Hartung PJ, Taber BJ, Richard GV. The physician values in practice scale: Construction and initial validation. *Journal of Vocational Behavior* 2005;67(2):309-20. doi: 10.1016/j.jvb.2004.05.008
87. Girasek E, Molnar R, Eke E, et al. The medical career choice motivations - Results from a Hungarian study. *Central European Journal of Medicine* 2011;6(4):502-09. doi: 10.2478/s11536-011-0034-0
88. Zuccato JA, Kulkarni AV. The Impact of Early Medical School Surgical Exposure on Interest in Neurosurgery. *Canadian Journal of Neurological Sciences* 2016;43(3):410-16. doi: 10.1017/cjn.2015.332
89. Wilbanks L, Spollen J, Messias E. Factors Influencing Medical School Graduates Toward a Career in Psychiatry: Analysis from the 2011-2013 Association of American Medical Colleges Graduation Questionnaire. *Academic Psychiatry* 2016;40(2):255-60. doi: 10.1007/s40596-015-0287-z
90. West CP, Drefahl MM, Popkave C, et al. Internal Medicine Resident Self-report of Factors Associated with Career Decisions. *Journal of General Internal Medicine* 2009;24(8):946-49. doi: 10.1007/s11606-009-1039-0
91. Watmough S, Taylor D, Ryland I. Using questionnaires to determine whether medical graduates' career choice is determined by undergraduate or postgraduate experiences. *Medical Teacher* 2007;29(8):830-32. doi: 10.1080/01421590701551755
92. Thakur A, Fedorka P, Ko C, et al. Impact of mentor guidance in surgical career selection. *Journal of Pediatric Surgery* 2001;36(12):1802-04. doi: 10.1053/jpsu.2001.28842
93. Scott I, Gowans M, Wright B, et al. Determinants of choosing a career in surgery. *Medical Teacher* 2011;33(12):1011-17. doi: 10.3109/0142159x.2011.558533
94. Schnuth RL, Vasilenko P, Mavis B, et al. What influences medical students to pursue careers in obstetrics and gynecology? *American Journal of Obstetrics and Gynecology* 2003;189(3):639-43. doi: 10.1067/s0002-9378(03)00886-x
95. Richards JMJ, Drummond R, Murray J, et al. WHAT PROPORTION OF BASIC SURGICAL TRAINEES CONTINUE IN A SURGICAL CAREER? A SURVEY OF THE FACTORS WHICH ARE IMPORTANT IN INFLUENCING CAREER DECISIONS. *Surgeon-Journal of the Royal Colleges of Surgeons of Edinburgh and Ireland* 2009;7(5):270-75.
96. Reed CE, Vaporciyan AA, Erikson C, et al. Factors Dominating Choice of Surgical Specialty. *Journal of the American College of Surgeons* 2010;210(3):319-24. doi: 10.1016/j.jamcollsurg.2009.11.016
97. de Souza LCL, Mendonca VRR, Garcia GBC, et al. Medical Specialty Choice and Related Factors of Brazilian Medical Students and Recent Doctors. *Plos One* 2015;10(7):15. doi: 10.1371/journal.pone.0133585

- 1
2
3
4 98. Pikoulis E, Avgerinos ED, Pedeli X, et al. Medical students' perceptions on factors influencing a surgical
5 career: The fate of general surgery in Greece. *Surgery* 2010;148(3):510-15. doi:
6 10.1016/j.surg.2010.01.013
7
- 8 99. Ozer U, Ceri V, Carpar E, et al. Factors Affecting the Choice of Psychiatry as a Specialty and Satisfaction
9 among Turkish Psychiatry Residents. *Academic Psychiatry* 2016;40(2):299-303. doi:
10 10.1007/s40596-015-0346-5
11
- 12 100. Noble J, Hechter FJ, Karaikos N, et al. Motivational factors and future life plans of orthodontic residents in
13 the United States. *American Journal of Orthodontics and Dentofacial Orthopedics* 2010;137(5):623-30.
14 doi: 10.1016/j.ajodo.2008.03.034
15
- 16 101. Noble J. Factors influencing career choice in ophthalmology. *Canadian Journal of Ophthalmology-Journal*
17 *Canadien D Ophtalmologie* 2006;41(5):596-99.
18
- 19 102. Newton DA, Grayson MS, Thompson LF. The variable influence of lifestyle and income on medical students'
20 career specialty choices: Data from two US medical schools, 1998-2004. *Academic Medicine*
21 2005;80(9):809-14. doi: 10.1097/00001888-200509000-00005
22
- 23 103. Moore HB, Moore PK, Grant AR, et al. Future of acute care surgery: A perspective from the next generation.
24 *Journal of Trauma and Acute Care Surgery* 2012;72(1):94-99. doi: 10.1097/TA.0b013e31823b990a
25
- 26 104. Momen AA, Shakurnia A. Factors Influencing Pediatric Specialty Choice among Pediatric Residents of
27 Ahvaz Jundishapur University of Medical Sciences. *International Journal of Pediatrics-Mashhad*
28 2015;3(3):701-06.
29
- 30 105. Mehmood SI, Kumar A, Al-Binali A, et al. Specialty preferences: Trends and perceptions among Saudi
31 undergraduate medical students. *Medical Teacher* 2012;34:S51-S60. doi:
32 10.3109/0142159x.2012.656753
33
- 34 106. Lorient Y, Albiges-Sauvin L, Dionysopoulos D, et al. Why do residents choose the medical oncology specialty?
35 Implications for future recruitment-results of the 2007 French Association of Residents in Oncology
36 (AERIO) Survey. *Annals of Oncology* 2010;21(1):161-65. doi: 10.1093/annonc/mdp294
37
- 38 107. Lefevre JH, Karila L, Kerneis S, et al. Motivation of French medical students to pursue surgical careers:
39 Results of national survey of 1742 students. *Journal of Visceral Surgery* 2010;147(3):E181-E86. doi:
40 10.1016/j.jviscsurg.2010.08.004
41
42
43
44
45
46
47
48
49
50
51
52
53

Legends

Table 1. Selected Characteristics of the 76 Studies Included in this Systematic Review and Meta-analysis

Table 2. Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty

Table 3. Meta-regression of the EOI Value Stratified by Study-level Characteristics

Figure 1. Bar Graph of the Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty Stratified by Region.

Figure 2. Bar Graph of the Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty Stratified by Survey Year.

Supplements

Methods S1. Search strategy used in the current systematic review and meta-analysis.

Table S1. Quality Assessment of the Included Studies.

Table S2. Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty Stratified by Region and Survey Year.

Figure S1. Flow Diagram of the Study Inclusion Process.

Figure S2. Forest Plot of "Academic Interest".

1
2
3
4 **Figure S3. Forest Plot of “Competencies”.**
5

6
7 **Figure S4. Forest Plot of “Controllable Lifestyle or Flexible Work Schedule”.**
8

9
10 **Figure S5. Forest Plot of “Patient Service Orientation”.**
11

12
13 **Figure S6. Forest Plot of “Medical Teachers or Mentors”.**
14

15
16 **Figure S7. Forest Plot of “Career Opportunities”.**
17

18
19 **Figure S8. Forest Plot of “Workload or Working Hours”.**
20

21
22 **Figure S9. Forest Plot of “Income”.**
23

24
25 **Figure S10. Forest Plot of “Length of Training”.**
26

27
28 **Figure S11. Forest Plot of “Prestige”.**
29

30
31 **Figure S12. Forest Plot of “Advice from Others”.**
32

33
34 **Figure S13. Forest Plot of “Student Debt”.**
35

36
37 **Figure S14. Funnel Plots of the Publication Bias Tests of the 12 Factors.**
38

Table 1. Selected Characteristics of the 76 Studies Included in this Systematic Review and Meta-analysis

First Author, Year	Country	Survey years	Sample size	Average age	Men, No. (%)	Scores
Smith et al, ³⁸ 2015	UK	2012	2,978	NR	NR	6
Cochran et al, ³⁹ 2005	USA	2002	408	27.2	214 (52.45)	5
Hauer et al, ⁴⁰ 2008	USA	2007	1,177	NR	NR	6
Johnson et al, ⁴¹ 2012	USA	2012	622	NR	NR	6
Kiolbassa et al, ⁴² 2011	Germany	2010	1,114	24.1	408 (36.62)	5
Klingensmith et al, ⁴³ 2015	USA	2013	792	NR	539 (68.06)	6
Lee et al, ⁴⁴ 2012	USA	2012	100	NR	58 (58)	7
Macdonald et al, ⁴⁵ 2012	New Zealand	2011	134	NR	79 (58.96)	7
Parsa et al, ³⁴ 2010	Iran	2006-2007	137	27.34	49 (35.77)	7
Paiva et al, ⁴⁶ 1982	USA	1982	144	NR	NR	6
Ni Chroinin et al, ⁴⁷ 2013	UK	2009-2011	274	NR	112 (40.89)	7
Newton et al, ²⁹ 2005	USA	1998-2004	1,258	NR	642 (51.03)	8
Rogers et al, ⁴⁸ 1990	USA	1989	266	NR	205 (77.07)	6
Abendroth J et al, ⁴⁹ 2014	Germany	2007-2012	45	NR	14 (31)	7
Alawad et al, ⁵⁰ 2015	USA	2010-2011	45	NR	36 (80)	8
Azizzadeh et al, ⁵¹ 2003	USA	2002	130	NR	NR	6
Celenza et al, ⁵² 2012	Australia	2009	216	NR	121 (56.02)	8
Dolan-Evans et al, ⁵³ 2014	Australia	2013	419	NR	215 (51.31)	8
Boyd et al, ⁵⁴ 2009	USA	2005-2006	5,848	NR	2,982 (50.99)	8
Egerton et al, ⁵⁵ 1985	Ireland	1977-1981	134	30	82 (61.19)	6
Diderichsen et al, ⁵⁶ 2013	Sweden	2006-2009	372	27	157 (42.20)	6
Ferrari et al, ⁵⁷ 2013	Italy, UK	2009-2011	45	25	NR	9
Freire et al, ⁵⁸ 2011	Brazil	2006-2008	290	23	102 (35.17)	7
Buddeberg-Fischer et al, ⁵⁹ 2006	Switzerland	2001-2003	522	31.1	241 (46.17)	9
Dorsey et al, ⁶⁰ 2005	USA	2003	11,029	NR	4,964 (45.01)	6
Ekenze et al, ⁶¹ 2013	Nigeria	2009-2010	96	25.9	NR	7
Barikani et al, ⁶² 2012	Australia	2008-2009	49	21.7	NR	6
Bittaye et al, ⁶³ 2012	Gambia	2011	106	24.1	48 (45.28)	6
Bonura et al, ⁶⁴ 2016	USA	2015	590	NR	321 (54.40)	9
Al-Fouzan et al, ⁶⁵ 2012	Kuwait	2011-2012	144	NR	NR	7
AlKot et al, ⁶⁶ 2015	Egypt	2013	451	21.8	NR	7
Borges et al, ⁶⁷ 2009	USA	2001-2005	341	NR	NR	5
Budd et al, ⁶⁸ 2011	UK	2011	870	22	NR	7
Corrigan et al, ⁶⁹ 2007	Ireland	2007	222	NR	142 (63.96)	7
Davis et al, ⁷⁰ 2016	UK	2016	173	NR	76 (43.93)	7

1							
2							
3							
4	Deutsch et al, ⁷¹ 2015	Germany	2011	659	27.9	NR	8
5	Gardner et al, ⁷² 2014	Australia	1993-2005	631	NR	NR	7
6	Dias et al, ⁷³ 2013	UK	2013	495	NR	438 (88.48)	5
7	Goltz et al, ⁷⁴ 2013	USA	2012	102	24.5	34 (33.33)	6
8	Gupta et al, ⁷⁵ 2013	India	2013	243	NR	179 (73.36)	6
9	Hanzlick et al, ⁷⁶ 2008	USA	2006	161	NR	NR	6
10	Harris et al, ⁷⁷ 2005	USA	1991-2002	104	NR	53 (50.96)	6
11	Hauer et al, ⁷⁸ 2008	USA	2008	80	NR	NR	6
12	Labiris et al, ⁷⁹ 2014	Greece	2014	111	23.6	55 (49.54)	6
13	Lambert et al, ⁸⁰ 2008	UK	2007	17,393	NR	NR	6
14	Shah et al, ⁸¹ 2012	USA	2011	892	NR	NR	6
15	Lefevre et al, ⁸² 2010	USA	2008	1,555	NR	589 (37.88)	6
16	Vicente et al, ⁸³ 2013	Chile	2013	30	NR	NR	6
17	Wiesenfeld et al, ⁸⁴ 2014	Canada	2013	60	NR	NR	7
18	Lam et al, ⁸⁵ 2016	Hong Kong	2015	228	23	NR	9
19	Hartung et al, ⁸⁶ 2005	USA	2004	192	20.59	74 (38.54)	4
20	Girasek et al, ⁸⁷ 2011	Hungary	2011	536	NR	NR	5
21	Zuccato et al, ⁸⁸ 2015	Canada	2012	37	NR	24 (65)	6
22	Wilbanks et al, ⁸⁹ 2015	USA	2011-2013	29,227	NR	15,164 (51.99)	9
23	West et al, ⁹⁰ 2009	USA	2005-2007	14,890	NR	8,700 (58.43)	6
24	Watmough et al, ⁹¹ 2007	UK	2005	116	NR	66 (56.90)	4
25	Thakur et al, ⁹² 2001	USA	2001	56	NR	53 (95)	8
26	Scott et al, ⁹³ 2011	Canada	2002-2004	1,542	NR	NR	6
27	Schnuth et al, ⁹⁴ 2003	USA	2002	203	NR	72 (53.47)	6
28	Richards et al, ⁹⁵ 2009	UK	2009	150	NR	108 (72.00)	5
29	Reed et al, ⁹⁶ 2009	USA	2008	2,022	NR	1,354 (66.96)	9
30	de Souza et al, ⁹⁷ 2015	Portugal	2012	1,303	NR	NR	7
31	Pikoulis et al, ⁹⁸ 2010	Greece	2006-2007	87	NR	NR	6
32	Ozer et al, ⁹⁹ 2015	Turkey	2013	98	27.7	26 (26.53)	6
33	Noble et al, ¹⁰⁰ 2004	Canada	2004	21,296	NR	NR	8
34	Noble et al, ¹⁰¹ 2010	Canada	2007	120	NR	NR	5
35	Newton et al, ¹⁰² 2005	USA	2004	1,286	NR	NR	6
36	Moore et al, ¹⁰³ 2012	USA	2011	337	26	179 (53.12)	6
37	Momen et al, ¹⁰⁴ 2015	Iran	2014-2015	38	35.6	11 (29)	6
38	Mehmood et al, ¹⁰⁵ 2012	Saudi Arabia	2012	550	NR	348 (63.27)	6
39	Loriot et al, ¹⁰⁶ 2010	France	2007	44	NR	17 (39)	7
40	Lefevre et al, ¹⁰⁷ 2010	France	2008	522	23.8	198 (37.93)	7
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							

Table 2. Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty

Factor	No. of studies	Total no. of participants	EOI (%)	value	<i>I-square</i> (%)	<i>Tau-square</i>	<i>P-Value</i>
Academic interests	37	82,276	74.87		99.80	1.60	<0.0001
Competencies	17	76,515	55.15		99.90	3.44	<0.0001
Controllable lifestyle or flexible work schedule	42	102,384	53.06		99.50	0.45	<0.0001
Patient service orientation	34	45,865	49.35		98.70	0.41	<0.0001
Medical teachers or mentors	32	85,071	46.93		99.80	1.14	<0.0001
Career opportunities	38	81,923	44.00		99.70	1.15	<0.0001
Workload or working hours	19	21,870	37.92		98.40	0.72	<0.0001
Income	49	109,610	35.25		99.70	1.09	<0.0001
Length of training	18	42,046	32.30		98.10	0.20	<0.0001
Prestige	24	30,012	31.29		98.40	0.53	<0.0001
Advice from others	18	82,692	28.24		99.80	0.02	<0.0001
Student debt	8	38,917	15.33		98.80	0.27	<0.0001

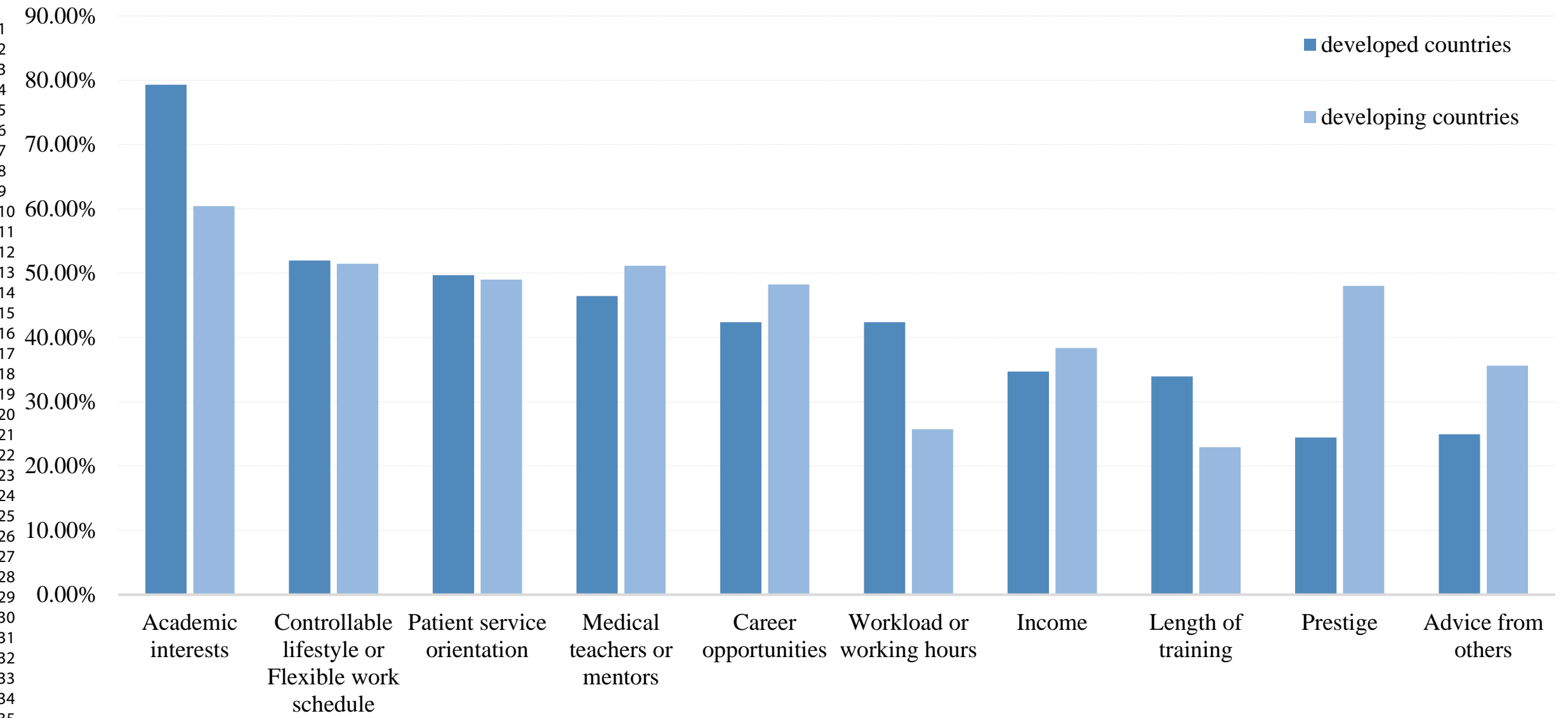
Table 3. Meta-regression of the EOI Value Stratified by Study-level Characteristics

Factor		P-Value
Academic interests	Country	0.6302
	Survey years	0.2711
	Specialty	0.4008
	Sample size	0.6537
Competencies	Country	0.8376
	Survey years	0.0151
	Specialty	0.9398
	Sample size	0.5823
Controllable lifestyle or flexible work schedule	Country	0.9614
	Survey years	0.9822
	Specialty	0.0035
	Sample size	0.7203
Patient service orientation	Country	0.0833
	Survey years	0.8524
	Specialty	0.0010
	Sample size	0.6358
Medical teachers or mentors	Country	0.0007
	Survey years	0.6376
	Specialty	0.8141
	Sample size	0.5894
Career opportunities	Country	0.5828
	Survey years	0.7546
	Specialty	0.0077
	Sample size	0.0081
Workload or working hours	Country	0.3981
	Survey years	0.3922
	Specialty	0.1070
	Sample size	0.8205
Income	Country	0.7390
	Survey years	0.8774
	Specialty	0.0480
	Sample size	0.6786
Length of training	Country	0.7854
	Survey years	0.7229
	Specialty	0.5667
Prestige	Sample size	0.7082
	Country	0.3485

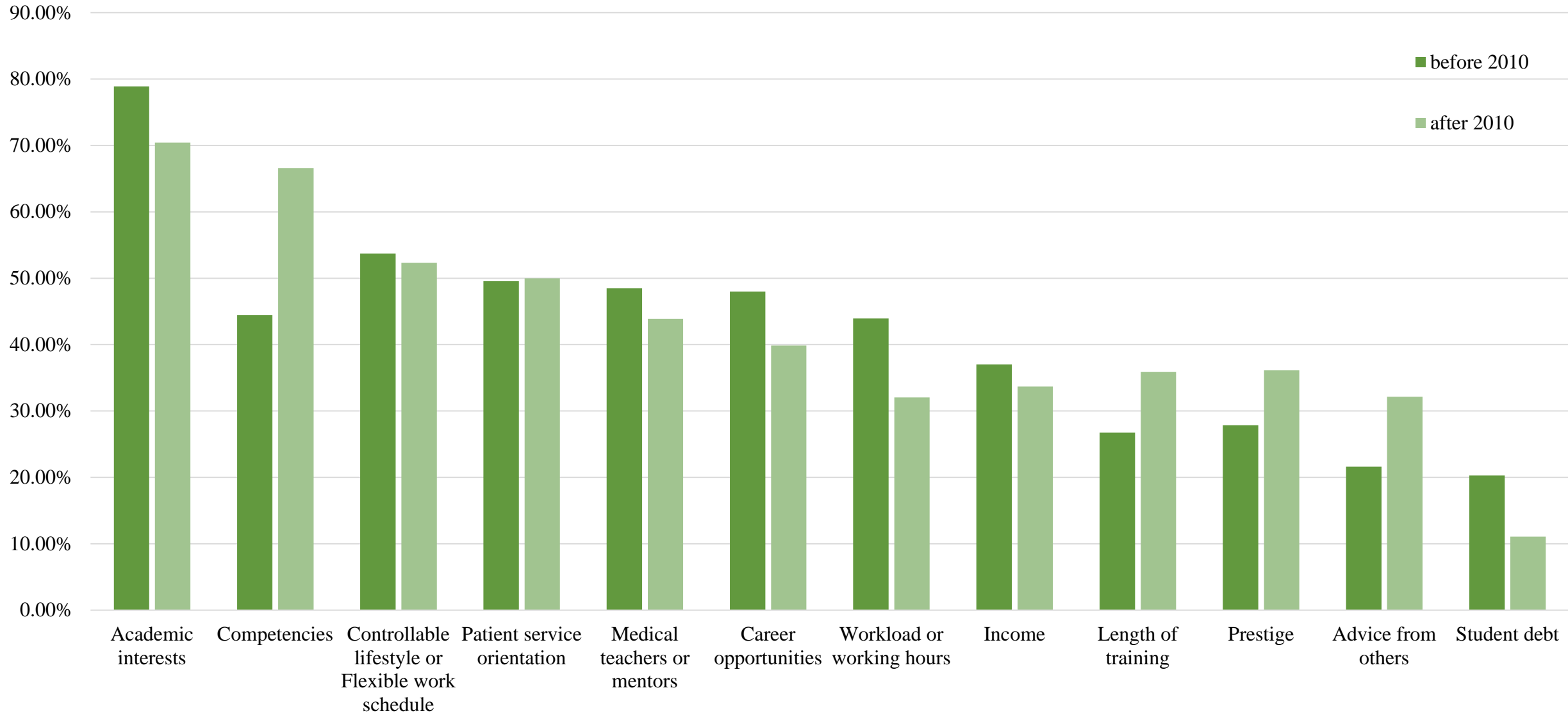
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

	Survey years	0.0950
	Specialty	0.0172
	Sample size	0.5214
	Country	0.9328
Advice from others	Survey years	0.0057
	Specialty	<0.0001
	Sample size<200	<0.0001
	Country	0.0001
Student debt	Survey years	0.5502
	Sample size	0.0343

For peer review only



1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41



1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41

1
2
3
4 **SI Methods. Search strategy used in the current systematic review and**
5
6 **meta-analysis.**
7
8
9

10
11 ***Medical Students***

12
13
14 1. Students, Medical [Mesh]

15
16 2. Medical students

17
18 3. Medical student

19
20 4. Student, Medical

21
22 5. OR / 1 – 4

14. Cross sectional study [Publication
Type]

15. Cross sectional study [Mesh Terms]

16. Systematic review

17. Systematic review [Publication

Type]

18. Systematic review [Mesh Terms]

23
24
25
26
27
28
29
30 ***Subspecialty Choice***

31
32 6. Career choices

33
34 7. Choice, Career

35
36 8. Choices career

37
38 9. Specialties

39
40 10. Sub-specialties

41
42 11. Sub-discipline

43
44 12. OR / 6 – 11

19. Meta-analysis [Title/Abstract]

20. Meta-analysis [Mesh Terms]

21. Meta-analysis [Publication Type]

22. OR / 12 – 21

45
46
47
48
49
50
51
52
53 ***Factors***

23. Factors

54
55
56
57
58
59
60 ***Combined search***

53 ***Study design***

13. Cross sectional study

24. #5 AND #12AND #22 AND #23

Abbreviations: MeSH, Medical Subject Heading in Pubmed.

Table S1. Quality assessment of the included studies

Quality assessment criteria	1	2	3	4	5	6	7	8	9	10	11	Scores
1 Smith et al, ³⁸ 2015	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
2 Cochran et al, ³⁹ 2005	Y	U	Y	Y	N	Y	N	Y	N	N	N	5
3 Hauer et al, ⁴⁰ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
4 Johnson et al, ⁴¹ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
5 Kiobassa et al, ⁴² 2011	Y	U	Y	Y	N	Y	N	Y	N	N	N	5
6 Klingensmith et al, ⁴³ 2015	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
7 Lee et al, ⁴⁴ 2012	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
8 Macdonald et al, ⁴⁵ 2012	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
9 Parsa et al, ³⁴ 2010	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
10 Paiva et al, ⁴⁶ 1982	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
11 Ni Chroinin et al, ⁴⁷ 2013	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
12 Newton et al, ²⁹ 2005	Y	U	Y	Y	Y	Y	Y	Y	N	Y	N	8
13 Rogers et al, ⁴⁸ 1990	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
14 Abendroth J et al, ⁴⁹ 2014	Y	U	Y	Y	N	Y	N	Y	N	Y	Y	7
15 Alawad et al, ⁵⁰ 2015	Y	U	Y	Y	N	Y	Y	Y	Y	Y	N	8
16 Azizzadeh et al, ⁵¹ 2003	Y	U	Y	Y	Y	Y	N	N	N	Y	N	6
17 Celenza et al, ⁵² 2012	Y	U	Y	Y	Y	Y	Y	N	Y	Y	N	8
18 Dolan-Evans et al, ⁵³ 2014	Y	U	Y	Y	Y	Y	N	Y	N	Y	Y	8
19 Boyd et al, ⁵⁴ 2009	Y	U	Y	Y	Y	Y	Y	Y	N	Y	N	8
20 Egerton et al, ⁵⁵ 1985	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
21 Diderichsen et al, ⁵⁶ 2013	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
22 Ferrari et al, ⁵⁷ 2013	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
23 Freire et al, ⁵⁸ 2011	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
24 Buddeberg-Fischer et al, ⁵⁹ 2006	Y	U	Y	Y	N	Y	Y	Y	Y	Y	Y	9
25 Dorsey et al, ⁶⁰ 2005	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
26 Ekenze et al, ⁶¹ 2013	Y	U	Y	Y	Y	Y	Y	N	N	Y	N	7
27 Barikani et al, ⁶² 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
28 Bittaye et al, ⁶³ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
29 Bonura et al, ⁶⁴ 2016	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
30 Al-Fouzan et al, ⁶⁵ 2012	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
31 AlKot et al, ⁶⁶ 2015	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
32 Borges et al, ⁶⁷ 2009	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
33 Budd et al, ⁶⁸ 2011	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
34 Corrigan et al, ⁶⁹ 2007	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
35 Davis et al, ⁷⁰ 2016	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
36 Deutsch et al, ⁷¹ 2015	Y	U	Y	Y	Y	Y	N	Y	Y	Y	N	8
37 Gardner et al, ⁷² 2014	Y	U	Y	Y	N	Y	N	Y	N	Y	N	7
38 Dias et al, ⁷³ 2013	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
39 Goltz et al, ⁷⁴ 2013	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
40 Gupta et al, ⁷⁵ 2013	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
41 Hanzlick et al, ⁷⁶ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
42 Harris et al, ⁷⁷ 2005	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
43 Hauer et al, ⁷⁸ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
44 Labiris et al, ⁷⁹ 2014	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
45 Lambert et al, ⁸⁰ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
46 Shah et al, ⁸¹ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
47 Lefevre et al, ⁸² 2010	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
48 Vicente et al, ⁸³ 2013	Y	U	Y	Y	N	N	Y	N	Y	Y	N	6
49 Wiesenfeld et al, ⁸⁴ 2014	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
50 Lam et al, ⁸⁵ 2016	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
51 Hartung et al, ⁸⁶ 2005	Y	U	Y	Y	N	Y	N	N	N	N	N	4
52 Girasek et al, ⁸⁷ 2011	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
53 Zuccato et al, ⁸⁸ 2015	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	6
54 Wilbanks et al, ⁸⁹ 2015	Y	U	Y	Y	N	Y	Y	Y	Y	Y	Y	9
55 West et al, ⁹⁰ 2009	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	6
56 Watmough et al, ⁹¹ 2007	Y	U	Y	Y	N	N	N	N	N	Y	N	4
57 Thakur et al, ⁹² 2001	Y	U	Y	Y	Y	Y	Y	N	Y	Y	N	8
58 Scott et al, ⁹³ 2011	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
59 Schnuth et al, ⁹⁴ 2003	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
60 Richards et al, ⁹⁵ 2009	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
61 Reed et al, ⁹⁶ 2009	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
62 de Souza et al, ⁹⁷ 2015	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
63 Pikoulis et al, ⁹⁸ 2010	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
64 Ozer et al, ⁹⁹ 2015	Y	U	Y	Y	N	N	Y	N	Y	Y	N	6
65 Noble et al, ¹⁰⁰ 2004	Y	U	Y	Y	Y	Y	Y	Y	N	Y	N	8
66 Noble et al, ¹⁰¹ 2010	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
67 Newton et al, ¹⁰² 2005	Y	U	Y	Y	N	Y	Y	N	N	Y	N	6
68 Moore et al, ¹⁰³ 2012	Y	U	Y	Y	Y	Y	N	Y	N	N	N	6
69 Momen et al, ¹⁰⁴ 2015	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
70 Mehmood et al, ¹⁰⁵ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
71 Loriot et al, ¹⁰⁶ 2010	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
72 Lefevre et al, ¹⁰⁷ 2010	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7

Quality assessment criteria in detail

1. Define the source of information (survey, record review).
2. List the inclusion and exclusion criteria for the exposed and unexposed subjects (cases and controls) or refer to previous publications.
3. Indicate the time period used for identifying patients.
4. Indicate whether the subjects were consecutive if not population-based.
5. Indicate whether the evaluators of the subjective components of the study were masked to the other aspects of participants' status.
6. Describe any assessments undertaken for quality assurance purposes (e.g., test/retest of primary outcome measurements)
7. Explain any patient exclusion from the analyses.
8. Describe how confounding was assessed and/or controlled.
9. If applicable, explain how missing data were handled in the analysis.
10. Summarize the patient response rates and the completeness of the data collection.
11. Clarify what follow-up, if any, was expected and the percentage of patients with incomplete data or follow-up.

“Y”: Yes; **“N”:** No; **“U”:** Unclear.

Table S2. Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty Stratified by Region and Survey Year.

Factor		No. of studies	Total no. of participants	Extent of influence (%)	<i>P</i> -Value	<i>Q</i> -Value
Academic interest	developed	27	79,910	79.30	0.02	3.37
	developing	10	2,366	60.41		
	before 2010	29	44,174	78.88	0.33	1.40
	after 2010	8	38,102	70.44		
Competencies	before 2010	9	43,134	44.44	0.21	1.86
	after 2010	8	33,381	66.60		
Controllable lifestyle or flexible work schedule	developed	36	100,799	51.97	0.53	0.89
	developing	6	1,581	51.47		
Patient service orientation	before 2010	22	62,945	53.72	0.99	0.02
	after 2010	20	39,439	52.34		
Medical teachers or mentors	developed	25	43,964	49.69	0.99	0.02
	developing	9	1,901	48.99		
	before 2010	18	40,997	49.56		
Career opportunities	after 2010	16	4,868	49.97	0.83	0.31
	developed	28	84,076	46.43		
	developing	4	995	51.14		
Workload or working hours	before 2010	21	49,654	48.48	0.70	0.54
	after 2010	11	35,417	43.87		
	developed	31	79,867	42.36		
Income	developing	7	2,056	48.24	0.60	0.74
	before 2010	20	43,417	47.97		
	after 2010	18	38,506	39.87		
Length of training	developed	14	20,789	42.36	0.34	1.35
	developing	5	1,081	25.72		
	before 2010	9	19,456	43.93		
Prestige	after 2010	10	2,414	32.04	0.42	1.17
	developed	38	106,910	34.69		
	developing	11	2,700	38.36		
Advice from others	before 2010	25	68,714	37.01	0.50	0.95
	after 2010	24	40,896	33.69		
	developed	15	41,246	33.95		
Student debt	developing	3	800	22.92	0.31	1.48
	before 2010	7	8,811	26.72		
	after 2010	11	33,234	35.87		
Prestige	developed	16	27,806	24.45	0.01	4.31
	developing	8	2,206	48.02		
	before 2010	12	25,542	27.86		
Advice from others	after 2010	12	4,470	36.12	0.25	1.67
	developed	14	81,205	24.95		
	developing	4	1,487	35.62		
Student debt	before 2010	10	48,319	21.61	0.31	1.47
	after 2010	8	34,373	32.13		
	before 2010	5	6,610	20.29		
	after 2010	3	32,307	11.08	0.69	0.59

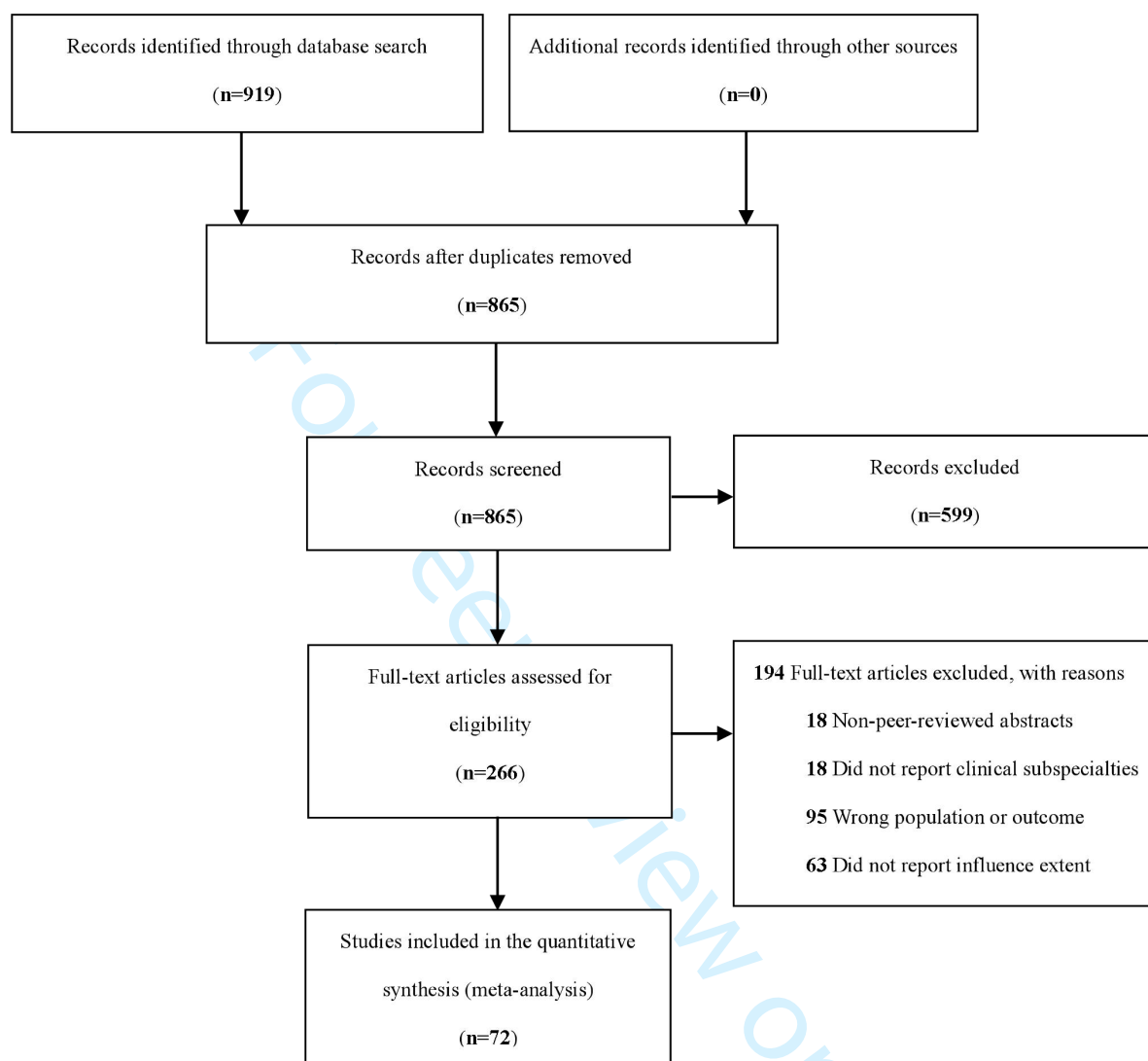
Figure S1. Flow Diagram of the Study Inclusion.

Figure S2. Forest Plot of “Academic Interest”.

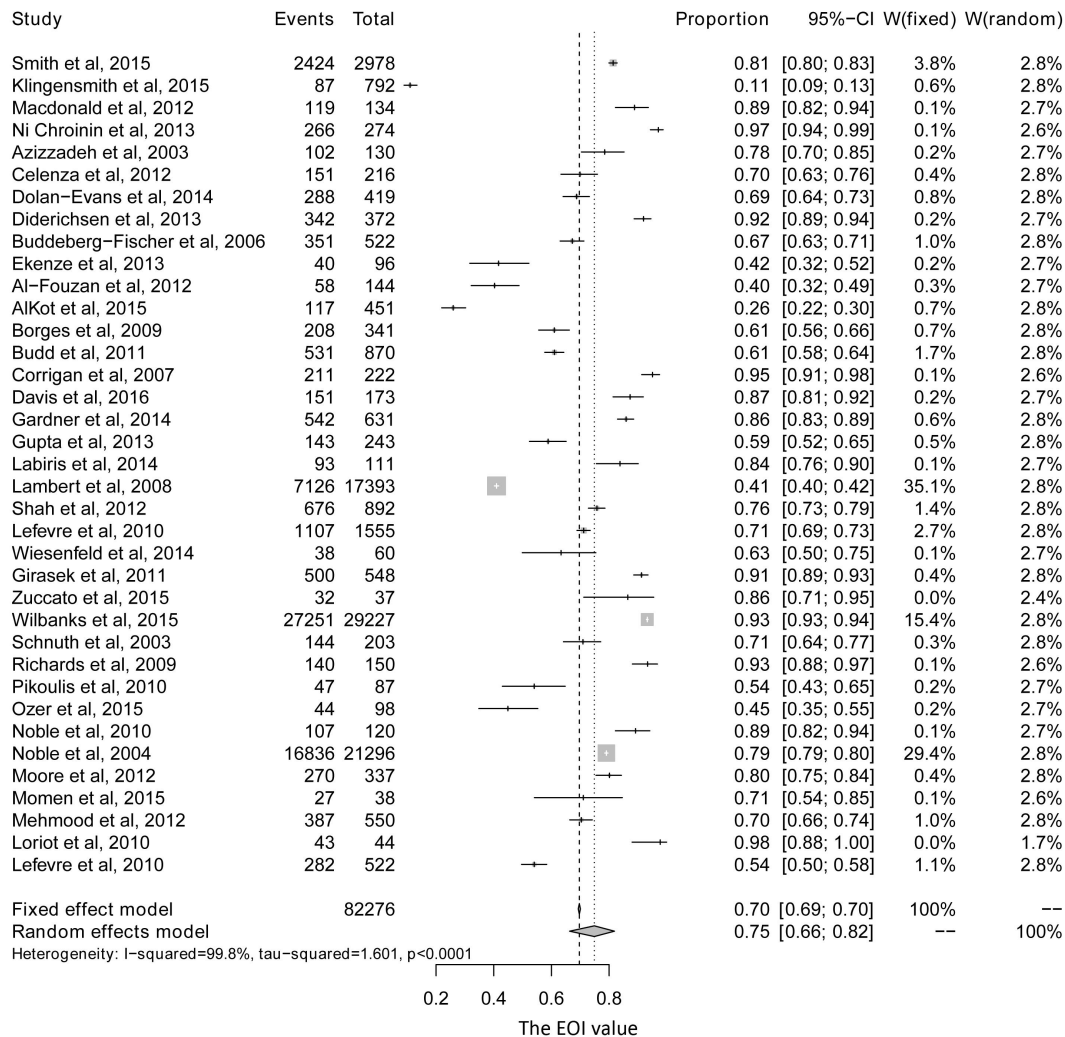


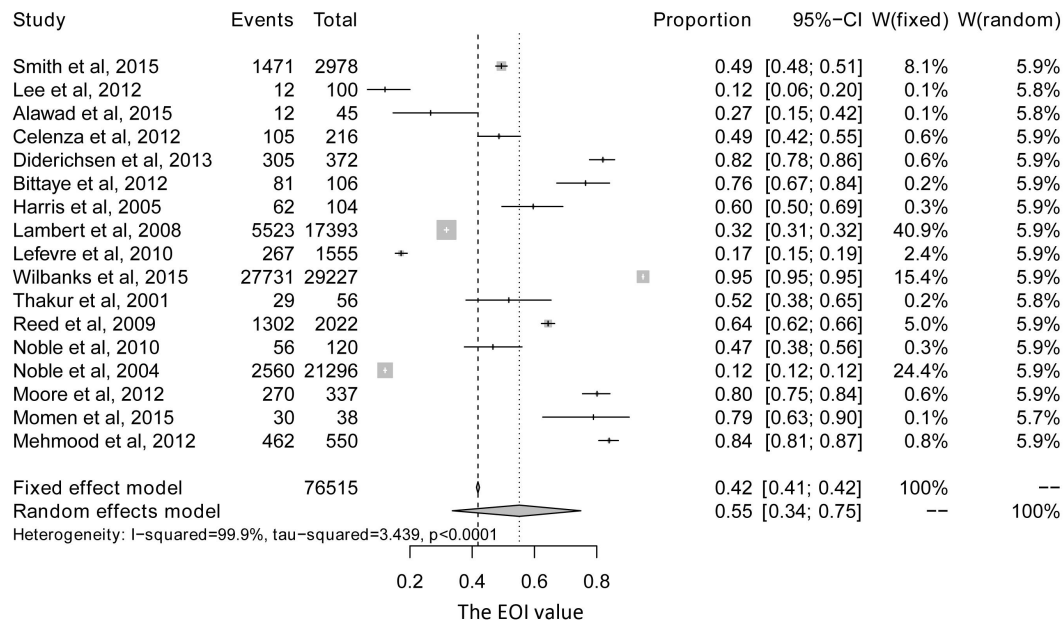
Figure S3. Forest Plot of “Competencies”.

Figure S4. Forest Plot of “Controllable Lifestyle or Flexible Work Schedule”.

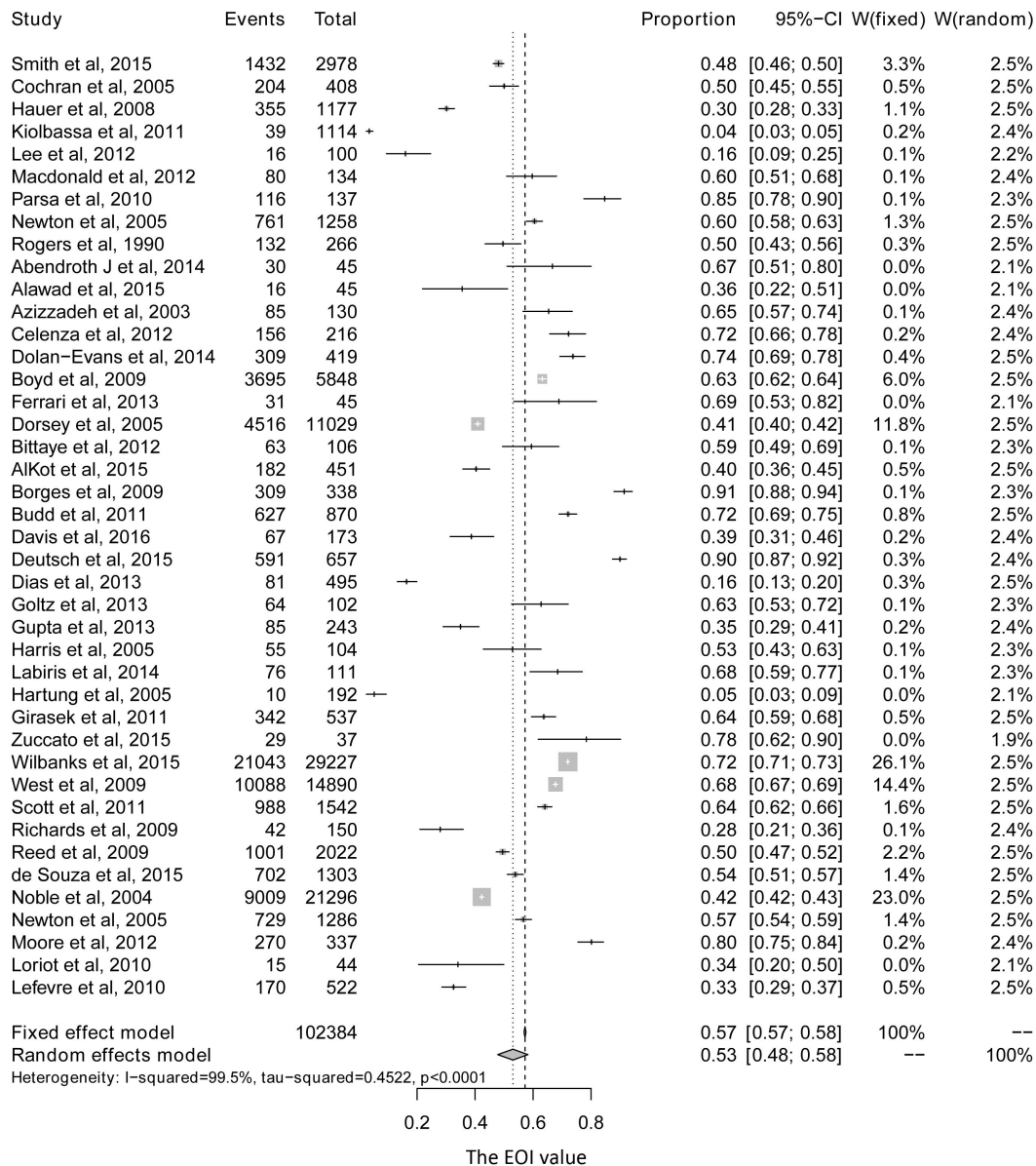
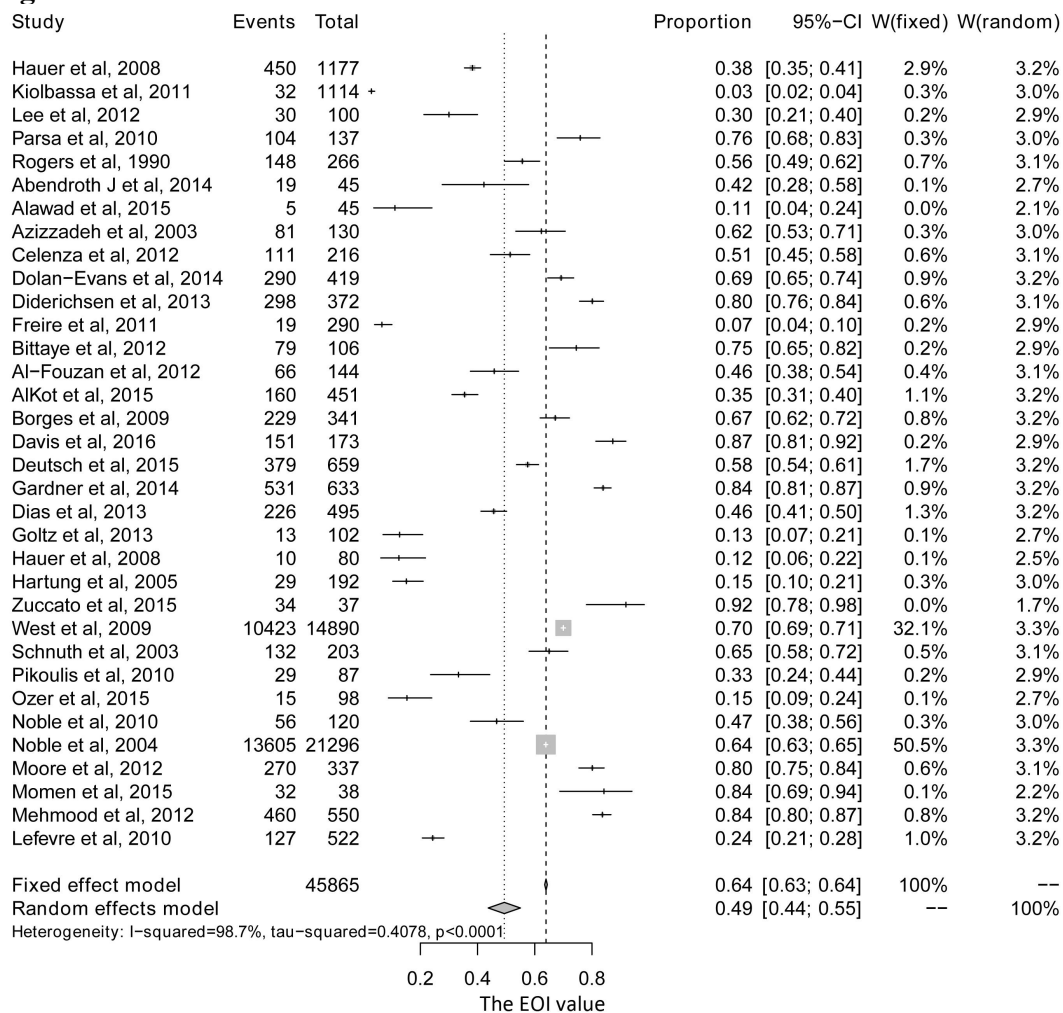


Figure S5. Forest Plot of “Patient Service Orientation”.



only

Figure S6. Forest Plot of “Medical Teachers or Mentors”.

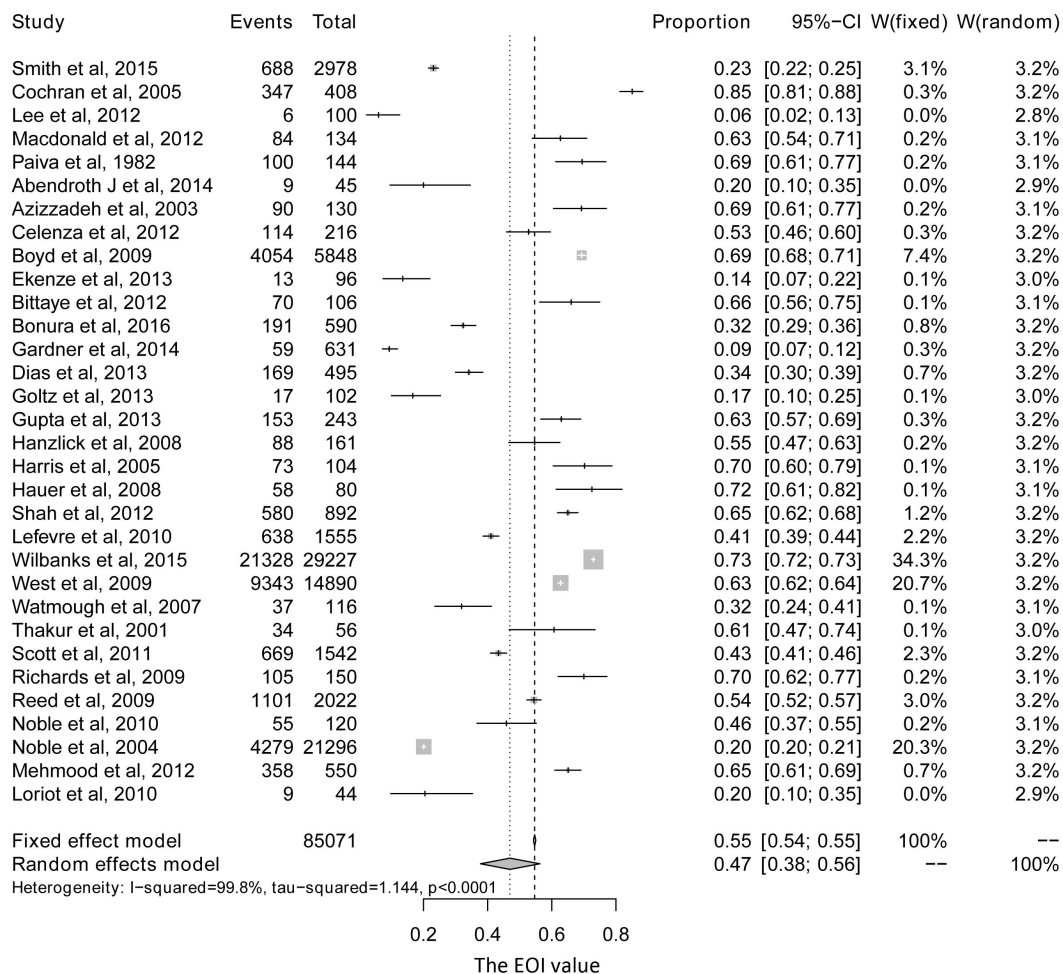


Figure S7. Forest Plot of “Career Opportunities”.

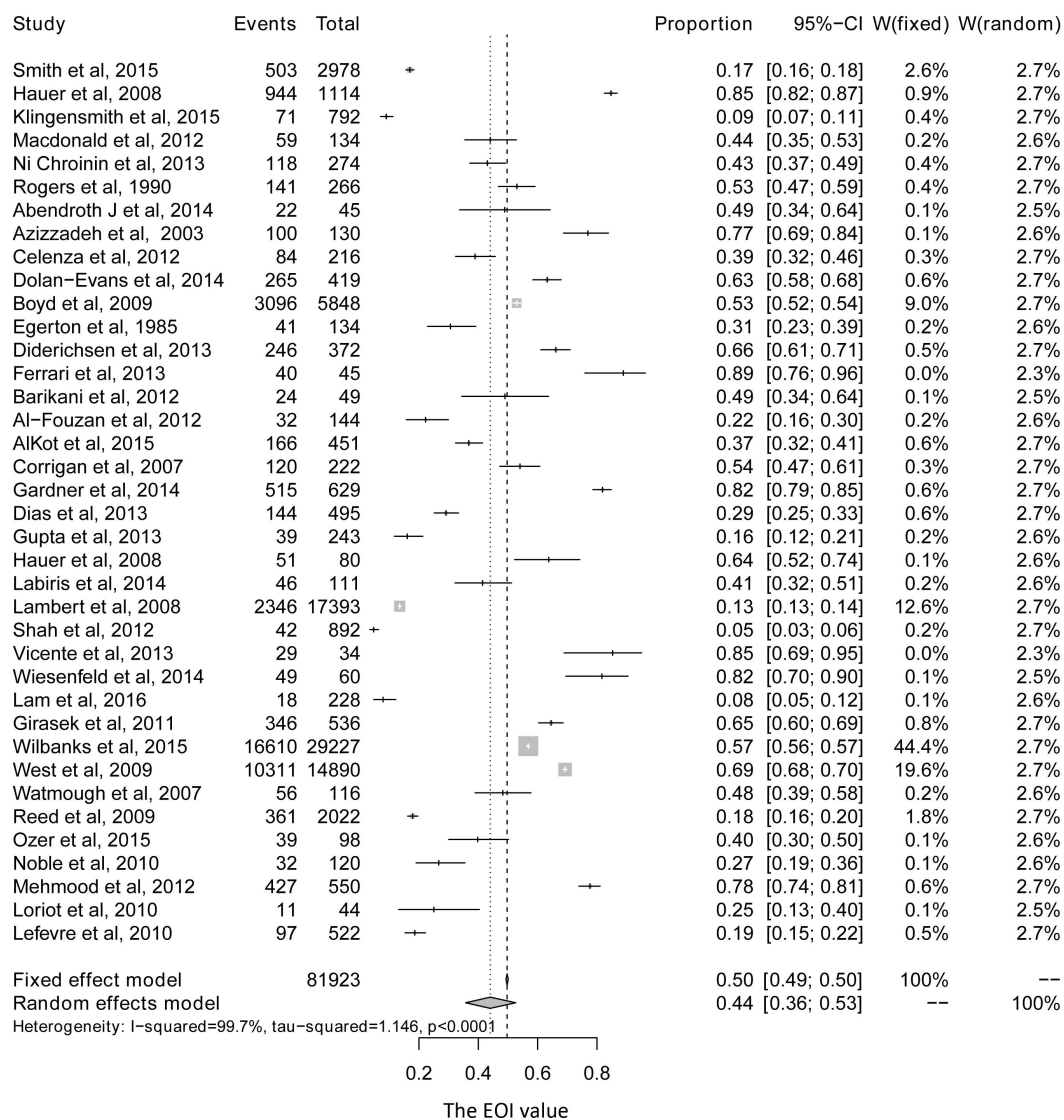
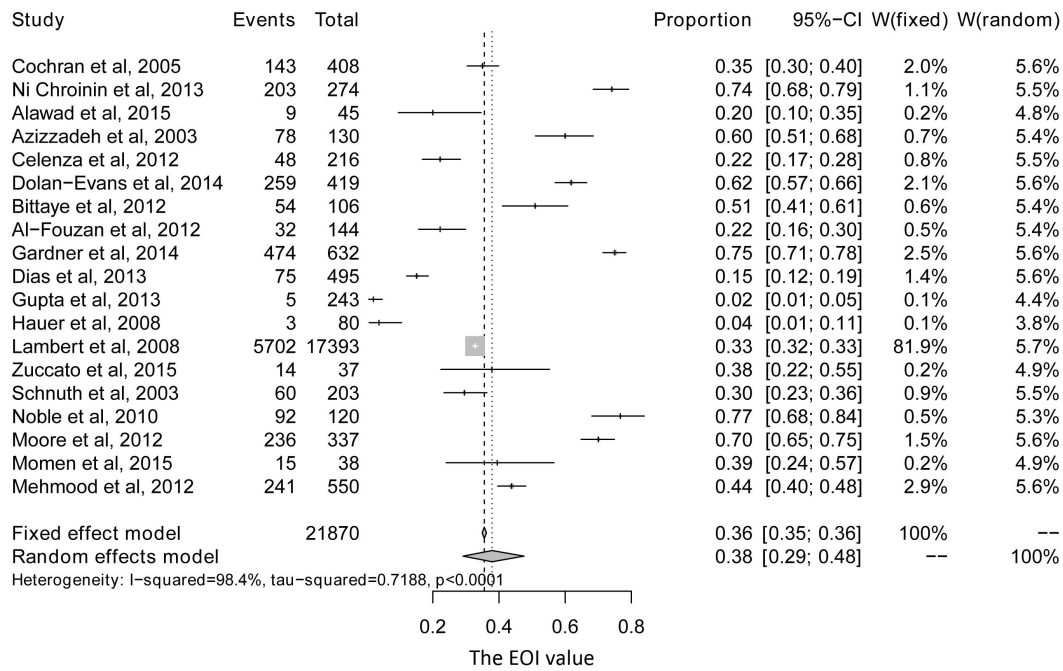


Figure S8. Forest Plot of “Workload or Working Hours”.



Review only

Figure S9. Forest Plot of “Income”.

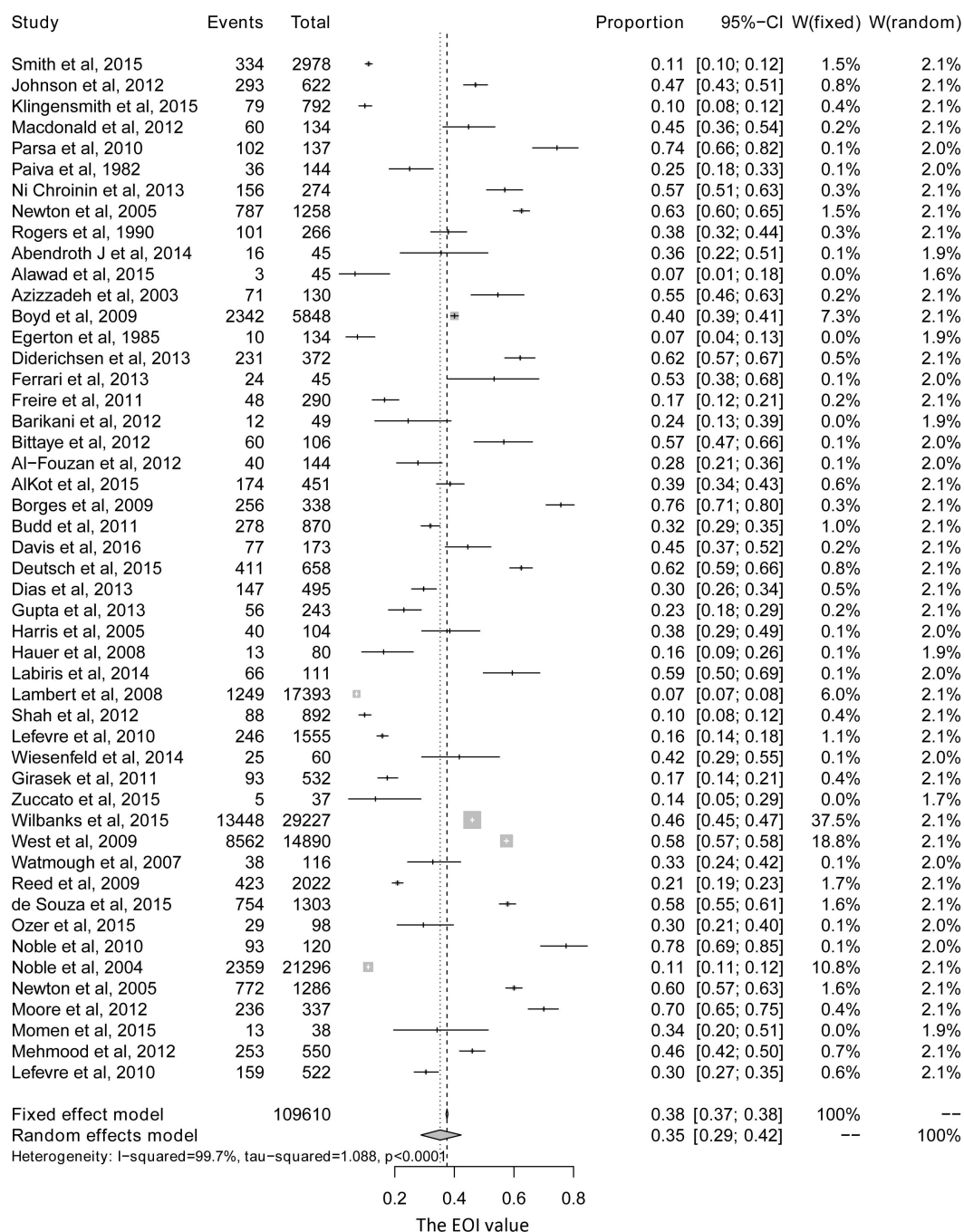


Figure S10. Forest Plot of “Length of Training”.

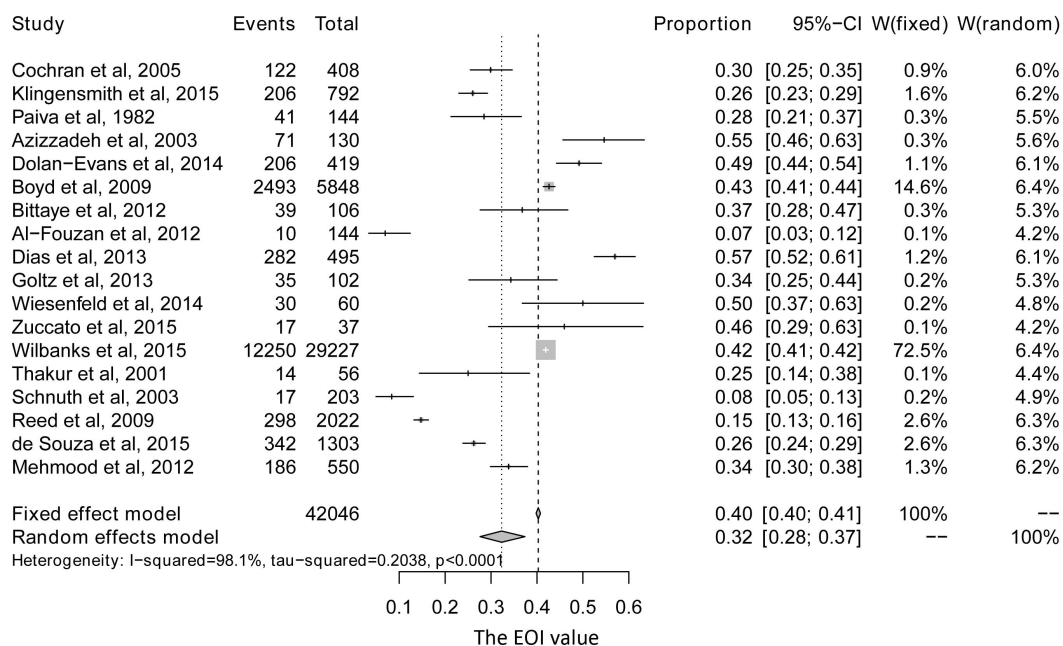
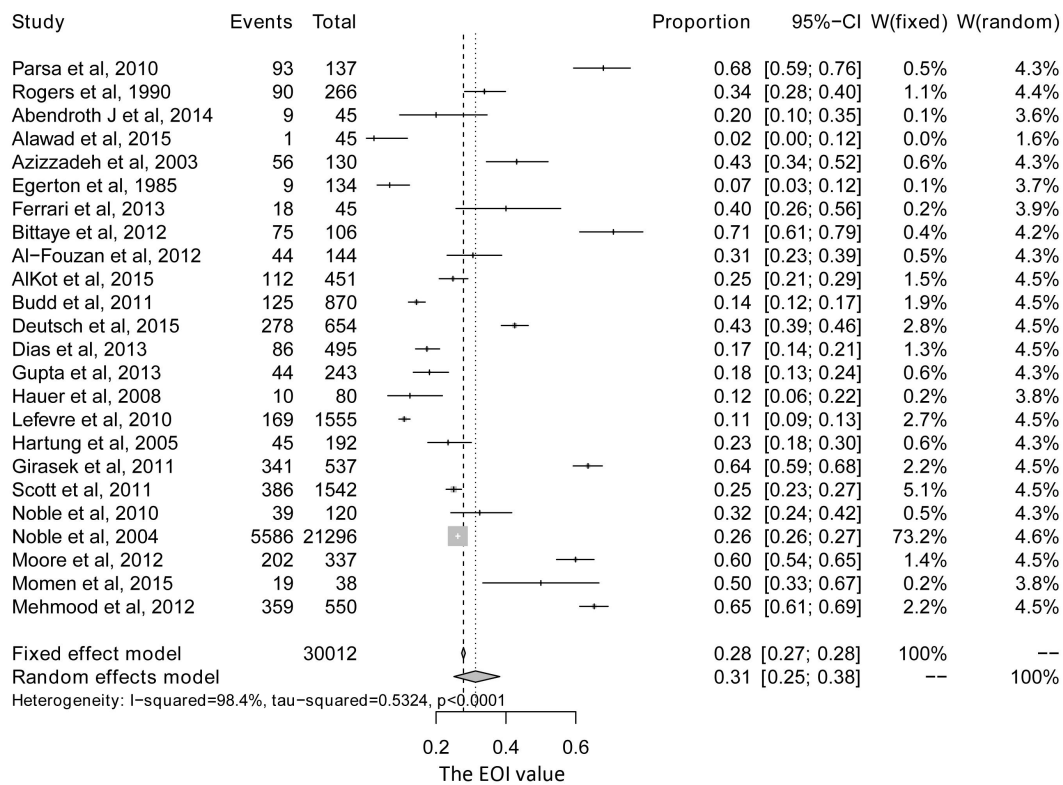


Figure S11. Forest Plot of “Prestige”.



Review only

Figure S12. Forest Plot of “Advice from Others”.

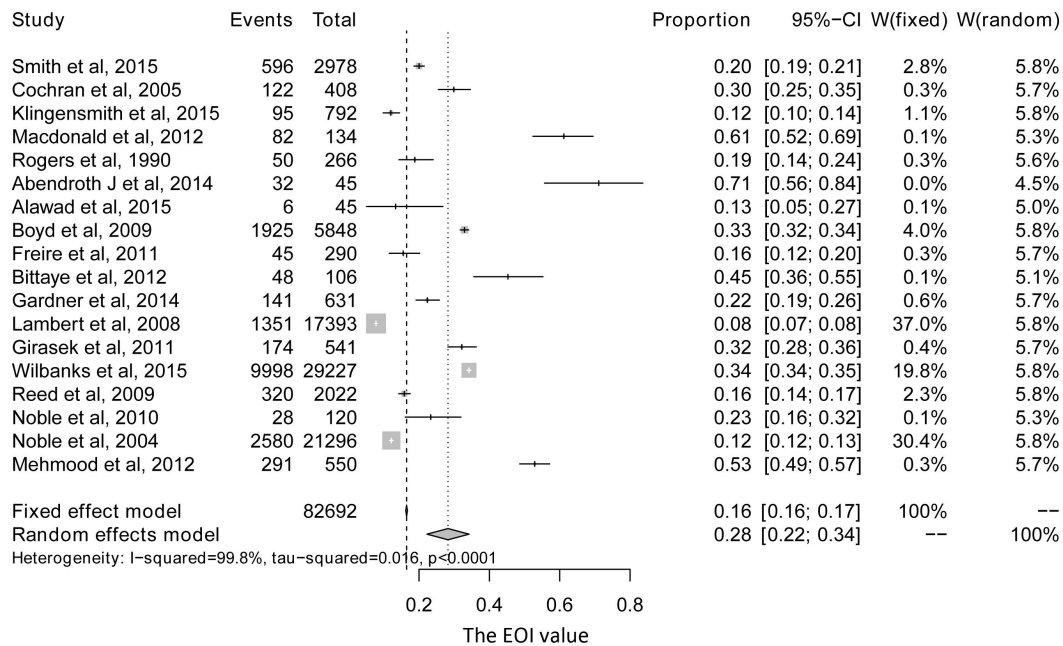


Figure S13. Forest Plot of “Student Debt”.

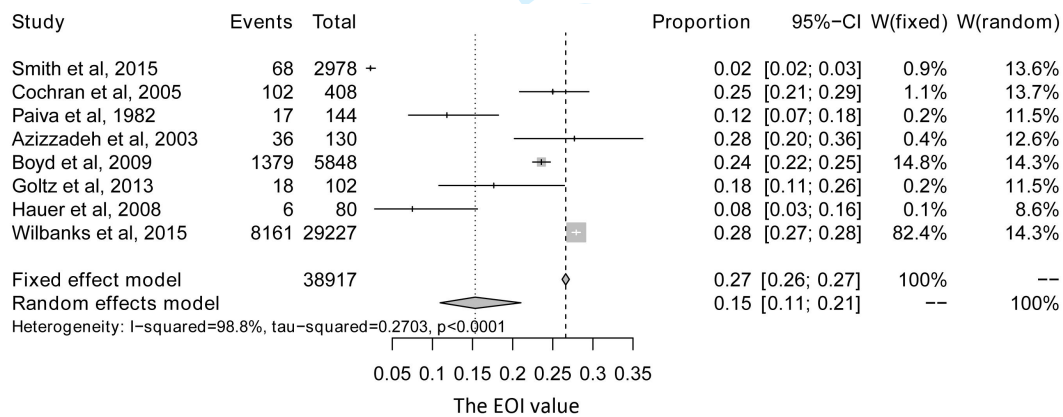
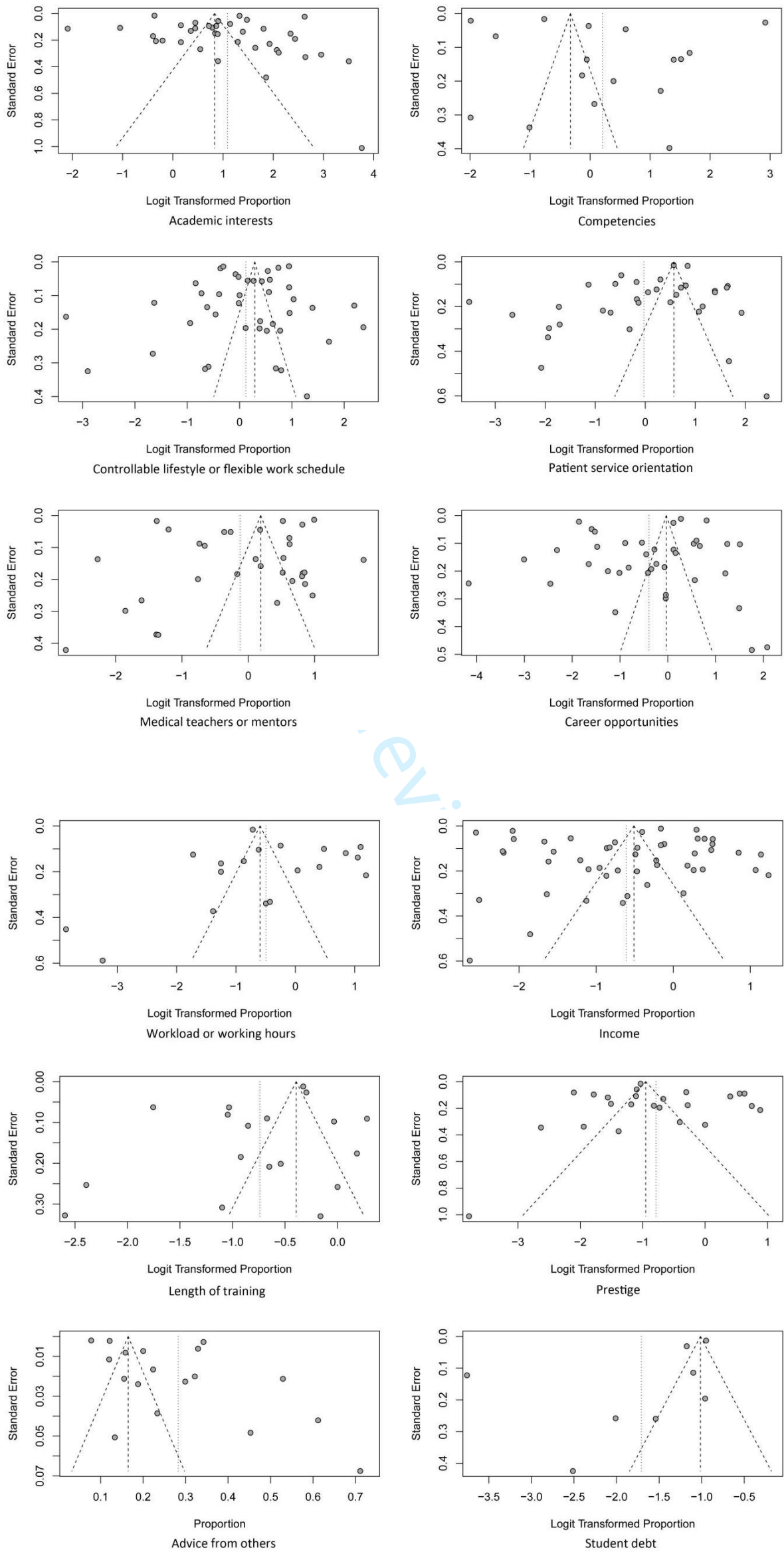


Figure S14. Funnel Plots of the Publication Bias Testing of the 12 Factors.





PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	3
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5-6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6-7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6-7
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	7



PRISMA 2009 Checklist

Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	7
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	7
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	5, 7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7-8
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	8
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	8
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	8-9
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	8-9
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	8-9
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	9-13
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	13
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	14
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	15

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

Page 2 of 2

For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

BMJ Open

Factors Influencing Subspecialty Choice Among Medical Students: A Systematic Review and Meta-analysis

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-022097.R1
Article Type:	Research
Date Submitted by the Author:	05-Jul-2018
Complete List of Authors:	Yang, Yahan; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology; Sun Yat-Sen University, Zhongshan School of Medicine Li, Jiawei; Sun Yat-Sen University, Zhongshan School of Mathematics Wu, Xiaohang; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology Wang, Jinghui; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology Li, Wangting; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology Zhu, Yi; University of Miami School of Medicine, Department of Molecular and Cellular Pharmacology; Sun Yat-Sen University Zhongshan Ophthalmic Center, Cataract Chen, Chuan; State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic Center, Sun Yat-sen University; University of Miami School of Medicine, Department of Molecular and Cellular Pharmacology Lin, Haotian; State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic Center, Sun Yat-sen University, Cataract
Primary Subject Heading:	Medical education and training
Secondary Subject Heading:	Medical education and training
Keywords:	Medical students, Career choice, Meta-analysis

SCHOLARONE™
Manuscripts

1
2
3 **1 Title Page**
4

5 **2 Factors Influencing Subspecialty Choice Among Medical Students: A Systematic**
6

7 **3 Review and Meta-analysis**
8

9 Yahan Yang, M.D.^{1,2}; Jiawei Li, M.D.³; Xiaohang Wu, M.D.¹; Jinghui Wang, M.D.¹;
10 Wangting Li, M.D.¹; Yi Zhu, M.D.^{1,4}; Chuan Chen, M.D.^{1,4}; Haotian Lin, M.D., Ph.
11 D^{1#}
12
13
14
15
16
17

18 **Institution:** 1. State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic
19 Center, Sun Yat-sen University, Guangzhou, Guangdong, 510060, People's Republic
20 of China
21
22

23 2. Zhongshan School of Medicine, Sun Yat-sen University, Guangzhou, China
24

25 3. Zhongshan School of Mathematics, Sun Yat-sen University, Guangzhou, China
26

27 4. Department of Molecular and Cellular Pharmacology, University of Miami Miller
28 School of Medicine, Miami, Florida 33136, USA.
29
30
31
32

33 15

34
35 **#Editorial Correspondence:**
36

37 Prof. Haotian Lin
38

39 Zhongshan Ophthalmic Center, Sun Yat-sen University
40

41 Xian Lie South Road 54#
42

43 Guangzhou, China, 510060.
44

45 Telephone number: +86-020-87330493
46

47 Fax: +86-020-87333271
48

49 E-mail: haot.lin@hotmail.com
50

51 Word count for text: 3122
52
53
54

55 25
56
57
58
59
60

1
2
3 26 **ABSTRACT**

4
5 27 **Objective** To characterize the contributing factors that affect medical students'

6
7 28 subspecialty choice and to estimate the extent of influence of individual

8
9 29 factors on the students' decision-making process.

10
11 30 **Design** Systematic review and meta-analysis.

12
13 31 **Methods** A systematic search of the Cochrane Library, ERIC, Web of Science, CNKI

14
15 32 and PubMed databases was conducted for studies published between January

16
17 33 1977 and June 2018. Information concerning study characteristics, influential

18
19 34 factors, and the extent of their influence (EOI) was extracted independently

20
21 35 by two trained investigators. EOI is the percentage level that describes how

22
23 36 much each of the factors influenced students' choice of subspecialty. The

24
25 37 estimates were pooled using a random-effects meta-analysis model due to the

26
27 38 between-study heterogeneity.

28
29 39 **Results** Data were extracted from 75 studies (882,209 individuals). Overall, the

30
31 40 factors influencing medical students' choice of subspecialty training mainly

32
33 41 included academic interests (75.29%), competencies (55.15%), controllable

34
35 42 lifestyles or flexible work schedules (53.00%), patient service orientation

36
37 43 (50.04%), medical teachers or mentors (46.93%), career opportunities

38
39 44 (44.00%), workload or working hours (37.99%), income (34.70%), length of

40
41 45 training (32.30%), prestige (31.17%), advice from others (28.24%), and

42
43 46 student debt (15.33%), with significant between-study heterogeneity

44
45 47 ($P<0.0001$). Subgroup analyses revealed that the EOI of academic interests

46
47 48 was higher in developed countries than that in developing countries (79.66%

48
49 49 [95% confidence interval (CI), 70.73%; 86.39%] vs. 60.41% [95% CI,

50
51 50 43.44%; 75.19%]; $Q=3.51$ $P=0.02$). The EOI value of prestige was lower in

1
2
3 51 developed countries than that in developing countries (23.96% [95% CI,
4
5 52 19.20%; 29.47%] vs. 47.65% [95% CI, 34.41%; 61.24%]; $Q=4.71$ $P=0.01$).

6
7 53 **Conclusions** This systematic review and meta-analysis provided a quantitative
8
9 54 evaluation of the top 12 influencing factors associated with medical students'
10
11 55 choice of subspecialty. Our findings provide the basis for the development of
12
13 56 specific, effective strategies to optimize the distribution of physicians among
14
15 57 different departments by modifying these influencing factors.

16
17
18 58 **Systematic review registration** PROSPERO CRD42017053781.

19
20 59 **STRENGTHS AND LIMITATIONS OF THIS STUDY**

- 21
22 60 ● This is the first study that provide a systematic estimate of the factors associated
23
24 61 with medical students' subspecialty choices.
25
26 62 ● A large number of studies conducted in varied populations have been included.
27
28 63 ● The differences in the characteristics of country, survey years, specialty, the type
29
30 64 of data used and sample size across studies represent a major limitation of our
31
32 65 study.
33
34

35 66 **KEYWORDS** Medical students, career choice, meta-analysis
36
37
38
39
40
41
42 69

70 Introduction

71 Because of the population aging, increased workload on doctors through increased
72 number of consultations and in managing patients with multi-morbidity, the demand
73 for physicians continues to increase; however, an imbalance in the supply of
74 physicians in different subspecialties has become a growing concern in both
75 developed and developing countries.¹⁻⁵ Some specialties and subspecialties, such as
76 family medicine and palliative medicine,^{6,7} are experiencing a desperate shortage of
77 physicians, whereas other specialties and subspecialties, such as cardiology,
78 ophthalmology and ear, nose and throat (ENT) surgery, require several years of
79 training before admission due to intense competition.^{8,9}

80 Specialty choice is the product of a complex interconnection of student expectation,
81 department expectation, and competition for available spots, and student choice is
82 where the choice begins.¹⁰ Previous studies have suggested that medical students'
83 choice of subspecialty is essential to the maintenance of an adequate medical
84 workforce and a balanced development of the medical system.^{11,12} However, the
85 influencing factors underlying students' subspecialty choice have not been
86 systemically reviewed. Recent changes in the training and practice environment may
87 influence medical students' career choice.¹³ Additionally, the variability in
88 preferences over time and in students' attitudes towards career choices can further
89 complicate this assessment. For example, a study in the UK indicated that half of the
90 medical students made a definitive subspecialty choice during their first year of
91 medical school.¹⁴ However, students were prone to changing their subspecialty
92 preference during medical school and internship.¹⁵ Notably, students may also reject
93 certain subspecialties during their medical school training, even those they have
94 previously seriously considered.¹⁶ Therefore, identifying the factors that influence

1
2
3 95 students' choice of subspecialty will enable a better understanding of the current
4
5 96 shortage/overload of physicians in specific fields and contribute to policy-building
6
7 97 and decision-making to improve the training and recruitment of students in the future.
8
9 98 We thus conducted a systematic review and a meta-analysis to investigate the
10
11 99 influencing factors and the extent of their influence on the choice of subspecialty
12
13 100 training among medical students. More specifically, we focused on the following
14
15 101 questions. First, can we gain a better understanding of students' preferences for
16
17 102 medical specialty according to the primary influencing factor? Second, do the
18
19 103 subgroups according to world region and survey years examined in this study differ
20
21 104 significantly with regard to the weight that students place on the identified
22
23 105 influencing factor?
24
25

26 106 **Methods**

27
28
29 107 We developed a review protocol (registration number: PROSPERO
30
31 108 CRD42017053781) prior to commencing the study. The Preferred Reporting Items
32
33 109 for Systematic Reviews and Meta-Analyses (PRISMA) guidelines was used to ensure
34
35 110 the reporting quality of this review (Fig. S1).¹⁷
36
37

38 111 **Search Strategy and Study Eligibility**

39
40 112 We performed a literature search in June 2018 using the Cochrane Library, Medline,
41
42 113 Web of Science, CNKI and ERIC databases without language restrictions. Articles
43
44 114 were screened by title, abstract and reference list, and by correspondence with study
45
46 115 investigators. Potentially relevant papers were first identified by reviewing the titles
47
48 116 and abstracts, and the full text of each retrieved article was then assessed. A detailed
49
50 117 example of search strategy for Medline/PubMed is shown in **Methods S1**. Studies
51
52 118 were included if they reported data on medical students, were published in
53
54 119 peer-reviewed journals, and used a validated method to assess the extent of a factor's
55
56

1
2
3 120 influence on the choice of subspecialty, such as pediatric gastroenterology and
4
5 121 vascular surgery, or its corresponding specialty, such as pediatrics and surgery.
6
7 122 Because of the differences between medical education systems in the world, the
8
9 123 medical students we recruited includes the student in medical school, internship,
10
11 124 residency training and fellowship, containing the students who about to make a
12
13 125 specialty choice and students who has just made a specialty choice. A guide to
14
15 126 medical specialty, available at
16
17 <https://www.abms.org/member-boards/specialty-subspecialty-certificates/>, were used
18
19 127
20 128 to identify the medical specialty and subspecialty of our research. We also conducted
21
22 129 an additional search using OpenGrey. However, no additional articles were further
23
24 130 included. All searches were performed using Google chrome (version 54.0.2840).

131 **Data Extraction and Quality Assessment**

132 The following information was independently extracted from each article by 2 trained
133 investigators (Y.Y. and J.L.) using a standardized form: study design, geographic
134 location, years of survey, journal, sample size, average age of the participants, the
135 number and percentage of male participants, and the influencing factors and the
136 extent of their influence. A third investigator was consulted if disagreements occurred.
137 Each study may involve one or several influencing factors. An 11-item checklist
138 which was recommended by Agency for Healthcare Research and Quality (AHRQ),
139 used for cross-sectional studies, available at
140 <https://www.ncbi.nlm.nih.gov/books/NBK35156/>, were used to assess the quality of
141 the studies. All discrepancies were resolved via discussion and consensus.

142 **Statistical Analysis**

143 As considerable heterogeneity was expected because of the multiple sources of
144 variances, a random effects meta-analysis model was used to estimate the influencing

1
2
3 145 factors and the extent of their influence.¹⁸ Between-study heterogeneity was assessed
4
5 146 using the I^2 statistic, which was calculated to describe the percentage of total
6
7 147 variation caused by heterogeneity across studies, with $\geq 50\%$ indicating considerable
8
9 148 heterogeneity.^{19 20} Potential sources of heterogeneity were identified using
10
11 149 meta-regression.²¹ Subgroup analyses were performed for each factor in the studies in
12
13 150 developed countries vs. developing countries and studies conducted before 2010 vs.
14
15 151 after 2010. The EOI value of competencies in developing countries was not
16
17 152 statistically significant (81.21% [95% CI, 75.27%; 86.51%], $P=0.1436$), and no
18
19 153 studies on the influence of student debt in developing countries were found. The
20
21 154 Q-test based on the analysis of variance was used to compare the subgroups, with a
22
23 155 significance threshold of 5%.²² The influence of individual studies on the overall EOI
24
25 156 value was explored by serially excluding each study in a sensitivity analysis.
26
27 157 Publication bias was investigated using a funnel plot test and Egger's test.^{23 24} All
28
29 158 analyses were performed using R (version 3.3.1, The R Foundation, Vienna, Austria).
30
31 159 The statistical tests were 2-sided with a significance threshold of $P<0.05$.

32 33 34 35 160 **Results**

36 37 38 161 **Study Characteristics**

39
40 162 Seventy-five cross-sectional studies involving a total of 882,209 individuals that
41
42 163 published between January 1977 and May 2018 were included in the present research
43
44 164 **(Table 1)**. Thirty-four studies were conducted in North America, 24 in Europe, 7 in
45
46 165 Asia, 5 in Oceania, 3 in Africa, and 2 in South America. The median number of
47
48 166 participants per study was 243 (range 37-29,227). Fourteen studies included students
49
50 167 who had already selected subspecialties, whereas 61 did not. The influencing factors
51
52 168 were ranked according to the frequency of occurrence and each factor was identified
53
54 169 when at least 5 papers were available describing it. The influencing factors for

1
2
3 170 subspecialty choice were then classified according to 17 aspects, including academic
4
5 171 interests, controllable lifestyle or flexible work schedule (defined as flexibility that
6
7 172 allows physicians to control the number of hours devoted to practicing the specialty),
8
9 173 competencies, patient service orientation, medical teachers or mentors, career
10
11 174 opportunities, workload or working hours (characterized by the physician's time
12
13 175 spent on professional responsibilities), income, prestige, length of training, advice
14
15 176 from others (advice from family, friends, and other students), student debt,
16
17 177 experience with the subject, working environment, personality, gender and job
18
19 178 security. Personality and gender are common factors that affect the choice of
20
21 179 subspecialty among medical students, but most of the relevant literature has not
22
23 180 reported on the extent of these factors' influence. Moreover, the funnel plots were
24
25 181 clearly asymmetrical with regard to experience with the subject, the working
26
27 182 environment and job variety, indicating the existence of publication bias. Thus, the
28
29 183 analysis of the remaining 12 influencing factors were shown in this paper. Studies
30
31 184 assessed for influencing factors using questionnaires validated to medical students
32
33 185 asking the extent of certain factors the studies investigated. Quality assessment scores
34
35 186 for the included studies are listed in **Table 1**. None of the studies received a point for
36
37 187 the second AHRQ Quality Indicator, which requires studies to list the inclusion and
38
39 188 exclusion criteria for exposed and unexposed subjects (cases and controls) or refer to
40
41 189 previous publications, since no comparison studies were referenced in the analyzed
42
43 190 articles. For the remaining 10 criteria, 6 studies received 9 points, 8 studies received
44
45 191 8 points, 17 studies received 7 points, 33 studies received 6 points, 9 studies received
46
47 192 5 points and 2 studies received 4 points (scores for individual studies are presented in
48
49 193 **Table S1**).

194 **Primary Analysis**

1
2
3 195 A meta-analysis was performed on the 12 influencing factors (**Table 2**): academic
4
5 196 interests (**Fig. S2**), competencies (**Fig. S3**), controllable lifestyle or flexible work
6
7 197 schedule (**Fig. S4**), patient service orientation (**Fig. S5**), medical teachers or mentors
8
9 198 (**Fig. S6**), career opportunities (**Fig. S7**), workload or working hours (**Fig. S8**),
10
11 199 income (**Fig. S9**), length of training (**Fig. S10**), prestige (**Fig. S11**), advice from
12
13 200 others (**Fig. S12**) and student debt (**Fig. S13**). All the factors were significant with
14
15 201 evidence of between-study heterogeneity ($P < 0.0001$). A sensitivity analysis, in which
16
17 202 the meta-analysis was serially repeated after the exclusion of each study,
18
19 203 demonstrated that no individual study affected the overall extent of a factor's
20
21 204 influence.

205 **Meta-regression and Subgroup Analysis**

206 Using common instructions when at least 5 studies were available and at least 2
207 studies were in each comparator subgroup, four categorical covariates were identified
208 as potential sources of heterogeneity by examining the studies conducted in the
209 United States (US) vs. the studies conducted in other countries, the studies conducted
210 before 2010 vs. those conducted after 2010, the studies concerning subspecialty only
211 vs. those that were not specific to a subspecialty, and the studies with a sample size
212 < 200 vs. the studies with a sample size ≥ 200 (**Table 3**). Some of the heterogeneities
213 observed among the 12 factors can be partially explained by country, survey years,
214 specialty and sample size.

215 EOI values were further analyzed by subgroup (**Table S2**) according to world region
216 (**Fig. 1**) and survey year (**Fig. 2**). The EOI value of academic interests in developed
217 countries was higher than that in developing countries (79.66% [95% CI, 70.73%;
218 86.39% vs. 60.41% [95% CI, 43.44%; 75.19%]; $Q = 3.51$ $P = 0.02$). Conversely, a
219 lower EOI value of prestige was found in studies conducted in developed countries

1
2
3 220 than in developing countries (23.96% [95% CI, 19.20%; 29.47%] vs. 47.65% [95%
4
5 221 CI, 34.41%; 61.24%]; $Q=4.71$ $P=0.01$). No statistically significant subgroup
6
7 222 differences in the EOI values of the other influencing factors were noted between
8
9 223 developed countries and developing countries. In addition, no statistically significant
10
11 224 differences in the EOI values of the influencing factors were observed when
12
13
14 225 subgroup analysis was performed by survey year.

15 16 226 **Assessment of Publication Bias**

17
18 227 We generated a funnel plot with proportion as the abscissa and standard error as the
19
20 228 ordinate. A visual inspection of the funnel plots revealed minimal asymmetry among
21
22 229 the various influencing factors (**Fig. S14**), and the results were concentrated in the
23
24 230 narrow upper part of the graph. However, there was evidence of small study effect in
25
26 231 the meta-analysis of “patient service orientation” (Egger’s test $P=0.02$).

27 28 29 232 **Discussion**

30 31 233 **Implications**

32
33 234 This systematic review and meta-analysis involved 75 studies with 882,209 medical
34
35 235 students. Twelve influencing factors were analyzed. These factors can be classified
36
37 236 into two categories: economic factors and non-economic factors. We found that the
38
39 237 EOI of the economic factors, including income (34.70%) and student debt (15.33%),
40
41 238 may not depend on the region’s level of economic development. However, income
42
43 239 remained a major influencing factor in the process of choosing a specialty or
44
45 240 subspecialty. In the US, 15% of full-time family medicine physicians earned less than
46
47 241 \$100,000 in 2004, which is significantly less than the income earned by invasive
48
49 242 cardiologists (median income=\$427,815), neurosurgeons (median income=\$211,094),
50
51 243 and orthopedists (median income=\$335,646).²⁵ This economic inequality made
52
53 244 family medicine less attractive to medical school graduates.²⁶ Benefits such as health

1
2
3 245 insurance and tuition reimbursement have been shown to be the most common
4
5 246 economic incentives used to attract applicants.²⁷
6

7 247 The non-economic factors can be divided into individual factors, specialty-related
8
9 248 factors and others. First, individual factors, including academic interest and
10
11 249 competencies, have a considerable impact on students' subspecialty choice, with EOI
12
13 250 values of 75.29% and 55.15%, respectively. In addition, in the subgroup analysis,
14
15 251 although academic interests were less influential in developing countries than in
16
17 252 developed countries (79.66% [95% CI, 70.73%; 86.39% vs. 60.41% [95% CI,
18
19 253 43.44%; 75.19%]; $Q=3.51$ $P=0.02$), they were still the most influential of the 12
20
21 254 factors regardless of regional economic level. These findings indicate that
22
23 255 subspecialties with a shortage of manpower may attract more students by increasing
24
25 256 students' interests and improving the quality of education. Previous studies indicated
26
27 257 that early specialty exposure in medical education may arouse students' academic
28
29 258 interest and improve their clinical competence.^{26 28} For example, an elective
30
31 259 extracurricular program designed to facilitate early contact with family medicine
32
33 260 physicians was found to significantly improve students' interest and clinical skills,
34
35 261 especially communication skills, in family medicine.²⁹ Furthermore, dispelling myths
36
37 262 and espousing the positive aspects of a discipline may provide a better understanding
38
39 263 of certain specialties; this approach could also be effective in increasing students'
40
41 264 academic interest.³⁰ For instance, family medicine is often considered a discipline
42
43 265 that requires less professional skills and knowledge. This misconception demotivates
44
45 266 students from choosing family medicine as their future career specialty, and this trend
46
47 267 may eventually lead to a shortage of family physicians.³⁰ Eliminating such prejudices
48
49 268 may help students pay greater attention to the areas in short supply and restore their
50
51 269 interests in other specialties.
52
53
54
55

1
2
3 270 Second, the specialty-related factors included controllable lifestyle/flexible work
4
5 271 schedule (EOI of 53.00%), career opportunities (EOI of 44.00%), workload (EOI of
6
7 272 37.99%) and training length (EOI of 32.30%). Of these factors, lifestyle varied
8
9 273 between different areas. Additionally, although certain specialties, such as general
10
11 274 surgery, seem to have an adequate number of surgeons on a per capita basis in the US,
12
13 275 there is still a poor geographic distribution within the surgical workforce according to
14
15 276 the type of surgical practice.³¹ The inflexible lifestyle is a common reason that
16
17 277 students perceive surgery to be less attractive.³¹ Reorganization of expected work
18
19 278 hours within shared practices and the increased use of physician extenders and
20
21 279 technologies such as electronic medical records may give physicians more flexibility
22
23 280 in work schedules.³² Moreover, providing promotion opportunities and shortening the
24
25 281 length of training are possible strategies to recruit new staff in subspecialties that
26
27 282 require a long period of post-graduate residency training, such as neurosurgery.³³
28
29
30
31 283 Finally, other factors such as service orientation (EOI of 50.74%), medical teachers
32
33 284 or mentors (EOI of 46.93%), prestige (EOI of 34.68%), and advice from others (EOI
34
35 285 of 28.24%) also contribute to the decision-making process of medical students. For
36
37 286 example, the desire to care for patients with end-stage diseases contributed to the
38
39 287 decision to enter palliative medicine in 86% of the medical students.⁷ Additionally,
40
41 288 exposure to mentors in a particular clinical field such as internal medicine has been
42
43 289 strongly associated with medical students' choice of clinical field.³⁴ Moreover,
44
45 290 improving the occupational prestige of areas such as family medicine, pathology, and
46
47 291 radiology may help reshape the distribution of the workforce.^{28 35 36}
48
49
50
51 292 In our study, several findings are especially noteworthy. First, interest was far more
52
53 293 important than income in deciding subspecialty. In our study, interest was the
54
55 294 top-ranked influencing factor (EOI of 75.29%) of subspecialty choice, while income

1
2
3 295 was ranked lower (EOI of 34.70%). This finding argues against the possible default
4
5 296 belief that raising physician's wages alone could solve the uneven distribution of
6
7 297 clinicians among subspecialties. Our findings highlight that cultivating and
8
9 298 stimulating students' professional interests may help improve the maldistribution of
10
11 299 medical resources in a more efficient and cost-saving manner.

12
13 300 Second, improving abilities in a certain subspecialty of interest can greatly affect
14
15 301 medical students' professional choice. In our study, competencies ranked second in
16
17 302 influence, which may reflect the impact of admission conditions on students' choice
18
19 303 of subspecialty. Hence, to reduce the risk that students are restricted to the
20
21 304 subspecialty of their interest due to a lack of personal skills, medical education
22
23 305 should focus more on enhancing students' personal competencies in addition to their
24
25 306 academic interests.

26
27
28 307 Third, balancing medical resources is a complex process in practical terms, as the
29
30 308 influencing factors are not mutually exclusive. The shortage of physicians in certain
31
32 309 subspecialties may increase physician workload, resulting in less time for teaching.
33
34 310 Hence, the quality of teaching cannot be guaranteed, and students may tend to avoid
35
36 311 choosing these subspecialties, thus worsening the imbalance in the medical
37
38 312 workforce. Additionally, some of the 12 factors identified are not amenable to
39
40 313 practical interventions. For example, prestige cannot be immediately increased using
41
42 314 interventional strategies.³⁵ Overall, effective strategies must be multi-pronged and
43
44 315 incorporate several different aspects, and maldistribution in the workforce should not
45
46 316 be tackled through a simple adjustment of one influencing factor.

317 **Interpretations of the results of this meta-analysis**

318 Our meta-regression stratified by the study-level characteristics found that country,
319 survey years, subspecialty and sample size may contribute to the heterogeneity

1
2
3 320 between studies. There was no significant difference in the sensitivity analysis, which
4
5 321 indicated that the results of the meta-analysis were convincing. The funnel plots and
6
7 322 Egger's tests revealed that most of the publication bias was small ($P>0.05$), except
8
9 323 for the meta-analysis of "patient service orientation". Moreover, the majority of the
10
11 324 studies collected in the database were from developed countries rather than
12
13
14 325 developing countries.

15 16 326 **Limitations**

17
18 327 Several limitations should be considered when interpreting the findings of this study.
19
20 328 First, the students involved in our study included medical students at different stages
21
22 329 of their medical education. Students' perception about different subspecialties may
23
24 330 change during medical training until the students applies for specialty training. For
25
26 331 example, compared to an intern, a freshman student may place greater emphasis on
27
28 332 income and prestige when considering a career choice.³⁷ A subgroup analysis
29
30 333 stratified by the stages of medical education and a secondary meta-analysis of
31
32 334 longitudinal studies may better reflect changes in influencing factors and the extent
33
34 335 of their influence over time. Second, our meta-analysis summarized the data from
35
36 336 different geographic regions around the world, and the general conclusions may not
37
38 337 be appropriate to guide policy development in each region. Enhanced effort is needed
39
40 338 to develop specific intervention strategies according to the specific economic level,
41
42 339 religious beliefs, healthcare system, educational system and endemic diseases of
43
44 340 different countries and regions. Subgroup analysis stratified by organizational and
45
46 341 medical training factors would provide more information of the factors influencing
47
48 342 subspecialty choice among medical students. Third, the surveys in the various studies
49
50 343 were also conducted using different methods. Most of the questionnaires used a
51
52 344 Likert scale. Therefore, when we converted the results to a percentage representing

1
2
3 345 the extent of a factor's influence, the Likert scale items were treated as interval
4
5 346 data.³⁸⁻⁴⁰ Consequently, there may have been differences in the conversion process.
6
7 347 Finally, the analysis relied on aggregated published data. A multicenter prospective
8
9 348 study would provide more accurate estimate of the influencing factors and the extent
10
11 349 of their influence on medical students' choice of subspecialty.

13 350 **Conclusion**

14
15
16 351 In conclusion, this systematic review and meta-analysis provided a summary
17
18 352 evaluation of 12 influencing factors and the extent of their influence on the choice of
19
20 353 subspecialty training among medical students. Understanding students' attitudes
21
22 354 toward their subspecialty decision-making process could provide the basis for
23
24 355 developing strategies to increase the attractiveness of subspecialties experiencing a
25
26 356 shortage of manpower, thereby balancing the distribution of medical recourses.
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 357 **Contributors:** Haotian Lin contributed to the conceptualizing and design of the study,
4
5 358 and to research funding, coordinated the research and oversaw the project. Yahan
6
7 359 Yang, Jiawei Li and Xiaohang Wu contributed to data collection and interpretation,
8
9 360 and to data analysis. Jinghui Wang, Yi Zhu, Chuan Chen and Wangting Li contributed
10
11 361 to the design of the study. All authors contributed to the drafting and revision of the
12
13 362 paper and approved the final manuscript for publication. No patients or the public
14
15 363 were involved in the development and design of this research.

16
17
18 364 **Funding:** The principal investigator of this study (Haotian Lin) is currently
19
20 365 supported by National key R & D project (2018YFC010302), the Key Research Plan
21
22 366 for the National Natural Science Foundation of China Cultivation Project (91546101),
23
24 367 the National Natural Science Foundation of China (81770967), the Fundamental
25
26 368 Research Funds for the Central Universities (16ykjc28), the Guangdong Provincial
27
28 369 Natural Science Foundation for Distinguished Young Scholars of China
29
30 370 (2014A030306030), the Guangdong Province Universities and Colleges Youth Pearl
31
32 371 River Scholar Funded Scheme (2016), the Clinical Research and Translational
33
34 372 Medical Center of Pediatric Cataract in Guangzhou City (201505032017516), and
35
36 373 Ministry of Science and Technology of China Grants (2015CB964600). These
37
38 374 sponsors and funding organizations had no role in the design or performance of this
39
40 375 study.

41
42
43
44 376 **Competing Interests:** The authors declare no competing financial interests.

45
46 377 **Data sharing:** No additional data available.

47
48 378 **Patient and public involvement:** Patients and the public were not involved in
49
50 379 development of the research question and outcome measures, nor the study design.
51
52 380 The study does not involve patient recruitment, and patients were not involved in
53
54
55
56
57
58
59
60

1
2
3 381 conduct of the study. We plan to liaise closely with patients, special interest groups,
4
5 382 and charities in the dissemination of our results in printed and electronic media.
6

7 383 **References**

- 8 384 1. Zurn P, Dal Poz MR, Stilwell B, et al. Imbalance in the health workforce. *Hum Resour Health*
9 385 2004;2(1):13. doi: 10.1186/1478-4491-2-13
- 10 386 2. Diallo K, Zurn P, Gupta N, et al. Monitoring and evaluation of human resources for health: an
11 387 international perspective. *Hum Resour Health* 2003;1(1):3. doi: 10.1186/1478-4491-1-3
- 12 388 3. Anderson GF, Hussey PS. Population aging: A comparison among industrialized countries. *Health*
13 389 *Affair* 2000;19(3):191-203. doi: DOI 10.1377/hlthaff.19.3.191
- 14 390 4. Hobbs FDR, Bankhead C, Mukhtar T, et al. Clinical workload in UK primary care: a retrospective
15 391 analysis of 100 million consultations in England, 2007-14. *Lancet* 2016;387(10035):2323-30.
16 392 doi: 10.1016/S0140-6736(16)00620-6
- 17 393 5. Reeve J, Blakeman T, Freeman GK, et al. Generalist solutions to complex problems: generating
18 394 practice-based evidence - the example of managing multi-morbidity. *Bmc Fam Pract* 2013;14
19 395 doi: Artn 112
20 396 10.1186/1471-2296-14-112
- 21 397 6. Bodenheimer T. Primary care--will it survive? *N Engl J Med* 2006;355(9):861-4. doi:
22 398 10.1056/NEJMp068155
- 23 399 7. LeGrand SB, Heintz JB. Palliative Medicine Fellowship: A Study of Resident Choices. *Journal of*
24 400 *Pain and Symptom Management* 2012;43(3):558-68. doi:
25 401 10.1016/j.jpainsymman.2011.04.018
- 26 402 8. Kim YY, Kim UN, Kim YS, et al. Factors associated with the specialty choice of Korean medical
27 403 students: a cross-sectional survey. *Human Resources for Health* 2016;14:8. doi:
28 404 10.1186/s12960-016-0141-8
- 29 405 9. McNally SA. Competition ratios for different specialties and the effect of gender and immigration
30 406 status. *J R Soc Med* 2008;101(10):489-92. doi: 10.1258/jrsm.2008.070284
- 31 407 10. Reed VA, Jernstedt GC, Reber ES. Understanding and improving medical student specialty choice:
32 408 a synthesis of the literature using decision theory as a referent. *Teach Learn Med*
33 409 2001;13(2):117-29. doi: 10.1207/S15328015TLM1302_7
- 34 410 11. Al-Ansari SS, Khafagy MA. FACTORS AFFECTING THE CHOICE OF HEALTH SPECIALTY
35 411 BY MEDICAL GRADUATES. *Journal of Family & Community Medicine*
36 412 2015;13(3):119-23.
- 37 413 12. Leduc N, Vanasse A, Scott I, et al. The career decision-making process of medical students and
38 414 residents and the choice of specialty and practice location: how does Postgraduate Medical
39 415 Education fit in? 2011
- 40 416 13. Delamothe T. Modernising Medical Careers: final report. *BMJ* 2008;336(7635):54-55.
- 41 417 14. Goldacre MJ, Laxton L, Harrison EM, et al. Early career choices and successful career progression
42 418 in surgery in the UK: prospective cohort studies. *Bmc Surgery* 2010;10:11. doi:
43 419 10.1186/1471-2482-10-32
- 44 420 15. Weissman C, Zisk-Rony RY, Schroeder JE, et al. Medical specialty considerations by medical
45 421 students early in their clinical experience. *Isr J Health Policy Res* 2012;1(1):13. doi:
46 422 10.1186/2045-4015-1-13
- 47 423 16. Jackson C, Ball J, Hirsh W, et al. Informing choices: the need for career advice in medical training.
48 424 *Cambridge: National institute for careers Education and Counseling* 2003
- 49 425 17. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and
50 426 meta-analyses: the PRISMA statement. *J Clin Epidemiol* 2009;62(10):1006-12. doi:
51 427 10.1016/j.jclinepi.2009.06.005
- 52 428 18. Borenstein M, Hedges LV, Higgins JP, et al. A basic introduction to fixed-effect and random-effects
53 429 models for meta-analysis. *Res Synth Methods* 2010;1(2):97-111. doi: 10.1002/jrsm.12
- 54 430 19. Higgins JP, Thompson SG, Deeks JJ, et al. Measuring inconsistency in meta-analyses. *BMJ*
55 431 2003;327(7414):557-60. doi: 10.1136/bmj.327.7414.557
- 56 432 20. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med*
57 433 2002;21(11):1539-58. doi: 10.1002/sim.1186
- 58 434 21. Sterne JA, Juni P, Schulz KF, et al. Statistical methods for assessing the influence of study
59 435 characteristics on treatment effects in 'meta-epidemiological' research. *Stat Med*
60 436 2002;21(11):1513-24. doi: 10.1002/sim.1184

- 1
2
3 437 22. Borenstein M, Hedges LV, Higgins J, et al. Criticisms of meta - analysis. *Introduction to*
4 438 *meta-analysis* 2009:377-87.
- 5 439 23. Egger M, Davey Smith G, Schneider M, et al. Bias in meta-analysis detected by a simple,
6 440 graphical test. *BMJ* 1997;315(7109):629-34.
- 7 441 24. Sterne JA, Egger M. Funnel plots for detecting bias in meta-analysis: guidelines on choice of axis.
8 442 *J Clin Epidemiol* 2001;54(10):1046-55.
- 9 443 25. Bodenheimer T, Berenson RA, Rudolf P. The primary care-specialty income gap: why it matters.
10 444 *Annals of internal medicine* 2007;146(4):301-6.
- 11 445 26. Bodenheimer T, Pham HH. Primary care: current problems and proposed solutions. *Health Aff*
12 446 *(Millwood)* 2010;29(5):799-805. doi: 10.1377/hlthaff.2010.0026
- 13 447 27. Association AH. The hospital workforce shortage: Immediate and future. *Trend Watch*
14 448 2001;3(2):1-8.
- 15 449 28. Compton MT, Frank E, Elon L, et al. Changes in US medical students' specialty interests over the
16 450 course of medical school. *Journal of General Internal Medicine* 2008;23(7):1095-100. doi:
17 451 10.1007/s11606-008-0579-z
- 18 452 29. Indyk D, Deen D, Fornari A, et al. The influence of longitudinal mentoring on medical student
19 453 selection of primary care residencies. *BMC medical education* 2011;11(1):27.
- 20 454 30. Gill H, McLeod S, Duerksen K, et al. Factors influencing medical students' choice of family
21 455 medicine Effects of rural versus urban background. *Canadian Family Physician*
22 456 2012;58(11):E649-E57.
- 23 457 31. Richardson JD. Workforce and lifestyle issues in general surgery training and practice. *Archives of*
24 458 *surgery (Chicago, Ill. : 1960)* 2002;137(5):515-20.
- 25 459 32. Newton DA, Grayson MS, Thompson LF. The variable influence of lifestyle and income on
26 460 medical students' career specialty choices: data from two U.S. medical schools, 1998-2004.
27 461 *Academic medicine : journal of the Association of American Medical Colleges*
28 462 2005;80(9):809-14.
- 29 463 33. Orrico K. Ensuring an adequate neurosurgical workforce for 21st century. *Surgeons AAoN* 2012
- 30 464 34. Wright SM, Wong A, Newill CA. The impact of role models on medical students. *Journal of*
31 465 *General Internal Medicine* 1997;12(1):53-56.
- 32 466 35. Glazer GM, Ruiz-Wibbelsmann JA. Decades of perceived mediocrity: prestige and radiology.
33 467 *Radiology* 2011;260(2):311-16.
- 34 468 36. Schwartzbaum AM, McGrath JH, Rothman RA. The perception of prestige differences among
35 469 medical subspecialties. *Soc Sci Med* 1973;7(5):365-71.
- 36 470 37. Parsa S, Aghazadeh A, Nejatiasafa AA, et al. Freshmen versus Interns' Specialty Interests. *Archives*
37 471 *of Iranian Medicine* 2010;13(6):509-15.
- 38 472 38. Komorita SS. Attitude Content, Intensity, and the Neutral Point on a Likert Scale. *J Soc Psychol*
39 473 1963;61:327-34. doi: 10.1080/00224545.1963.9919489
- 40 474 39. Baggaley AR, Hull AL. The effect of nonlinear transformations on a Likert scale. *Eval Health Prof*
41 475 1983;6(4):483-91.
- 42 476 40. Norman G. Likert scales, levels of measurement and the "laws" of statistics. *Advances in health*
43 477 *sciences education : theory and practice* 2010;15(5):625-32. doi:
44 478 10.1007/s10459-010-9222-y
- 45 479 41. Smith F, Lambert TW, Goldacre MJ. Factors influencing junior doctors' choices of future specialty:
46 480 trends over time and demographics based on results from UK national surveys. *Journal of the*
47 481 *Royal Society of Medicine* 2015;108(10):396-405. doi: 10.1177/0141076815599674
- 48 482 42. Cochran A, Melby S, Neumayer LA. An Internet-based survey of factors influencing medical
49 483 student selection of a general surgery career. *American Journal of Surgery*
50 484 2005;189(6):742-46. doi: 10.1016/j.amjsurg.2005.03.019
- 51 485 43. Hauer KE, Durning SJ, Kernan WN, et al. Factors associated with medical students' career choices
52 486 regarding internal medicine. *Jama-Journal of the American Medical Association*
53 487 2008;300(10):1154-64. doi: 10.1001/jama.300.10.1154
- 54 488 44. Johnson AL, Sharma J, Chinchilli VM, et al. Why do medical students choose orthopaedics as a
55 489 career? *The Journal of bone and joint surgery American volume* 2012;94(11):e78. doi:
56 490 10.2106/jbjs.k.00826 [published Online First: 2012/05/29]
- 57 491 45. Kiolbassa K, Miksch A, Hermann K, et al. Becoming a general practitioner - Which factors have
58 492 most impact on career choice of medical students? *Bmc Family Practice* 2011;12:7. doi:
59 493 10.1186/1471-2296-12-25
- 60 494 46. Klingensmith ME, Cogbill TH, Luchette F, et al. Factors Influencing the Decision of Surgery
55 495 Residency Graduates to Pursue General Surgery Practice Versus Fellowship. *Annals of*

- 1
2
3 496 *Surgery* 2015;262(3):449-55. doi: 10.1097/sla.0000000000001435
- 4 497 47. Lee JY, Kerbl DC, McDougall EM, et al. Medical Students Pursuing Surgical Fields Have No
498 Greater Innate Motor Dexterity than Those Pursuing Nonsurgical Fields. *Journal of Surgical*
499 *Education* 2012;69(3):360-63. doi: 10.1016/j.jsurg.2011.11.005
- 500 48. Macdonald C, Cawood T. Factors influencing career decisions in internal medicine. *Internal*
501 *Medicine Journal* 2012;42(8):918-23. doi: 10.1111/j.1445-5994.2012.02793.x
- 502 49. Paiva RE, Vu NV, Verhulst SJ. The effect of clinical experiences in medical school on specialty
503 choice decisions. *J Med Educ* 1982;57(9):666-74.
- 504 50. Ni Chroinin D, Cronin E, Cullen W, et al. Would you be a geriatrician? Student career preferences
505 and attitudes to a career in geriatric medicine. *Age Ageing* 2013;42(5):654-7. doi:
506 10.1093/ageing/aft093 [published Online First: 2013/08/07]
- 507 51. Rogers LQ, Fincher RM, Lewis LA. Factors influencing medical students to choose primary care
508 or non-primary care specialties. *Academic medicine : journal of the Association of American*
509 *Medical Colleges* 1990;65(9 Suppl):S47-8.
- 510 52. Abendroth J, Schnell U, Lichte T, et al. Motives of former interns in general practice for
511 speciality-choice--results of a cross-sectional study among graduates 2007 to 2012. *GMS*
512 *Zeitschrift für medizinische Ausbildung* 2014;31(1):Doc11. doi: 10.3205/zma000903
513 [published Online First: 2014/02/28]
- 514 53. Alawad A, Khan WS, Abdelrazig YM, et al. Factors considered by undergraduate medical students
515 when selecting specialty of their future careers. *Pan African Medical Journal* 2015;20:6. doi:
516 10.11604/pamj.2015.20.102.4715
- 517 54. Azizzadeh A, McCollum CH, Miller CC, 3rd, et al. Factors influencing career choice among
518 medical students interested in surgery. *Curr Surg* 2003;60(2):210-3. doi:
519 10.1016/s0149-7944(02)00679-7 [published Online First: 2004/02/20]
- 520 55. Celenza A, Bharath J, Scop J. Improving the attractiveness of an emergency medicine career to
521 medical students: An exploratory study. *Emergency Medicine Australasia* 2012;24(6):625-33.
522 doi: 10.1111/j.1742-6723.2012.01607.x
- 523 56. Dolan-Evans E, Rogers GD. Barriers for students pursuing a surgical career and where the Surgical
524 Interest Association can intervene. *Anz Journal of Surgery* 2014;84(6):406-11. doi:
525 10.1111/ans.12521
- 526 57. Boyd JS, Clyne B, Reinert SE, et al. Emergency Medicine Career Choice: A Profile of Factors and
527 Influences from the Association of American Medical Colleges (AAMC) Graduation
528 Questionnaires. *Academic Emergency Medicine* 2009;16(6):544-49. doi:
529 10.1111/j.1553-2712.2009.00385.x
- 530 58. Egerton EA. Choice of career of doctors who graduated from Queen's University, Belfast in 1977.
531 *Med Educ* 1985;19(2):131-7.
- 532 59. Diderichsen S, Johansson EE, Verdonk P, et al. Few gender differences in specialty preferences and
533 motivational factors: a cross-sectional Swedish study on last-year medical students. *Bmc*
534 *Medical Education* 2013;13:8. doi: 10.1186/1472-6920-13-39
- 535 60. Ferrari S, Reggianini C, Mattei G, et al. International Study of Student Career Choice in Psychiatry
536 (ISoSCCIP): Results from Modena, Italy. *International Review of Psychiatry*
537 2013;25(4):450-59. doi: 10.3109/09540261.2013.804402
- 538 61. Freire MDM, Jordao LMR, Ferreira ND, et al. Motivation Towards Career Choice of Brazilian
539 Freshman Students in a Fifteen-Year Period. *Journal of Dental Education* 2011;75(1):115-21.
- 540 62. Buddeberg-Fischer B, Klaghofer R, Abel T, et al. Swiss residents' speciality choices--impact of
541 gender, personality traits, career motivation and life goals. *BMC Health Serv Res* 2006;6:137.
542 doi: 10.1186/1472-6963-6-137
- 543 63. Dorsey ER, Jarjoura D, Rutecki GW. The influence of controllable lifestyle and sex on the
544 specialty choices of graduating U.S. medical students, 1996-2003. *Academic medicine :*
545 *journal of the Association of American Medical Colleges* 2005;80(9):791-6. [published
546 Online First: 2005/08/27]
- 547 64. Ekenze SO, Ugwumba FO, Obi UM, et al. Undergraduate Surgery Clerkship and the Choice of
548 Surgery as a Career: Perspective from a Developing Country. *World Journal of Surgery*
549 2013;37(9):2094-100. doi: 10.1007/s00268-013-2073-y
- 550 65. Barikani A, Afaghi M, Barikani F, et al. Perception of the medical students on their future career in
551 Qazvin University of Medical Sciences. *Global journal of health science* 2012;4(4):176-80.
552 doi: 10.5539/gjhs.v4n4p176 [published Online First: 2012/09/18]
- 553 66. Bittaye M, Odukogbe AT, Nyan O, et al. Medical students' choices of specialty in The Gambia: the
554 need for career counseling. *BMC Med Educ* 2012;12:72. doi: 10.1186/1472-6920-12-72

- 1
2
3 555 67. Bonura EM, Lee ES, Ramsey K, et al. Factors Influencing Internal Medicine Resident Choice of
4 556 Infectious Diseases or Other Specialties: A National Cross-sectional Study. *Clinical Infectious*
5 557 *Diseases* 2016;63(2):155-63. doi: 10.1093/cid/ciw263
- 6 558 68. Al-Fouzan R, Al-Ajlan S, Marwan Y, et al. Factors affecting future specialty choice among medical
7 559 students in Kuwait. *Medical Education Online* 2012;17:7. doi: 10.3402/meo.v17i0.19587
- 8 560 69. AlKot MM, Gouda MA, KhalafAllah MT, et al. Family Medicine in Egypt From Medical Students'
9 561 Perspective: A Nationwide Survey. *Teaching and Learning in Medicine* 2015;27(3):264-73.
10 562 doi: 10.1080/10401334.2015.1044654
- 11 563 70. Borges NJ, Manuel RS, Duffy RD, et al. Influences on specialty choice for students entering
12 564 person-oriented and technique-oriented specialties. *Medical Teacher* 2009;31(12):1086-88.
13 565 doi: 10.3109/01421590903183787
- 14 566 71. Budd S, Kelley R, Day R, et al. Student attitudes to psychiatry and their clinical placements.
15 567 *Medical Teacher* 2011;33(11):E586-E92. doi: 10.3109/0142159x.2011.610836
- 16 568 72. Corrigan MA, Shields CJ, Redmond HP. Factors influencing surgical career choices and
17 569 advancement in Ireland and Britain. *World Journal of Surgery* 2007;31(10):1921-29. doi:
18 570 10.1007/s00268-007-9175-3
- 19 571 73. Davis CR, Trevatt AEJ, McGoldrick RB, et al. How to train plastic surgeons of the future. *Journal*
20 572 *of Plastic Reconstructive and Aesthetic Surgery* 2016;69(8):1134-40. doi:
21 573 10.1016/j.bjps.2016.05.001
- 22 574 74. Deutsch T, Lippmann S, Frese T, et al. Who wants to become a general practitioner? Student and
23 575 curriculum factors associated with choosing a GP career - a multivariable analysis with
24 576 particular consideration of practice-orientated GP courses. *Scandinavian Journal of Primary*
25 577 *Health Care* 2015;33(1):47-53. doi: 10.3109/02813432.2015.1020661
- 26 578 75. Gardner SP, Roberts-Thomson KF. The effect of a change in selection procedures on students'
27 579 motivation to study dentistry. *Australian Dental Journal* 2014;59(1):2-8. doi:
28 580 10.1111/adj.12141
- 29 581 76. Dias MS, Sussman JS, Durham S, et al. Perceived benefits and barriers to a career in pediatric
30 582 neurosurgery: a survey of neurosurgical residents Clinical article. *Journal of*
31 583 *Neurosurgery-Pediatrics* 2013;12(5):422-33. doi: 10.3171/2013.5.peds12597
- 32 584 77. Goltz CJ, Bachusz RC, Mancini E, et al. Medical Student Career Survey-Vascular Surgery
33 585 Awareness Initiative. *Annals of Vascular Surgery* 2013;27(2):225-31. doi:
34 586 10.1016/j.avsg.2012.02.012
- 35 587 78. Gupta NB, Khadilkar SV, Bangar SS, et al. Neurology as career option among postgraduate
36 588 medical students. *Annals of Indian Academy of Neurology* 2013;16(4):478-82. doi:
37 589 10.4103/0972-2327.120427
- 38 590 79. Hanzlick R, Prahlow JA, Denton S, et al. Selecting forensic pathology as a career - A survey of the
39 591 post with an eye on the future. *American Journal of Forensic Medicine and Pathology*
40 592 2008;29(2):114-22. doi: 10.1097/PAF.0b013e318174f0a9
- 41 593 80. Harris MC, Marx J, Gallagher PR, et al. General vs subspecialty pediatrics - Factors leading to
42 594 residents' career decisions over a 12-year period. *Archives of Pediatrics & Adolescent*
43 595 *Medicine* 2005;159(3):212-16. doi: 10.1001/archpedi.159.3.212
- 44 596 81. Hauer KE, Fagan MJ, Kernan W, et al. Internal medicine clerkship directors' perceptions about
45 597 student interest in internal medicine careers. *Journal of General Internal Medicine*
46 598 2008;23(7):1101-04. doi: 10.1007/s11606-008-0640-y
- 47 599 82. Labiris G, Vamvakerou V, Tsolakaki O, et al. Perceptions of Greek medical students regarding
48 600 medical profession and the specialty selection process during the economic crisis years.
49 601 *Health Policy* 2014;117(2):203-09. doi: 10.1016/j.healthpol.2014.04.009
- 50 602 83. Lambert TW, Goldacre MJ, Bron AJ. Career choices for ophthalmology made by newly qualified
51 603 doctors in the United Kingdom, 1974-2005. *Bmc Ophthalmology* 2008;8:9. doi:
52 604 10.1186/1471-2415-8-3
- 53 605 84. Shah HH, Jhaveri KD, Sparks MA, et al. Career Choice Selection and Satisfaction among US
54 606 Adult Nephrology Fellows. *Clinical Journal of the American Society of Nephrology*
55 607 2012;7(9):1513-20. doi: 10.2215/cjn.01620212
- 56 608 85. Lefevre JH, Roupert M, Kerneis S, et al. Career choices of medical students: a national survey of
57 609 1780 students. *Medical Education* 2010;44(6):603-12. doi:
58 610 10.1111/j.1365-2923.2010.03707.x
- 59 611 86. Vicente B, Rosel L. Challenges for psychiatric recruitment and training in Chile. *International*
60 612 *Review of Psychiatry* 2013;25(4):413-18. doi: 10.3109/09540261.2013.822348
- 61 613 87. Wiesenfeld L, Abbey S, Takahashi SG, et al. Choosing Psychiatry as a Career: Motivators and

- 1
2
3 614 Deterrents at a Critical Decision-Making Juncture. *Canadian Journal of Psychiatry-Revue*
4 615 *Canadienne De Psychiatrie* 2014;59(8):450-54.
- 5 616 88. Lam CYY, Cheung CSY, Hui ASY. Factors influencing the career interest of medical graduates in
6 617 obstetrics and gynaecology in Hong Kong: a cross-sectional questionnaire survey. *Hong Kong*
7 618 *Medical Journal* 2016;22(2):138-43.
- 8 619 89. Hartung PJ, Taber BJ, Richard GV. The physician values in practice scale: Construction and initial
9 620 validation. *Journal of Vocational Behavior* 2005;67(2):309-20. doi:
10.1016/j.jvb.2004.05.008
- 10 622 90. Girasek E, Molnar R, Eke E, et al. The medical career choice motivations - Results from a
11 623 Hungarian study. *Central European Journal of Medicine* 2011;6(4):502-09. doi:
12 624 10.2478/s11536-011-0034-0
- 13 625 91. Zuccato JA, Kulkarni AV. The Impact of Early Medical School Surgical Exposure on Interest in
14 626 Neurosurgery. *Canadian Journal of Neurological Sciences* 2016;43(3):410-16. doi:
15 627 10.1017/cjn.2015.332
- 16 628 92. Wilbanks L, Spollen J, Messias E. Factors Influencing Medical School Graduates Toward a Career
17 629 in Psychiatry: Analysis from the 2011-2013 Association of American Medical Colleges
18 630 Graduation Questionnaire. *Academic Psychiatry* 2016;40(2):255-60. doi:
19 631 10.1007/s40596-015-0287-z
- 20 632 93. West CP, Drefahl MM, Popkave C, et al. Internal Medicine Resident Self-report of Factors
21 633 Associated with Career Decisions. *Journal of General Internal Medicine* 2009;24(8):946-49.
22 634 doi: 10.1007/s11606-009-1039-0
- 23 635 94. Watmough S, Taylor D, Ryland I. Using questionnaires to determine whether medical graduates'
24 636 career choice is determined by undergraduate or postgraduate experiences. *Medical Teacher*
25 637 2007;29(8):830-32. doi: 10.1080/01421590701551755
- 26 638 95. Thakur A, Fedorka P, Ko C, et al. Impact of mentor guidance in surgical career selection. *Journal*
27 639 *of Pediatric Surgery* 2001;36(12):1802-04. doi: 10.1053/jpsu.2001.28842
- 28 640 96. Scott I, Gowans M, Wright B, et al. Determinants of choosing a career in surgery. *Medical Teacher*
29 641 2011;33(12):1011-17. doi: 10.3109/0142159x.2011.558533
- 30 642 97. Schnuth RL, Vasilenko P, Mavis B, et al. What influences medical students to pursue careers in
31 643 obstetrics and gynecology? *American Journal of Obstetrics and Gynecology*
32 644 2003;189(3):639-43. doi: 10.1067/s0002-9378(03)00886-x
- 33 645 98. Richards JMJ, Drummond R, Murray J, et al. WHAT PROPORTION OF BASIC SURGICAL
34 646 TRAINEES CONTINUE IN A SURGICAL CAREER? A SURVEY OF THE FACTORS
35 647 WHICH ARE IMPORTANT IN INFLUENCING CAREER DECISIONS. *Surgeon-Journal*
36 648 *of the Royal Colleges of Surgeons of Edinburgh and Ireland* 2009;7(5):270-75.
- 37 649 99. Reed CE, Vaporciyan AA, Erikson C, et al. Factors Dominating Choice of Surgical Specialty.
38 650 *Journal of the American College of Surgeons* 2010;210(3):319-24. doi:
39 651 10.1016/j.jamcollsurg.2009.11.016
- 40 652 100. de Souza LCL, Mendonca VRR, Garcia GBC, et al. Medical Specialty Choice and Related
41 653 Factors of Brazilian Medical Students and Recent Doctors. *Plos One* 2015;10(7):15. doi:
42 654 10.1371/journal.pone.0133585
- 43 655 101. Pikoulis E, Avgerinos ED, Pedeli X, et al. Medical students' perceptions on factors influencing a
44 656 surgical career: The fate of general surgery in Greece. *Surgery* 2010;148(3):510-15. doi:
45 657 10.1016/j.surg.2010.01.013
- 46 658 102. Ozer U, Ceri V, Carpar E, et al. Factors Affecting the Choice of Psychiatry as a Specialty and
47 659 Satisfaction among Turkish Psychiatry Residents. *Academic Psychiatry* 2016;40(2):299-303.
48 660 doi: 10.1007/s40596-015-0346-5
- 49 661 103. Noble J, Hechter FJ, Karaikos N, et al. Motivational factors and future life plans of orthodontic
50 662 residents in the United States. *American Journal of Orthodontics and Dentofacial*
51 663 *Orthopedics* 2010;137(5):623-30. doi: 10.1016/j.ajodo.2008.03.034
- 52 664 104. Noble J. Factors influencing career choice in ophthalmology. *Canadian Journal of*
53 665 *Ophthalmology-Journal Canadien D Ophthalmologie* 2006;41(5):596-99.
- 54 666 105. Newton DA, Grayson MS, Thompson LF. The variable influence of lifestyle and income on
55 667 medical students' career specialty choices: Data from two US medical schools, 1998-2004.
56 668 *Academic Medicine* 2005;80(9):809-14. doi: 10.1097/00001888-200509000-00005
- 57 669 106. Moore HB, Moore PK, Grant AR, et al. Future of acute care surgery: A perspective from the next
58 670 generation. *Journal of Trauma and Acute Care Surgery* 2012;72(1):94-99. doi:
59 671 10.1097/TA.0b013e31823b990a
- 60 672 107. Momen AA, Shakurnia A. Factors Influencing Pediatric Specialty Choice among Pediatric

- 1
2
3 673 Residents of Ahvaz Jundishapur University of Medical Sciences. *International Journal of*
4 674 *Pediatrics-Mashhad* 2015;3(3):701-06.
5 675 108. Mehmood SI, Kumar A, Al-Binali A, et al. Specialty preferences: Trends and perceptions among
6 676 Saudi undergraduate medical students. *Medical Teacher* 2012;34:S51-S60. doi:
7 677 10.3109/0142159x.2012.656753
8 678 109. Lorient Y, Albiges-Sauvin L, Dionysopoulos D, et al. Why do residents choose the medical
9 679 oncology specialty? Implications for future recruitment-results of the 2007 French
10 680 Association of Residents in Oncology (AERIO) Survey. *Annals of Oncology*
11 681 2010;21(1):161-65. doi: 10.1093/annonc/mdp294
12 682 110. Lefevre JH, Karila L, Kerneis S, et al. Motivation of French medical students to pursue surgical
13 683 careers: Results of national survey of 1742 students. *Journal of Visceral Surgery*
14 684 2010;147(3):E181-E86. doi: 10.1016/j.jvisc Surg.2010.08.004
15 685 111. Vo A, McLean L, McInnes MDF. Medical specialty preferences in early medical school training
16 686 in Canada. *Int J Med Educ* 2017;8:400-07. doi: 10.5116/ijme.59f4.3c15
17 687 112. Grasreiner D, Dahmen U, Settmacher U. Specialty preferences and influencing factors: a repeated
18 688 cross-sectional survey of first- to sixth-year medical students in Jena, Germany. *BMC medical*
19 689 *education* 2018;18 doi: ARTN 103
20 690 10.1186/s12909-018-1200-8
21 691 113. Alkhaneen H, Alhusain F, Alshahri K, et al. Factors influencing medical students' choice of
22 692 emergency medicine as a career specialty-a descriptive study of Saudi medical students.
23 693 *International journal of emergency medicine* 2018;11(1):14. doi: 10.1186/s12245-018-0174-y
24 694 [published Online First: 2018/03/09]
25 695

1
2
3 696 **Legends**

4
5 697 **Table 1. Selected Characteristics of the 75 Studies Included in this Systematic**
6
7 698 **Review and Meta-analysis**

8
9 699 **Table 2. Meta-analyses of the Factors Influencing Medical Students' Choice of**
10
11 700 **Subspecialty**

12
13 701 **Table 3. Meta-regression of the EOI Value Stratified by Study-level**
14
15 702 **Characteristics**

16
17 703 **Figure 1. Bar Graph of the Meta-analyses of the Factors Influencing Medical**
18
19 704 **Students' Choice of Subspecialty Stratified by Region.**

20
21 705 **Figure 2. Bar Graph of the Meta-analyses of the Factors Influencing Medical**
22
23 706 **Students' Choice of Subspecialty Stratified by Survey Year.**

24
25
26 707 **Supplements**

27
28 708 **Methods S1. Search strategy used in the current systematic review and**
29
30 709 **meta-analysis.**

31
32 710 **Table S1. Quality Assessment of the Included Studies.**

33
34 711 **Table S2. Meta-analyses of the Factors Influencing Medical Students' Choice of**
35
36 712 **Subspecialty Stratified by Region and Survey Year.**

37
38 713 **Figure S1. Flow Diagram of the Study Inclusion Process.**

39
40 714 **Figure S2. Forest Plot of "Academic Interest".**

41
42 715 **Figure S3. Forest Plot of "Competencies".**

43
44 716 **Figure S4. Forest Plot of "Controllable Lifestyle or Flexible Work Schedule".**

45
46 717 **Figure S5. Forest Plot of "Patient Service Orientation".**

47
48 718 **Figure S6. Forest Plot of "Medical Teachers or Mentors".**

49
50 719 **Figure S7. Forest Plot of "Career Opportunities".**

51
52 720 **Figure S8. Forest Plot of "Workload or Working Hours".**

1
2
3 721 **Figure S9. Forest Plot of “Income”.**

4
5 722 **Figure S10. Forest Plot of “Length of Training”.**

6
7 723 **Figure S11. Forest Plot of “Prestige”.**

8
9 724 **Figure S12. Forest Plot of “Advice from Others”.**

10
11 725 **Figure S13. Forest Plot of “Student Debt”.**

12
13 726 **Figure S14. Funnel Plots of the Publication Bias Tests of the 12 Factors.**

14
15
16 727

17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

Table 1. Selected Characteristics of the 75 Studies Included in this Systematic Review and Meta-analysis

First Author, Year	Country	Survey years	Sample size	Average age	Men, No. (%)	Scores
Smith et al, ⁴¹ 2015	UK	2012	2,978	NR	NR	6
Cochran et al, ⁴² 2005	USA	2002	408	27.2	214 (52.45)	5
Hauer et al, ⁴³ 2008	USA	2007	1,177	NR	NR	6
Johnson et al, ⁴⁴ 2012	USA	2012	622	NR	NR	6
Kiolbassa et al, ⁴⁵ 2011	Germany	2010	1,114	24.1	408 (36.62)	5
Klingensmith et al, ⁴⁶ 2015	USA	2013	792	NR	539 (68.06)	6
Lee et al, ⁴⁷ 2012	USA	2012	100	NR	58 (58)	7
Macdonald et al, ⁴⁸ 2012	New Zealand	2011	134	NR	79 (58.96)	7
Parsa et al, ³⁷ 2010	Iran	2006-2007	137	27.34	49 (35.77)	7
Paiva et al, ⁴⁹ 1982	USA	1982	144	NR	NR	6
Ni Chroinin et al, ⁵⁰ 2013	UK	2009-2011	274	NR	112 (40.89)	7
Newton et al, ³² 2005	USA	1998-2004	1,258	NR	642 (51.03)	8
Rogers et al, ⁵¹ 1990	USA	1989	266	NR	205 (77.07)	6
Abendroth J et al, ⁵² 2014	Germany	2007-2012	45	NR	14 (31)	7
Alawad et al, ⁵³ 2015	USA	2010-2011	45	NR	36 (80)	8
Azizzadeh et al, ⁵⁴ 2003	USA	2002	130	NR	NR	6
Celenza et al, ⁵⁵ 2012	Australia	2009	216	NR	121 (56.02)	8
Dolan-Evans et al, ⁵⁶ 2014	Australia	2013	419	NR	215 (51.31)	8
Boyd et al, ⁵⁷ 2009	USA	2005-2006	5,848	NR	2,982 (50.99)	8
Egerton et al, ⁵⁸ 1985	Ireland	1977-1981	134	30	82 (61.19)	6
Diderichsen et al, ⁵⁹ 2013	Sweden	2006-2009	372	27	157 (42.20)	6
Ferrari et al, ⁶⁰ 2013	Italy, UK	2009-2011	45	25	NR	9
Freire et al, ⁶¹ 2011	Brazil	2006-2008	290	23	102 (35.17)	7
Buddeberg-Fischer et al, ⁶² 2006	Switzerland	2001-2003	522	31.1	241 (46.17)	9
Dorsey et al, ⁶³ 2005	USA	2003	11,029	NR	4,964 (45.01)	6
Ekenze et al, ⁶⁴ 2013	Nigeria	2009-2010	96	25.9	NR	7
Barikani et al, ⁶⁵ 2012	Australia	2008-2009	49	21.7	NR	6
Bittaye et al, ⁶⁶ 2012	Gambia	2011	106	24.1	48 (45.28)	6
Bonura et al, ⁶⁷ 2016	USA	2015	590	NR	321 (54.40)	9
Al-Fouzan et al, ⁶⁸ 2012	Kuwait	2011-2012	144	NR	NR	7
AlKot et al, ⁶⁹ 2015	Egypt	2013	451	21.8	NR	7
Borges et al, ⁷⁰ 2009	USA	2001-2005	341	NR	NR	5
Budd et al, ⁷¹ 2011	UK	2011	870	22	NR	7
Corrigan et al, ⁷² 2007	Ireland	2007	222	NR	142 (63.96)	7
Davis et al, ⁷³ 2016	UK	2016	173	NR	76 (43.93)	7
Deutsch et al, ⁷⁴ 2015	Germany	2011	659	27.9	NR	8
Gardner et al, ⁷⁵ 2014	Australia	1993-2005	631	NR	NR	7
Dias et al, ⁷⁶ 2013	UK	2013	495	NR	438 (88.48)	5
Goltz et al, ⁷⁷ 2013	USA	2012	102	24.5	34 (33.33)	6
Gupta et al, ⁷⁸ 2013	India	2013	243	NR	179 (73.36)	6

1								
2								
3		Hanzlick et al, ⁷⁹ 2008	USA	2006	161	NR	NR	6
4		Harris et al, ⁸⁰ 2005	USA	1991-2002	104	NR	53 (50.96)	6
5		Hauer et al, ⁸¹ 2008	USA	2008	80	NR	NR	6
6		Labiris et al, ⁸² 2014	Greece	2014	111	23.6	55 (49.54)	6
7		Lambert et al, ⁸³ 2008	UK	2007	17,393	NR	NR	6
8		Shah et al, ⁸⁴ 2012	USA	2011	892	NR	NR	6
9		Lefevre et al, ⁸⁵ 2010	USA	2008	1,555	NR	589 (37.88)	6
10		Vicente et al, ⁸⁶ 2013	Chile	2013	30	NR	NR	6
11		Wiesenfeld et al, ⁸⁷ 2014	Canada	2013	60	NR	NR	7
12		Lam et al, ⁸⁸ 2016	Hong Kong	2015	228	23	NR	9
13		Hartung et al, ⁸⁹ 2005	USA	2004	192	20.59	74 (38.54)	4
14		Girasek et al, ⁹⁰ 2011	Hungary	2011	536	NR	NR	5
15		Zuccato et al, ⁹¹ 2015	Canada	2012	37	NR	24 (65)	6
16		Wilbanks et al, ⁹² 2015	USA	2011-2013	29,227	NR	15,164 (51.99)	9
17		West et al, ⁹³ 2009	USA	2005-2007	14,890	NR	8,700 (58.43)	6
18		Watmough et al, ⁹⁴ 2007	UK	2005	116	NR	66 (56.90)	4
19		Thakur et al, ⁹⁵ 2001	USA	2001	56	NR	53 (95)	8
20		Scott et al, ⁹⁶ 2011	Canada	2002-2004	1,542	NR	NR	6
21		Schnuth et al, ⁹⁷ 2003	USA	2002	203	NR	72 (53.47)	6
22		Richards et al, ⁹⁸ 2009	UK	2009	150	NR	108 (72.00)	5
23		Reed et al, ⁹⁹ 2009	USA	2008	2,022	NR	1,354 (66.96)	9
24		de Souza et al, ¹⁰⁰ 2015	Portugal	2012	1,303	NR	NR	7
25		Pikoulis et al, ¹⁰¹ 2010	Greece	2006-2007	87	NR	NR	6
26		Ozer et al, ¹⁰² 2015	Turkey	2013	98	27.7	26 (26.53)	6
27		Noble et al, ¹⁰³ 2004	Canada	2004	21,296	NR	NR	8
28		Noble et al, ¹⁰⁴ 2010	Canada	2007	120	NR	NR	5
29		Newton et al, ¹⁰⁵ 2005	USA	2004	1,286	NR	NR	6
30		Moore et al, ¹⁰⁶ 2012	USA	2011	337	26	179 (53.12)	6
31		Momen et al, ¹⁰⁷ 2015	Iran	2014-2015	38	35.6	11 (29)	6
32		Mehmood et al, ¹⁰⁸ 2012	Saudi Arabia	2012	550	NR	348 (63.27)	6
33		Loriot et al, ¹⁰⁹ 2010	France	2007	44	NR	17 (39)	7
34		Lefevre et al, ¹¹⁰ 2010	France	2008	522	23.8	198 (37.93)	7
35		Vo et al, ¹¹¹ 2017	Canada	2017	90	22.5	52 (57.78)	5
36		Grasreiner et al, ¹¹² 2018	Germany	2014-2016	181	24	33 (18.10)	6
37		Alkhaman et al, ¹¹³ 2018	Saudi Arabia	2017	436	NA	250 (57.00)	5

728 Footnotes: scores: quality score of the AHRQ scale.

729

Table 2. Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty

Factor	No. of studies	Total no. of participants	EOI value (%)	95% CI of EOI		<i>I-square</i> (%)	<i>Tau-square</i>	<i>P-Value</i>
				value				
				Lower	Upper			
Academic interests	38	82,366	75.29	66.93	82.11	99.70	1.60	<0.0001
Competencies	17	76,515	55.15	33.63	74.90	99.90	3.44	<0.0001
Controllable lifestyle or flexible work schedule	44	101,001	53.00	47.90	58.03	99.50	0.45	<0.0001
Patient service orientation	37	46,572	50.04	44.65	55.43	98.70	0.41	<0.0001
Medical teachers or	32	85,071	46.93	37.77	56.30	99.80	1.14	<0.0001
Career opportunities	38	81,923	44.00	32.26	48.78	99.70	1.15	<0.0001
Workload or working hours	20	22,051	37.99	29.59	47.19	98.30	0.69	<0.0001
Income	50	109,791	34.70	28.36	41.62	99.70	1.09	<0.0001
Length of training	18	42,046	32.30	27.61	37.37	98.10	0.20	<0.0001
Prestige	26	30,629	31.17	26.32	37.69	98.30	0.52	<0.0001
Advice from others	18	82,692	28.24	22.26	34.23	99.80	0.02	<0.0001
Student debt	8	38,917	15.33	10.96	21.03	98.80	0.27	<0.0001

730

Table 3. Meta-regression of the EOI Value Stratified by Study-level Characteristics

Factor	estimate	95 CI% of estimate		P-Value	
		Lower	Upper		
Academic interests	Country	-0.2314	-1.1575	0.6946	0.6302
	Survey years	0.3811	-0.3580	1.1202	0.2711
	Specialty	-0.4892	-1.5345	0.5562	0.4008
Competencies	Sample size	0.2362	-0.5488	1.0212	0.6537
	Country	0.6946	-1.1461	0.8938	0.8376
	Survey years	-1.0418	-2.0950	0.0114	0.0151
Controllable lifestyle or flexible work schedule	Specialty	0.0904	-1.5786	1.7594	0.9398
	Sample size	-0.5720	-1.8606	0.7166	0.5823
	Country	-0.1261	-1.1461	0.8938	0.9614
Patient service orientation	Survey years	-0.0001	-0.4052	0.4051	0.9822
	Specialty	-0.8989	-1.4979	-0.3000	0.0035
	Sample size	-0.0518	-0.4396	0.3361	0.7203
Medical teachers or mentors	Country	-0.6238	-1.3118	0.0642	0.0833
	Survey years	-0.0414	-0.6912	0.6083	0.8524
	Specialty	-1.5982	-2.5227	-0.6737	0.0010
Career opportunities	Sample size	-0.1157	-0.7473	0.5159	0.6358
	Country	0.7395	0.3117	1.1674	0.0007
	Survey years	0.1133	-0.3580	0.5845	0.6376
Workload or working hours	Specialty	0.0605	-0.4441	0.5652	0.8141
	Sample size	-0.1202	-0.5567	0.3163	0.5894
	Country	0.1075	-0.7030	0.9179	0.5828
Income	Survey years	0.3284	-0.3913	1.0480	0.7546
	Specialty	-0.9292	-1.8015	-0.0570	0.0077
	Sample size	0.3654	0.1156	1.5478	0.0081
Length of training	Country	-0.4535	-1.5086	0.6016	0.3981
	Survey years	0.4624	-0.5417	1.4665	0.3922
	Specialty	-0.9878	-2.1727	0.1972	0.1070
Prestige	Sample size	0.0982	-0.8589	1.0553	0.8205
	Country	0.1058	-0.4665	0.6781	0.7390
	Survey years	0.0999	-0.4379	0.6377	0.8774
Advice from others	Specialty	-0.6457	-1.3267	0.0352	0.0480
	Sample size	0.0523	-0.4826	0.5872	0.6786
	Country	-0.1559	-1.2782	0.9664	0.7854
Advice from others	Survey years	-0.2158	-1.4089	0.9772	0.7229
	Specialty	0.3959	-0.9585	1.7502	0.5667
	Sample size	0.1565	-0.6631	0.9761	0.7082
Advice from others	Country	-0.3346	-1.0799	0.4106	0.3485
	Survey years	-0.4513	-1.1378	0.2352	0.0950
	Specialty	-1.0112	-1.8980	-0.1244	0.0172
Advice from others	Sample size	0.0355	-0.6013	0.6723	0.5214
	Country	-0.0097	-0.0722	0.0529	0.9328
Advice from others	Survey years	-0.0861	-0.1471	-0.0251	0.0057

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

731

	Specialty	-0.2017	-0.2790	-0.1244	<0.0001
	Sample size	0.2125	0.1309	0.2941	<0.0001
	Country	2.7853	2.0544	3.5162	0.0001
Student debt	Survey years	-0.1567	-0.6707	0.3573	0.5502
	Sample size	-0.5248	-1.0108	-0.0388	0.0343

For peer review only

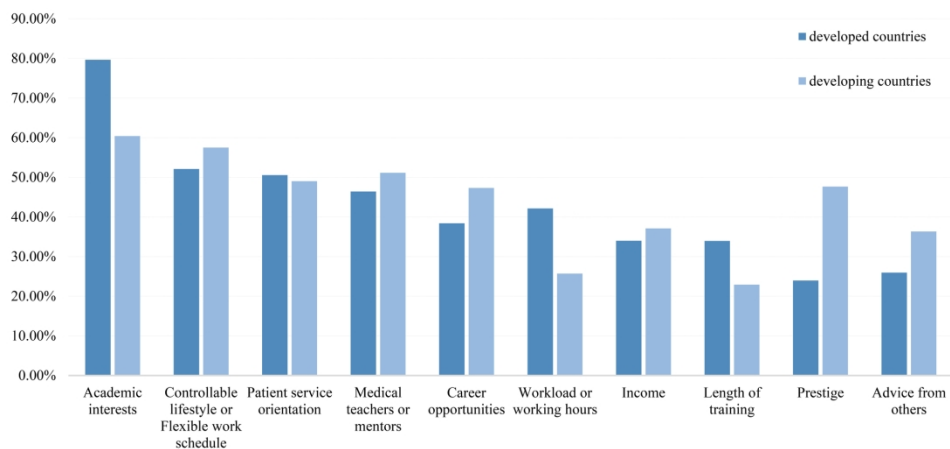


Figure 1. Bar Graph of the Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty Stratified by Region.

190x107mm (300 x 300 DPI)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

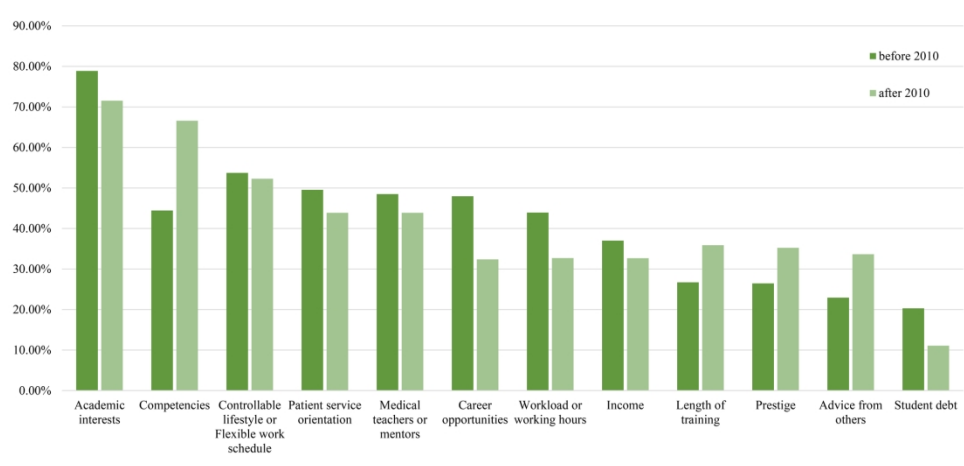


Figure 2. Bar Graph of the Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty Stratified by Survey Year.

190x107mm (300 x 300 DPI)

1
2
3
4 **SI Methods. Search strategy used in the current systematic review and meta-**
5
6 **analysis.**
7
8
9

10
11 ***Medical Students***

- 12
13
14 1. Students, Medical [Mesh]
15
16 2. Medical students
17
18 3. Medical student
19
20 4. Student, Medical
21
22 5. OR / 1 – 4
23
24
25
26

13. Cross sectional study
14. Cross sectional study [Publication
Type]
15. Cross sectional study [Mesh Terms]
16. Systematic review
17. Systematic review [Publication Type]
18. Systematic review [Mesh Terms]

27
28
29
30 ***Subspecialty Choice***

- 31
32 6. Career choices
33
34 7. Choice, Career
35
36 8. Choices career
37
38 9. Specialties
39
40
41
42 10. Sub-specialties
43
44
45 11. Sub-discipline
46
47
48 12. OR / 6 – 11
49
50

19. Meta-analysis [Title/Abstract]
20. Meta-analysis [Mesh Terms]
21. Meta-analysis [Publication Type]
22. OR / 12 – 21

51
52 ***Factors***

23. Factors

53 ***Combined search***

23. #5 AND #12AND #22 AND #2

54 ***Study design***

55
56
57
58 **Abbreviations:** MeSH, Medical Subject Heading in PubMed
59
60

Table S1. Quality assessment of the included studies

Quality assessment criteria	1	2	3	4	5	6	7	8	9	10	11	Scores
1 Smith et al, ⁴¹ 2015	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
2 Cochran et al, ⁴² 2005	Y	U	Y	Y	N	Y	N	Y	N	N	N	5
3 Hauer et al, ⁴³ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
4 Johnson et al, ⁴⁴ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
5 Kiolbassa et al, ⁴⁵ 2011	Y	U	Y	Y	N	Y	N	Y	N	N	N	5
6 Klingensmith et al, ⁴⁶ 2015	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
7 Lee et al, ⁴⁷ 2012	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
8 Macdonald et al, ⁴⁸ 2012	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
9 Parsa et al, ³⁷ 2010	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
10 Paiva et al, ⁴⁹ 1982	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
11 Ni Chroinin et al, ⁵⁰ 2013	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
12 Newton et al, ³² 2005	Y	U	Y	Y	Y	Y	Y	Y	N	Y	N	8
13 Rogers et al, ⁵¹ 1990	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
14 Abendroth J et al, ⁵² 2014	Y	U	Y	Y	N	Y	N	Y	N	Y	Y	7
15 Alawad et al, ⁵³ 2015	Y	U	Y	Y	N	Y	Y	Y	Y	Y	N	8
16 Azizzadeh et al, ⁵⁴ 2003	Y	U	Y	Y	Y	Y	N	N	N	Y	N	6
17 Celenza et al, ⁵⁵ 2012	Y	U	Y	Y	Y	Y	Y	N	Y	Y	N	8
18 Dolan-Evans et al, ⁵⁶ 2014	Y	U	Y	Y	Y	Y	N	Y	N	Y	Y	8
19 Boyd et al, ⁵⁷ 2009	Y	U	Y	Y	Y	Y	Y	Y	N	Y	N	8
20 Egerton et al, ⁵⁸ 1985	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
21 Diderichsen et al, ⁵⁹ 2013	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
22 Ferrari et al, ⁶⁰ 2013	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
23 Freire et al, ⁶¹ 2011	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
24 Buddeberg-Fischer et al, ⁶² 2006	Y	U	Y	Y	N	Y	Y	Y	Y	Y	Y	9
25 Dorsey et al, ⁶³ 2005	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
26 Ekenze et al, ⁶⁴ 2013	Y	U	Y	Y	Y	Y	Y	N	N	Y	N	7
27 Barikani et al, ⁶⁵ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
28 Bittaye et al, ⁶⁶ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
39 Bonura et al, ⁶⁷ 2016	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
30 Al-Fouzan et al, ⁶⁸ 2012	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
31 AlKot et al, ⁶⁹ 2015	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
32 Borges et al, ⁷⁰ 2009	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
33 Budd et al, ⁷¹ 2011	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
34 Corrigan et al, ⁷² 2007	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
35 Davis et al, ⁷³ 2016	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
36 Deutsch et al, ⁷⁴ 2015	Y	U	Y	Y	Y	Y	N	Y	Y	Y	N	8
37 Gardner et al, ⁷⁵ 2014	Y	U	Y	Y	N	Y	N	Y	N	Y	N	7
38 Dias et al, ⁷⁶ 2013	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
39 Goltz et al, ⁷⁷ 2013	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
40 Gupta et al, ⁷⁸ 2013	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
41 Hanzlick et al, ⁷⁹ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
42 Harris et al, ⁸⁰ 2005	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
43 Hauer et al, ⁸¹ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
44 Labiris et al, ⁸² 2014	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
45 Lambert et al, ⁸³ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
46 Shah et al, ⁸⁴ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
47 Lefevre et al, ⁸⁵ 2010	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
48 Vicente et al, ⁸⁶ 2013	Y	U	Y	Y	N	N	Y	N	Y	Y	N	6
49 Wiesenfeld et al, ⁸⁷ 2014	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
50 Lam et al, ⁸⁸ 2016	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
51 Hartung et al, ⁸⁹ 2005	Y	U	Y	Y	N	Y	N	N	N	N	N	4
52 Girasek et al, ⁹⁰ 2011	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
53 Zuccato et al, ⁹¹ 2015	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
54 Wilbanks et al, ⁹² 2015	Y	U	Y	Y	N	Y	Y	Y	Y	Y	Y	9
55 West et al, ⁹³ 2009	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
56 Watmough et al, ⁹⁴ 2007	Y	U	Y	Y	N	N	N	N	N	Y	N	4
57 Thakur et al, ⁹⁵ 2001	Y	U	Y	Y	Y	Y	Y	N	Y	Y	N	8
58 Scott et al, ⁹⁶ 2011	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
59 Schnuth et al, ⁹⁷ 2003	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
60 Richards et al, ⁹⁸ 2009	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
61 Reed et al, ⁹⁹ 2009	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
62 de Souza et al, ¹⁰⁰ 2015	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
63 Pikoulis et al, ¹⁰¹ 2010	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
64 Ozer et al, ¹⁰² 2015	Y	U	Y	Y	N	N	Y	N	Y	Y	N	6
65 Noble et al, ¹⁰³ 2004	Y	U	Y	Y	Y	Y	Y	Y	N	Y	N	8
66 Noble et al, ¹⁰⁴ 2010	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
67 Newton et al, ¹⁰⁵ 2005	Y	U	Y	Y	N	Y	Y	N	N	Y	N	6
68 Moore et al, ¹⁰⁶ 2012	Y	U	Y	Y	Y	Y	N	Y	N	N	N	6
69 Momen et al, ¹⁰⁷ 2015	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
70 Mehmood et al, ¹⁰⁸ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
71 Loriot et al, ¹⁰⁹ 2010	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
72 Lefevre et al, ¹¹⁰ 2010	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
73 Vo et al, ¹¹¹ 2017	Y	U	Y	Y	Y	N	N	N	N	Y	N	5
74 Grasreiner et al, ¹¹² 2018	Y	U	Y	Y	Y	Y	N	N	N	Y	N	6
75 Alkhaman et al, ¹¹³ 2018	Y	U	Y	Y	N	N	Y	N	N	Y	N	5

Quality assessment criteria in detail

1. Define the source of information (survey, record review).
2. List the inclusion and exclusion criteria for the exposed and unexposed subjects (cases and controls) or refer to previous publications.
3. Indicate the time period used for identifying patients.
4. Indicate whether the subjects were consecutive if not population-based.
5. Indicate whether the evaluators of the subjective components of the study were masked to the other aspects of participants' status.
6. Describe any assessments undertaken for quality assurance purposes (e.g., test/retest of primary outcome measurements)
7. Explain any patient exclusion from the analyses.
8. Describe how confounding was assessed and/or controlled.
9. If applicable, explain how missing data were handled in the analysis.
10. Summarize the patient response rates and the completeness of the data collection.
11. Clarify what follow-up, if any, was expected and the percentage of patients with incomplete data or follow-up.

“Y”: Yes; “N”: No; “U”: Unclear.

Table S2. Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty Stratified by Region and Survey Year.

Factor		No. of studies	Total no. of participants	Extent of influence (%)	95 CI% of EOI value		<i>I-square</i> (%)	<i>P</i> -Value	<i>Q</i> -Value		
					Lower	Upper					
Academic interest	developed	28	80,000	79.66	70.73	86.39	99.8	0.02	3.51		
	developing	10	2,366	60.41	43.44	75.19	98.0				
	before 2010	29	44,174	78.88	69.04	86.22	99.7	0.40	1.21		
	after 2010	9	38,192	71.54	57.66	82.27	99.6				
Competencies	before 2010	9	43,134	44.40	29.11	60.83	99.8	0.21	1.86		
	after 2010	8	33,381	66.60	34.48	88.31	99.8				
Controllable lifestyle or flexible work schedule	developed	37	100,980	52.11	46.52	57.65	99.6	0.63	0.68		
	developing	7	2,017	57.50	45.81	68.41	95.9				
	before 2010	22	62,945	53.72	47.48	59.84	99.4			0.97	0.05
after 2010	22	40,056	52.29	43.51	60.93	99.2					
Patient service orientation	developed	27	44,235	50.56	44.68	56.42	98.8	0.74	0.48		
	developing	10	2,337	49.02	31.62	66.67	98.1				
	before 2010	18	40,997	49.56	43.29	55.84	98.8			0.70	0.54
	after 2010	19	5,579	43.87	38.62	63.80	98.3				
Medical teachers or mentors	developed	28	84,076	46.43	36.63	56.52	99.8	0.73	0.48		
	developing	4	995	51.14	33.97	68.04	95.4				
	before 2010	21	49,654	48.48	36.93	60.19	99.8			0.70	0.54
	after 2010	11	35,417	43.87	27.94	61.18	99.7				
Career opportunities	developed	31	79,867	38.41	29.61	48.04	99.8	0.60	0.74		
	developing	7	2,056	47.32	30.38	64.91	98.1				
	before 2010	20	43,417	47.97	33.54	62.74	99.8			0.24	1.68
	after 2010	18	38,506	32.38	21.68	45.31	99.5				
Workload or working hours	developed	15	20,970	42.14	31.35	53.72	98.6	0.34	1.39		
	developing	5	1,081	25.72	13.29	43.88	95.3				
	before 2010	9	19,456	43.93	29.43	59.54	98.8			0.41	1.21
	after 2010	11	2,595	32.70	29.43	59.54	97.4				
Income	developed	39	107,091	34.01	26.89	41.93	99.8	0.84	0.29		
	developing	11	2,700	37.11	27.06	48.41	96.4				
	before 2010	25	68,714	37.01	25.95	49.62	99.8			0.41	1.18
	after 2010	25	41,077	32.67	26.04	40.07	98.9				
Length of training	developed	15	41,246	33.95	28.72	39.60	98.4	0.31	1.48		
	developing	3	800	22.92	10.94	41.85	94.0				
	before 2010	7	8,811	26.72	15.89	41.29	98.9			0.28	1.59
	after 2010	11	33,234	35.87	29.67	42.59	96.9				
Prestige	developed	17	27,987	23.96	19.20	29.47	97.3	0.01	4.71		
	developing	9	2,642	47.65	34.41	61.24	97.6				
	before 2010	12	25,542	26.46	20.78	33.03	96.7			0.25	1.67
	after 2010	14	5,087	35.22	24.70	47.40	98.3				
Advice from others	developed	14	81,205	25.95	19.27	32.64	99.8	0.36	1.33		
	developing	4	1,487	36.34	18.91	53.77	98.1				
	before 2010	10	48,319	22.93	17.85	28.01	99.5			0.31	1.47
	after 2010	8	34,373	33.65	25.12	42.18	99.1				
Student debt	before 2010	5	6,610	20.29	15.86	25.57	81.8	0.69	0.59		
	after 2010	3	32,307	11.08	1.58	49.08	99.6				

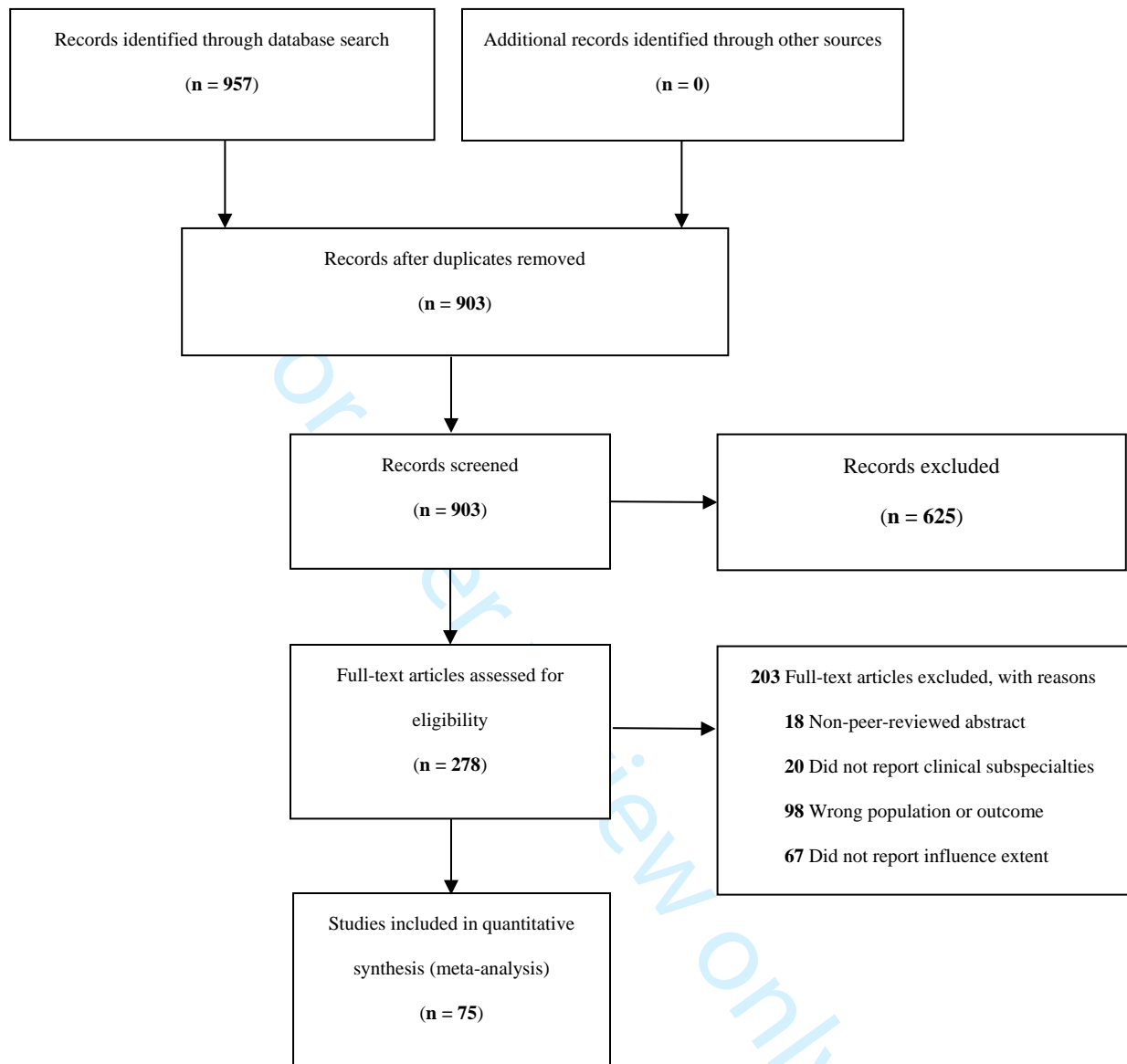
Figure S1. Flow Diagram of the Study Inclusion.

Figure S2. Forest Plot of “Academic Interest”.

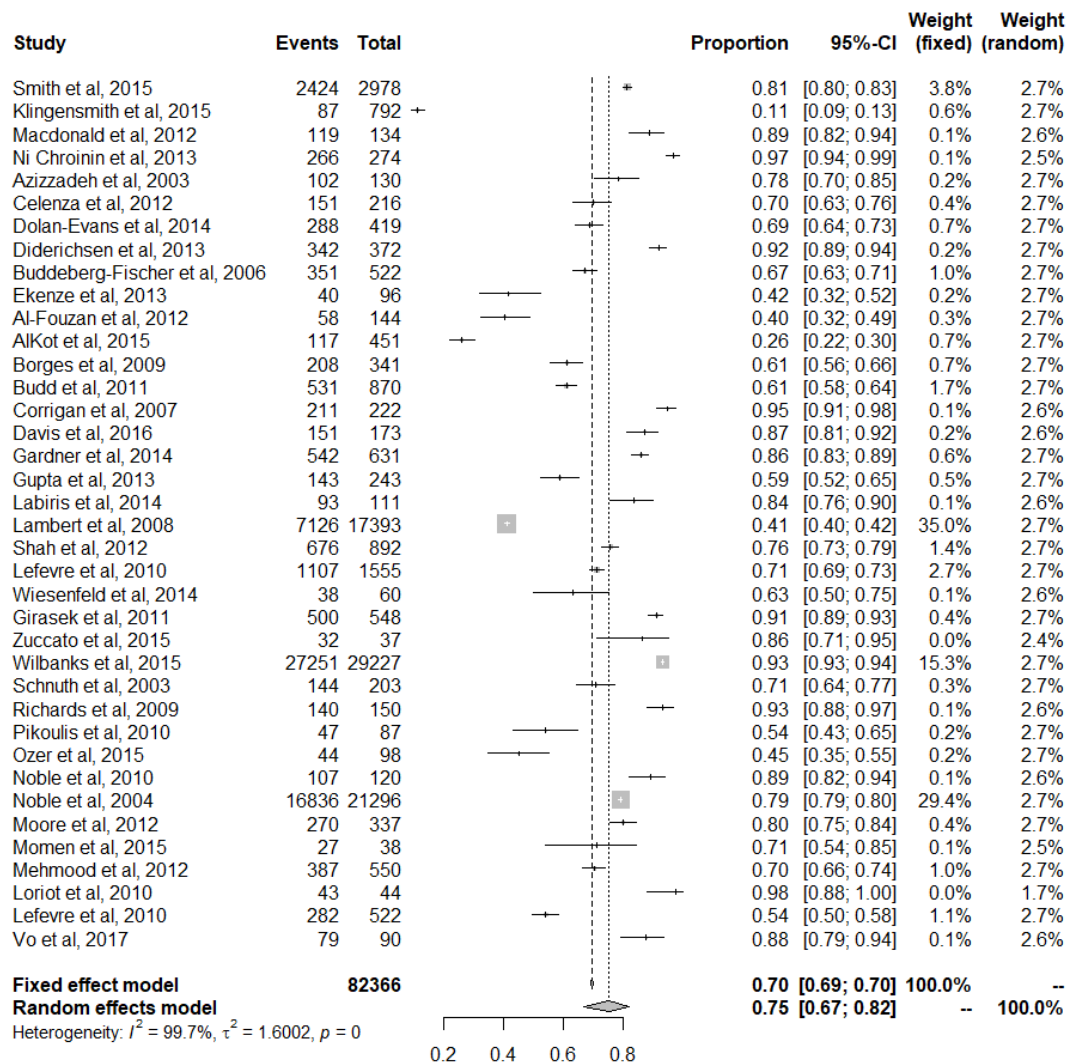
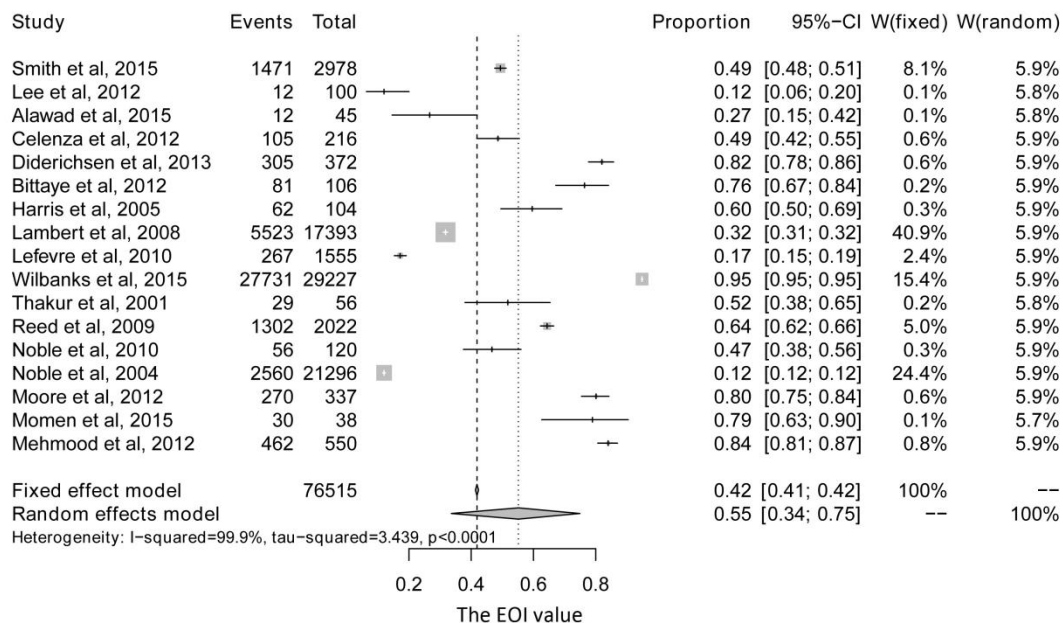


Figure S3. Forest Plot of “Competencies”.



review only

Figure S4. Forest Plot of “Controllable Lifestyle or Flexible Work Schedule”.

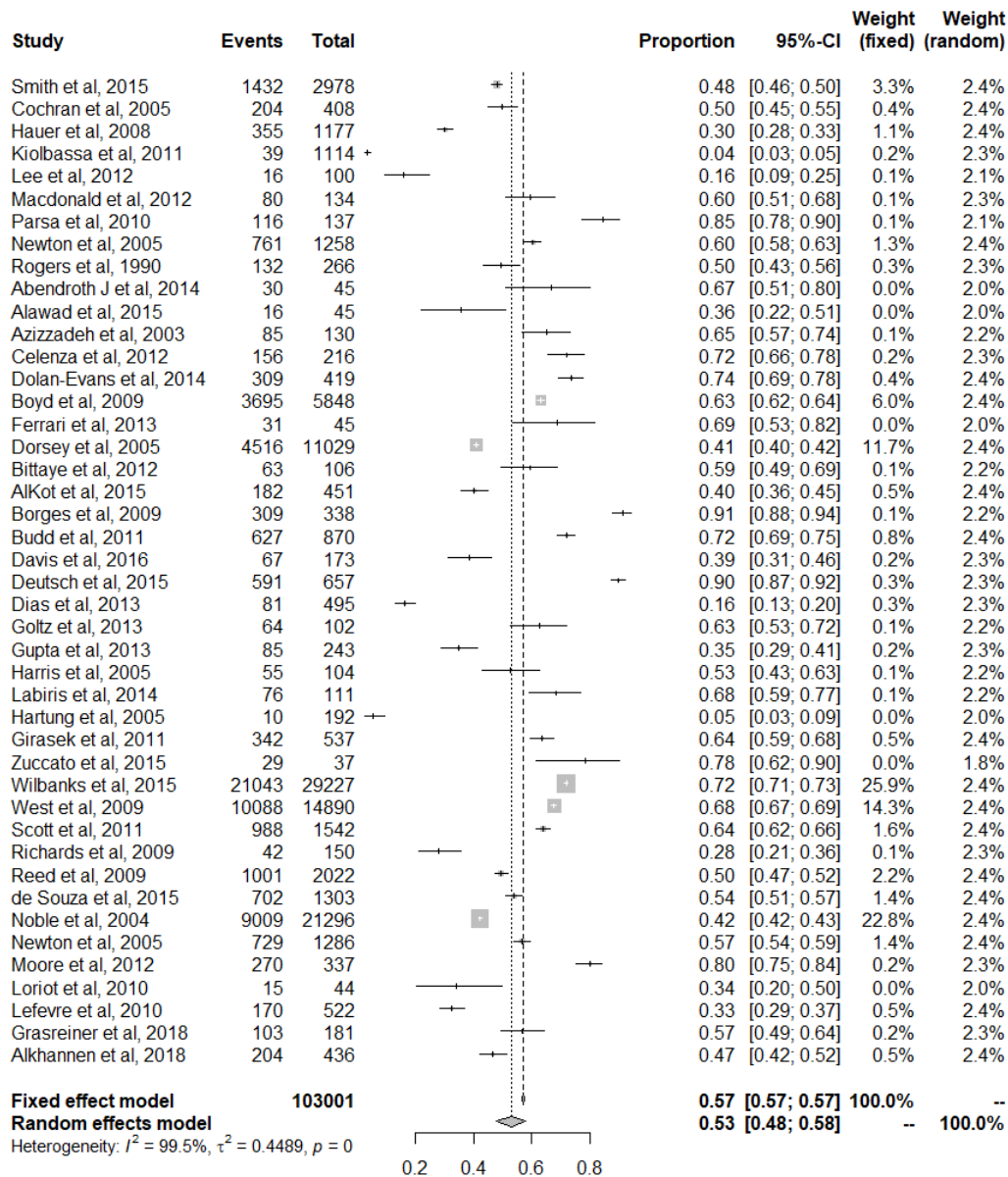


Figure S5. Forest Plot of “Patient Service Orientation”.

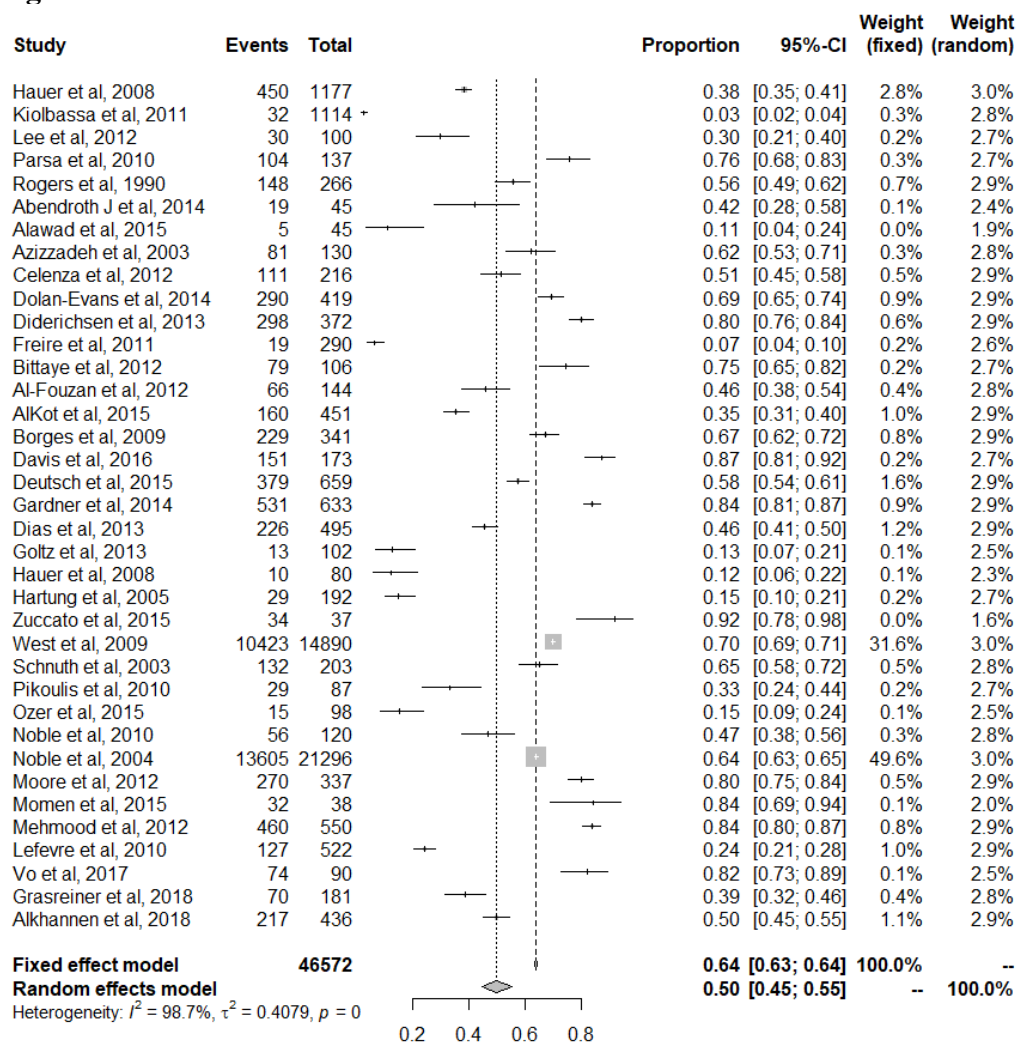


Figure S6. Forest Plot of “Medical Teachers or Mentors”.

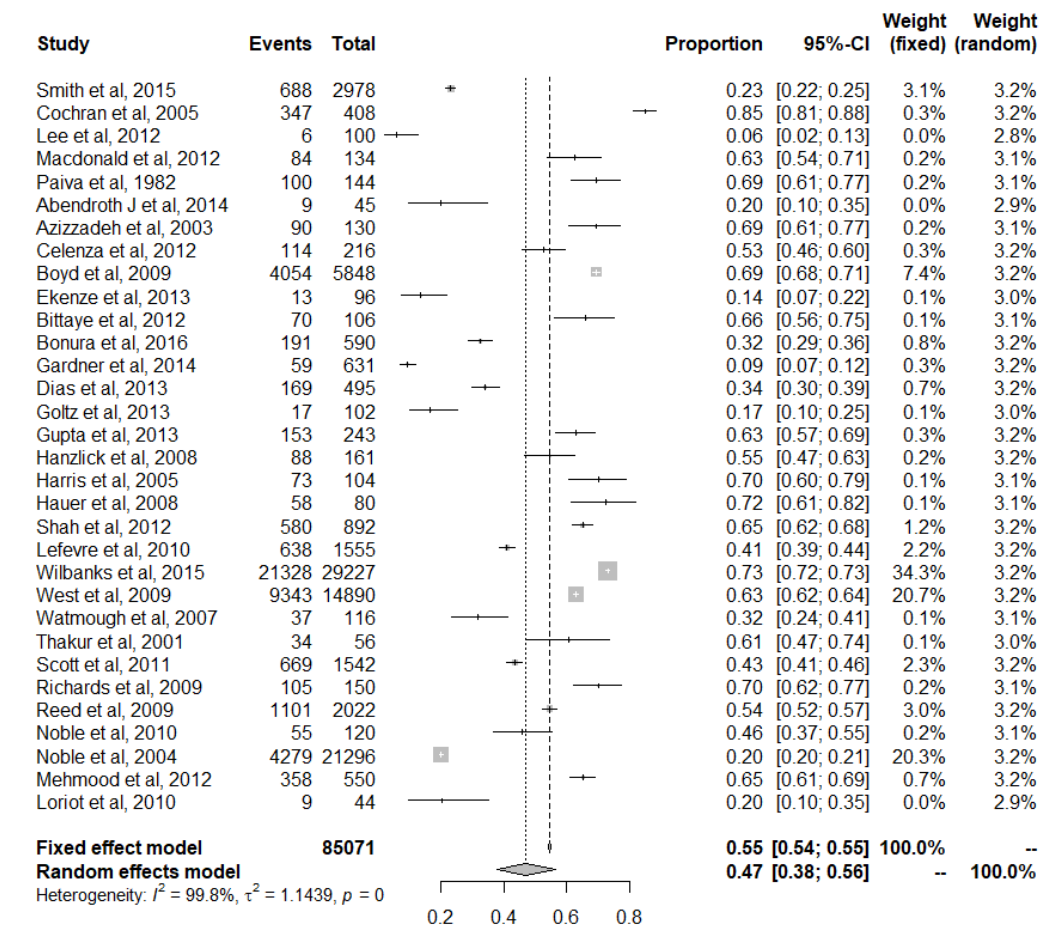


Figure S7. Forest Plot of “Career Opportunities”.

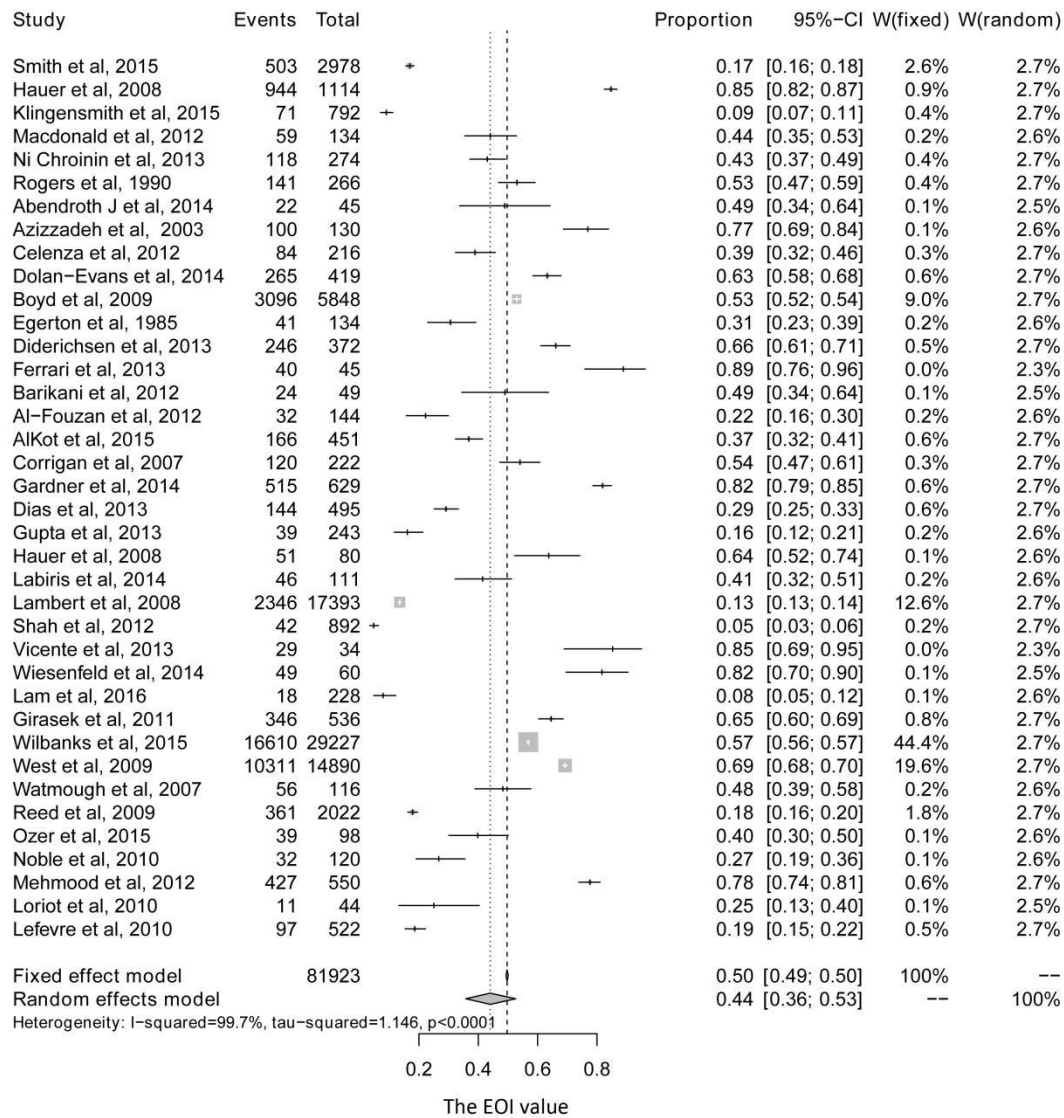


Figure S8. Forest Plot of “Workload or Working Hours”.

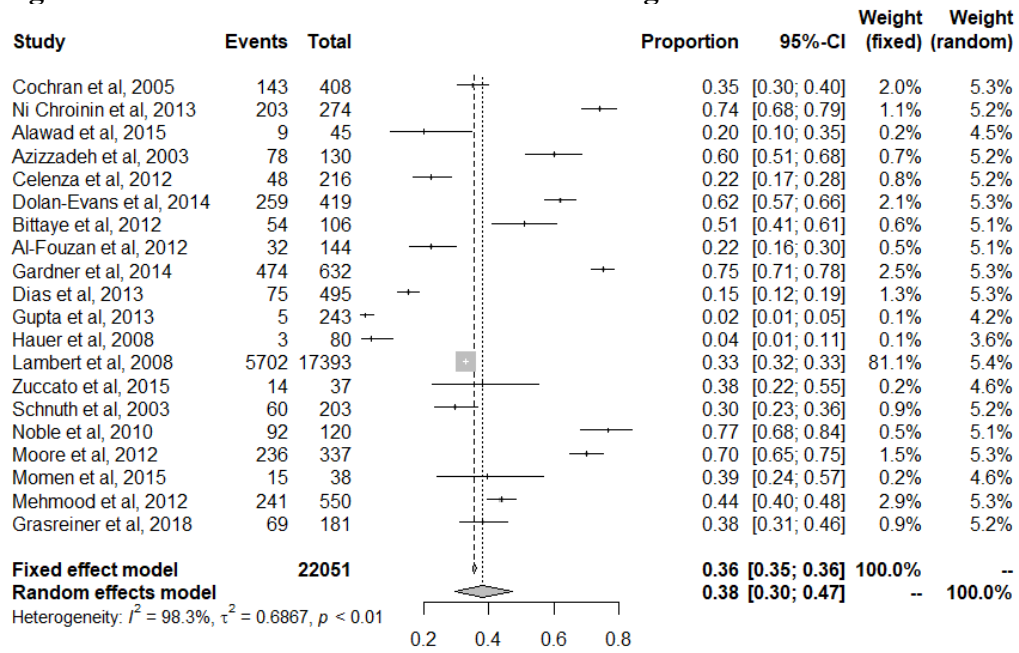


Figure S9. Forest Plot of “Income”.

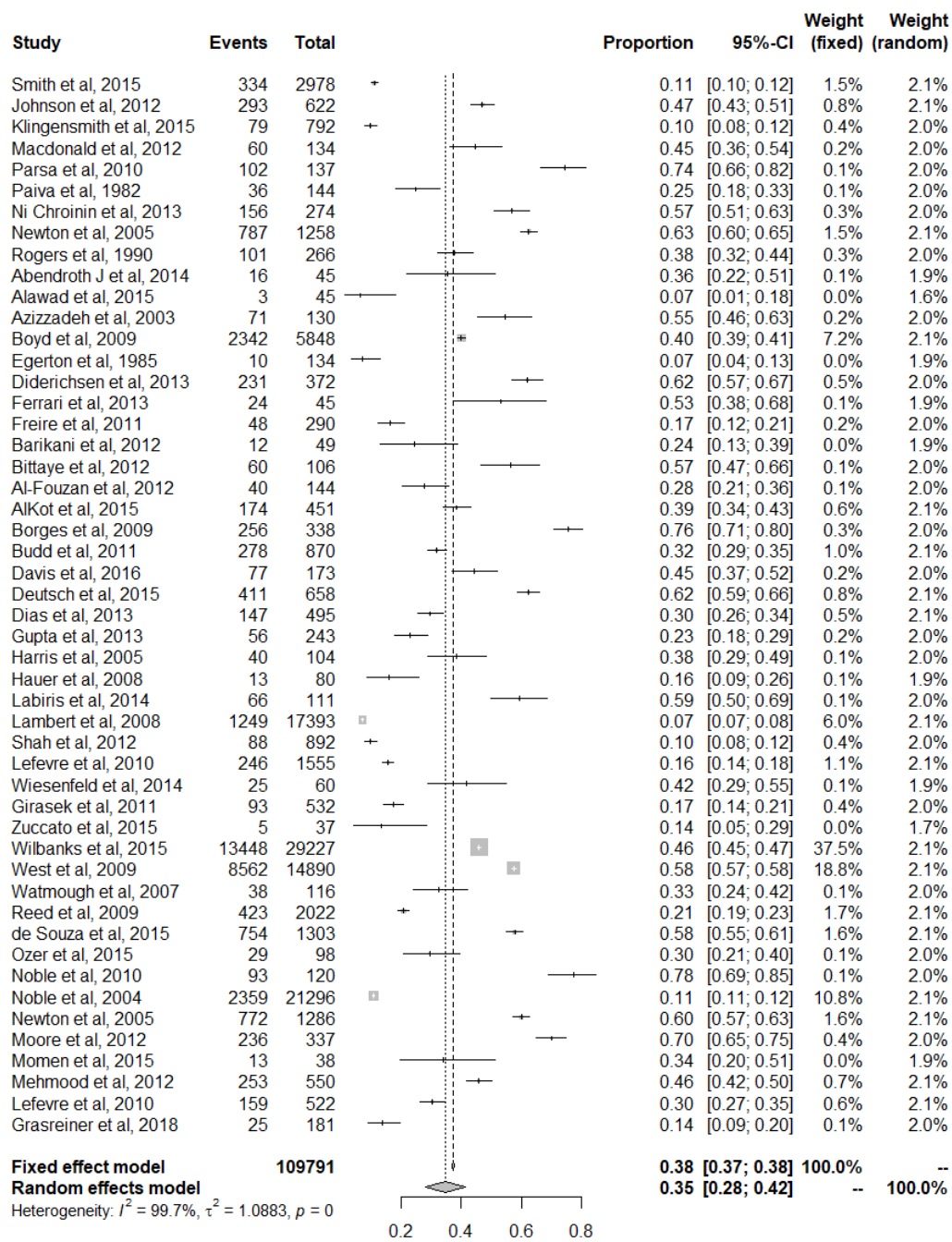
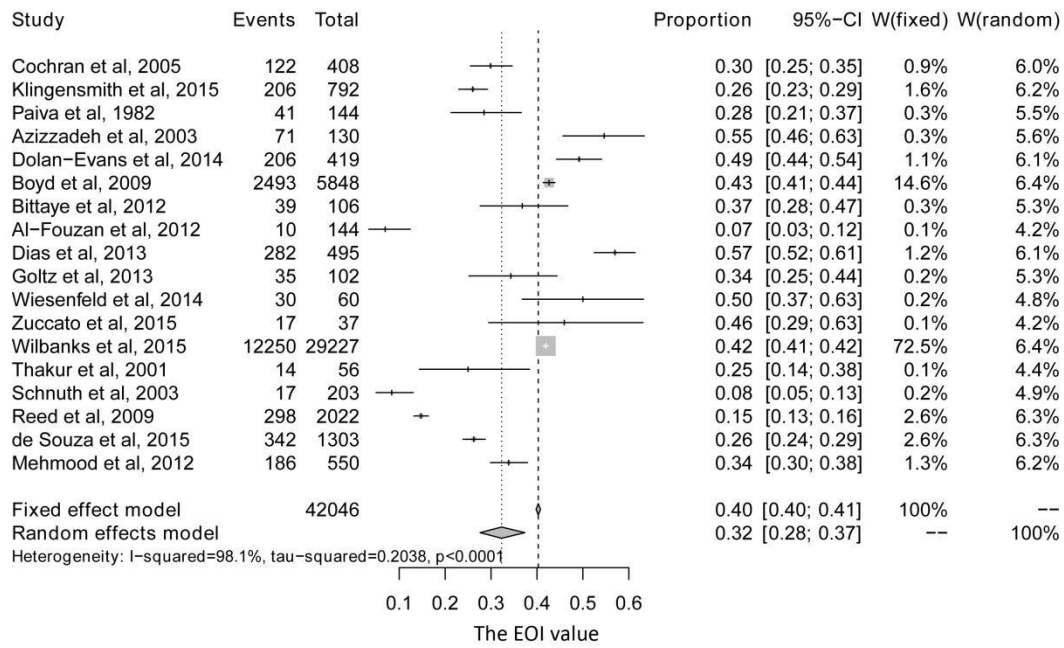
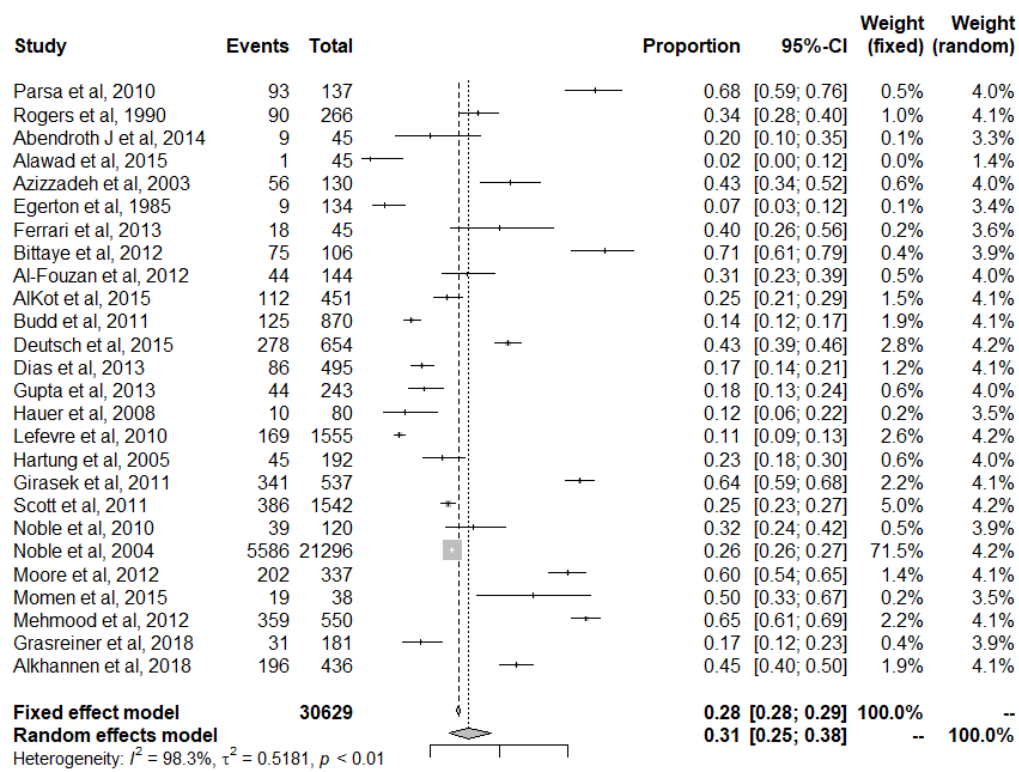


Figure S10. Forest Plot of “Length of Training”.



review only

Figure S11. Forest Plot of “Prestige”.



only

Figure S12. Forest Plot of “Advice from Others”.

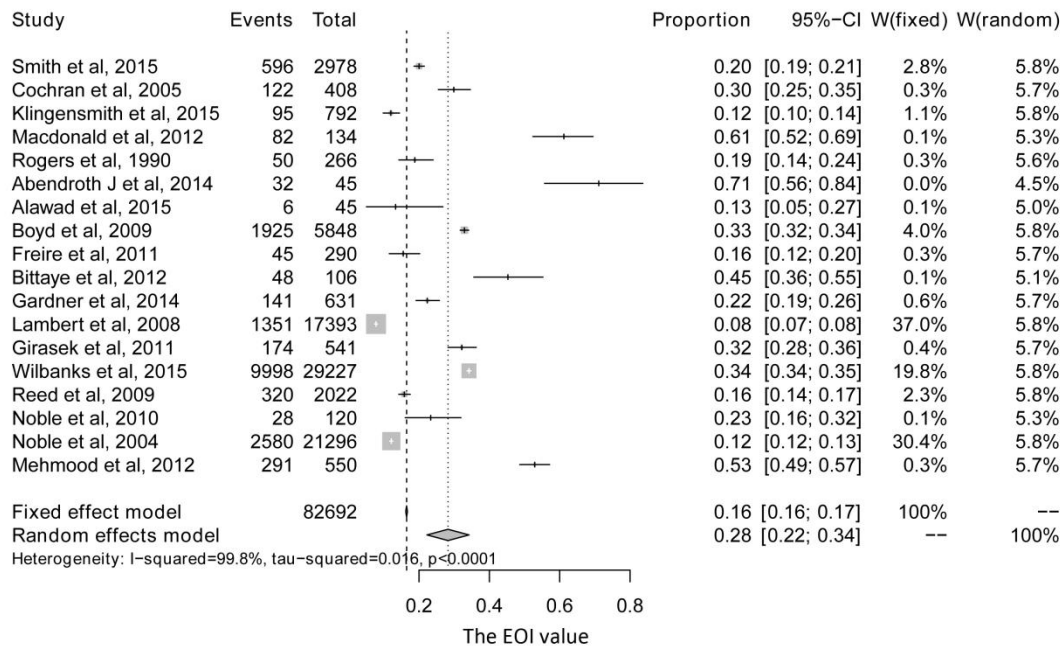


Figure S13. Forest Plot of “Student Debt”.

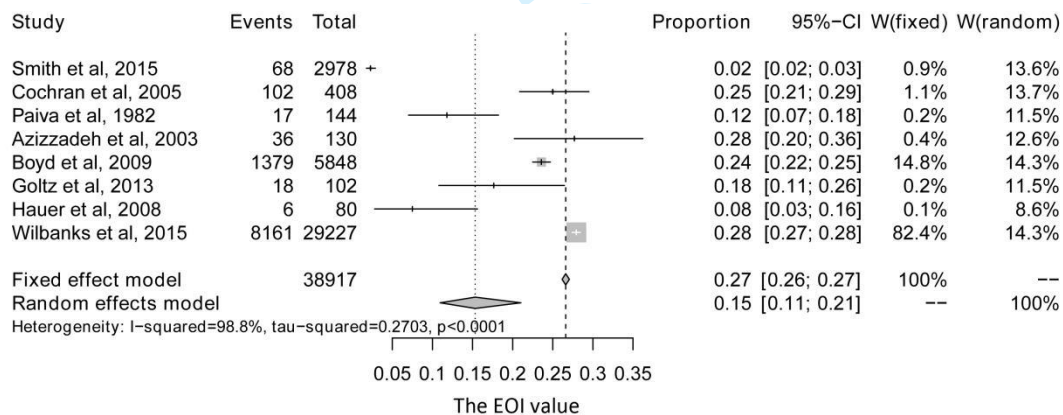
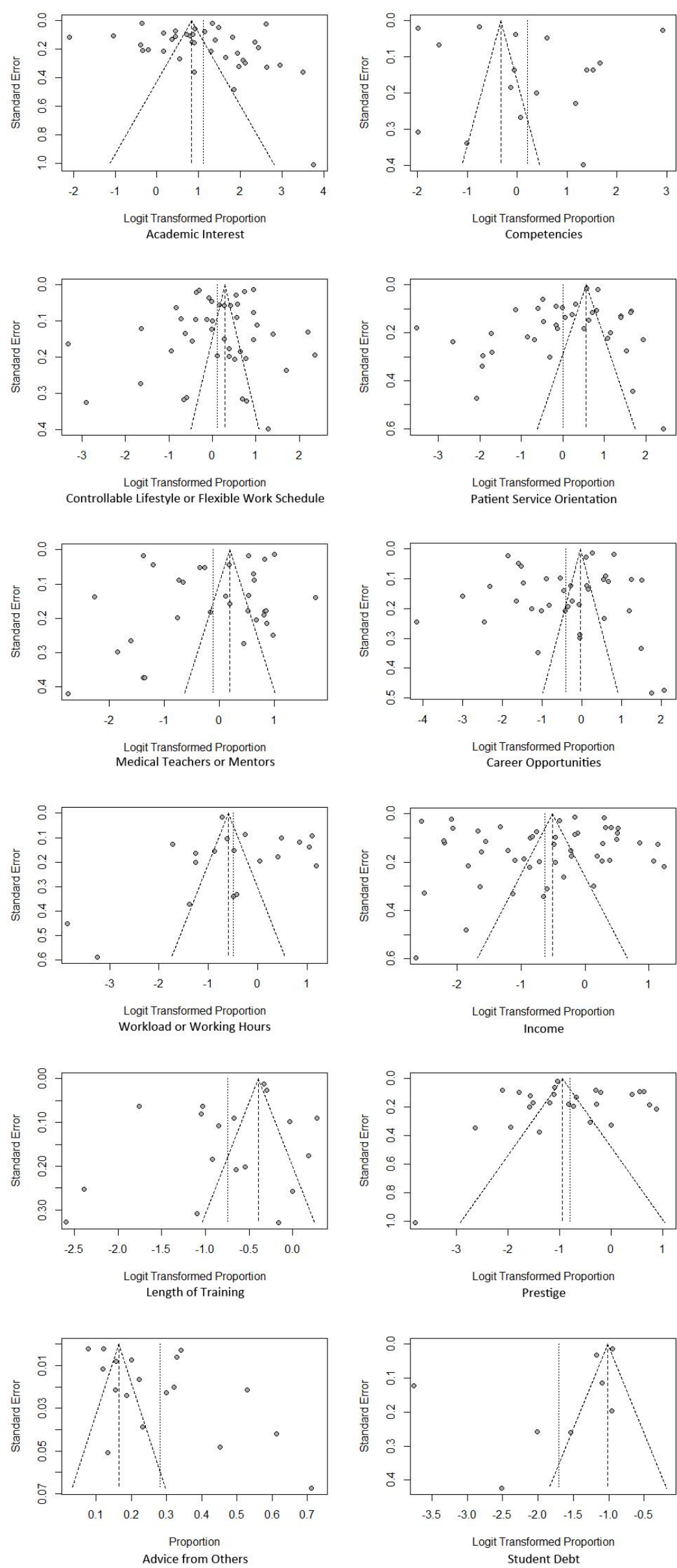


Figure S14. Funnel Plots of the Publication Bias Testing of the 12 Factors.





PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	3
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5-6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6-7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6-7
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	7



PRISMA 2009 Checklist

Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	7
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	7
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	5, 7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7-8
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	8
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	8
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	8-9
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	8-9
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	8-9
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	9-13
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	13
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	14
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	15

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

Page 2 of 2

For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

MOOSE Checklist for Meta-analyses of Observational Studies

Item No	Recommendation	Reported on Page No
Reporting of background should include		
1	Problem definition	5
2	Hypothesis statement	5
3	Description of study outcome(s)	5
4	Type of exposure or intervention used	5
5	Type of study designs used	5
6	Study population	5
Reporting of search strategy should include		
7	Qualifications of searchers (eg, librarians and investigators)	6
8	Search strategy, including time period included in the synthesis and key words	5
9	Effort to include all available studies, including contact with authors	5
10	Databases and registries searched	5
11	Search software used, name and version, including special features used (eg, explosion)	6
12	Use of hand searching (eg, reference lists of obtained articles)	5
13	List of citations located and those excluded, including justification	5-6
14	Method of addressing articles published in languages other than English	5
15	Method of handling abstracts and unpublished studies	5
16	Description of any contact with authors	5
Reporting of methods should include		
17	Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested	6
18	Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	6-7
19	Documentation of how data were classified and coded (eg, multiple raters, blinding and interrater reliability)	6-7
20	Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	6
21	Assessment of study quality, including blinding of quality assessors, stratification or regression on possible predictors of study results	6
22	Assessment of heterogeneity	6
23	Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	6-7
24	Provision of appropriate tables and graphics	5-7
Reporting of results should include		
25	Graphic summarizing individual study estimates and overall estimate	8
26	Table giving descriptive information for each study included	7
27	Results of sensitivity testing (eg, subgroup analysis)	8
28	Indication of statistical uncertainty of findings	7-9

Item No	Recommendation	Reported on Page No
Reporting of discussion should include		
29	Quantitative assessment of bias (eg, publication bias)	13
30	Justification for exclusion (eg, exclusion of non-English language citations)	13-14
31	Assessment of quality of included studies	13-14
Reporting of conclusions should include		
32	Consideration of alternative explanations for observed results	14
33	Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)	14
34	Guidelines for future research	14
35	Disclosure of funding source	15

From: Stroup DF, Berlin JA, Morton SC, et al, for the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) Group. Meta-analysis of Observational Studies in Epidemiology. A Proposal for Reporting. *JAMA*. 2000;283(15):2008-2012. doi: 10.1001/jama.283.15.2008.

Transcribed from the original paper within the NEUROSURGERY® Editorial Office, Atlanta, GA, United States. August 2012.

BMJ Open

Factors Influencing Subspecialty Choice Among Medical Students: A Systematic Review and Meta-analysis

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-022097.R2
Article Type:	Research
Date Submitted by the Author:	09-Oct-2018
Complete List of Authors:	<p>Yang, Yahan; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology; Sun Yat-Sen University, Zhongshan School of Medicine</p> <p>Li, Jiawei; Sun Yat-Sen University, Zhongshan School of Mathematics</p> <p>Wu, Xiaohang; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology</p> <p>Wang, Jinghui; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology</p> <p>Li, Wangting; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology</p> <p>Zhu, Yi; University of Miami School of Medicine, Department of Molecular and Cellular Pharmacology; Sun Yat-Sen University Zhongshan Ophthalmic Center, Cataract</p> <p>Chen, Chuan; State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic Center, Sun Yat-sen University; University of Miami School of Medicine, Department of Molecular and Cellular Pharmacology</p> <p>Lin, Haotian; State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic Center, Sun Yat-sen University, Cataract</p>
Primary Subject Heading:	Medical education and training
Secondary Subject Heading:	Medical education and training
Keywords:	Medical students, Career choice, Meta-analysis

SCHOLARONE™
Manuscripts

1
2
3 **1 Title Page**
4

5 **2 Factors Influencing Subspecialty Choice Among Medical Students: A Systematic**
6

7 **3 Review and Meta-analysis**
8

9 4 Yahan Yang, M.D.^{1,2}; Jiawei Li, M.D.³; Xiaohang Wu, M.D.¹; Jinghui Wang, M.D.¹;
10

11 5 Wangting Li, M.D.¹; Yi Zhu, M.D.^{1,4}; Chuan Chen, M.D.^{1,4}; Haotian Lin, M.D., Ph.
12

13 6 D^{1#}
14
15

16 7

18 **Institution:** 1. State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic
19

20 9 Center, Sun Yat-sen University, Guangzhou, Guangdong, 510060, People's Republic
21

22 10 of China
23

24 11 2. Zhongshan School of Medicine, Sun Yat-sen University, Guangzhou, China
25

26 12 3. Zhongshan School of Mathematics, Sun Yat-sen University, Guangzhou, China
27

28 13 4. Department of Molecular and Cellular Pharmacology, University of Miami Miller
29

30 14 School of Medicine, Miami, Florida 33136, USA.
31
32

33 15
34

35 **#Editorial Correspondence:**
36

37 17 Prof. Haotian Lin
38

39 18 Zhongshan Ophthalmic Center, Sun Yat-sen University
40

41 19 Xian Lie South Road 54#
42

43 20 Guangzhou, China, 510060.
44

45 21 Telephone number: +86-020-87330493
46

47 22 Fax: +86-020-87333271
48

49 23 E-mail: haot.lin@hotmail.com
50

51 24 Word count for text: 3122
52
53

54 25
55
56

1
2
3 26 **ABSTRACT**

4
5 27 **Objective** To characterize the contributing factors that affect medical students'

6
7 28 subspecialty choice and to estimate the extent of influence of individual

8
9 29 factors on the students' decision-making process.

10
11 30 **Design** Systematic review and meta-analysis.

12
13 31 **Methods** A systematic search of the Cochrane Library, ERIC, Web of Science, CNKI

14
15 32 and PubMed databases was conducted for studies published between January

16
17 33 1977 and June 2018. Information concerning study characteristics, influential

18
19 34 factors, and the extent of their influence (EOI) was extracted independently

20
21 35 by two trained investigators. EOI is the percentage level that describes how

22
23 36 much each of the factors influenced students' choice of subspecialty. The

24
25 37 recruited medical students includes students in medical school, internship,

26
27 38 residency training and fellowship, who are about to or have just made a

28
29 39 specialty choice. The estimates were pooled using a random-effects

30
31 40 meta-analysis model due to the between-study heterogeneity.

32
33 41 **Results** Data were extracted from 75 studies (882,209 individuals). Overall, the

34
35 42 factors influencing medical students' choice of subspecialty training mainly

36
37 43 included academic interests (75.29%), competencies (55.15%), controllable

38
39 44 lifestyles or flexible work schedules (53.00%), patient service orientation

40
41 45 (50.04%), medical teachers or mentors (46.93%), career opportunities

42
43 46 (44.00%), workload or working hours (37.99%), income (34.70%), length of

44
45 47 training (32.30%), prestige (31.17%), advice from others (28.24%), and

46
47 48 student debt (15.33%), with significant between-study heterogeneity

48
49 49 ($P<0.0001$). Subgroup analyses revealed that the EOI of academic interests

50
51 50 was higher in developed countries than that in developing countries (79.66%

1
2
3 51 [95% confidence interval (CI), 70.73%; 86.39%] vs. 60.41% [95% CI,
4
5 52 43.44%; 75.19%]; $Q=3.51$ $P=0.02$). The EOI value of prestige was lower in
6
7 53 developed countries than that in developing countries (23.96% [95% CI,
8
9 54 19.20%; 29.47%] vs. 47.65% [95% CI, 34.41%; 61.24%]; $Q=4.71$ $P=0.01$).

11 **Conclusions** This systematic review and meta-analysis provided a quantitative
12
13
14 56 evaluation of the top 12 influencing factors associated with medical students'
15
16 57 choice of subspecialty. Our findings provide the basis for the development of
17
18 58 specific, effective strategies to optimize the distribution of physicians among
19
20 59 different departments by modifying these influencing factors.

22 60 **Systematic review registration** PROSPERO CRD42017053781.

61 **STRENGTHS AND LIMITATIONS OF THIS STUDY**

- 26
27 62 ● This is the first study that provide a systematic estimate of the factors associated
28
29 63 with medical students' subspecialty choices.
- 31 64 ● A large number of studies conducted in varied populations have been included.
- 33 65 ● The differences in the characteristics of country, survey years, specialty, the type
34
35 66 of data used and sample size across studies represent a major limitation of our
36
37 67 study.

39
40 68 **KEYWORDS** Medical students, career choice, meta-analysis

41
42 69

43
44 70

45
46 71

72 Introduction

73 Because of the population aging, increased workload on doctors through increased
74 number of consultations and in managing patients with multi-morbidity, the demand
75 for physicians continues to increase; however, an imbalance in the supply of
76 physicians in different subspecialties has become a growing concern in both
77 developed and developing countries.¹⁻⁵ Some specialties and subspecialties, such as
78 family medicine and palliative medicine,^{6,7} are experiencing a desperate shortage of
79 physicians, whereas other specialties and subspecialties, such as cardiology,
80 ophthalmology and ear, nose and throat (ENT) surgery, are highly competitive
81 specialties with low success rate for candidates.^{8,9}

82 Specialty choice is the product of a complex interconnection of student expectation,
83 department expectation, and competition for available spots, and student choice is
84 where the choice begins.¹⁰ Previous studies have suggested that medical students'
85 choice of subspecialty is essential to the maintenance of an adequate medical
86 workforce and a balanced development of the medical system.^{11,12} However, the
87 influencing factors underlying students' subspecialty choice have not been
88 systemically reviewed. Recent changes in the training and practice environment may
89 influence medical students' career choice.¹³ Additionally, the variability in
90 preferences over time and in students' attitudes towards career choices can further
91 complicate this assessment. For example, a study in the UK indicated that half of the
92 medical students made a definitive subspecialty choice during their first year of
93 medical school.¹⁴ However, students were prone to changing their subspecialty
94 preference during medical school and internship.¹⁵ Notably, students may also reject
95 certain subspecialties during their medical school training, even those they have
96 previously seriously considered.¹⁶ Therefore, identifying the factors that influence

1
2
3 97 students' choice of subspecialty will enable a better understanding of the current
4
5 98 shortage/overload of physicians in specific fields and contribute to policy-building
6
7 99 and decision-making to improve the training and recruitment of students in the future.
8
9
10 100 We thus conducted a systematic review and a meta-analysis to investigate the
11
12 101 influencing factors and the extent of their influence on the choice of subspecialty
13
14 102 training among medical students. More specifically, we focused on the following
15
16 103 questions. First, can we gain a better understanding of students' preferences for
17
18 104 medical specialty according to the primary influencing factor? Second, do the
19
20 105 subgroups according to world region and survey years examined in this study differ
21
22 106 significantly with regard to the weight that students place on the identified
23
24 107 influencing factor?

26 27 108 **Methods**

28
29 109 We developed a review protocol (registration number: PROSPERO
30
31 110 CRD42017053781) prior to commencing the study. The Preferred Reporting Items
32
33 111 for Systematic Reviews and Meta-Analyses (PRISMA) guidelines was used to ensure
34
35 112 the reporting quality of this review (Fig. S1).¹⁷

36 37 113 **Search Strategy and Study Eligibility**

38
39 114 We performed a literature search in June 2018 using the Cochrane Library, Medline,
40
41 115 Web of Science, CNKI and ERIC databases without language restrictions. Articles
42
43 116 were screened by title, abstract and reference list, and by correspondence with study
44
45 117 investigators. Potentially relevant papers were first identified by reviewing the titles
46
47 118 and abstracts, and the full text of each retrieved article was then assessed. A detailed
48
49 119 example of search strategy for Medline/PubMed is shown in **Methods S1**. Studies
50
51 120 were included if they were systematic review or cross-sectional studies, reported data
52
53 121 on medical students, were published in peer-reviewed journals, and used a validated
54
55

1
2
3 122 method to assess the extent of a factor's influence on the choice of subspecialty, such
4
5 123 as pediatric gastroenterology and vascular surgery, or its corresponding specialty,
6
7 124 such as pediatrics and surgery. Because of the differences between medical education
8
9 125 systems in the world, the medical students we recruited includes the student in
10
11 126 medical school, internship, residency training and fellowship, containing the students
12
13 127 who about to make a specialty choice and students who has just made a specialty
14
15 128 choice. A guide to medical specialty, available at
16
17 129 <https://www.abms.org/member-boards/specialty-subspecialty-certificates/>, were used
18
19 130 to identify the medical specialty and subspecialty of our research. We also conducted
20
21 131 an additional search using OpenGrey. However, no additional articles were further
22
23 132 included. All searches were performed using Google chrome (version 54.0.2840).

26 133 **Data Extraction and Quality Assessment**

27
28
29 134 Each article was reviewed by two trained investigators (Y.Y. and J.L.) and the
30
31 135 following information was independently extracted from each selected article using a
32
33 136 standardized form: study design, geographic location, years of survey, journal,
34
35 137 sample size, average age of the participants, the number and percentage of male
36
37 138 participants, and the influencing factors and the extent of their influence. A third
38
39 139 investigator was consulted if disagreements occurred. Each study may involve one or
40
41 140 several influencing factors. An 11-item checklist which was recommended by Agency
42
43 141 for Healthcare Research and Quality (AHRQ), used for cross-sectional studies¹⁸,
44
45 142 available at <https://www.ncbi.nlm.nih.gov/books/NBK35156/>, were used to assess the
46
47 143 quality of the studies. All discrepancies were resolved via discussion and consensus.

50 144 **Statistical Analysis**

51
52
53 145 As considerable heterogeneity was expected because of the multiple sources of
54
55 146 variances, a random effects meta-analysis model was used to estimate the influencing

1
2
3 147 factors and the extent of their influence.¹⁹ Between-study heterogeneity was assessed
4
5 148 using the Cochran's Q-test, and was quantified with the I^2 statistic, which was
6
7 149 calculated to describe the percentage of total variation caused by heterogeneity across
8
9 150 studies, with $\geq 50\%$ indicating considerable heterogeneity.^{20 21} Potential sources of
10
11 151 heterogeneity were identified using meta-regression.²² Four categorical covariates
12
13 152 were defined as potential sources of heterogeneity by examining the studies
14
15 153 conducted in the United States (US) vs. the studies conducted in other countries, the
16
17 154 studies conducted before 2010 vs. those conducted after 2010, the studies concerning
18
19 155 subspecialty only vs. those that were not specific to a subspecialty, and the studies
20
21 156 with a sample size < 200 vs. the studies with a sample size ≥ 200 . Subgroup analyses
22
23 157 were performed for each factor in the studies in developed countries vs. developing
24
25 158 countries and studies conducted before 2010 vs. after 2010. The EOI value of
26
27 159 competencies in developing countries was not statistically significant (81.21% [95%
28
29 160 CI, 75.27%; 86.51%], $P=0.1436$), and no studies on the influence of student debt in
30
31 161 developing countries were found. The Q-test based on the analysis of variance was
32
33 162 used to compare the subgroups, with a significance threshold of 5%.²³ The influence
34
35 163 of individual studies on the overall EOI value was explored by serially excluding
36
37 164 each study in a sensitivity analysis. Publication bias was investigated using a funnel
38
39 165 plot test and Egger's test.^{24 25} Fill and trim approach, which imputes estimates from
40
41 166 hypothetical negative unpublished reports,²⁶ was also used to investigate the
42
43 167 publication bias if the Egger's test was significant. All analyses were performed
44
45 168 using R (version 3.3.1, The R Foundation, Vienna, Austria). The statistical tests were
46
47 169 2-sided with a significance threshold of $P < 0.05$.

52 **Patient and public involvement:** Patients and the public were not involved in
53
54 171 development of the research question and outcome measures, nor the study design.

1
2
3 172 The study does not involve patient recruitment, and patients were not involved in
4
5 173 conduct of the study. We plan to liaise closely with patients, special interest groups,
6
7 174 and charities in the dissemination of our results in printed and electronic media.
8

9 175 **Results**

10 176 **Study Characteristics**

11
12
13 177 Seventy-five cross-sectional studies involving a total of 882,209 individuals that
14
15 178 published between January 1977 and May 2018 were included in the present research
16
17 179 **(Table 1)**. Thirty-four studies were conducted in North America, 24 in Europe, 7 in
18
19 180 Asia, 5 in Oceania, 3 in Africa, and 2 in South America. The median number of
20
21 181 participants per study was 243 (range 37-29,227). Fourteen studies included students
22
23 182 who had already selected subspecialties, whereas 61 did not. The influencing factors
24
25 183 were ranked according to the frequency of occurrence and each factor was identified
26
27 184 when at least 5 papers were available describing it. The influencing factors for
28
29 185 subspecialty choice were then classified according to 17 aspects, including academic
30
31 186 interests, controllable lifestyle or flexible work schedule (defined as flexibility that
32
33 187 allows physicians to control the number of hours devoted to practicing the specialty),
34
35 188 competencies, patient service orientation, medical teachers or mentors, career
36
37 189 opportunities, workload or working hours (characterized by the physician's time
38
39 190 spent on professional responsibilities), income, prestige, length of training, advice
40
41 191 from others (advice from family, friends, and other students), student debt,
42
43 192 experience with the subject, working environment, personality, gender and job
44
45 193 security. Personality and gender are common factors that affect the choice of
46
47 194 subspecialty among medical students, but most of the relevant literature has not
48
49 195 reported on the extent of these factors' influence. Moreover, the funnel plots were
50
51 196 clearly asymmetrical with regard to experience with the subject, the working
52
53
54
55
56
57
58
59
60

1
2
3 197 environment and job variety, indicating the existence of publication bias. Thus, the
4
5 198 analysis of the remaining 12 influencing factors were shown in this paper. Studies
6
7 199 assessed for influencing factors using questionnaires validated to medical students
8
9 200 asking the extent of certain factors the studies investigated. Quality assessment scores
10
11 201 for the included studies are listed in **Table 1**. None of the studies received a point for
12
13 202 the second AHRQ Quality Indicator, which requires studies to list the inclusion and
14
15 203 exclusion criteria for exposed and unexposed subjects (cases and controls) or refer to
16
17 204 previous publications, since no comparison studies were referenced in the analyzed
18
19 205 articles. For the remaining 10 criteria, 6 studies received 9 points, 8 studies received
20
21 206 8 points, 17 studies received 7 points, 33 studies received 6 points, 9 studies received
22
23 207 5 points and 2 studies received 4 points (scores for individual studies are presented in
24
25 208 **Table S1**).

29 **Primary Analysis**

30
31 210 A meta-analysis was performed on the 12 influencing factors (**Table 2**): academic
32
33 211 interests (**Fig. S2**), competencies (**Fig. S3**), controllable lifestyle or flexible work
34
35 212 schedule (**Fig. S4**), patient service orientation (**Fig. S5**), medical teachers or mentors
36
37 213 (**Fig. S6**), career opportunities (**Fig. S7**), workload or working hours (**Fig. S8**),
38
39 214 income (**Fig. S9**), length of training (**Fig. S10**), prestige (**Fig. S11**), advice from
40
41 215 others (**Fig. S12**) and student debt (**Fig. S13**). All the factors were significant with
42
43 216 evidence of between-study heterogeneity ($P < 0.0001$). A sensitivity analysis, in which
44
45 217 the meta-analysis was serially repeated after the exclusion of each study,
46
47 218 demonstrated that no individual study affected the overall extent of a factor's
48
49 219 influence.

52 **Meta-regression and Subgroup Analysis**

53
54
55 221 We performed meta-regression to identified the potential sources of heterogeneity

1
2
3 222 using common instructions when at least 5 studies were available and at least 2
4
5 223 studies were in each comparator subgroup (**Table 3**). Some of the heterogeneities
6
7 224 observed among the 12 factors can be partially explained by country, survey years,
8
9 225 specialty and sample size.
10
11 226 EOI values were further analyzed by subgroup (**Table S2**) according to world region
12
13 227 (**Fig. 1**) and survey year (**Fig. 2**). The EOI value of academic interests in developed
14
15 228 countries was higher than that in developing countries (79.66% [95% CI, 70.73%;
16
17 229 86.39% vs. 60.41% [95% CI, 43.44%; 75.19%]; $Q=3.51$ $P=0.02$). Conversely, a
18
19 230 lower EOI value of prestige was found in studies conducted in developed countries
20
21 231 than in developing countries (23.96% [95% CI, 19.20%; 29.47%] vs. 47.65% [95%
22
23 232 CI, 34.41%; 61.24%]; $Q=4.71$ $P=0.01$). No statistically significant subgroup
24
25 233 differences in the EOI values of the other influencing factors were noted between
26
27 234 developed countries and developing countries. In addition, no statistically significant
28
29 235 differences in the EOI values of the influencing factors were observed when
30
31 236 subgroup analysis was performed by survey year.

237 **Assessment of Publication Bias**

32
33
34
35
36
37 238 We generated a funnel plot with proportion as the abscissa and standard error as the
38
39 239 ordinate. A visual inspection of the funnel plots revealed minimal asymmetry among
40
41 240 the various influencing factors (**Fig. S14**), and the results were concentrated in the
42
43 241 narrow upper part of the graph. There was evidence of small study effect in the
44
45 242 meta-analysis of “patient service orientation” (Egger’s test $P=0.02$). However, the
46
47 243 trim-and-fill method showed the publication-bias corrected estimate remained
48
49 244 statistically significant (63.79%, 95% CI, 58.20%; 69.04%).

245 **Discussion**

246 **Implications**

1
2
3 247 This systematic review and meta-analysis involved 75 studies with 882,209 medical
4
5 248 students. Twelve influencing factors were analyzed. These factors can be classified
6
7 249 into two categories: economic factors and non-economic factors. We found that the
8
9 250 EOI of the economic factors, including income (34.70%) and student debt (15.33%),
10
11 251 may not depend on the region's level of economic development. However, income
12
13 252 remained a major influencing factor in the process of choosing a specialty or
14
15 253 subspecialty. In the US, 15% of full-time family medicine physicians earned less than
16
17 254 \$100,000 in 2004, which is significantly less than the income earned by invasive
18
19 255 cardiologists (median income=\$427,815), neurosurgeons (median income=\$211,094),
20
21 256 and orthopedists (median income=\$335,646).²⁷ This economic inequality made
22
23 257 family medicine less attractive to medical school graduates.²⁸ Benefits such as health
24
25 258 insurance and tuition reimbursement have been shown to be the most common
26
27 259 economic incentives used to attract applicants.²⁹
28
29
30
31 260 The non-economic factors can be divided into individual factors, specialty-related
32
33 261 factors and others. First, individual factors, including academic interest and
34
35 262 competencies, have a considerable impact on students' subspecialty choice, with EOI
36
37 263 values of 75.29% and 55.15%, respectively. In addition, in the subgroup analysis,
38
39 264 although academic interests were less influential in developing countries than in
40
41 265 developed countries (79.66% [95% CI, 70.73%; 86.39% vs. 60.41% [95% CI,
42
43 266 43.44%; 75.19%]; $Q=3.51$ $P=0.02$), they were still the most influential of the 12
44
45 267 factors regardless of regional economic level. These findings indicate that
46
47 268 subspecialties with a shortage of manpower may attract more students by increasing
48
49 269 students' interests and improving the quality of education. Previous studies indicated
50
51 270 that early specialty exposure in medical education may arouse students' academic
52
53 271 interest and improve their clinical competence.^{28 30} For example, an elective

1
2
3 272 extracurricular program designed to facilitate early contact with family medicine
4
5 273 physicians was found to significantly improve students' interest and clinical skills,
6
7 274 especially communication skills, in family medicine.³¹ Furthermore, dispelling myths
8
9 275 and espousing the positive aspects of a discipline may provide a better understanding
10
11 276 of certain specialties; this approach could also be effective in increasing students'
12
13 277 academic interest.³² For instance, family medicine is often considered a discipline
14
15 278 that requires less professional skills and knowledge. This misconception demotivates
16
17 279 students from choosing family medicine as their future career specialty, and this trend
18
19 280 may eventually lead to a shortage of family physicians.³² Eliminating such prejudices
20
21 281 may help students pay greater attention to the areas in short supply and restore their
22
23 282 interests in other specialties.

24
25
26 283 Second, the specialty-related factors included controllable lifestyle/flexible work
27
28 284 schedule (EOI of 53.00%), career opportunities (EOI of 44.00%), workload (EOI of
29
30 285 37.99%) and training length (EOI of 32.30%). Of these factors, lifestyle varied
31
32 286 between different areas. Additionally, although certain specialties, such as general
33
34 287 surgery, seem to have an adequate number of surgeons on a per capita basis in the US,
35
36 288 there is still a poor geographic distribution within the surgical workforce according to
37
38 289 the type of surgical practice.³³ The inflexible lifestyle is a common reason that
39
40 290 students perceive surgery to be less attractive.³³ Reorganization of expected work
41
42 291 hours within shared practices and the increased use of physician extenders and
43
44 292 technologies such as electronic medical records may give physicians more flexibility
45
46 293 in work schedules.³⁴ Moreover, providing promotion opportunities and shortening the
47
48 294 length of training are possible strategies to recruit new staff in subspecialties that
49
50 295 require a long period of post-graduate residency training, such as neurosurgery.³⁵

51
52
53 296 Finally, other factors such as service orientation (EOI of 50.74%), medical teachers

1
2
3 297 or mentors (EOI of 46.93%), prestige (EOI of 34.68%), and advice from others (EOI
4
5 298 of 28.24%) also contribute to the decision-making process of medical students. For
6
7 299 example, the desire to care for patients with end-stage diseases contributed to the
8
9 300 decision to enter palliative medicine in 86% of the medical students.⁷ Additionally,
10
11 301 exposure to mentors in a particular clinical field such as internal medicine has been
12
13 302 strongly associated with medical students' choice of clinical field.³⁶ Moreover,
14
15 303 improving the occupational prestige of areas such as family medicine, pathology, and
16
17 304 radiology may help reshape the distribution of the workforce.^{30 37 38}

18
19
20 305 In our study, several findings are especially noteworthy. First, interest was far more
21
22 306 important than income in deciding subspecialty. In our study, interest was the
23
24 307 top-ranked influencing factor (EOI of 75.29%) of subspecialty choice, while income
25
26 308 was ranked lower (EOI of 34.70%). This finding argues against the possible default
27
28 309 belief that raising physician's wages alone could solve the uneven distribution of
29
30 310 clinicians among subspecialties. Our findings highlight that cultivating and
31
32 311 stimulating students' professional interests may help improve the maldistribution of
33
34 312 medical resources in a more efficient and cost-saving manner.

35
36
37 313 Second, improving abilities in a certain subspecialty of interest can greatly affect
38
39 314 medical students' professional choice. In our study, competencies ranked second in
40
41 315 influence, which may reflect the impact of admission conditions on students' choice
42
43 316 of subspecialty. Hence, to reduce the risk that students are restricted to the
44
45 317 subspecialty of their interest due to a lack of personal skills, medical education
46
47 318 should focus more on enhancing students' personal competencies in addition to their
48
49 319 academic interests.

50
51
52 320 Third, balancing medical resources is a complex process in practical terms, as the
53
54 321 influencing factors are not mutually exclusive. The shortage of physicians in certain

1
2
3 322 subspecialties may increase physician workload, resulting in less time for teaching.
4
5 323 Hence, the quality of teaching cannot be guaranteed, and students may tend to avoid
6
7 324 choosing these subspecialties, thus worsening the imbalance in the medical
8
9 325 workforce. Additionally, some of the 12 factors identified are not amenable to
10
11 326 practical interventions. For example, prestige cannot be immediately increased using
12
13 327 interventional strategies.³⁷ Overall, effective strategies must be multi-pronged and
14
15 328 incorporate several different aspects, and maldistribution in the workforce should not
16
17 329 be tackled through a simple adjustment of one influencing factor.

330 **Interpretations of the results of this meta-analysis**

331 Our meta-regression stratified by the study-level characteristics found that country,
332 survey years, subspecialty and sample size may contribute to the heterogeneity
333 between studies. There was no significant difference in the sensitivity analysis, which
334 indicated that the results of the meta-analysis were convincing. The funnel plots and
335 Egger's tests revealed that most of the publication bias was small ($P>0.05$), except
336 for the meta-analysis of "patient service orientation". Moreover, the majority of the
337 studies collected in the database were from developed countries rather than
338 developing countries.

339 **Limitations**

340 Several limitations should be considered when interpreting the findings of this study.
341 First, the students involved in our study included medical students at different stages
342 of their medical education. Students' perception about different subspecialties may
343 change during medical training until the students applies for specialty training. For
344 example, compared to an intern, a freshman student may place greater emphasis on
345 income and prestige when considering a career choice.³⁹ A subgroup analysis
346 stratified by the stages of medical education and a secondary meta-analysis of

1
2
3 347 longitudinal studies may better reflect changes in influencing factors and the extent
4
5 348 of their influence over time. Second, our meta-analysis summarized the data from
6
7 349 different geographic regions around the world, and the general conclusions may not
8
9 350 be appropriate to guide policy development in each region. Enhanced effort is needed
10
11 351 to develop specific intervention strategies according to the specific economic level,
12
13 352 religious beliefs, healthcare system, educational system and endemic diseases of
14
15 353 different countries and regions. Subgroup analysis stratified by organizational and
16
17 354 medical training factors would provide more information of the factors influencing
18
19 355 subspecialty choice among medical students. Third, the surveys in the various studies
20
21 356 were also conducted using different methods. Most of the questionnaires used a
22
23 357 Likert scale. Therefore, when we converted the results to a percentage representing
24
25 358 the extent of a factor's influence, the Likert scale items were treated as interval
26
27 359 data.⁴⁰⁻⁴² Consequently, there may have been differences in the conversion process.
28
29 360 Finally, the analysis relied on aggregated published data. A multicenter prospective
30
31 361 study would provide more accurate estimate of the influencing factors and the extent
32
33 362 of their influence on medical students' choice of subspecialty.
34
35
36

363 **Conclusion**

364 In conclusion, this systematic review and meta-analysis provided a summary
365 evaluation of 12 influencing factors and the extent of their influence on the choice of
366 subspecialty training among medical students. Understanding students' attitudes
367 toward their subspecialty decision-making process could provide the basis for
368 developing strategies to increase the attractiveness of subspecialties experiencing a
369 shortage of manpower, thereby balancing the distribution of medical recourses.

1
2
3 370 **Contributors:** Haotian Lin contributed to the conceptualizing and design of the study,
4
5 371 and to research funding, coordinated the research and oversaw the project. Yahan
6
7 372 Yang, Jiawei Li and Xiaohang Wu contributed to data collection and interpretation,
8
9 373 and to data analysis. Jinghui Wang, Yi Zhu, Chuan Chen and Wangting Li contributed
10
11 374 to the design of the study. All authors contributed to the drafting and revision of the
12
13 375 paper and approved the final manuscript for publication. No patients or the public
14
15 376 were involved in the development and design of this research.

16
17
18 377 **Funding:** The principal investigator of this study (Haotian Lin) is currently
19
20 378 supported by National key R & D project (2018YFC010302), the Key Research Plan
21
22 379 for the National Natural Science Foundation of China Cultivation Project (91546101),
23
24 380 the National Natural Science Foundation of China (81770967), the Fundamental
25
26 381 Research Funds for the Central Universities (16ykjc28), the Guangdong Provincial
27
28 382 Natural Science Foundation for Distinguished Young Scholars of China
29
30 383 (2014A030306030), the Guangdong Province Universities and Colleges Youth Pearl
31
32 384 River Scholar Funded Scheme (2016), the Clinical Research and Translational
33
34 385 Medical Center of Pediatric Cataract in Guangzhou City (201505032017516), and
35
36 386 Ministry of Science and Technology of China Grants (2015CB964600). These
37
38 387 sponsors and funding organizations had no role in the design or performance of this
39
40 388 study.

41
42
43
44 389 **Competing Interests:** The authors declare no competing financial interests.

45
46 390 **Data sharing:** Extracted data are available upon request to the corresponding author.

47
48 391

392 **References**

- 393 1. Zurn P, Dal Poz MR, Stilwell B, et al. Imbalance in the health workforce. *Hum Resour Health*
394 2004;2(1):13. doi: 10.1186/1478-4491-2-13
- 395 2. Diallo K, Zurn P, Gupta N, et al. Monitoring and evaluation of human resources for health: an
396 international perspective. *Hum Resour Health* 2003;1(1):3. doi: 10.1186/1478-4491-1-3
- 397 3. Anderson GF, Hussey PS. Population aging: A comparison among industrialized countries. *Health*
398 *Affair* 2000;19(3):191-203. doi: DOI 10.1377/hlthaff.19.3.191
- 399 4. Hobbs FDR, Bankhead C, Mukhtar T, et al. Clinical workload in UK primary care: a retrospective
400 analysis of 100 million consultations in England, 2007-14. *Lancet* 2016;387(10035):2323-30.
401 doi: 10.1016/S0140-6736(16)00620-6
- 402 5. Reeve J, Blakeman T, Freeman GK, et al. Generalist solutions to complex problems: generating
403 practice-based evidence - the example of managing multi-morbidity. *Bmc Fam Pract* 2013;14
404 doi: Artn 112
405 10.1186/1471-2296-14-112
- 406 6. Bodenheimer T. Primary care--will it survive? *N Engl J Med* 2006;355(9):861-4. doi:
407 10.1056/NEJMp068155
- 408 7. LeGrand SB, Heintz JB. Palliative Medicine Fellowship: A Study of Resident Choices. *Journal of*
409 *Pain and Symptom Management* 2012;43(3):558-68. doi:
410 10.1016/j.jpainsymman.2011.04.018
- 411 8. Kim YY, Kim UN, Kim YS, et al. Factors associated with the specialty choice of Korean medical
412 students: a cross-sectional survey. *Human Resources for Health* 2016;14:8. doi:
413 10.1186/s12960-016-0141-8
- 414 9. McNally SA. Competition ratios for different specialties and the effect of gender and immigration
415 status. *J R Soc Med* 2008;101(10):489-92. doi: 10.1258/jrsm.2008.070284
- 416 10. Reed VA, Jernstedt GC, Reber ES. Understanding and improving medical student specialty choice:
417 a synthesis of the literature using decision theory as a referent. *Teach Learn Med*
418 2001;13(2):117-29. doi: 10.1207/S15328015TLM1302_7
- 419 11. Al-Ansari SS, Khafagy MA. FACTORS AFFECTING THE CHOICE OF HEALTH SPECIALTY
420 BY MEDICAL GRADUATES. *Journal of Family & Community Medicine*
421 2015;13(3):119-23.
- 422 12. Leduc N, Vanasse A, Scott I, et al. The career decision-making process of medical students and
423 residents and the choice of specialty and practice location: how does Postgraduate Medical
424 Education fit in? 2011
- 425 13. Delamothe T. Modernising Medical Careers: final report. *BMJ* 2008;336(7635):54-55.
- 426 14. Goldacre MJ, Laxton L, Harrison EM, et al. Early career choices and successful career progression
427 in surgery in the UK: prospective cohort studies. *Bmc Surgery* 2010;10:11. doi:
428 10.1186/1471-2482-10-32
- 429 15. Weissman C, Zisk-Rony RY, Schroeder JE, et al. Medical specialty considerations by medical
430 students early in their clinical experience. *Isr J Health Policy Res* 2012;1(1):13. doi:
431 10.1186/2045-4015-1-13
- 432 16. Jackson C, Ball J, Hirsh W, et al. Informing choices: the need for career advice in medical training.
433 *Cambridge: National institute for careers Education and Counseling* 2003
- 434 17. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and
435 meta-analyses: the PRISMA statement. *J Clin Epidemiol* 2009;62(10):1006-12. doi:
436 10.1016/j.jclinepi.2009.06.005
- 437 18. Rostom A, Dube C, Cranney A, et al. Celiac disease. *Evid Rep Technol Assess (Summ)*
438 2004(104):1-6. [published Online First: 2004/09/07]
- 439 19. Borenstein M, Hedges LV, Higgins JP, et al. A basic introduction to fixed-effect and random-effects
440 models for meta-analysis. *Res Synth Methods* 2010;1(2):97-111. doi: 10.1002/jrsm.12
- 441 20. Higgins JP, Thompson SG, Deeks JJ, et al. Measuring inconsistency in meta-analyses. *BMJ*
442 2003;327(7414):557-60. doi: 10.1136/bmj.327.7414.557
- 443 21. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med*
444 2002;21(11):1539-58. doi: 10.1002/sim.1186
- 445 22. Sterne JA, Juni P, Schulz KF, et al. Statistical methods for assessing the influence of study
446 characteristics on treatment effects in 'meta-epidemiological' research. *Stat Med*
447 2002;21(11):1513-24. doi: 10.1002/sim.1184
- 448 23. Borenstein M, Hedges LV, Higgins J, et al. Criticisms of meta - analysis. *Introduction to*
449 *meta-analysis* 2009:377-87.
- 450 24. Egger M, Davey Smith G, Schneider M, et al. Bias in meta-analysis detected by a simple,

- graphical test. *BMJ* 1997;315(7109):629-34.
25. Sterne JA, Egger M. Funnel plots for detecting bias in meta-analysis: guidelines on choice of axis. *J Clin Epidemiol* 2001;54(10):1046-55.
26. Duval S, Tweedie R. Trim and fill: A simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. *Biometrics* 2000;56(2):455-63. [published Online First: 2000/07/06]
27. Bodenheimer T, Berenson RA, Rudolf P. The primary care-specialty income gap: why it matters. *Annals of internal medicine* 2007;146(4):301-6.
28. Bodenheimer T, Pham HH. Primary care: current problems and proposed solutions. *Health Aff (Millwood)* 2010;29(5):799-805. doi: 10.1377/hlthaff.2010.0026
29. Association AH. The hospital workforce shortage: Immediate and future. *Trend Watch* 2001;3(2):1-8.
30. Compton MT, Frank E, Elon L, et al. Changes in US medical students' specialty interests over the course of medical school. *Journal of General Internal Medicine* 2008;23(7):1095-100. doi: 10.1007/s11606-008-0579-z
31. Indyk D, Deen D, Fornari A, et al. The influence of longitudinal mentoring on medical student selection of primary care residencies. *BMC medical education* 2011;11(1):27.
32. Gill H, McLeod S, Duerksen K, et al. Factors influencing medical students' choice of family medicine Effects of rural versus urban background. *Canadian Family Physician* 2012;58(11):E649-E57.
33. Richardson JD. Workforce and lifestyle issues in general surgery training and practice. *Archives of surgery (Chicago, Ill : 1960)* 2002;137(5):515-20.
34. Newton DA, Grayson MS, Thompson LF. The variable influence of lifestyle and income on medical students' career specialty choices: data from two U.S. medical schools, 1998-2004. *Academic medicine : journal of the Association of American Medical Colleges* 2005;80(9):809-14.
35. Orrico K. Ensuring an adequate neurosurgical workforce for 21st century. *Surgeons AAoN* 2012
36. Wright SM, Wong A, Newill CA. The impact of role models on medical students. *Journal of General Internal Medicine* 1997;12(1):53-56.
37. Glazer GM, Ruiz-Wibbelsmann JA. Decades of perceived mediocrity: prestige and radiology. *Radiology* 2011;260(2):311-16.
38. Schwartzbaum AM, McGrath JH, Rothman RA. The perception of prestige differences among medical subspecialties. *Soc Sci Med* 1973;7(5):365-71.
39. Parsa S, Aghazadeh A, Nejatiasafa AA, et al. Freshmen versus Interns' Specialty Interests. *Archives of Iranian Medicine* 2010;13(6):509-15.
40. Komorita SS. Attitude Content, Intensity, and the Neutral Point on a Likert Scale. *J Soc Psychol* 1963;61:327-34. doi: 10.1080/00224545.1963.9919489
41. Baggaley AR, Hull AL. The effect of nonlinear transformations on a Likert scale. *Eval Health Prof* 1983;6(4):483-91.
42. Norman G. Likert scales, levels of measurement and the "laws" of statistics. *Advances in health sciences education : theory and practice* 2010;15(5):625-32. doi: 10.1007/s10459-010-9222-y
43. Smith F, Lambert TW, Goldacre MJ. Factors influencing junior doctors' choices of future specialty: trends over time and demographics based on results from UK national surveys. *Journal of the Royal Society of Medicine* 2015;108(10):396-405. doi: 10.1177/0141076815599674
44. Cochran A, Melby S, Neumayer LA. An Internet-based survey of factors influencing medical student selection of a general surgery career. *American Journal of Surgery* 2005;189(6):742-46. doi: 10.1016/j.amjsurg.2005.03.019
45. Hauer KE, Durning SJ, Kernan WN, et al. Factors associated with medical students' career choices regarding internal medicine. *Jama-Journal of the American Medical Association* 2008;300(10):1154-64. doi: 10.1001/jama.300.10.1154
46. Johnson AL, Sharma J, Chinchilli VM, et al. Why do medical students choose orthopaedics as a career? *The Journal of bone and joint surgery American volume* 2012;94(11):e78. doi: 10.2106/jbjs.k.00826 [published Online First: 2012/05/29]
47. Kiolbassa K, Miksch A, Hermann K, et al. Becoming a general practitioner - Which factors have most impact on career choice of medical students? *Bmc Family Practice* 2011;12:7. doi: 10.1186/1471-2296-12-25
48. Klingensmith ME, Cogbill TH, Luchette F, et al. Factors Influencing the Decision of Surgery Residency Graduates to Pursue General Surgery Practice Versus Fellowship. *Annals of*

- 1
2
3 510 *Surgery* 2015;262(3):449-55. doi: 10.1097/sla.0000000000001435
- 4 511 49. Lee JY, Kerbl DC, McDougall EM, et al. Medical Students Pursuing Surgical Fields Have No
5 512 Greater Innate Motor Dexterity than Those Pursuing Nonsurgical Fields. *Journal of Surgical*
6 513 *Education* 2012;69(3):360-63. doi: 10.1016/j.jsurg.2011.11.005
- 7 514 50. Macdonald C, Cawood T. Factors influencing career decisions in internal medicine. *Internal*
8 515 *Medicine Journal* 2012;42(8):918-23. doi: 10.1111/j.1445-5994.2012.02793.x
- 9 516 51. Paiva RE, Vu NV, Verhulst SJ. The effect of clinical experiences in medical school on specialty
10 517 choice decisions. *J Med Educ* 1982;57(9):666-74.
- 11 518 52. Ni Chroinin D, Cronin E, Cullen W, et al. Would you be a geriatrician? Student career preferences
12 519 and attitudes to a career in geriatric medicine. *Age Ageing* 2013;42(5):654-7. doi:
13 520 10.1093/ageing/aft093 [published Online First: 2013/08/07]
- 14 521 53. Rogers LQ, Fincher RM, Lewis LA. Factors influencing medical students to choose primary care
15 522 or non-primary care specialties. *Academic medicine : journal of the Association of American*
16 523 *Medical Colleges* 1990;65(9 Suppl):S47-8.
- 17 524 54. Abendroth J, Schnell U, Lichte T, et al. Motives of former interns in general practice for
18 525 speciality-choice--results of a cross-sectional study among graduates 2007 to 2012. *GMS*
19 526 *Zeitschrift fur medizinische Ausbildung* 2014;31(1):Doc11. doi: 10.3205/zma000903
20 527 [published Online First: 2014/02/28]
- 21 528 55. Alawad A, Khan WS, Abdelrazig YM, et al. Factors considered by undergraduate medical students
22 529 when selecting specialty of their future careers. *Pan African Medical Journal* 2015;20:6. doi:
23 530 10.11604/pamj.2015.20.102.4715
- 24 531 56. Azizzadeh A, McCollum CH, Miller CC, 3rd, et al. Factors influencing career choice among
25 532 medical students interested in surgery. *Curr Surg* 2003;60(2):210-3. doi:
26 533 10.1016/s0149-7944(02)00679-7 [published Online First: 2004/02/20]
- 27 534 57. Celenza A, Bharath J, Scop J. Improving the attractiveness of an emergency medicine career to
28 535 medical students: An exploratory study. *Emergency Medicine Australasia* 2012;24(6):625-33.
29 536 doi: 10.1111/j.1742-6723.2012.01607.x
- 30 537 58. Dolan-Evans E, Rogers GD. Barriers for students pursuing a surgical career and where the Surgical
31 538 Interest Association can intervene. *Anz Journal of Surgery* 2014;84(6):406-11. doi:
32 539 10.1111/ans.12521
- 33 540 59. Boyd JS, Clyne B, Reinert SE, et al. Emergency Medicine Career Choice: A Profile of Factors and
34 541 Influences from the Association of American Medical Colleges (AAMC) Graduation
35 542 Questionnaires. *Academic Emergency Medicine* 2009;16(6):544-49. doi:
36 543 10.1111/j.1553-2712.2009.00385.x
- 37 544 60. Egerton EA. Choice of career of doctors who graduated from Queen's University, Belfast in 1977.
38 545 *Med Educ* 1985;19(2):131-7.
- 39 546 61. Diderichsen S, Johansson EE, Verdonk P, et al. Few gender differences in specialty preferences and
40 547 motivational factors: a cross-sectional Swedish study on last-year medical students. *Bmc*
41 548 *Medical Education* 2013;13:8. doi: 10.1186/1472-6920-13-39
- 42 549 62. Ferrari S, Reggianini C, Mattei G, et al. International Study of Student Career Choice in Psychiatry
43 550 (ISoSCCIP): Results from Modena, Italy. *International Review of Psychiatry*
44 551 2013;25(4):450-59. doi: 10.3109/09540261.2013.804402
- 45 552 63. Freire MDM, Jordao LMR, Ferreira ND, et al. Motivation Towards Career Choice of Brazilian
46 553 Freshman Students in a Fifteen-Year Period. *Journal of Dental Education* 2011;75(1):115-21.
- 47 554 64. Buddeberg-Fischer B, Klaghofer R, Abel T, et al. Swiss residents' speciality choices--impact of
48 555 gender, personality traits, career motivation and life goals. *BMC Health Serv Res* 2006;6:137.
49 556 doi: 10.1186/1472-6963-6-137
- 50 557 65. Dorsey ER, Jarjoura D, Rutecki GW. The influence of controllable lifestyle and sex on the
51 558 specialty choices of graduating U.S. medical students, 1996-2003. *Academic medicine :*
52 559 *journal of the Association of American Medical Colleges* 2005;80(9):791-6. [published
53 560 Online First: 2005/08/27]
- 54 561 66. Ekenze SO, Ugwumba FO, Obi UM, et al. Undergraduate Surgery Clerkship and the Choice of
55 562 Surgery as a Career: Perspective from a Developing Country. *World Journal of Surgery*
56 563 2013;37(9):2094-100. doi: 10.1007/s00268-013-2073-y
- 57 564 67. Barikani A, Afaghi M, Barikani F, et al. Perception of the medical students on their future career in
58 565 Qazvin University of Medical Sciences. *Global journal of health science* 2012;4(4):176-80.
59 566 doi: 10.5539/gjhs.v4n4p176 [published Online First: 2012/09/18]
- 60 567 68. Bittaye M, Odukogbe AT, Nyan O, et al. Medical students' choices of specialty in The Gambia: the
568 568 need for career counseling. *BMC Med Educ* 2012;12:72. doi: 10.1186/1472-6920-12-72

- 1
2
3 569 69. Bonura EM, Lee ES, Ramsey K, et al. Factors Influencing Internal Medicine Resident Choice of
4 570 Infectious Diseases or Other Specialties: A National Cross-sectional Study. *Clinical Infectious*
5 571 *Diseases* 2016;63(2):155-63. doi: 10.1093/cid/ciw263
- 6 572 70. Al-Fouzan R, Al-Ajlan S, Marwan Y, et al. Factors affecting future specialty choice among medical
7 573 students in Kuwait. *Medical Education Online* 2012;17:7. doi: 10.3402/meo.v17i0.19587
- 8 574 71. AlKot MM, Gouda MA, KhalafAllah MT, et al. Family Medicine in Egypt From Medical Students'
9 575 Perspective: A Nationwide Survey. *Teaching and Learning in Medicine* 2015;27(3):264-73.
10 576 doi: 10.1080/10401334.2015.1044654
- 11 577 72. Borges NJ, Manuel RS, Duffy RD, et al. Influences on specialty choice for students entering
12 578 person-oriented and technique-oriented specialties. *Medical Teacher* 2009;31(12):1086-88.
13 579 doi: 10.3109/01421590903183787
- 14 580 73. Budd S, Kelley R, Day R, et al. Student attitudes to psychiatry and their clinical placements.
15 581 *Medical Teacher* 2011;33(11):E586-E92. doi: 10.3109/0142159x.2011.610836
- 16 582 74. Corrigan MA, Shields CJ, Redmond HP. Factors influencing surgical career choices and
17 583 advancement in Ireland and Britain. *World Journal of Surgery* 2007;31(10):1921-29. doi:
18 584 10.1007/s00268-007-9175-3
- 19 585 75. Davis CR, Trevatt AEJ, McGoldrick RB, et al. How to train plastic surgeons of the future. *Journal*
20 586 *of Plastic Reconstructive and Aesthetic Surgery* 2016;69(8):1134-40. doi:
21 587 10.1016/j.bjps.2016.05.001
- 22 588 76. Deutsch T, Lippmann S, Frese T, et al. Who wants to become a general practitioner? Student and
23 589 curriculum factors associated with choosing a GP career - a multivariable analysis with
24 590 particular consideration of practice-orientated GP courses. *Scandinavian Journal of Primary*
25 591 *Health Care* 2015;33(1):47-53. doi: 10.3109/02813432.2015.1020661
- 26 592 77. Gardner SP, Roberts-Thomson KF. The effect of a change in selection procedures on students'
27 593 motivation to study dentistry. *Australian Dental Journal* 2014;59(1):2-8. doi:
28 594 10.1111/adj.12141
- 29 595 78. Dias MS, Sussman JS, Durham S, et al. Perceived benefits and barriers to a career in pediatric
30 596 neurosurgery: a survey of neurosurgical residents Clinical article. *Journal of*
31 597 *Neurosurgery-Pediatrics* 2013;12(5):422-33. doi: 10.3171/2013.5.peds12597
- 32 598 79. Goltz CJ, Bachusz RC, Mancini E, et al. Medical Student Career Survey-Vascular Surgery
33 599 Awareness Initiative. *Annals of Vascular Surgery* 2013;27(2):225-31. doi:
34 600 10.1016/j.avsg.2012.02.012
- 35 601 80. Gupta NB, Khadilkar SV, Bangar SS, et al. Neurology as career option among postgraduate
36 602 medical students. *Annals of Indian Academy of Neurology* 2013;16(4):478-82. doi:
37 603 10.4103/0972-2327.120427
- 38 604 81. Hanzlick R, Prahlow JA, Denton S, et al. Selecting forensic pathology as a career - A survey of the
39 605 post with an eye on the future. *American Journal of Forensic Medicine and Pathology*
40 606 2008;29(2):114-22. doi: 10.1097/PAF.0b013e318174f0a9
- 41 607 82. Harris MC, Marx J, Gallagher PR, et al. General vs subspecialty pediatrics - Factors leading to
42 608 residents' career decisions over a 12-year period. *Archives of Pediatrics & Adolescent*
43 609 *Medicine* 2005;159(3):212-16. doi: 10.1001/archpedi.159.3.212
- 44 610 83. Hauer KE, Fagan MJ, Kernan W, et al. Internal medicine clerkship directors' perceptions about
45 611 student interest in internal medicine careers. *Journal of General Internal Medicine*
46 612 2008;23(7):1101-04. doi: 10.1007/s11606-008-0640-y
- 47 613 84. Labiris G, Vamvakerou V, Tsolakaki O, et al. Perceptions of Greek medical students regarding
48 614 medical profession and the specialty selection process during the economic crisis years.
49 615 *Health Policy* 2014;117(2):203-09. doi: 10.1016/j.healthpol.2014.04.009
- 50 616 85. Lambert TW, Goldacre MJ, Bron AJ. Career choices for ophthalmology made by newly qualified
51 617 doctors in the United Kingdom, 1974-2005. *Bmc Ophthalmology* 2008;8:9. doi:
52 618 10.1186/1471-2415-8-3
- 53 619 86. Shah HH, Jhaveri KD, Sparks MA, et al. Career Choice Selection and Satisfaction among US
54 620 Adult Nephrology Fellows. *Clinical Journal of the American Society of Nephrology*
55 621 2012;7(9):1513-20. doi: 10.2215/cjn.01620212
- 56 622 87. Lefevre JH, Roupert M, Kerneis S, et al. Career choices of medical students: a national survey of
57 623 1780 students. *Medical Education* 2010;44(6):603-12. doi:
58 624 10.1111/j.1365-2923.2010.03707.x
- 59 625 88. Vicente B, Rosel L. Challenges for psychiatric recruitment and training in Chile. *International*
60 626 *Review of Psychiatry* 2013;25(4):413-18. doi: 10.3109/09540261.2013.822348
- 61 627 89. Wiesenfeld L, Abbey S, Takahashi SG, et al. Choosing Psychiatry as a Career: Motivators and

- 1
2
3 628 Deterrents at a Critical Decision-Making Juncture. *Canadian Journal of Psychiatry-Revue*
4 629 *Canadienne De Psychiatrie* 2014;59(8):450-54.
- 5 630 90. Lam CYY, Cheung CSY, Hui ASY. Factors influencing the career interest of medical graduates in
6 631 obstetrics and gynaecology in Hong Kong: a cross-sectional questionnaire survey. *Hong Kong*
7 632 *Medical Journal* 2016;22(2):138-43.
- 8 633 91. Hartung PJ, Taber BJ, Richard GV. The physician values in practice scale: Construction and initial
9 634 validation. *Journal of Vocational Behavior* 2005;67(2):309-20. doi:
10.1016/j.jvb.2004.05.008
- 10 636 92. Girasek E, Molnar R, Eke E, et al. The medical career choice motivations - Results from a
11 637 Hungarian study. *Central European Journal of Medicine* 2011;6(4):502-09. doi:
12 638 10.2478/s11536-011-0034-0
- 13 639 93. Zuccato JA, Kulkarni AV. The Impact of Early Medical School Surgical Exposure on Interest in
14 640 Neurosurgery. *Canadian Journal of Neurological Sciences* 2016;43(3):410-16. doi:
15 641 10.1017/cjn.2015.332
- 16 642 94. Wilbanks L, Spollen J, Messias E. Factors Influencing Medical School Graduates Toward a Career
17 643 in Psychiatry: Analysis from the 2011-2013 Association of American Medical Colleges
18 644 Graduation Questionnaire. *Academic Psychiatry* 2016;40(2):255-60. doi:
19 645 10.1007/s40596-015-0287-z
- 20 646 95. West CP, Drefahl MM, Popkave C, et al. Internal Medicine Resident Self-report of Factors
21 647 Associated with Career Decisions. *Journal of General Internal Medicine* 2009;24(8):946-49.
22 648 doi: 10.1007/s11606-009-1039-0
- 23 649 96. Watmough S, Taylor D, Ryland I. Using questionnaires to determine whether medical graduates'
24 650 career choice is determined by undergraduate or postgraduate experiences. *Medical Teacher*
25 651 2007;29(8):830-32. doi: 10.1080/01421590701551755
- 26 652 97. Thakur A, Fedorka P, Ko C, et al. Impact of mentor guidance in surgical career selection. *Journal*
27 653 *of Pediatric Surgery* 2001;36(12):1802-04. doi: 10.1053/jpsu.2001.28842
- 28 654 98. Scott I, Gowans M, Wright B, et al. Determinants of choosing a career in surgery. *Medical Teacher*
29 655 2011;33(12):1011-17. doi: 10.3109/0142159x.2011.558533
- 30 656 99. Schnuth RL, Vasilenko P, Mavis B, et al. What influences medical students to pursue careers in
31 657 obstetrics and gynecology? *American Journal of Obstetrics and Gynecology*
32 658 2003;189(3):639-43. doi: 10.1067/s0002-9378(03)00886-x
- 33 659 100. Richards MJM, Drummond R, Murray J, et al. WHAT PROPORTION OF BASIC SURGICAL
34 660 TRAINEES CONTINUE IN A SURGICAL CAREER? A SURVEY OF THE FACTORS
35 661 WHICH ARE IMPORTANT IN INFLUENCING CAREER DECISIONS. *Surgeon-Journal*
36 662 *of the Royal Colleges of Surgeons of Edinburgh and Ireland* 2009;7(5):270-75.
- 37 663 101. Reed CE, Vaporciyan AA, Erikson C, et al. Factors Dominating Choice of Surgical Specialty.
38 664 *Journal of the American College of Surgeons* 2010;210(3):319-24. doi:
39 665 10.1016/j.jamcollsurg.2009.11.016
- 40 666 102. de Souza LCL, Mendonca VRR, Garcia GBC, et al. Medical Specialty Choice and Related
41 667 Factors of Brazilian Medical Students and Recent Doctors. *Plos One* 2015;10(7):15. doi:
42 668 10.1371/journal.pone.0133585
- 43 669 103. Pikoulis E, Avgerinos ED, Pedeli X, et al. Medical students' perceptions on factors influencing a
44 670 surgical career: The fate of general surgery in Greece. *Surgery* 2010;148(3):510-15. doi:
45 671 10.1016/j.surg.2010.01.013
- 46 672 104. Ozer U, Ceri V, Carpar E, et al. Factors Affecting the Choice of Psychiatry as a Specialty and
47 673 Satisfaction among Turkish Psychiatry Residents. *Academic Psychiatry* 2016;40(2):299-303.
48 674 doi: 10.1007/s40596-015-0346-5
- 49 675 105. Noble J, Hechter FJ, Karaikos N, et al. Motivational factors and future life plans of orthodontic
50 676 residents in the United States. *American Journal of Orthodontics and Dentofacial*
51 677 *Orthopedics* 2010;137(5):623-30. doi: 10.1016/j.ajodo.2008.03.034
- 52 678 106. Noble J. Factors influencing career choice in ophthalmology. *Canadian Journal of*
53 679 *Ophthalmology-Journal Canadien D Ophthalmologie* 2006;41(5):596-99.
- 54 680 107. Newton DA, Grayson MS, Thompson LF. The variable influence of lifestyle and income on
55 681 medical students' career specialty choices: Data from two US medical schools, 1998-2004.
56 682 *Academic Medicine* 2005;80(9):809-14. doi: 10.1097/00001888-200509000-00005
- 57 683 108. Moore HB, Moore PK, Grant AR, et al. Future of acute care surgery: A perspective from the next
58 684 generation. *Journal of Trauma and Acute Care Surgery* 2012;72(1):94-99. doi:
59 685 10.1097/TA.0b013e31823b990a
- 60 686 109. Momen AA, Shakurnia A. Factors Influencing Pediatric Specialty Choice among Pediatric

- 1
2
3 687 Residents of Ahvaz Jundishapur University of Medical Sciences. *International Journal of*
4 688 *Pediatrics-Mashhad* 2015;3(3):701-06.
5 689 110. Mehmood SI, Kumar A, Al-Binali A, et al. Specialty preferences: Trends and perceptions among
6 690 Saudi undergraduate medical students. *Medical Teacher* 2012;34:S51-S60. doi:
7 691 10.3109/0142159x.2012.656753
8 692 111. Lorient Y, Albiges-Sauvin L, Dionysopoulos D, et al. Why do residents choose the medical
9 693 oncology specialty? Implications for future recruitment-results of the 2007 French
10 694 Association of Residents in Oncology (AERIO) Survey. *Annals of Oncology*
11 695 2010;21(1):161-65. doi: 10.1093/annonc/mdp294
12 696 112. Lefevre JH, Karila L, Kerneis S, et al. Motivation of French medical students to pursue surgical
13 697 careers: Results of national survey of 1742 students. *Journal of Visceral Surgery*
14 698 2010;147(3):E181-E86. doi: 10.1016/j.jviscsurg.2010.08.004
15 699 113. Vo A, McLean L, McInnes MDF. Medical specialty preferences in early medical school training
16 700 in Canada. *Int J Med Educ* 2017;8:400-07. doi: 10.5116/ijme.59f4.3c15
17 701 114. Grasreiner D, Dahmen U, Settmacher U. Specialty preferences and influencing factors: a repeated
18 702 cross-sectional survey of first- to sixth-year medical students in Jena, Germany. *BMC medical*
19 703 *education* 2018;18 doi: ARTN 103
20 704 10.1186/s12909-018-1200-8
21 705 115. Alkhaneen H, Alhusain F, Alshahri K, et al. Factors influencing medical students' choice of
22 706 emergency medicine as a career specialty-a descriptive study of Saudi medical students.
23 707 *International journal of emergency medicine* 2018;11(1):14. doi: 10.1186/s12245-018-0174-y
24 708 [published Online First: 2018/03/09]
25 709

1
2
3 710 **Legends**

4
5 711 **Table 1. Selected Characteristics of the 75 Studies Included in this Systematic**
6
7 712 **Review and Meta-analysis**

8
9 713 **Table 2. Meta-analyses of the Factors Influencing Medical Students' Choice of**
10
11 714 **Subspecialty**

12
13 715 **Table 3. Meta-regression of the EOI Value Stratified by Study-level**
14
15 716 **Characteristics**

16
17 717 **Figure 1. Bar Graph of the Meta-analyses of the Factors Influencing Medical**
18
19 718 **Students' Choice of Subspecialty Stratified by Region.**

20
21 719 **Figure 2. Bar Graph of the Meta-analyses of the Factors Influencing Medical**
22
23 720 **Students' Choice of Subspecialty Stratified by Survey Year.**

24
25
26 721 **Supplements**

27
28 722 **Methods S1. Search strategy used in the current systematic review and**
29
30 723 **meta-analysis.**

31
32 724 **Table S1. Quality Assessment of the Included Studies.**

33
34 725 **Table S2. Meta-analyses of the Factors Influencing Medical Students' Choice of**
35
36 726 **Subspecialty Stratified by Region and Survey Year.**

37
38 727 **Figure S1. Flow Diagram of the Study Inclusion Process.**

39
40 728 **Figure S2. Forest Plot of "Academic Interest".**

41
42 729 **Figure S3. Forest Plot of "Competencies".**

43
44 730 **Figure S4. Forest Plot of "Controllable Lifestyle or Flexible Work Schedule".**

45
46 731 **Figure S5. Forest Plot of "Patient Service Orientation".**

47
48 732 **Figure S6. Forest Plot of "Medical Teachers or Mentors".**

49
50 733 **Figure S7. Forest Plot of "Career Opportunities".**

51
52 734 **Figure S8. Forest Plot of "Workload or Working Hours".**

1
2
3 735 **Figure S9. Forest Plot of “Income”.**

4
5 736 **Figure S10. Forest Plot of “Length of Training”.**

6
7 737 **Figure S11. Forest Plot of “Prestige”.**

8
9 738 **Figure S12. Forest Plot of “Advice from Others”.**

10
11 739 **Figure S13. Forest Plot of “Student Debt”.**

12
13 740 **Figure S14. Funnel Plots of the Publication Bias Tests of the 12 Factors.**

14
15
16 741

17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

Table 1. Selected Characteristics of the 75 Studies Included in this Systematic Review and Meta-analysis

First Author, Year	Country	Survey years	Sample size	Average age	Men, No. (%)	Scores
Smith et al, ⁴³ 2015	UK	2012	2,978	NR	NR	6
Cochran et al, ⁴⁴ 2005	USA	2002	408	27.2	214 (52.45)	5
Hauer et al, ⁴⁵ 2008	USA	2007	1,177	NR	NR	6
Johnson et al, ⁴⁶ 2012	USA	2012	622	NR	NR	6
Kiolbassa et al, ⁴⁷ 2011	Germany	2010	1,114	24.1	408 (36.62)	5
Klingensmith et al, ⁴⁸ 2015	USA	2013	792	NR	539 (68.06)	6
Lee et al, ⁴⁹ 2012	USA	2012	100	NR	58 (58)	7
Macdonald et al, ⁵⁰ 2012	New Zealand	2011	134	NR	79 (58.96)	7
Parsa et al, ³⁹ 2010	Iran	2006-2007	137	27.34	49 (35.77)	7
Paiva et al, ⁵¹ 1982	USA	1982	144	NR	NR	6
Ni Chroinin et al, ⁵² 2013	UK	2009-2011	274	NR	112 (40.89)	7
Newton et al, ³⁴ 2005	USA	1998-2004	1,258	NR	642 (51.03)	8
Rogers et al, ⁵³ 1990	USA	1989	266	NR	205 (77.07)	6
Abendroth J et al, ⁵⁴ 2014	Germany	2007-2012	45	NR	14 (31)	7
Alawad et al, ⁵⁵ 2015	USA	2010-2011	45	NR	36 (80)	8
Azizzadeh et al, ⁵⁶ 2003	USA	2002	130	NR	NR	6
Celenza et al, ⁵⁷ 2012	Australia	2009	216	NR	121 (56.02)	8
Dolan-Evans et al, ⁵⁸ 2014	Australia	2013	419	NR	215 (51.31)	8
Boyd et al, ⁵⁹ 2009	USA	2005-2006	5,848	NR	2,982 (50.99)	8
Egerton et al, ⁶⁰ 1985	Ireland	1977-1981	134	30	82 (61.19)	6
Diderichsen et al, ⁶¹ 2013	Sweden	2006-2009	372	27	157 (42.20)	6
Ferrari et al, ⁶² 2013	Italy, UK	2009-2011	45	25	NR	9
Freire et al, ⁶³ 2011	Brazil	2006-2008	290	23	102 (35.17)	7
Buddeberg-Fischer et al, ⁶⁴ 2006	Switzerland	2001-2003	522	31.1	241 (46.17)	9
Dorsey et al, ⁶⁵ 2005	USA	2003	11,029	NR	4,964 (45.01)	6
Ekenze et al, ⁶⁶ 2013	Nigeria	2009-2010	96	25.9	NR	7
Barikani et al, ⁶⁷ 2012	Australia	2008-2009	49	21.7	NR	6
Bittaye et al, ⁶⁸ 2012	Gambia	2011	106	24.1	48 (45.28)	6
Bonura et al, ⁶⁹ 2016	USA	2015	590	NR	321 (54.40)	9
Al-Fouzan et al, ⁷⁰ 2012	Kuwait	2011-2012	144	NR	NR	7
AlKot et al, ⁷¹ 2015	Egypt	2013	451	21.8	NR	7
Borges et al, ⁷² 2009	USA	2001-2005	341	NR	NR	5
Budd et al, ⁷³ 2011	UK	2011	870	22	NR	7
Corrigan et al, ⁷⁴ 2007	Ireland	2007	222	NR	142 (63.96)	7
Davis et al, ⁷⁵ 2016	UK	2016	173	NR	76 (43.93)	7
Deutsch et al, ⁷⁶ 2015	Germany	2011	659	27.9	NR	8
Gardner et al, ⁷⁷ 2014	Australia	1993-2005	631	NR	NR	7
Dias et al, ⁷⁸ 2013	UK	2013	495	NR	438 (88.48)	5
Goltz et al, ⁷⁹ 2013	USA	2012	102	24.5	34 (33.33)	6
Gupta et al, ⁸⁰ 2013	India	2013	243	NR	179 (73.36)	6

1								
2								
3		Hanzlick et al, ⁸¹ 2008	USA	2006	161	NR	NR	6
4		Harris et al, ⁸² 2005	USA	1991-2002	104	NR	53 (50.96)	6
5		Hauer et al, ⁸³ 2008	USA	2008	80	NR	NR	6
6		Labiris et al, ⁸⁴ 2014	Greece	2014	111	23.6	55 (49.54)	6
7		Lambert et al, ⁸⁵ 2008	UK	2007	17,393	NR	NR	6
8		Shah et al, ⁸⁶ 2012	USA	2011	892	NR	NR	6
9		Lefevre et al, ⁸⁷ 2010	USA	2008	1,555	NR	589 (37.88)	6
10		Vicente et al, ⁸⁸ 2013	Chile	2013	30	NR	NR	6
11		Wiesenfeld et al, ⁸⁹ 2014	Canada	2013	60	NR	NR	7
12		Lam et al, ⁹⁰ 2016	Hong Kong	2015	228	23	NR	9
13		Hartung et al, ⁹¹ 2005	USA	2004	192	20.59	74 (38.54)	4
14		Girasek et al, ⁹² 2011	Hungary	2011	536	NR	NR	5
15		Zuccato et al, ⁹³ 2015	Canada	2012	37	NR	24 (65)	6
16		Wilbanks et al, ⁹⁴ 2015	USA	2011-2013	29,227	NR	15,164 (51.99)	9
17		West et al, ⁹⁵ 2009	USA	2005-2007	14,890	NR	8,700 (58.43)	6
18		Watmough et al, ⁹⁶ 2007	UK	2005	116	NR	66 (56.90)	4
19		Thakur et al, ⁹⁷ 2001	USA	2001	56	NR	53 (95)	8
20		Scott et al, ⁹⁸ 2011	Canada	2002-2004	1,542	NR	NR	6
21		Schnuth et al, ⁹⁹ 2003	USA	2002	203	NR	72 (53.47)	6
22		Richards et al, ¹⁰⁰ 2009	UK	2009	150	NR	108 (72.00)	5
23		Reed et al, ¹⁰¹ 2009	USA	2008	2,022	NR	1,354 (66.96)	9
24		de Souza et al, ¹⁰² 2015	Portugal	2012	1,303	NR	NR	7
25		Pikoulis et al, ¹⁰³ 2010	Greece	2006-2007	87	NR	NR	6
26		Ozer et al, ¹⁰⁴ 2015	Turkey	2013	98	27.7	26 (26.53)	6
27		Noble et al, ¹⁰⁵ 2004	Canada	2004	21,296	NR	NR	8
28		Noble et al, ¹⁰⁶ 2010	Canada	2007	120	NR	NR	5
29		Newton et al, ¹⁰⁷ 2005	USA	2004	1,286	NR	NR	6
30		Moore et al, ¹⁰⁸ 2012	USA	2011	337	26	179 (53.12)	6
31		Momen et al, ¹⁰⁹ 2015	Iran	2014-2015	38	35.6	11 (29)	6
32		Mehmood et al, ¹¹⁰ 2012	Saudi Arabia	2012	550	NR	348 (63.27)	6
33		Loriot et al, ¹¹¹ 2010	France	2007	44	NR	17 (39)	7
34		Lefevre et al, ¹¹² 2010	France	2008	522	23.8	198 (37.93)	7
35		Vo et al, ¹¹³ 2017	Canada	2017	90	22.5	52 (57.78)	5
36		Grasreiner et al, ¹¹⁴ 2018	Germany	2014-2016	181	24	33 (18.10)	6
37		Alkhaman et al, ¹¹⁵ 2018	Saudi Arabia	2017	436	NA	250 (57.00)	5

742 Footnotes: scores: quality score of the AHRQ scale.

743

Table 2. Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty

Factor	No. of studies	Total no. of participants	EOI value (%)	95% CI of EOI		Cochran's <i>Q</i>	<i>I</i> -square (%)	<i>Tau</i> -square	<i>P</i> -Value
				value	value				
				Lower	Upper				
Academic interests	38	82,366	75.29	66.93	82.11	14719.76	99.70	1.60	<0.0001
Competencies	17	76,515	55.15	33.63	74.90	23572.74	99.90	3.44	<0.0001
Controllable lifestyle or flexible work schedule	44	101,001	53.00	47.90	58.03	8624.46	99.50	0.45	<0.0001
Patient service orientation	37	46,572	50.04	44.65	55.43	2668.79	98.70	0.41	<0.0001
Medical teachers or Career opportunities	32	85,071	46.93	37.77	56.30	15216.32	99.80	1.14	<0.0001
	38	81,923	44.00	32.26	48.78	13553.20	99.70	1.15	<0.0001
Workload or working hours	20	22,051	37.99	29.59	47.19	584.81	98.30	0.69	<0.0001
Income	50	109,791	34.70	28.36	41.62	16952.48	99.70	1.09	<0.0001
Length of training	18	42,046	32.30	27.61	37.37	917.21	98.10	0.20	<0.0001
Prestige	26	30,629	31.17	26.32	37.69	1464.67	98.30	0.52	<0.0001
Advice from others	18	82,692	28.24	22.26	34.23	7679.73	99.80	0.02	<0.0001
Student debt	8	38,917	15.33	10.96	21.03	574.81	98.80	0.27	<0.0001

744

Table 3. Meta-regression of the EOI Value Stratified by Study-level Characteristics

Factor	estimate	95 CI% of estimate		P-Value	
		Lower	Upper		
Academic interests	Country	-0.2314	-1.1575	0.6946	0.6302
	Survey years	0.3811	-0.3580	1.1202	0.2711
	Specialty	-0.4892	-1.5345	0.5562	0.4008
	Sample size	0.2362	-0.5488	1.0212	0.6537
Competencies	Country	0.6946	-1.1461	0.8938	0.8376
	Survey years	-1.0418	-2.0950	0.0114	0.0151
	Specialty	0.0904	-1.5786	1.7594	0.9398
	Sample size	-0.5720	-1.8606	0.7166	0.5823
Controllable lifestyle or flexible work schedule	Country	-0.1261	-1.1461	0.8938	0.9614
	Survey years	-0.0001	-0.4052	0.4051	0.9822
	Specialty	-0.8989	-1.4979	-0.3000	0.0035
	Sample size	-0.0518	-0.4396	0.3361	0.7203
Patient service orientation	Country	-0.6238	-1.3118	0.0642	0.0833
	Survey years	-0.0414	-0.6912	0.6083	0.8524
	Specialty	-1.5982	-2.5227	-0.6737	0.0010
	Sample size	-0.1157	-0.7473	0.5159	0.6358
Medical teachers or mentors	Country	0.7395	0.3117	1.1674	0.0007
	Survey years	0.1133	-0.3580	0.5845	0.6376
	Specialty	0.0605	-0.4441	0.5652	0.8141
	Sample size	-0.1202	-0.5567	0.3163	0.5894
Career opportunities	Country	0.1075	-0.7030	0.9179	0.5828
	Survey years	0.3284	-0.3913	1.0480	0.7546
	Specialty	-0.9292	-1.8015	-0.0570	0.0077
	Sample size	0.3654	0.1156	1.5478	0.0081
Workload or working hours	Country	-0.4535	-1.5086	0.6016	0.3981
	Survey years	0.4624	-0.5417	1.4665	0.3922
	Specialty	-0.9878	-2.1727	0.1972	0.1070
	Sample size	0.0982	-0.8589	1.0553	0.8205
Income	Country	0.1058	-0.4665	0.6781	0.7390
	Survey years	0.0999	-0.4379	0.6377	0.8774
	Specialty	-0.6457	-1.3267	0.0352	0.0480
	Sample size	0.0523	-0.4826	0.5872	0.6786
Length of training	Country	-0.1559	-1.2782	0.9664	0.7854
	Survey years	-0.2158	-1.4089	0.9772	0.7229
	Specialty	0.3959	-0.9585	1.7502	0.5667
	Sample size	0.1565	-0.6631	0.9761	0.7082
Prestige	Country	-0.3346	-1.0799	0.4106	0.3485
	Survey years	-0.4513	-1.1378	0.2352	0.0950
	Specialty	-1.0112	-1.8980	-0.1244	0.0172
	Sample size	0.0355	-0.6013	0.6723	0.5214
Advice from others	Country	-0.0097	-0.0722	0.0529	0.9328
	Survey years	-0.0861	-0.1471	-0.0251	0.0057

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

	Specialty	-0.2017	-0.2790	-0.1244	<0.0001
	Sample size	0.2125	0.1309	0.2941	<0.0001
	Country	2.7853	2.0544	3.5162	0.0001
Student debt	Survey years	-0.1567	-0.6707	0.3573	0.5502
	Sample size	-0.5248	-1.0108	-0.0388	0.0343

745

For peer review only

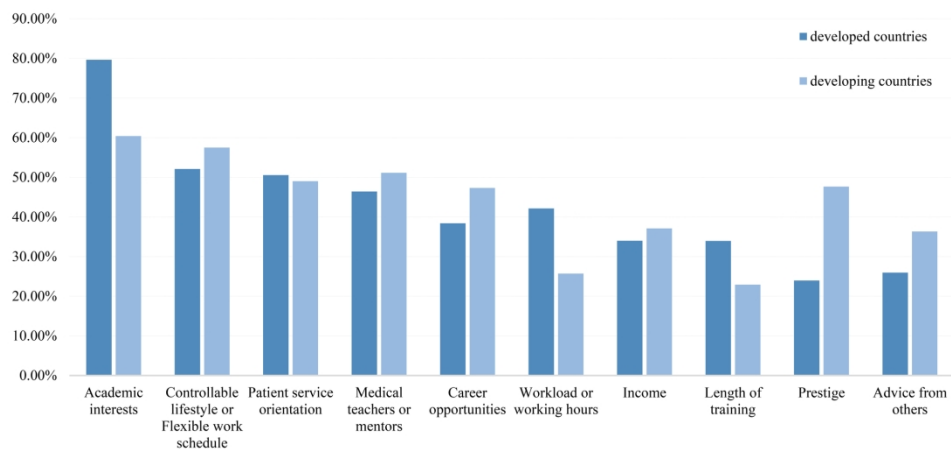


Figure 1. Bar Graph of the Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty Stratified by Region.

190x107mm (300 x 300 DPI)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

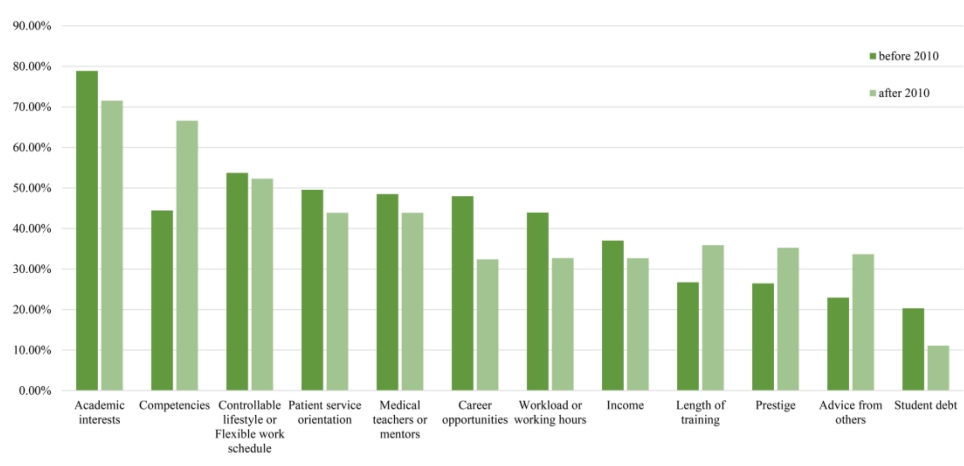


Figure 2. Bar Graph of the Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty Stratified by Survey Year.

190x107mm (300 x 300 DPI)

1
2
3
4 **SI Methods. Search strategy used in the current systematic review and meta-**
5
6 **analysis.**
7
8
9

10
11 ***Medical Students***

- 12
13
14 1. Students, Medical [Mesh]
15
16 2. Medical students
17
18 3. Medical student
19
20 4. Student, Medical
21
22 5. OR / 1 – 4
23
24
25
26

13. Cross sectional study
14. Cross sectional study [Publication
Type]
15. Cross sectional study [Mesh Terms]
16. Systematic review
17. Systematic review [Publication Type]
18. Systematic review [Mesh Terms]

27
28
29
30 ***Subspecialty Choice***

- 31
32 6. Career choices
33
34 7. Choice, Career
35
36 8. Choices career
37
38 9. Specialties
39
40
41
42 10. Sub-specialties
43
44 11. Sub-discipline
45
46
47 12. OR / 6 – 11
48
49
50

19. Meta-analysis [Title/Abstract]
20. Meta-analysis [Mesh Terms]
21. Meta-analysis [Publication Type]
22. OR / 12 – 21

51
52
53 ***Factors***

23. Factors

54
55
56
57 ***Combined search***

23. #5 AND #12AND #22 AND #2

58
59 ***Study design***

60 **Abbreviations:** MeSH, Medical Subject Heading in PubMed

Table S1. Quality assessment of the included studies

Quality assessment criteria	1	2	3	4	5	6	7	8	9	10	11	Scores
1 Smith et al, ⁴¹ 2015	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
2 Cochran et al, ⁴² 2005	Y	U	Y	Y	N	Y	N	Y	N	N	N	5
3 Hauer et al, ⁴³ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
4 Johnson et al, ⁴⁴ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
5 Kiobassa et al, ⁴⁵ 2011	Y	U	Y	Y	N	Y	N	Y	N	N	N	5
6 Klingensmith et al, ⁴⁶ 2015	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
7 Lee et al, ⁴⁷ 2012	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
8 Macdonald et al, ⁴⁸ 2012	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
9 Parsa et al, ³⁷ 2010	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
10 Paiva et al, ⁴⁹ 1982	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
11 Ni Chroinin et al, ⁵⁰ 2013	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
12 Newton et al, ³² 2005	Y	U	Y	Y	Y	Y	Y	Y	N	Y	N	8
13 Rogers et al, ⁵¹ 1990	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
14 Abendroth J et al, ⁵² 2014	Y	U	Y	Y	N	Y	N	Y	N	Y	Y	7
15 Alawad et al, ⁵³ 2015	Y	U	Y	Y	N	Y	Y	Y	Y	Y	N	8
16 Azizzadeh et al, ⁵⁴ 2003	Y	U	Y	Y	Y	Y	N	N	N	Y	N	6
17 Celenza et al, ⁵⁵ 2012	Y	U	Y	Y	Y	Y	Y	N	Y	Y	N	8
18 Dolan-Evans et al, ⁵⁶ 2014	Y	U	Y	Y	Y	Y	N	Y	N	Y	Y	8
19 Boyd et al, ⁵⁷ 2009	Y	U	Y	Y	Y	Y	Y	Y	N	Y	N	8
20 Egerton et al, ⁵⁸ 1985	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
21 Diderichsen et al, ⁵⁹ 2013	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
22 Ferrari et al, ⁶⁰ 2013	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
23 Freire et al, ⁶¹ 2011	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
24 Buddeberg-Fischer et al, ⁶² 2006	Y	U	Y	Y	N	Y	Y	Y	Y	Y	Y	9
25 Dorsey et al, ⁶³ 2005	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
26 Ekenze et al, ⁶⁴ 2013	Y	U	Y	Y	Y	Y	Y	N	N	Y	N	7
27 Barikani et al, ⁶⁵ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
28 Bittaye et al, ⁶⁶ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
39 Bonura et al, ⁶⁷ 2016	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
30 Al-Fouzan et al, ⁶⁸ 2012	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
31 AlKot et al, ⁶⁹ 2015	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
32 Borges et al, ⁷⁰ 2009	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
33 Budd et al, ⁷¹ 2011	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
34 Corrigan et al, ⁷² 2007	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
35 Davis et al, ⁷³ 2016	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
36 Deutsch et al, ⁷⁴ 2015	Y	U	Y	Y	Y	Y	N	Y	Y	Y	N	8
37 Gardner et al, ⁷⁵ 2014	Y	U	Y	Y	N	Y	N	Y	N	Y	N	7
38 Dias et al, ⁷⁶ 2013	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
39 Goltz et al, ⁷⁷ 2013	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
40 Gupta et al, ⁷⁸ 2013	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
41 Hanzlick et al, ⁷⁹ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
42 Harris et al, ⁸⁰ 2005	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
43 Hauer et al, ⁸¹ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
44 Labiris et al, ⁸² 2014	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
45 Lambert et al, ⁸³ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
46 Shah et al, ⁸⁴ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
47 Lefevre et al, ⁸⁵ 2010	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
48 Vicente et al, ⁸⁶ 2013	Y	U	Y	Y	N	N	Y	N	Y	Y	N	6
49 Wiesenfeld et al, ⁸⁷ 2014	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
50 Lam et al, ⁸⁸ 2016	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
51 Hartung et al, ⁸⁹ 2005	Y	U	Y	Y	N	Y	N	N	N	N	N	4
52 Girasek et al, ⁹⁰ 2011	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
53 Zuccato et al, ⁹¹ 2015	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
54 Wilbanks et al, ⁹² 2015	Y	U	Y	Y	N	Y	Y	Y	Y	Y	Y	9
55 West et al, ⁹³ 2009	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
56 Watmough et al, ⁹⁴ 2007	Y	U	Y	Y	N	N	N	N	N	Y	N	4
57 Thakur et al, ⁹⁵ 2001	Y	U	Y	Y	Y	Y	Y	N	Y	Y	N	8
58 Scott et al, ⁹⁶ 2011	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
59 Schnuth et al, ⁹⁷ 2003	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
60 Richards et al, ⁹⁸ 2009	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
61 Reed et al, ⁹⁹ 2009	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
62 de Souza et al, ¹⁰⁰ 2015	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
63 Pikoulis et al, ¹⁰¹ 2010	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
64 Ozer et al, ¹⁰² 2015	Y	U	Y	Y	N	N	Y	N	Y	Y	N	6
65 Noble et al, ¹⁰³ 2004	Y	U	Y	Y	Y	Y	Y	Y	N	Y	N	8
66 Noble et al, ¹⁰⁴ 2010	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
67 Newton et al, ¹⁰⁵ 2005	Y	U	Y	Y	N	Y	Y	N	N	Y	N	6
68 Moore et al, ¹⁰⁶ 2012	Y	U	Y	Y	Y	Y	N	Y	N	N	N	6
69 Momen et al, ¹⁰⁷ 2015	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
70 Mehmood et al, ¹⁰⁸ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
71 Loriot et al, ¹⁰⁹ 2010	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
72 Lefevre et al, ¹¹⁰ 2010	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
73 Vo et al, ¹¹¹ 2017	Y	U	Y	Y	Y	N	N	N	N	Y	N	5
74 Grasreiner et al, ¹¹² 2018	Y	U	Y	Y	Y	Y	N	N	N	Y	N	6
75 Alkhaman et al, ¹¹³ 2018	Y	U	Y	Y	N	N	Y	N	N	Y	N	5

Quality assessment criteria in detail

1. Define the source of information (survey, record review).
2. List the inclusion and exclusion criteria for the exposed and unexposed subjects (cases and controls) or refer to previous publications.
3. Indicate the time period used for identifying patients.
4. Indicate whether the subjects were consecutive if not population-based.
5. Indicate whether the evaluators of the subjective components of the study were masked to the other aspects of participants' status.
6. Describe any assessments undertaken for quality assurance purposes (e.g., test/retest of primary outcome measurements)
7. Explain any patient exclusion from the analyses.
8. Describe how confounding was assessed and/or controlled.
9. If applicable, explain how missing data were handled in the analysis.
10. Summarize the patient response rates and the completeness of the data collection.
11. Clarify what follow-up, if any, was expected and the percentage of patients with incomplete data or follow-up.

“Y”: Yes; “N”: No; “U”: Unclear.

Table S2. Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty Stratified by Region and Survey Year.

Factor		No. of studies	Total no. of participants	Extent of influence (%)	95 CI% of EOI value		<i>I-square</i> (%)	<i>P</i> -Value	<i>Q</i> -Value		
					Lower	Upper					
Academic interest	developed	28	80,000	79.66	70.73	86.39	99.8	0.02	3.51		
	developing	10	2,366	60.41	43.44	75.19	98.0				
	before 2010	29	44,174	78.88	69.04	86.22	99.7	0.40	1.21		
	after 2010	9	38,192	71.54	57.66	82.27	99.6				
Competencies	before 2010	9	43,134	44.40	29.11	60.83	99.8	0.21	1.86		
	after 2010	8	33,381	66.60	34.48	88.31	99.8				
Controllable lifestyle or flexible work schedule	developed	37	100,980	52.11	46.52	57.65	99.6	0.63	0.68		
	developing	7	2,017	57.50	45.81	68.41	95.9				
	before 2010	22	62,945	53.72	47.48	59.84	99.4			0.97	0.05
after 2010	22	40,056	52.29	43.51	60.93	99.2					
Patient service orientation	developed	27	44,235	50.56	44.68	56.42	98.8	0.74	0.48		
	developing	10	2,337	49.02	31.62	66.67	98.1				
	before 2010	18	40,997	49.56	43.29	55.84	98.8			0.70	0.54
	after 2010	19	5,579	43.87	38.62	63.80	98.3				
Medical teachers or mentors	developed	28	84,076	46.43	36.63	56.52	99.8	0.73	0.48		
	developing	4	995	51.14	33.97	68.04	95.4				
	before 2010	21	49,654	48.48	36.93	60.19	99.8			0.70	0.54
	after 2010	11	35,417	43.87	27.94	61.18	99.7				
Career opportunities	developed	31	79,867	38.41	29.61	48.04	99.8	0.60	0.74		
	developing	7	2,056	47.32	30.38	64.91	98.1				
	before 2010	20	43,417	47.97	33.54	62.74	99.8			0.24	1.68
	after 2010	18	38,506	32.38	21.68	45.31	99.5				
Workload or working hours	developed	15	20,970	42.14	31.35	53.72	98.6	0.34	1.39		
	developing	5	1,081	25.72	13.29	43.88	95.3				
	before 2010	9	19,456	43.93	29.43	59.54	98.8			0.41	1.21
	after 2010	11	2,595	32.70	29.43	59.54	97.4				
Income	developed	39	107,091	34.01	26.89	41.93	99.8	0.84	0.29		
	developing	11	2,700	37.11	27.06	48.41	96.4				
	before 2010	25	68,714	37.01	25.95	49.62	99.8			0.41	1.18
	after 2010	25	41,077	32.67	26.04	40.07	98.9				
Length of training	developed	15	41,246	33.95	28.72	39.60	98.4	0.31	1.48		
	developing	3	800	22.92	10.94	41.85	94.0				
	before 2010	7	8,811	26.72	15.89	41.29	98.9			0.28	1.59
	after 2010	11	33,234	35.87	29.67	42.59	96.9				
Prestige	developed	17	27,987	23.96	19.20	29.47	97.3	0.01	4.71		
	developing	9	2,642	47.65	34.41	61.24	97.6				
	before 2010	12	25,542	26.46	20.78	33.03	96.7			0.25	1.67
	after 2010	14	5,087	35.22	24.70	47.40	98.3				
Advice from others	developed	14	81,205	25.95	19.27	32.64	99.8	0.36	1.33		
	developing	4	1,487	36.34	18.91	53.77	98.1				
	before 2010	10	48,319	22.93	17.85	28.01	99.5			0.31	1.47
	after 2010	8	34,373	33.65	25.12	42.18	99.1				
Student debt	before 2010	5	6,610	20.29	15.86	25.57	81.8	0.69	0.59		
	after 2010	3	32,307	11.08	1.58	49.08	99.6				

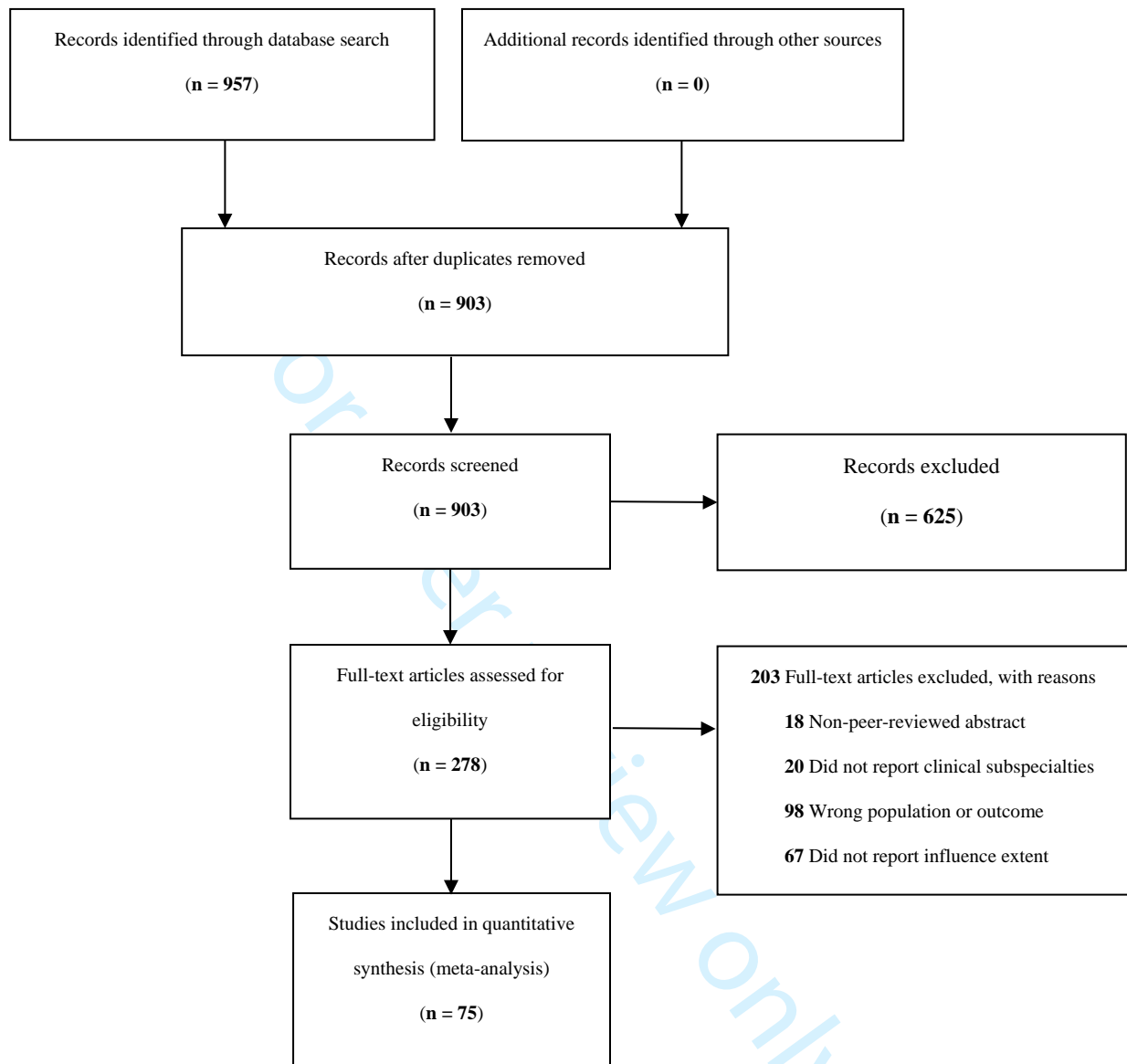
Figure S1. Flow Diagram of the Study Inclusion.

Figure S2. Forest Plot of “Academic Interest”.

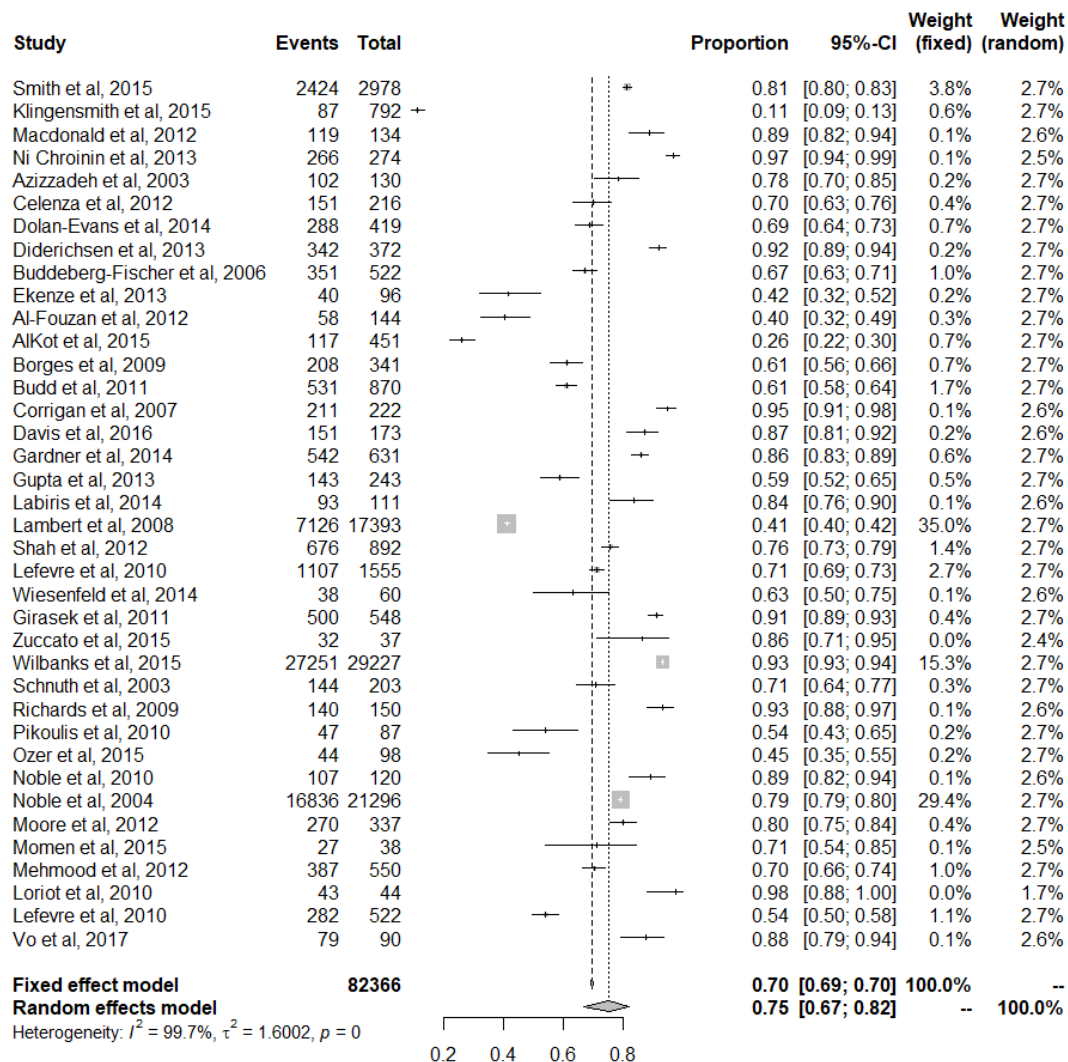
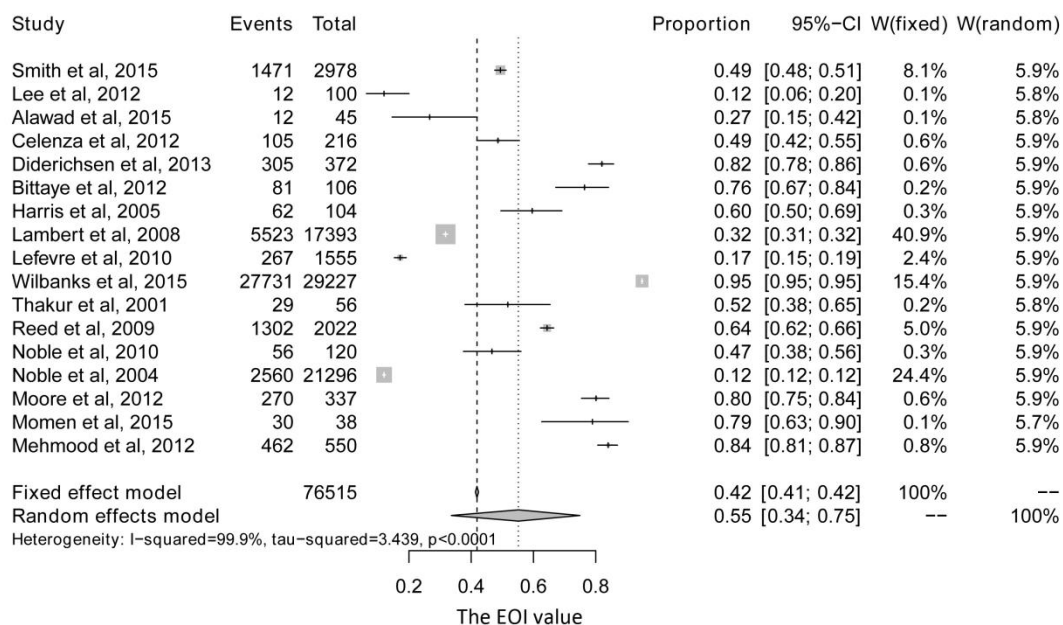


Figure S3. Forest Plot of “Competencies”.



review only

Figure S4. Forest Plot of “Controllable Lifestyle or Flexible Work Schedule”.

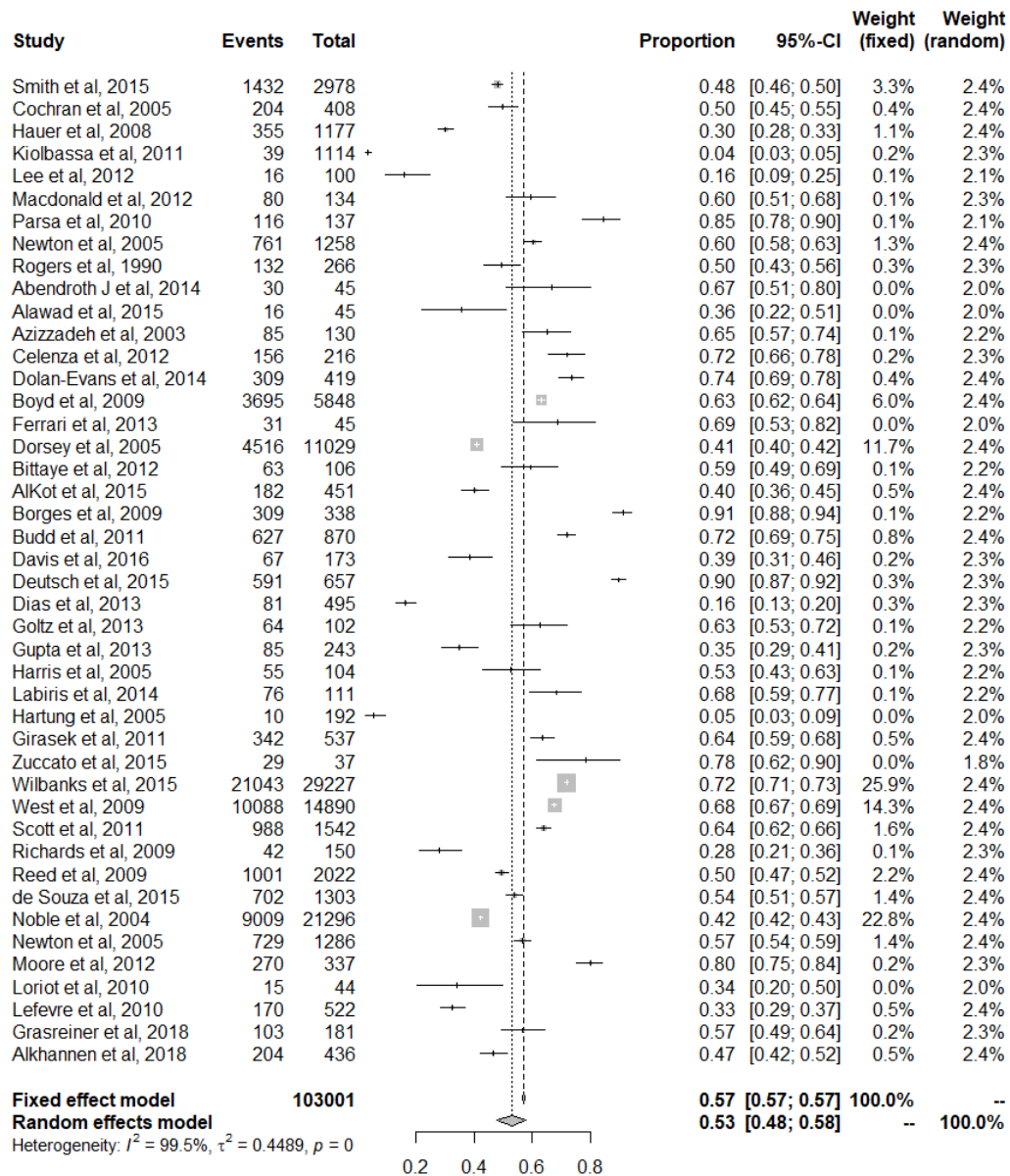


Figure S5. Forest Plot of “Patient Service Orientation”.

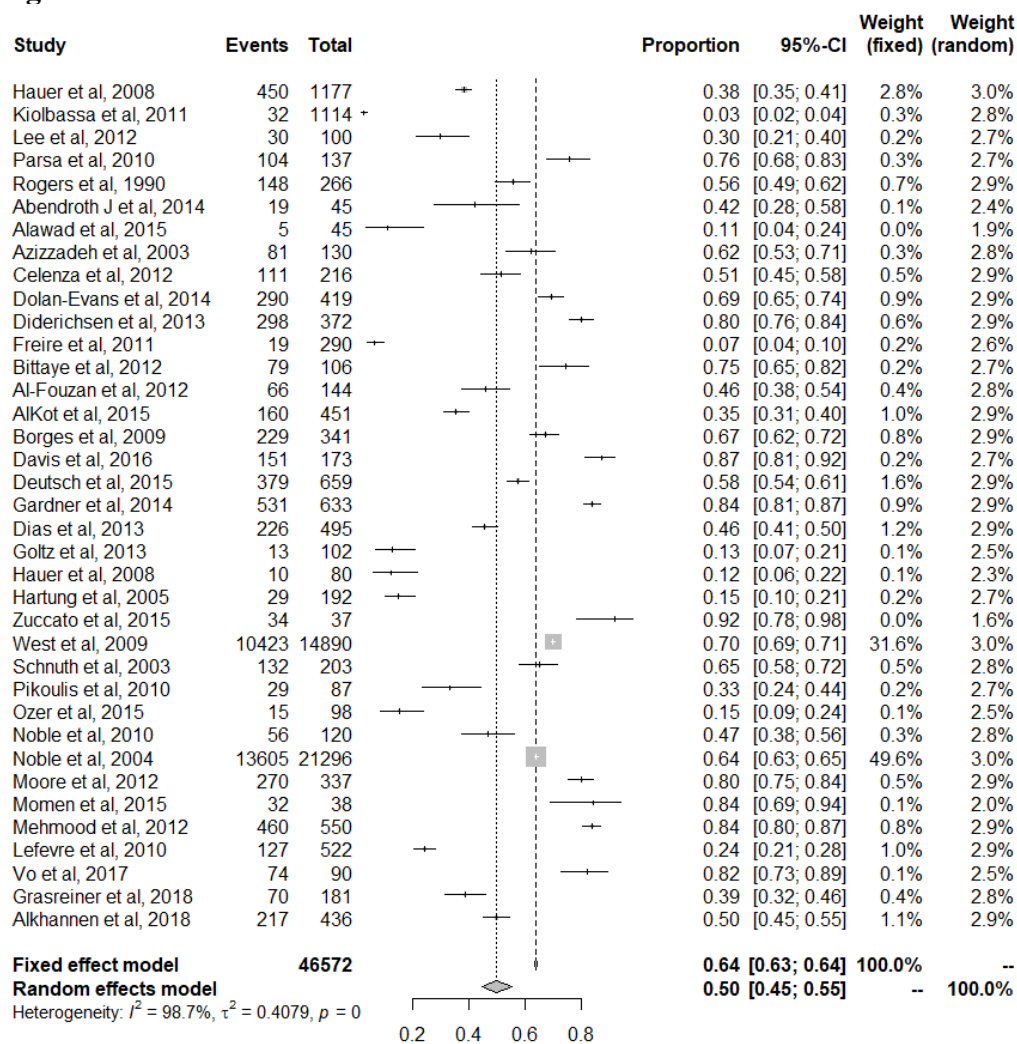


Figure S6. Forest Plot of “Medical Teachers or Mentors”.

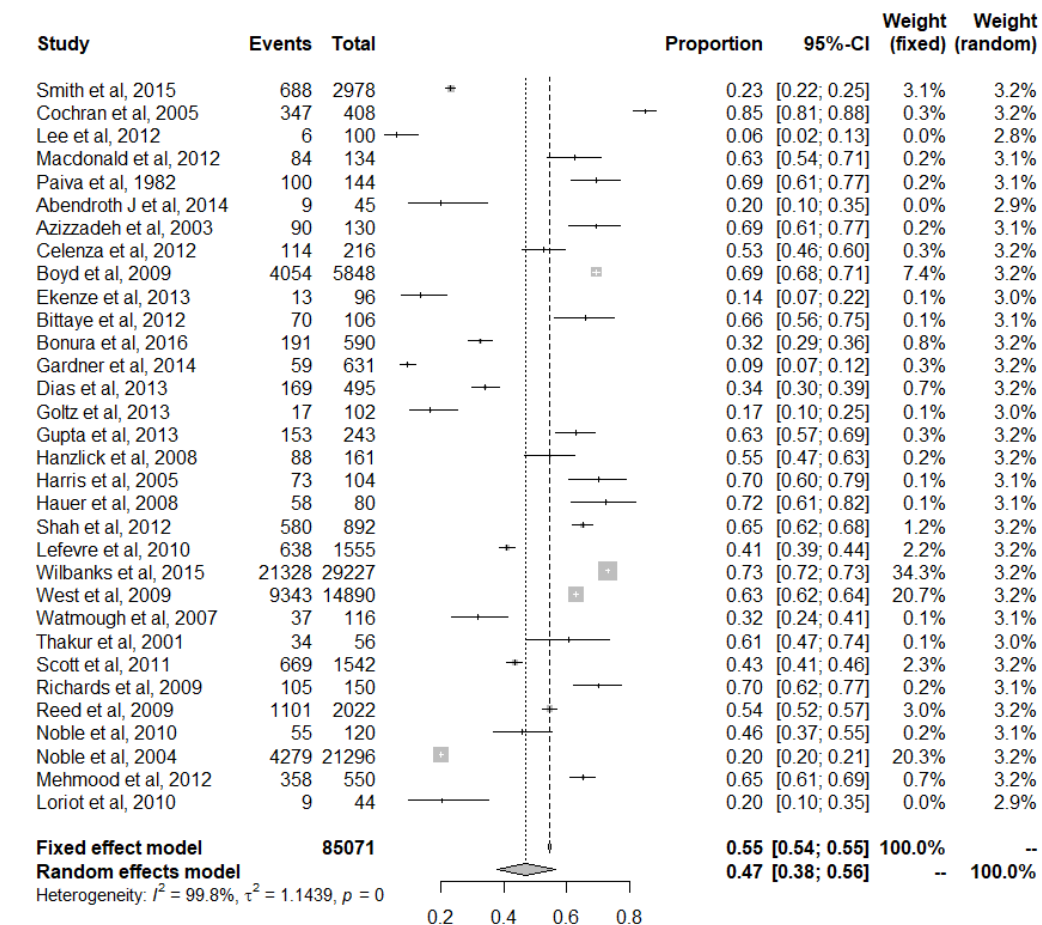


Figure S7. Forest Plot of “Career Opportunities”.

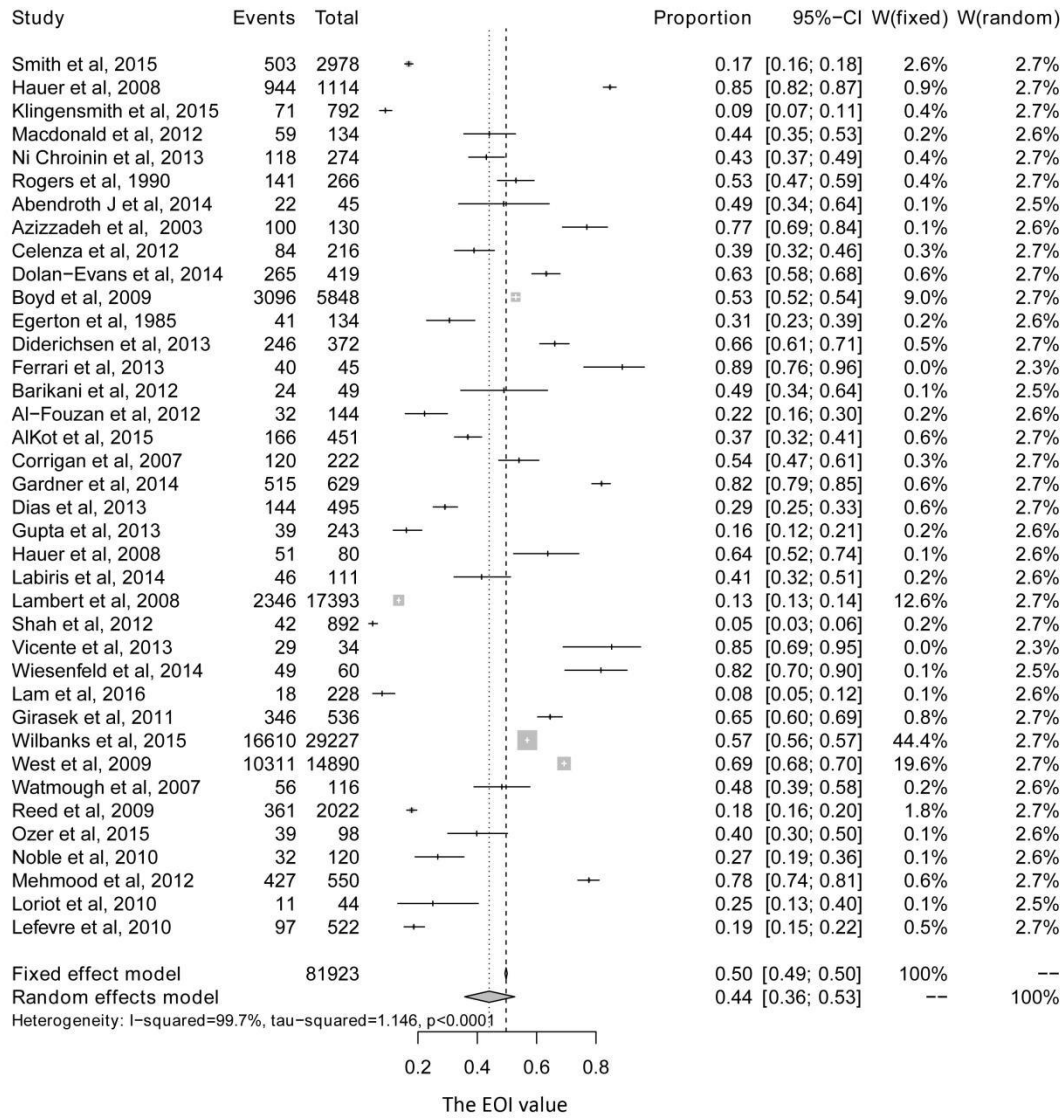


Figure S8. Forest Plot of “Workload or Working Hours”.

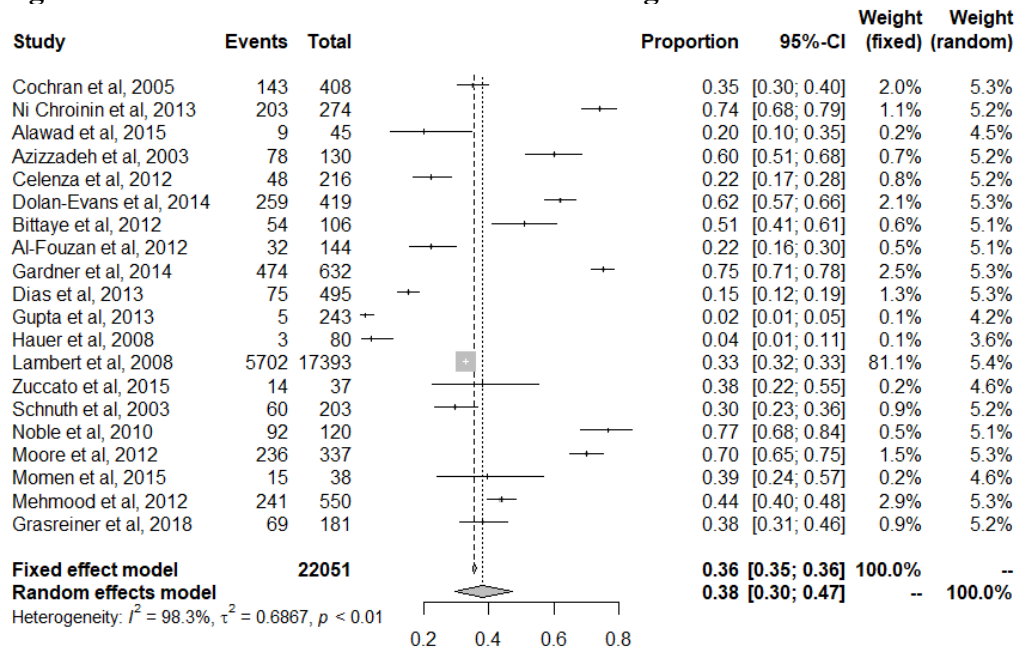


Figure S9. Forest Plot of “Income”.

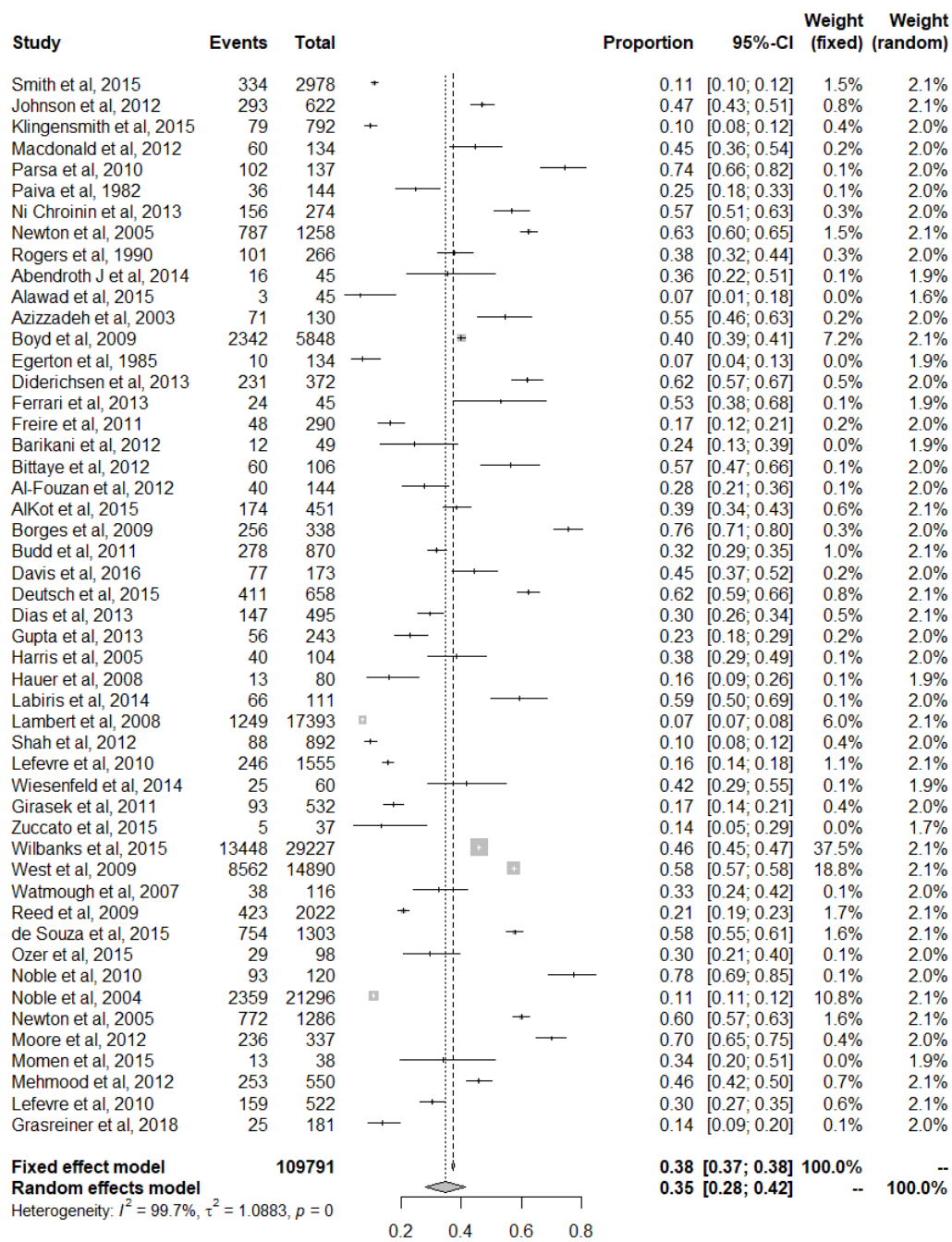


Figure S10. Forest Plot of “Length of Training”.

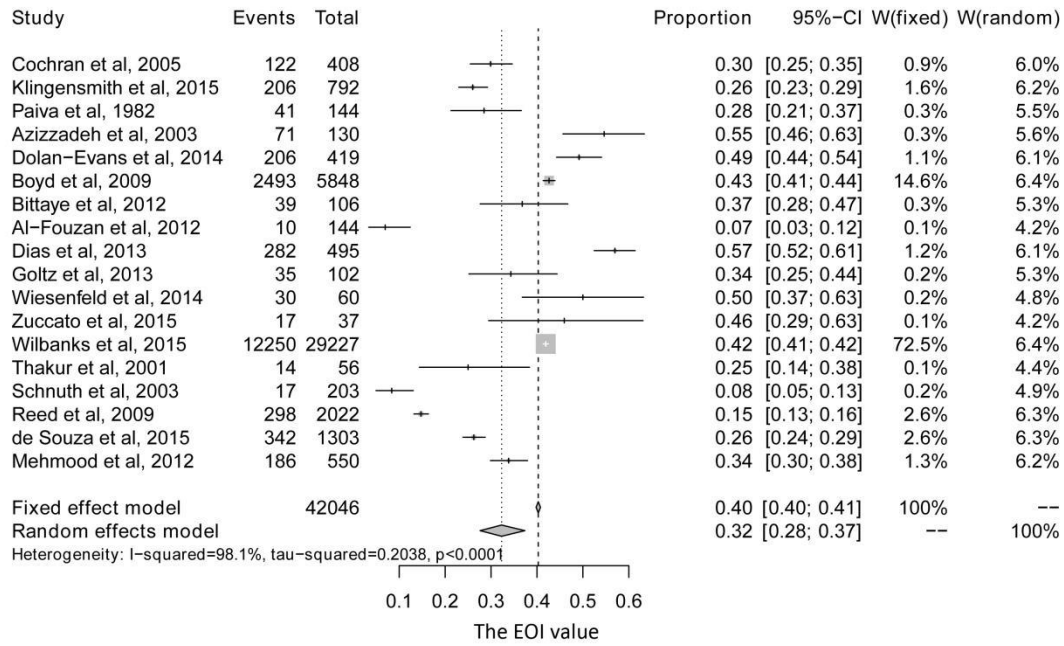


Figure S11. Forest Plot of “Prestige”.

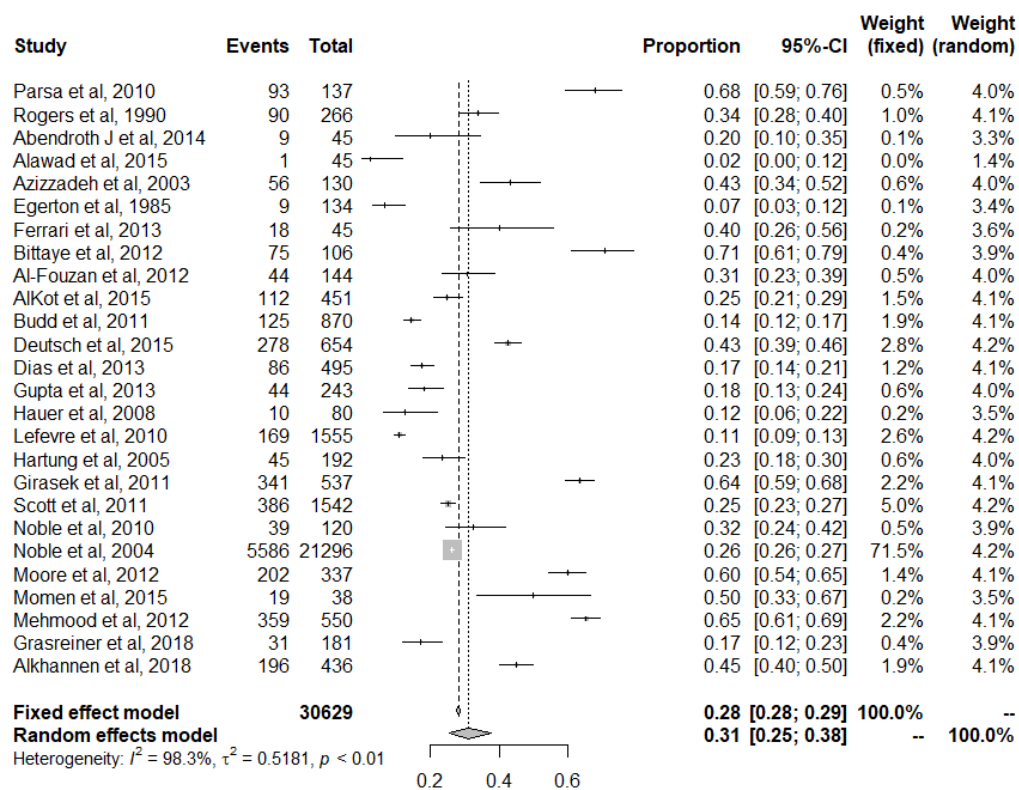


Figure S12. Forest Plot of “Advice from Others”.

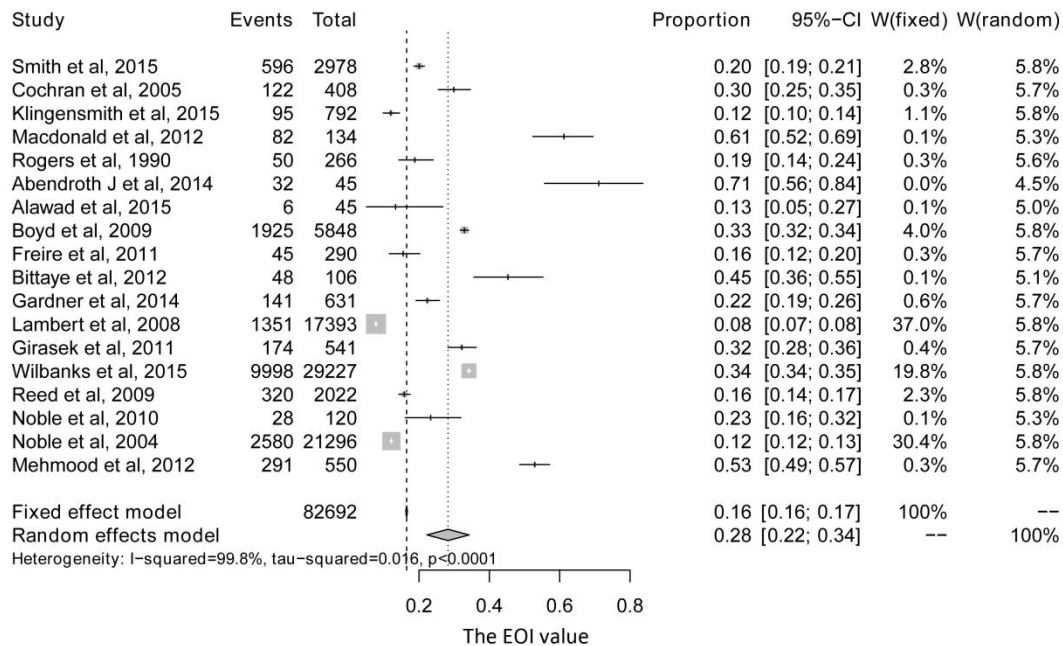


Figure S13. Forest Plot of “Student Debt”.

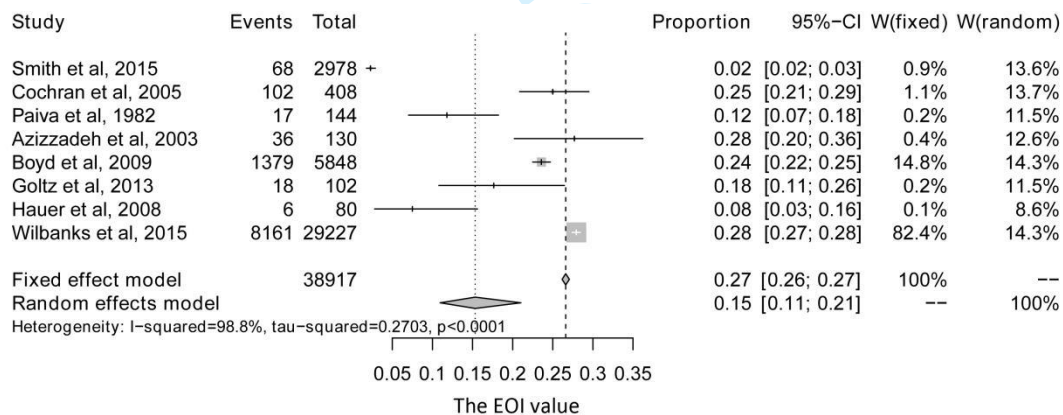
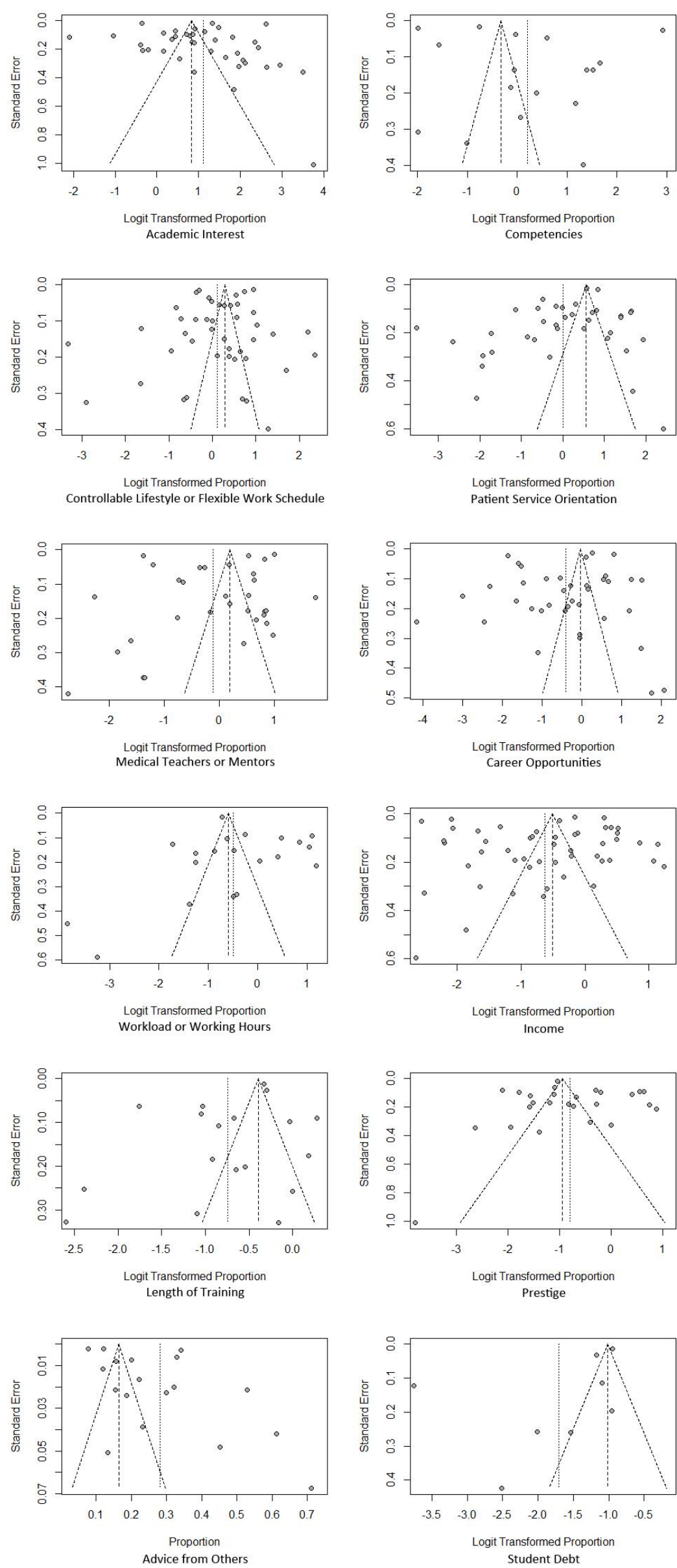


Figure S14. Funnel Plots of the Publication Bias Testing of the 12 Factors.





PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	3
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5-6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6-7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6-7
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	7



PRISMA 2009 Checklist

Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	7
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	7
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	5, 7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7-8
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	8
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	8
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	8-9
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	8-9
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	8-9
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	9-13
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	13
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	14
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	15

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

Page 2 of 2

For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

MOOSE Checklist for Meta-analyses of Observational Studies

Item No	Recommendation	Reported on Page No
Reporting of background should include		
1	Problem definition	5
2	Hypothesis statement	5
3	Description of study outcome(s)	5
4	Type of exposure or intervention used	5
5	Type of study designs used	5
6	Study population	5
Reporting of search strategy should include		
7	Qualifications of searchers (eg, librarians and investigators)	6
8	Search strategy, including time period included in the synthesis and key words	5
9	Effort to include all available studies, including contact with authors	5
10	Databases and registries searched	5
11	Search software used, name and version, including special features used (eg, explosion)	6
12	Use of hand searching (eg, reference lists of obtained articles)	5
13	List of citations located and those excluded, including justification	5-6
14	Method of addressing articles published in languages other than English	5
15	Method of handling abstracts and unpublished studies	5
16	Description of any contact with authors	5
Reporting of methods should include		
17	Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested	6
18	Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	6-7
19	Documentation of how data were classified and coded (eg, multiple raters, blinding and interrater reliability)	6-7
20	Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	6
21	Assessment of study quality, including blinding of quality assessors, stratification or regression on possible predictors of study results	6
22	Assessment of heterogeneity	6
23	Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	6-7
24	Provision of appropriate tables and graphics	5-7
Reporting of results should include		
25	Graphic summarizing individual study estimates and overall estimate	8
26	Table giving descriptive information for each study included	7
27	Results of sensitivity testing (eg, subgroup analysis)	8
28	Indication of statistical uncertainty of findings	7-9

Item No	Recommendation	Reported on Page No
Reporting of discussion should include		
29	Quantitative assessment of bias (eg, publication bias)	13
30	Justification for exclusion (eg, exclusion of non-English language citations)	13-14
31	Assessment of quality of included studies	13-14
Reporting of conclusions should include		
32	Consideration of alternative explanations for observed results	14
33	Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)	14
34	Guidelines for future research	14
35	Disclosure of funding source	15

From: Stroup DF, Berlin JA, Morton SC, et al, for the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) Group. Meta-analysis of Observational Studies in Epidemiology. A Proposal for Reporting. *JAMA*. 2000;283(15):2008-2012. doi: 10.1001/jama.283.15.2008.

Transcribed from the original paper within the NEUROSURGERY® Editorial Office, Atlanta, GA, United States. August 2012.

BMJ Open

Factors Influencing Subspecialty Choice Among Medical Students: A Systematic Review and Meta-analysis

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-022097.R3
Article Type:	Research
Date Submitted by the Author:	15-Jan-2019
Complete List of Authors:	<p>Yang, Yahan; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology; Sun Yat-Sen University, Zhongshan School of Medicine</p> <p>Li, Jiawei; Sun Yat-Sen University, Zhongshan School of Mathematics</p> <p>Wu, Xiaohang; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology</p> <p>Wang, Jinghui; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology</p> <p>Li, Wangting; Sun Yat-Sen University Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology</p> <p>Zhu, Yi; University of Miami School of Medicine, Department of Molecular and Cellular Pharmacology; Sun Yat-Sen University Zhongshan Ophthalmic Center, Cataract</p> <p>Chen, Chuan; State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic Center, Sun Yat-sen University; University of Miami School of Medicine, Department of Molecular and Cellular Pharmacology</p> <p>Lin, Haotian; State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic Center, Sun Yat-sen University, Cataract</p>
Primary Subject Heading:	Medical education and training
Secondary Subject Heading:	Medical education and training
Keywords:	Medical students, Career choice, Meta-analysis

SCHOLARONE™
Manuscripts

1
2
3
4
5 **1 Title Page**
6
7

8 **2 Factors Influencing Subspecialty Choice Among Medical Students: A Systematic**
9
10 **3 Review and Meta-analysis**
11
12

13 4 Yahan Yang, M.D.^{1,2}; Jiawei Li, M.D.³; Xiaohang Wu, M.D.¹; Jinghui Wang, M.D.¹;
14
15 Wangting Li, M.D.¹; Yi Zhu, M.D.^{1,4}; Chuan Chen, M.D.^{1,4}; Haotian Lin, M.D., Ph.
16
17 D^{1#}
18
19
20
21
22
23

24 **8 Institution:** 1. State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic
25
26 9 Center, Sun Yat-sen University, Guangzhou, Guangdong, 510060, People's Republic
27
28 of China
29
30

31
32 11 2. Zhongshan School of Medicine, Sun Yat-sen University, Guangzhou, China
33
34

35 12 3. Zhongshan School of Mathematics, Sun Yat-sen University, Guangzhou, China
36
37

38 13 4. Department of Molecular and Cellular Pharmacology, University of Miami Miller
39
40 14 School of Medicine, Miami, Florida 33136, USA.
41
42
43
44
45
46

47 **16 #Editorial Correspondence:**
48
49

50 17 Prof. Haotian Lin
51
52

53 18 Zhongshan Ophthalmic Center, Sun Yat-sen University
54
55
56
57
58
59
60

1
2
3
4
5 19 Xian Lie South Road 54#
6
7

8 20 Guangzhou, China, 510060.
9

10
11 21 Telephone number: +86-020-87330493
12

13
14 22 Fax: +86-020-87333271
15

16
17 23 E-mail: haot.lin@hotmail.com
18

19
20 24 Word count for text: 3122
21

22
23
24 25
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 26 **ABSTRACT**
6
7

8 27 **Objective** To characterize the contributing factors that affect medical students'
9
10 28 subspecialty choice and to estimate the extent of influence of individual factors
11
12 29 on the students' decision-making process.
13
14

15 30 **Design** Systematic review and meta-analysis.
16
17

18 31 **Methods** A systematic search of the Cochrane Library, ERIC, Web of Science, CNKI
19
20 32 and PubMed databases was conducted for studies published between January
21
22 33 1977 and June 2018. Information concerning study characteristics, influential
23
24 34 factors, and the extent of their influence (EOI) was extracted independently by
25
26 35 two trained investigators. EOI is the percentage level that describes how much
27
28 36 each of the factors influenced students' choice of subspecialty. The recruited
29
30 37 medical students include students in medical school, internship, residency
31
32 38 training and fellowship, who are about to or have just made a specialty choice.
33
34 39 The estimates were pooled using a random-effects meta-analysis model due to
35
36 40 the between-study heterogeneity.
37
38
39
40
41

42 41 **Results** Data were extracted from 75 studies (882,209 individuals). Overall, the factors
43
44 42 influencing medical students' choice of subspecialty training mainly included
45
46 43 academic interests (75.29%), competencies (55.15%), controllable lifestyles or
47
48 44 flexible work schedules (53.00%), patient service orientation (50.04%),
49
50 45 medical teachers or mentors (46.93%), career opportunities (44.00%),
51
52 46 workload or working hours (37.99%), income (34.70%), length of training
53
54
55
56
57
58
59
60

1
2
3
4
5 47 (32.30%), prestige (31.17%), advice from others (28.24%), and student debt
6
7 48 (15.33%), with significant between-study heterogeneity ($P<0.0001$). Subgroup
8
9 49 analyses revealed that the EOI of academic interests was higher in developed
10
11 50 countries than that in developing countries (79.66% [95% confidence interval
12
13 51 (CI), 70.73%; 86.39%] vs. 60.41% [95% CI, 43.44%; 75.19%]; $Q=3.51$
14
15
16 52 $P=0.02$). The EOI value of prestige was lower in developed countries than that
17
18 53 in developing countries (23.96% [95% CI, 19.20%; 29.47%] vs. 47.65% [95%
19
20 54 CI, 34.41%; 61.24%]; $Q=4.71$ $P=0.01$).

21
22
23
24 55 **Conclusions** This systematic review and meta-analysis provided a quantitative
25
26 56 evaluation of the top 12 influencing factors associated with medical students'
27
28 57 choice of subspecialty. Our findings provide the basis for the development of
29
30 58 specific, effective strategies to optimize the distribution of physicians among
31
32 59 different departments by modifying these influencing factors.

33
34
35
36 60 **Systematic review registration** PROSPERO CRD42017053781.

37 38 39 61 **STRENGTHS AND LIMITATIONS OF THIS STUDY**

- 40
41
42 62 ● This is the first study that provide a systematic estimate of the factors associated
43
44 63 with medical students' subspecialty choices.
- 45
46
47 64 ● A large number of studies conducted in varied populations have been included.
- 48
49
50 65 ● The differences in the characteristics of country, survey years, specialty, the type
51
52 66 of data used and sample size across studies represent a major limitation of our
53
54
55 67 study.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

68 KEYWORDS Medical students, career choice, meta-analysis

69

70

For peer review only

72 **Introduction**

73 Because of the population aging, increased workload on doctors through increased
74 number of consultations and in managing patients with multi-morbidity, the demand
75 for physicians continues to increase; however, an imbalance in the supply of physicians
76 in different subspecialties has become a growing concern in both developed and
77 developing countries.¹⁻⁵ Some specialties and subspecialties, such as family medicine
78 and palliative medicine,^{6,7} are experiencing a desperate shortage of physicians, whereas
79 other specialties and subspecialties, such as cardiology, ophthalmology and ear, nose
80 and throat (ENT) surgery, are highly competitive specialties with low success rate for
81 candidates.^{8,9}

82 Specialty choice is the product of a complex interconnection of student expectation,
83 department expectation, and competition for available spots, and student choice is
84 where the choice begins.¹⁰ Previous studies have suggested that medical students'
85 choice of subspecialty is essential to the maintenance of an adequate medical
86 workforce and a balanced development of the medical system.^{11, 12} However, the
87 influencing factors underlying students' subspecialty choice have not been
88 systemically reviewed. Recent changes in the training and practice environment may
89 influence medical students' career choice.¹³ Additionally, the variability in preferences
90 over time and in students' attitudes towards career choices can further complicate this
91 assessment. For example, a study in the UK indicated that half of the medical students
92 made a definitive subspecialty choice during their first year of medical school.¹⁴
93 However, students were prone to changing their subspecialty preference during

1
2
3
4
5 94 medical school and internship.¹⁵ Notably, students may also reject certain
6
7 95 subspecialties during their medical school training, even those they have previously
8
9 96 seriously considered.¹⁶ Therefore, identifying the factors that influence students'
10
11 97 choice of subspecialty will enable a better understanding of the current
12
13 98 shortage/overload of physicians in specific fields and contribute to policy-building and
14
15 99 decision-making to improve the training and recruitment of students in the future.

16
17
18
19 100 We thus conducted a systematic review and a meta-analysis to investigate the
20
21 101 influencing factors and the extent of their influence on the choice of subspecialty
22
23 102 training among medical students. More specifically, we focused on the following
24
25 103 questions. First, can we gain a better understanding of students' preferences for
26
27 104 medical specialty according to the primary influencing factor? Second, do the
28
29 105 subgroups according to world region and survey years examined in this study differ
30
31 106 significantly with regard to the weight that students place on the identified influencing
32
33 107 factor?
34
35
36
37

38 108 **Methods**

39
40
41 109 We developed a review protocol (registration number: PROSPERO
42
43 110 CRD42017053781) prior to commencing the study. The Preferred Reporting Items for
44
45 111 Systematic Reviews and Meta-Analyses (PRISMA) guidelines was used to ensure the
46
47 112 reporting quality of this review (Fig. S1).¹⁷
48
49
50

51 113 **Search Strategy and Study Eligibility**

52
53
54
55 114 We performed a literature search in June 2018 using the Cochrane Library, Medline,
56

1
2
3
4
5 115 Web of Science, CNKI and ERIC databases without language restrictions. Articles
6
7 116 were screened by title, abstract and reference list, and by correspondence with study
8
9 117 investigators. Potentially relevant papers were first identified by reviewing the titles
10
11 118 and abstracts, and the full text of each retrieved article was then assessed. A detailed
12
13 119 example of search strategy for Medline/PubMed is shown in **Methods S1**. Studies were
14
15 120 included if they were systematic review or cross-sectional studies, reported data on
16
17 121 medical students, were published in peer-reviewed journals, and used a validated
18
19 122 method to assess the EOI on the choice of subspecialty, such as pediatric
20
21 123 gastroenterology and vascular surgery, or its corresponding specialty, such as
22
23 124 pediatrics and surgery. Because of the differences between medical education systems
24
25 125 in the world, the medical students we recruited includes the student in medical school,
26
27 126 internship, residency training and fellowship, containing the students who about to
28
29 127 make a specialty choice and students who has just made a specialty choice. A guide to
30
31 128 medical specialty, available at [https://www.abms.org/member-boards/specialty-
34
35 130 subspecialty-certificates/](https://www.abms.org/member-boards/specialty-
32
33 129 subspecialty-certificates/), were used to identify the medical specialty and subspecialty
36
37 131 of our research. We also conducted an additional search using OpenGrey. However,
38
39 132 no additional articles were further included. All searches were performed using Google
40
41
42
43
44
45
46

47 133 **Data Extraction and Quality Assessment**

48
49
50 134 Each article was reviewed by two trained investigators (Y.Y. and J.L.) and the
51
52 135 following information was independently extracted from each selected article using a
53
54 136 standardized form: study design, geographic location, years of survey, journal, sample
55
56
57
58
59
60

1
2
3
4
5 137 size, average age of the participants, the number and percentage of male participants,
6
7 138 and the influencing factors and the extent of their influence. A third investigator was
8
9 139 consulted if disagreements occurred. Each study may involve one or several
10
11 140 influencing factors. An 11-item checklist which was recommended by Agency for
12
13 141 Healthcare Research and Quality (AHRQ), used for cross-sectional studies¹⁸, available
14
15 142 at <https://www.ncbi.nlm.nih.gov/books/NBK35156/>, were used to assess the quality of
16
17 143 the studies. All discrepancies were resolved via discussion and consensus.
18
19
20

21 144 **Statistical Analysis**

22
23
24 145 As considerable heterogeneity was expected because of the multiple sources of
25
26 146 variances, a random effects meta-analysis model was used to estimate the influencing
27
28 147 factors and the extent of their influence.¹⁹ Between-study heterogeneity was assessed
29
30 148 using the Cochran's Q-test, and was quantified with the I^2 statistic, which was
31
32 149 calculated to describe the percentage of total variation caused by heterogeneity across
33
34 150 studies, with $\geq 50\%$ indicating considerable heterogeneity.^{20 21} Potential sources of
35
36 151 heterogeneity were identified using meta-regression.²² Four categorical covariates
37
38 152 were defined as potential sources of heterogeneity by examining the studies conducted
39
40 153 in the United States (US) vs. the studies conducted in other countries, the studies
41
42 154 conducted before 2010 vs. those conducted after 2010, the studies concerning
43
44 155 subspecialty only vs. those that were not specific to a subspecialty, and the studies with
45
46 156 a sample size < 200 vs. the studies with a sample size ≥ 200 . Subgroup analyses were
47
48 157 performed for each factor in the studies in developed countries vs. developing countries
49
50 158 and studies conducted before 2010 vs. after 2010. The EOI value of competencies in
51
52
53
54
55
56

1
2
3
4
5 159 developing countries was not statistically significant (81.21% [95% CI, 75.27%;
6
7 160 86.51%], $P=0.1436$), and no studies on the influence of student debt in developing
8
9 161 countries were found. The Q-test based on the analysis of variance was used to compare
10
11 162 the subgroups, with a significance threshold of 5%.²³ The influence of individual
12
13 163 studies on the overall EOI value was explored by serially excluding each study in a
14
15 164 sensitivity analysis. Publication bias was investigated using a funnel plot test and
16
17 165 Egger's test.^{24 25} Fill and trim approach, which imputes estimates from hypothetical
18
19 166 negative unpublished reports,²⁶ was also used to investigate the publication bias if the
20
21 167 Egger's test was significant. All analyses were performed using R
22
23 168 (version 3.3.1, The R Foundation, Vienna, Austria). The statistical tests were 2-sided
24
25 169 with a significance threshold of $P<0.05$.

26
27
28
29
30
31 170 **Patient and public involvement:** Patients and the public were not involved in
32
33 171 development of the research question and outcome measures, nor the study design. The
34
35 172 study does not involve patient recruitment, and patients were not involved in conduct
36
37 173 of the study. We plan to liaise closely with patients, special interest groups, and
38
39 174 charities in the dissemination of our results in printed and electronic media.

40 41 42 43 175 **Results**

44 45 46 176 **Study Characteristics**

47
48
49 177 Seventy-five cross-sectional studies involving a total of 882,209 individuals that
50
51 178 published between January 1977 and May 2018 were included in the present research
52
53 179 **(Table 1)**. Thirty-four studies were conducted in North America, 24 in Europe, 7 in

1
2
3
4
5 180 Asia, 5 in Oceania, 3 in Africa, and 2 in South America. The median number of
6
7 181 participants per study was 243 (range 37-29,227). Fourteen studies included students
8
9 182 who had already selected subspecialties, whereas 61 did not. The influencing factors
10
11 183 were ranked according to the frequency of occurrence and each factor was identified
12
13 184 when at least 5 papers were available describing it. The influencing factors for
14
15 185 subspecialty choice were then classified according to 17 aspects, including academic
16
17 186 interests, controllable lifestyle or flexible work schedule (defined as flexibility that
18
19 187 allows physicians to control the number of hours devoted to practicing the specialty),
20
21 188 competencies, patient service orientation, medical teachers or mentors, career
22
23 189 opportunities, workload or working hours (characterized by the physician's time spent
24
25 190 on professional responsibilities), income, prestige, length of training, advice from
26
27 191 others (advice from family, friends, and other students), student debt, experience with
28
29 192 the subject, working environment, personality, gender and job security. Personality and
30
31 193 gender are common factors that affect the choice of subspecialty among medical
32
33 194 students, but most of the relevant literature has not reported on the extent of these
34
35 195 factors' influence. Moreover, the funnel plots were clearly asymmetrical with regard
36
37 196 to experience with the subject, the working environment and job variety, indicating the
38
39 197 existence of publication bias. Thus, the analysis of the remaining 12 influencing factors
40
41 198 were shown in this paper. Studies assessed for influencing factors using questionnaires
42
43 199 validated to medical students asking the extent of certain factors the studies
44
45 200 investigated. Quality assessment scores for the included studies are listed in **Table 1**.
46
47 201 None of the studies received a point for the second AHRQ Quality Indicator, which
48
49 202 requires studies to list the inclusion and exclusion criteria for exposed and unexposed
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 203 subjects (cases and controls) or refer to previous publications, since no comparison
6
7 204 studies were referenced in the analyzed articles. For the remaining 10 criteria, 6 studies
8
9 205 received 9 points, 8 studies received 8 points, 17 studies received 7 points, 33 studies
10
11 206 received 6 points, 9 studies received 5 points and 2 studies received 4 points (scores
12
13
14 207 for individual studies are presented in **Table S1**).

17 208 **Primary Analysis**

19
20 209 A meta-analysis was performed on the 12 influencing factors (**Table 2**): academic
21
22 210 interests (**Fig. S2**), competencies (**Fig. S3**), controllable lifestyle or flexible work
23
24 211 schedule (**Fig. S4**), patient service orientation (**Fig. S5**), medical teachers or mentors
25
26 212 (**Fig. S6**), career opportunities (**Fig. S7**), workload or working hours (**Fig. S8**), income
27
28 213 (**Fig. S9**), length of training (**Fig. S10**), prestige (**Fig. S11**), advice from others (**Fig.**
29
30 214 **S12**) and student debt (**Fig. S13**). All the factors were significant with evidence of
31
32 215 between-study heterogeneity ($P<0.0001$). A sensitivity analysis, in which the meta-
33
34 216 analysis was serially repeated after the exclusion of each study, demonstrated that no
35
36 217 individual study affected the overall extent of a factor's influence.

41 218 **Meta-regression and Subgroup Analysis**

42
43
44
45 219 We performed meta-regression to identified the potential sources of heterogeneity
46
47 220 using common instructions when at least 5 studies were available and at least 2 studies
48
49 221 were in each comparator subgroup (**Table 3**). Some of the heterogeneities observed
50
51 222 among the 12 factors can be partially explained by country, survey years, specialty and
52
53 223 sample size.

1
2
3
4
5 224 EOI values were further analyzed by subgroup (**Table S2**) according to world region
6
7 225 (**Fig. 1**) and survey year (**Fig. 2**). The EOI value of academic interests in developed
8
9 226 countries was higher than that in developing countries (79.66% [95% CI, 70.73%;
10
11 227 86.39% vs. 60.41% [95% CI, 43.44%; 75.19%]; $Q=3.51$ $P=0.02$). Conversely, a lower
12
13 228 EOI value of prestige was found in studies conducted in developed countries than in
14
15 229 developing countries (23.96% [95% CI, 19.20%; 29.47%] vs. 47.65% [95% CI,
16
17 230 34.41%; 61.24%]; $Q=4.71$ $P=0.01$). No statistically significant subgroup differences
18
19 231 in the EOI values of the other influencing factors were noted between developed
20
21 232 countries and developing countries. In addition, no statistically significant differences
22
23 233 in the EOI values of the influencing factors were observed when subgroup analysis
24
25 234 was performed by survey year.

235 **Assessment of Publication Bias**

236 We generated a funnel plot with proportion as the abscissa and standard error as the
237 ordinate. A visual inspection of the funnel plots revealed minimal asymmetry among
238 the various influencing factors (**Fig. S14**), and the results were concentrated in the
239 narrow upper part of the graph. There was evidence of small study effect in the meta-
240 analysis of “patient service orientation” (Egger’s test $P=0.02$). However, the trim-and-
241 fill method showed the publication-bias corrected estimate remained statistically
242 significant (63.79%, 95% CI, 58.20%; 69.04%).

243 **Discussion**

244 **Implications**

1
2
3
4
5 245 This systematic review and meta-analysis involved 75 studies with 882,209 medical
6
7 246 students. Twelve influencing factors were analyzed. These factors can be classified
8
9 247 into two categories: economic factors and non-economic factors. We found that the
10
11 248 EOI of the economic factors, including income (34.70%) and student debt (15.33%),
12
13 249 may not depend on the region's level of economic development. However, income
14
15 250 remained a major influencing factor in the process of choosing a specialty or
16
17 251 subspecialty. In the US, 15% of full-time family medicine physicians earned less than
18
19 252 \$100,000 in 2004, which is significantly less than the income earned by invasive
20
21 253 cardiologists (median income=\$427,815), neurosurgeons (median income=\$211,094),
22
23 254 and orthopedists (median income=\$335,646).²⁷ This economic inequality made family
24
25 255 medicine less attractive to medical school graduates.²⁸ Benefits such as health
26
27 256 insurance and tuition reimbursement have been shown to be the most common
28
29 257 economic incentives used to attract applicants.²⁹

30
31
32
33
34
35 258 The non-economic factors can be divided into individual factors, specialty-related
36
37 259 factors and others. First, individual factors, including academic interest and
38
39 260 competencies, have a considerable impact on students' subspecialty choice, with EOI
40
41 261 values of 75.29% and 55.15%, respectively. In addition, in the subgroup analysis,
42
43 262 although academic interests were less influential in developing countries than in
44
45 263 developed countries (79.66% [95% CI, 70.73%; 86.39% vs. 60.41% [95% CI, 43.44%;
46
47 264 75.19%]; $Q=3.51$ $P=0.02$), they were still the most influential of the 12 factors
48
49 265 regardless of regional economic level. These findings indicate that subspecialties with
50
51 266 a shortage of manpower may attract more students by increasing students' interests and
52
53
54
55
56

1
2
3
4
5 267 improving the quality of education. Previous studies indicated that early specialty
6
7 268 exposure in medical education may arouse students' academic interest and improve
8
9 269 their clinical competence.^{28 30} For example, an elective extracurricular program
10
11 270 designed to facilitate early contact with family medicine physicians was found to
12
13 271 significantly improve students' interest and clinical skills, especially communication
14
15 272 skills, in family medicine.³¹ Furthermore, dispelling myths and espousing the positive
16
17 273 aspects of a discipline may provide a better understanding of certain specialties; this
18
19 274 approach could also be effective in increasing students' academic interest.³² For
20
21 275 instance, family medicine is often considered a discipline that requires less professional
22
23 276 skills and knowledge. This misconception demotivates students from choosing family
24
25 277 medicine as their future career specialty, and this trend may eventually lead to a
26
27 278 shortage of family physicians.³² Eliminating such prejudices may help students pay
28
29 279 greater attention to the areas in short supply and restore their interests in other
30
31 280 specialties.

32
33
34
35
36
37
38 281 Second, the specialty-related factors included controllable lifestyle/flexible work
39
40 282 schedule (EOI of 53.00%), career opportunities (EOI of 44.00%), workload (EOI of
41
42 283 37.99%) and training length (EOI of 32.30%). Of these factors, lifestyle varied between
43
44 284 different areas. Additionally, although certain specialties, such as general surgery,
45
46 285 seem to have an adequate number of surgeons on a per capita basis in the US, there is
47
48 286 still a poor geographic distribution within the surgical workforce according to the type
49
50 287 of surgical practice.³³ The inflexible lifestyle is a common reason that students perceive
51
52 288 surgery to be less attractive.³³ Reorganization of expected work hours within shared
53
54
55
56

1
2
3
4
5 289 practices and the increased use of physician extenders and technologies such as
6
7 290 electronic medical records may give physicians more flexibility in work schedules.³⁴
8
9 291 Moreover, providing promotion opportunities and shortening the length of training are
10
11 292 possible strategies to recruit new staff in subspecialties that require a long period of
12
13 293 post-graduate residency training, such as neurosurgery.³⁵
14
15
16

17 294 Finally, other factors such as service orientation (EOI of 50.74%), medical teachers or
18
19 295 mentors (EOI of 46.93%), prestige (EOI of 34.68%), and advice from others (EOI of
20
21 296 28.24%) also contribute to the decision-making process of medical students. For
22
23 297 example, the desire to care for patients with end-stage diseases contributed to the
24
25 298 decision to enter palliative medicine in 86% of the medical students.⁷ Additionally,
26
27 299 exposure to mentors in a particular clinical field such as internal medicine has been
28
29 300 strongly associated with medical students' choice of clinical field.³⁶ Moreover,
30
31 301 improving the occupational prestige of areas such as family medicine, pathology, and
32
33 302 radiology may help reshape the distribution of the workforce.^{30 37 38}
34
35
36
37

38 303 In our study, several findings are especially noteworthy. First, interest was far more
39
40 304 important than income in deciding subspecialty. In our study, interest was the top-
41
42 305 ranked influencing factor (EOI of 75.29%) of subspecialty choice, while income was
43
44 306 ranked lower (EOI of 34.70%). This finding argues against the possible default belief
45
46 307 that raising physician's wages alone could solve the uneven distribution of clinicians
47
48 308 among subspecialties. Our findings highlight that cultivating and stimulating students'
49
50 309 professional interests may help improve the maldistribution of medical resources in a
51
52 310 more efficient and cost-saving manner.
53
54
55
56

1
2
3
4
5 311 Second, improving abilities in a certain subspecialty of interest can greatly affect
6
7 312 medical students' professional choice. In our study, competencies ranked second in
8
9 313 influence, which may reflect the impact of admission conditions on students' choice of
10
11 314 subspecialty. Hence, to reduce the risk that students are restricted to the subspecialty
12
13
14 315 of their interest due to a lack of personal skills, medical education should focus more
15
16 316 on enhancing students' personal competencies in addition to their academic interests.

17
18
19 317 Third, balancing medical resources is a complex process in practical terms, as the
20
21 318 influencing factors are not mutually exclusive. The shortage of physicians in certain
22
23 319 subspecialties may increase physician workload, resulting in less time for teaching.
24
25
26 320 Hence, the quality of teaching cannot be guaranteed, and students may tend to avoid
27
28 321 choosing these subspecialties, thus worsening the imbalance in the medical workforce.
29
30
31 322 Additionally, some of the 12 factors identified are not amenable to practical
32
33 323 interventions. For example, prestige cannot be immediately increased using
34
35 324 interventional strategies.³⁷ Overall, effective strategies must be multi-pronged and
36
37 325 incorporate several different aspects, and maldistribution in the workforce should not
38
39 326 be tackled through a simple adjustment of one influencing factor.

40 41 42 43 327 **Interpretations of the results of this meta-analysis**

44
45
46 328 Our meta-regression stratified by the study-level characteristics found that country,
47
48 329 survey years, subspecialty and sample size may contribute to the heterogeneity
49
50 330 between studies. There was no significant difference in the sensitivity analysis, which
51
52 331 indicated that the results of the meta-analysis were convincing. The funnel plots and
53
54
55 332 Egger's tests revealed that most of the publication bias was small ($P>0.05$), except for

1
2
3
4
5 333 the meta-analysis of “patient service orientation”. Moreover, the majority of the studies
6
7 334 collected in the database were from developed countries rather than developing
8
9 335 countries.

12 336 **Limitations**

15 337 Several limitations should be considered when interpreting the findings of this study.
17
18 338 First, the students involved in our study included medical students at different stages
19
20 339 of their medical education. Students’ perception about different subspecialties may
21
22 340 change during medical training until the students applies for specialty training. For
23
24
25 341 example, compared to an intern, a freshman student may place greater emphasis on
26
27 342 income and prestige when considering a career choice.³⁹ A subgroup analysis stratified
28
29 343 by the stages of medical education and a secondary meta-analysis of longitudinal
30
31 344 studies may better reflect changes in influencing factors and the extent of their
32
33 345 influence over time. Second, our meta-analysis summarized the data from different
34
35 346 geographic regions around the world, and the general conclusions may not be
36
37 347 appropriate to guide policy development in each region. Enhanced effort is needed to
38
39 348 develop specific intervention strategies according to the specific economic level,
40
41 349 religious beliefs, healthcare system, educational system and endemic diseases of
42
43 350 different countries and regions. Subgroup analysis stratified by organizational and
44
45 351 medical training factors would provide more information of the factors influencing
46
47 352 subspecialty choice among medical students. Third, the surveys in the various studies
48
49 353 were also conducted using different methods. Most of the questionnaires used a Likert
50
51 354 scale. Therefore, when we converted the results to a percentage representing the extent
52
53
54
55
56

1
2
3
4
5 355 of a factor's influence, the Likert scale items were treated as interval data.⁴⁰⁻⁴²
6
7 356 Consequently, there may have been differences in the conversion process. Finally, the
8
9 357 analysis relied on aggregated published data. A multicenter prospective study would
10
11 358 provide more accurate estimate of the influencing factors and the extent of their
12
13
14 359 influence on medical students' choice of subspecialty.
15
16

17 360 **Conclusion**

18
19
20 361 In conclusion, this systematic review and meta-analysis provided a summary
21
22 362 evaluation of 12 influencing factors and the extent of their influence on the choice of
23
24 363 subspecialty training among medical students. Understanding students' attitudes
25
26
27 364 toward their subspecialty decision-making process could provide the basis for
28
29 365 developing strategies to increase the attractiveness of subspecialties experiencing a
30
31 366 shortage of manpower, thereby balancing the distribution of medical recourses.
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 367 **Contributors:** Haotian Lin contributed to the conceptualizing and design of the study,
6
7 368 and to research funding, coordinated the research and oversaw the project. Yahan Yang,
8
9 369 Jiawei Li and Xiaohang Wu contributed to data collection and interpretation, and to
10
11 370 data analysis. Jinghui Wang, Yi Zhu, Chuan Chen and Wangting Li contributed to the
12
13 371 design of the study. All authors contributed to the drafting and revision of the paper
14
15 372 and approved the final manuscript for publication. No patients or the public were
16
17 373 involved in the development and design of this research.
18
19
20

21 374 **Funding:** The principal investigator of this study (Haotian Lin) is currently supported
22
23 375 by National key R & D project (2018YFC010302), the Key Research Plan for the
24
25 376 National Natural Science Foundation of China Cultivation Project (91546101), the
26
27 377 National Natural Science Foundation of China (81770967), the Fundamental Research
28
29 378 Funds for the Central Universities (16ykjc28), the Guangdong Provincial Natural
30
31 379 Science Foundation for Distinguished Young Scholars of China (2014A030306030),
32
33 380 the Guangdong Province Universities and Colleges Youth Pearl River Scholar Funded
34
35 381 Scheme (2016), the Clinical Research and Translational Medical Center of Pediatric
36
37 382 Cataract in Guangzhou City (201505032017516), and Ministry of Science and
38
39 383 Technology of China Grants (2015CB964600). These sponsors and funding
40
41 384 organizations had no role in the design or performance of this study.
42
43
44
45
46
47

48 385 **Competing Interests:** The authors declare no competing financial interests.
49
50

51 386 **Data sharing:** Extracted data are available upon request to the corresponding author.
52
53
54
55
56
57
58
59
60

388 **References**

- 389 1. Zurn P, Dal Poz MR, Stilwell B, et al. Imbalance in the health workforce. *Hum Resour Health*
390 2004;2(1):13. doi: 10.1186/1478-4491-2-13
- 391 2. Diallo K, Zurn P, Gupta N, et al. Monitoring and evaluation of human resources for health: an
392 international perspective. *Hum Resour Health* 2003;1(1):3. doi: 10.1186/1478-4491-1-3
- 393 3. Anderson GF, Hussey PS. Population aging: A comparison among industrialized countries. *Health*
394 *Affair* 2000;19(3):191-203. doi: DOI 10.1377/hlthaff.19.3.191
- 395 4. Hobbs FDR, Bankhead C, Mukhtar T, et al. Clinical workload in UK primary care: a retrospective
396 analysis of 100 million consultations in England, 2007-14. *Lancet* 2016;387(10035):2323-30.
397 doi: 10.1016/S0140-6736(16)00620-6
- 398 5. Reeve J, Blakeman T, Freeman GK, et al. Generalist solutions to complex problems: generating
399 practice-based evidence - the example of managing multi-morbidity. *Bmc Fam Pract* 2013;14
400 doi: Artn 112
401 10.1186/1471-2296-14-112
- 402 6. Bodenheimer T. Primary care--will it survive? *N Engl J Med* 2006;355(9):861-4. doi:
403 10.1056/NEJMp068155
- 404 7. LeGrand SB, Heintz JB. Palliative Medicine Fellowship: A Study of Resident Choices. *Journal of*
405 *Pain and Symptom Management* 2012;43(3):558-68. doi: 10.1016/j.jpainsymman.2011.04.018
- 406 8. Kim YY, Kim UN, Kim YS, et al. Factors associated with the specialty choice of Korean medical
407 students: a cross-sectional survey. *Human Resources for Health* 2016;14:8. doi:
408 10.1186/s12960-016-0141-8
- 409 9. McNally SA. Competition ratios for different specialties and the effect of gender and immigration
410 status. *J R Soc Med* 2008;101(10):489-92. doi: 10.1258/jrsm.2008.070284
- 411 10. Reed VA, Jernstedt GC, Reber ES. Understanding and improving medical student specialty choice:
412 a synthesis of the literature using decision theory as a referent. *Teach Learn Med*
413 2001;13(2):117-29. doi: 10.1207/S15328015TLM1302_7
- 414 11. Al-Ansari SS, Khafagy MA. FACTORS AFFECTING THE CHOICE OF HEALTH SPECIALTY
415 BY MEDICAL GRADUATES. *Journal of Family & Community Medicine* 2015;13(3):119-
416 23.
- 417 12. Leduc N, Vanasse A, Scott I, et al. The career decision-making process of medical students and
418 residents and the choice of specialty and practice location: how does Postgraduate Medical
419 Education fit in? 2011
- 420 13. Delamothe T. Modernising Medical Careers: final report. *BMJ* 2008;336(7635):54-55.
- 421 14. Goldacre MJ, Laxton L, Harrison EM, et al. Early career choices and successful career progression
422 in surgery in the UK: prospective cohort studies. *Bmc Surgery* 2010;10:11. doi: 10.1186/1471-
423 2482-10-32

- 1
2
3
4
5 424 15. Weissman C, Zisk-Rony RY, Schroeder JE, et al. Medical specialty considerations by medical
6 425 students early in their clinical experience. *Isr J Health Policy Res* 2012;1(1):13. doi:
7 426 10.1186/2045-4015-1-13
- 8
9 427 16. Jackson C, Ball J, Hirsh W, et al. Informing choices: the need for career advice in medical training.
10 428 *Cambridge: National institute for careers Education and Counseling* 2003
- 11
12 429 17. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-
13 430 analyses: the PRISMA statement. *J Clin Epidemiol* 2009;62(10):1006-12. doi:
14 431 10.1016/j.jclinepi.2009.06.005
- 15
16 432 18. Rostom A, Dube C, Cranney A, et al. Celiac disease. *Evid Rep Technol Assess (Summ)* 2004(104):1-
17 433 6. [published Online First: 2004/09/07]
- 18
19 434 19. Borenstein M, Hedges LV, Higgins JP, et al. A basic introduction to fixed-effect and random-effects
20 435 models for meta-analysis. *Res Synth Methods* 2010;1(2):97-111. doi: 10.1002/jrsm.12
- 21
22 436 20. Higgins JP, Thompson SG, Deeks JJ, et al. Measuring inconsistency in meta-analyses. *BMJ*
23 437 2003;327(7414):557-60. doi: 10.1136/bmj.327.7414.557
- 24
25 438 21. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med*
26 439 2002;21(11):1539-58. doi: 10.1002/sim.1186
- 27
28 440 22. Sterne JA, Juni P, Schulz KF, et al. Statistical methods for assessing the influence of study
29 441 characteristics on treatment effects in 'meta-epidemiological' research. *Stat Med*
30 442 2002;21(11):1513-24. doi: 10.1002/sim.1184
- 31
32 443 23. Borenstein M, Hedges LV, Higgins J, et al. Criticisms of meta - analysis. *Introduction to meta-*
33 444 *analysis* 2009:377-87.
- 34
35 445 24. Egger M, Davey Smith G, Schneider M, et al. Bias in meta-analysis detected by a simple, graphical
36 446 test. *BMJ* 1997;315(7109):629-34.
- 37
38 447 25. Sterne JA, Egger M. Funnel plots for detecting bias in meta-analysis: guidelines on choice of axis.
39 448 *J Clin Epidemiol* 2001;54(10):1046-55.
- 40
41 449 26. Duval S, Tweedie R. Trim and fill: A simple funnel-plot-based method of testing and adjusting for
42 450 publication bias in meta-analysis. *Biometrics* 2000;56(2):455-63. [published Online First:
43 451 2000/07/06]
- 44
45 452 27. Bodenheimer T, Berenson RA, Rudolf P. The primary care-specialty income gap: why it matters.
46 453 *Annals of internal medicine* 2007;146(4):301-6.
- 47
48 454 28. Bodenheimer T, Pham HH. Primary care: current problems and proposed solutions. *Health Aff*
49 455 *(Millwood)* 2010;29(5):799-805. doi: 10.1377/hlthaff.2010.0026
- 50
51 456 29. Association AH. The hospital workforce shortage: Immediate and future. *Trend Watch* 2001;3(2):1-
52 457 8.
- 53
54 458 30. Compton MT, Frank E, Elon L, et al. Changes in US medical students' specialty interests over the
55 459 course of medical school. *Journal of General Internal Medicine* 2008;23(7):1095-100. doi:

- 1
2
3
4
5 460 10.1007/s11606-008-0579-z
6
7 461 31. Indyk D, Deen D, Fornari A, et al. The influence of longitudinal mentoring on medical student
8 462 selection of primary care residencies. *BMC medical education* 2011;11(1):27.
9
10 463 32. Gill H, McLeod S, Duerksen K, et al. Factors influencing medical students' choice of family
11 464 medicine Effects of rural versus urban background. *Canadian Family Physician*
12 465 2012;58(11):E649-E57.
13
14 466 33. Richardson JD. Workforce and lifestyle issues in general surgery training and practice. *Archives of*
15 467 *surgery (Chicago, Ill : 1960)* 2002;137(5):515-20.
16
17 468 34. Newton DA, Grayson MS, Thompson LF. The variable influence of lifestyle and income on medical
18 469 students' career specialty choices: data from two U.S. medical schools, 1998-2004. *Academic*
19 470 *medicine : journal of the Association of American Medical Colleges* 2005;80(9):809-14.
20
21 471 35. Orrico K. Ensuring an adequate neurosurgical workforce for 21st century. *Surgeons AAoN* 2012
22
23 472 36. Wright SM, Wong A, Newill CA. The impact of role models on medical students. *Journal of General*
24 473 *Internal Medicine* 1997;12(1):53-56.
25
26 474 37. Glazer GM, Ruiz-Wibbelsmann JA. Decades of perceived mediocrity: prestige and radiology.
27 475 *Radiology* 2011;260(2):311-16.
28
29 476 38. Schwartzbaum AM, McGrath JH, Rothman RA. The perception of prestige differences among
30 477 medical subspecialties. *Soc Sci Med* 1973;7(5):365-71.
31
32 478 39. Parsa S, Aghazadeh A, Nejatiasafa AA, et al. Freshmen versus Interns' Specialty Interests. *Archives*
33 479 *of Iranian Medicine* 2010;13(6):509-15.
34
35 480 40. Komorita SS. Attitude Content, Intensity, and the Neutral Point on a Likert Scale. *J Soc Psychol*
36 481 1963;61:327-34. doi: 10.1080/00224545.1963.9919489
37
38 482 41. Baggaley AR, Hull AL. The effect of nonlinear transformations on a Likert scale. *Eval Health Prof*
39 483 1983;6(4):483-91.
40
41 484 42. Norman G. Likert scales, levels of measurement and the "laws" of statistics. *Advances in health*
42 485 *sciences education : theory and practice* 2010;15(5):625-32. doi: 10.1007/s10459-010-9222-y
43
44 486 43. Smith F, Lambert TW, Goldacre MJ. Factors influencing junior doctors' choices of future specialty:
45 487 trends over time and demographics based on results from UK national surveys. *Journal of the*
46 488 *Royal Society of Medicine* 2015;108(10):396-405. doi: 10.1177/0141076815599674
47
48 489 44. Cochran A, Melby S, Neumayer LA. An Internet-based survey of factors influencing medical student
49 490 selection of a general surgery career. *American Journal of Surgery* 2005;189(6):742-46. doi:
50 491 10.1016/j.amjsurg.2005.03.019
51
52 492 45. Hauer KE, Durning SJ, Kernan WN, et al. Factors associated with medical students' career choices
53 493 regarding internal medicine. *Jama-Journal of the American Medical Association*
54 494 2008;300(10):1154-64. doi: 10.1001/jama.300.10.1154
55
56
57
58
59
60

- 1
2
3
4
5 495 46. Johnson AL, Sharma J, Chinchilli VM, et al. Why do medical students choose orthopaedics as a
6 496 career? *The Journal of bone and joint surgery American volume* 2012;94(11):e78. doi:
7 497 10.2106/jbjs.k.00826 [published Online First: 2012/05/29]
- 8
9 498 47. Kiolbassa K, Miksch A, Hermann K, et al. Becoming a general practitioner - Which factors have
10 499 most impact on career choice of medical students? *Bmc Family Practice* 2011;12:7. doi:
11 500 10.1186/1471-2296-12-25
- 12
13 501 48. Klingensmith ME, Cogbill TH, Luchette F, et al. Factors Influencing the Decision of Surgery
14 502 Residency Graduates to Pursue General Surgery Practice Versus Fellowship. *Annals of Surgery*
15 503 2015;262(3):449-55. doi: 10.1097/sla.0000000000001435
- 16
17 504 49. Lee JY, Kerbl DC, McDougall EM, et al. Medical Students Pursuing Surgical Fields Have No
18 505 Greater Innate Motor Dexterity than Those Pursuing Nonsurgical Fields. *Journal of Surgical*
19 506 *Education* 2012;69(3):360-63. doi: 10.1016/j.jsurg.2011.11.005
- 20
21 507 50. Macdonald C, Cawood T. Factors influencing career decisions in internal medicine. *Internal*
22 508 *Medicine Journal* 2012;42(8):918-23. doi: 10.1111/j.1445-5994.2012.02793.x
- 23
24 509 51. Paiva RE, Vu NV, Verhulst SJ. The effect of clinical experiences in medical school on specialty
25 510 choice decisions. *J Med Educ* 1982;57(9):666-74.
- 26
27 511 52. Ni Chroinin D, Cronin E, Cullen W, et al. Would you be a geriatrician? Student career preferences
28 512 and attitudes to a career in geriatric medicine. *Age Ageing* 2013;42(5):654-7. doi:
29 513 10.1093/ageing/aft093 [published Online First: 2013/08/07]
- 30
31 514 53. Rogers LQ, Fincher RM, Lewis LA. Factors influencing medical students to choose primary care or
32 515 non-primary care specialties. *Academic medicine : journal of the Association of American*
33 516 *Medical Colleges* 1990;65(9 Suppl):S47-8.
- 34
35 517 54. Abendroth J, Schnell U, Lichte T, et al. Motives of former interns in general practice for speciality-
36 518 choice--results of a cross-sectional study among graduates 2007 to 2012. *GMS Zeitschrift fur*
37 519 *medizinische Ausbildung* 2014;31(1):Doc11. doi: 10.3205/zma000903 [published Online First:
38 520 2014/02/28]
- 39
40
41 521 55. Alawad A, Khan WS, Abdelrazig YM, et al. Factors considered by undergraduate medical students
42 522 when selecting specialty of their future careers. *Pan African Medical Journal* 2015;20:6. doi:
43 523 10.11604/pamj.2015.20.102.4715
- 44
45 524 56. Azizzadeh A, McCollum CH, Miller CC, 3rd, et al. Factors influencing career choice among medical
46 525 students interested in surgery. *Curr Surg* 2003;60(2):210-3. doi: 10.1016/s0149-
47 526 7944(02)00679-7 [published Online First: 2004/02/20]
- 48
49 527 57. Celenza A, Bharath J, Scop J. Improving the attractiveness of an emergency medicine career to
50 528 medical students: An exploratory study. *Emergency Medicine Australasia* 2012;24(6):625-33.
51 529 doi: 10.1111/j.1742-6723.2012.01607.x
- 52
53 530 58. Dolan-Evans E, Rogers GD. Barriers for students pursuing a surgical career and where the Surgical
54 531 Interest Association can intervene. *Anz Journal of Surgery* 2014;84(6):406-11. doi:
55 532 10.1111/ans.12521

- 1
2
3
4
5 533 59. Boyd JS, Clyne B, Reinert SE, et al. Emergency Medicine Career Choice: A Profile of Factors and
6 534 Influences from the Association of American Medical Colleges (AAMC) Graduation
7 535 Questionnaires. *Academic Emergency Medicine* 2009;16(6):544-49. doi: 10.1111/j.1553-
8 536 2712.2009.00385.x
- 9
10 537 60. Egerton EA. Choice of career of doctors who graduated from Queen's University, Belfast in 1977.
11 538 *Med Educ* 1985;19(2):131-7.
- 12
13 539 61. Diderichsen S, Johansson EE, Verdonk P, et al. Few gender differences in specialty preferences and
14 540 motivational factors: a cross-sectional Swedish study on last-year medical students. *Bmc*
15 541 *Medical Education* 2013;13:8. doi: 10.1186/1472-6920-13-39
- 16
17 542 62. Ferrari S, Reggianini C, Mattei G, et al. International Study of Student Career Choice in Psychiatry
18 543 (ISoSCCiP): Results from Modena, Italy. *International Review of Psychiatry* 2013;25(4):450-
19 544 59. doi: 10.3109/09540261.2013.804402
- 20
21 545 63. Freire MDM, Jordao LMR, Ferreira ND, et al. Motivation Towards Career Choice of Brazilian
22 546 Freshman Students in a Fifteen-Year Period. *Journal of Dental Education* 2011;75(1):115-21.
- 23
24 547 64. Buddeberg-Fischer B, Klaghofer R, Abel T, et al. Swiss residents' speciality choices--impact of
25 548 gender, personality traits, career motivation and life goals. *BMC Health Serv Res* 2006;6:137.
26 549 doi: 10.1186/1472-6963-6-137
- 27
28 550 65. Dorsey ER, Jarjoura D, Rutecki GW. The influence of controllable lifestyle and sex on the specialty
29 551 choices of graduating U.S. medical students, 1996-2003. *Academic medicine : journal of the*
30 552 *Association of American Medical Colleges* 2005;80(9):791-6. [published Online First:
31 553 2005/08/27]
- 32
33 554 66. Ekenze SO, Ugwumba FO, Obi UM, et al. Undergraduate Surgery Clerkship and the Choice of
34 555 Surgery as a Career: Perspective from a Developing Country. *World Journal of Surgery*
35 556 2013;37(9):2094-100. doi: 10.1007/s00268-013-2073-y
- 36
37
38 557 67. Barikani A, Afaghi M, Barikani F, et al. Perception of the medical students on their future career in
39 558 Qazvin University of Medical Sciences. *Global journal of health science* 2012;4(4):176-80.
40 559 doi: 10.5539/gjhs.v4n4p176 [published Online First: 2012/09/18]
- 41
42 560 68. Bittaye M, Odukogbe AT, Nyan O, et al. Medical students' choices of specialty in The Gambia: the
43 561 need for career counseling. *BMC Med Educ* 2012;12:72. doi: 10.1186/1472-6920-12-72
- 44
45 562 69. Bonura EM, Lee ES, Ramsey K, et al. Factors Influencing Internal Medicine Resident Choice of
46 563 Infectious Diseases or Other Specialties: A National Cross-sectional Study. *Clinical Infectious*
47 564 *Diseases* 2016;63(2):155-63. doi: 10.1093/cid/ciw263
- 48
49 565 70. Al-Fouzani R, Al-Ajlan S, Marwan Y, et al. Factors affecting future specialty choice among medical
50 566 students in Kuwait. *Medical Education Online* 2012;17:7. doi: 10.3402/meo.v17i0.19587
- 51
52 567 71. AlKot MM, Gouda MA, KhalafAllah MT, et al. Family Medicine in Egypt From Medical Students'
53 568 Perspective: A Nationwide Survey. *Teaching and Learning in Medicine* 2015;27(3):264-73.
54 569 doi: 10.1080/10401334.2015.1044654

- 1
2
3
4
5 570 72. Borges NJ, Manuel RS, Duffy RD, et al. Influences on specialty choice for students entering person-
6 571 oriented and technique-oriented specialties. *Medical Teacher* 2009;31(12):1086-88. doi:
7 572 10.3109/01421590903183787
- 8
9 573 73. Budd S, Kelley R, Day R, et al. Student attitudes to psychiatry and their clinical placements. *Medical*
10 574 *Teacher* 2011;33(11):E586-E92. doi: 10.3109/0142159x.2011.610836
- 11
12 575 74. Corrigan MA, Shields CJ, Redmond HP. Factors influencing surgical career choices and
13 576 advancement in Ireland and Britain. *World Journal of Surgery* 2007;31(10):1921-29. doi:
14 577 10.1007/s00268-007-9175-3
- 15
16 578 75. Davis CR, Trevatt AEJ, McGoldrick RB, et al. How to train plastic surgeons of the future. *Journal*
17 579 *of Plastic Reconstructive and Aesthetic Surgery* 2016;69(8):1134-40. doi:
18 580 10.1016/j.bjps.2016.05.001
- 19
20 581 76. Deutsch T, Lippmann S, Frese T, et al. Who wants to become a general practitioner? Student and
21 582 curriculum factors associated with choosing a GP career - a multivariable analysis with
22 583 particular consideration of practice-orientated GP courses. *Scandinavian Journal of Primary*
23 584 *Health Care* 2015;33(1):47-53. doi: 10.3109/02813432.2015.1020661
- 24
25 585 77. Gardner SP, Roberts-Thomson KF. The effect of a change in selection procedures on students'
26 586 motivation to study dentistry. *Australian Dental Journal* 2014;59(1):2-8. doi:
27 587 10.1111/adj.12141
- 28
29 588 78. Dias MS, Sussman JS, Durham S, et al. Perceived benefits and barriers to a career in pediatric
30 589 neurosurgery: a survey of neurosurgical residents Clinical article. *Journal of Neurosurgery-*
31 590 *Pediatrics* 2013;12(5):422-33. doi: 10.3171/2013.5.peds12597
- 32
33 591 79. Goltz CJ, Bachusz RC, Mancini E, et al. Medical Student Career Survey-Vascular Surgery
34 592 Awareness Initiative. *Annals of Vascular Surgery* 2013;27(2):225-31. doi:
35 593 10.1016/j.avsg.2012.02.012
- 36
37 594 80. Gupta NB, Khadilkar SV, Bangar SS, et al. Neurology as career option among postgraduate medical
38 595 students. *Annals of Indian Academy of Neurology* 2013;16(4):478-82. doi: 10.4103/0972-
39 596 2327.120427
- 40
41 597 81. Hanzlick R, Prahlow JA, Denton S, et al. Selecting forensic pathology as a career - A survey of the
42 598 post with an eye on the future. *American Journal of Forensic Medicine and Pathology*
43 599 2008;29(2):114-22. doi: 10.1097/PAF.0b013e318174f0a9
- 44
45 600 82. Harris MC, Marx J, Gallagher PR, et al. General vs subspecialty pediatrics - Factors leading to
46 601 residents' career decisions over a 12-year period. *Archives of Pediatrics & Adolescent Medicine*
47 602 2005;159(3):212-16. doi: 10.1001/archpedi.159.3.212
- 48
49 603 83. Hauer KE, Fagan MJ, Kernan W, et al. Internal medicine clerkship directors' perceptions about
50 604 student interest in internal medicine careers. *Journal of General Internal Medicine*
51 605 2008;23(7):1101-04. doi: 10.1007/s11606-008-0640-y
- 52
53 606 84. Labiris G, Vamvakerou V, Tsolakaki O, et al. Perceptions of Greek medical students regarding
54 607 medical profession and the specialty selection process during the economic crisis years. *Health*

- 1
2
3
4
5 608 *Policy* 2014;117(2):203-09. doi: 10.1016/j.healthpol.2014.04.009
- 6
7 609 85. Lambert TW, Goldacre MJ, Bron AJ. Career choices for ophthalmology made by newly qualified
8 610 doctors in the United Kingdom, 1974-2005. *Bmc Ophthalmology* 2008;8:9. doi: 10.1186/1471-
9 611 2415-8-3
- 10
11 612 86. Shah HH, Jhaveri KD, Sparks MA, et al. Career Choice Selection and Satisfaction among US Adult
12 613 Nephrology Fellows. *Clinical Journal of the American Society of Nephrology* 2012;7(9):1513-
13 614 20. doi: 10.2215/cjn.01620212
- 14
15 615 87. Lefevre JH, Roupret M, Kerneis S, et al. Career choices of medical students: a national survey of
16 616 1780 students. *Medical Education* 2010;44(6):603-12. doi: 10.1111/j.1365-2923.2010.03707.x
- 17
18 617 88. Vicente B, Rosel L. Challenges for psychiatric recruitment and training in Chile. *International*
19 618 *Review of Psychiatry* 2013;25(4):413-18. doi: 10.3109/09540261.2013.822348
- 20
21 619 89. Wiesenfeld L, Abbey S, Takahashi SG, et al. Choosing Psychiatry as a Career: Motivators and
22 620 Deterrents at a Critical Decision-Making Juncture. *Canadian Journal of Psychiatry-Revue*
23 621 *Canadienne De Psychiatrie* 2014;59(8):450-54.
- 24
25 622 90. Lam CYY, Cheung CSY, Hui ASY. Factors influencing the career interest of medical graduates in
26 623 obstetrics and gynaecology in Hong Kong: a cross-sectional questionnaire survey. *Hong Kong*
27 624 *Medical Journal* 2016;22(2):138-43.
- 28
29 625 91. Hartung PJ, Taber BJ, Richard GV. The physician values in practice scale: Construction and initial
30 626 validation. *Journal of Vocational Behavior* 2005;67(2):309-20. doi: 10.1016/j.jvb.2004.05.008
- 31
32 627 92. Girasek E, Molnar R, Eke E, et al. The medical career choice motivations - Results from a Hungarian
33 628 study. *Central European Journal of Medicine* 2011;6(4):502-09. doi: 10.2478/s11536-011-
34 629 0034-0
- 35
36 630 93. Zuccato JA, Kulkarni AV. The Impact of Early Medical School Surgical Exposure on Interest in
37 631 Neurosurgery. *Canadian Journal of Neurological Sciences* 2016;43(3):410-16. doi:
38 632 10.1017/cjn.2015.332
- 39
40 633 94. Wilbanks L, Spollen J, Messias E. Factors Influencing Medical School Graduates Toward a Career
41 634 in Psychiatry: Analysis from the 2011-2013 Association of American Medical Colleges
42 635 Graduation Questionnaire. *Academic Psychiatry* 2016;40(2):255-60. doi: 10.1007/s40596-015-
43 636 0287-z
- 44
45 637 95. West CP, Drefahl MM, Popkave C, et al. Internal Medicine Resident Self-report of Factors
46 638 Associated with Career Decisions. *Journal of General Internal Medicine* 2009;24(8):946-49.
47 639 doi: 10.1007/s11606-009-1039-0
- 48
49
50 640 96. Watmough S, Taylor D, Ryland I. Using questionnaires to determine whether medical graduates'
51 641 career choice is determined by undergraduate or postgraduate experiences. *Medical Teacher*
52 642 2007;29(8):830-32. doi: 10.1080/01421590701551755
- 53
54 643 97. Thakur A, Fedorka P, Ko C, et al. Impact of mentor guidance in surgical career selection. *Journal*
55 644 *of Pediatric Surgery* 2001;36(12):1802-04. doi: 10.1053/jpsu.2001.28842

- 1
2
3
4
5 645 98. Scott I, Gowans M, Wright B, et al. Determinants of choosing a career in surgery. *Medical Teacher*
6 646 2011;33(12):1011-17. doi: 10.3109/0142159x.2011.558533
- 7
8 647 99. Schnuth RL, Vasilenko P, Mavis B, et al. What influences medical students to pursue careers in
9 648 obstetrics and gynecology? *American Journal of Obstetrics and Gynecology* 2003;189(3):639-
10 649 43. doi: 10.1067/s0002-9378(03)00886-x
- 11
12 650 100. Richards JMJ, Drummond R, Murray J, et al. WHAT PROPORTION OF BASIC SURGICAL
13 651 TRAINEES CONTINUE IN A SURGICAL CAREER? A SURVEY OF THE FACTORS
14 652 WHICH ARE IMPORTANT IN INFLUENCING CAREER DECISIONS. *Surgeon-Journal of*
15 653 *the Royal Colleges of Surgeons of Edinburgh and Ireland* 2009;7(5):270-75.
- 16
17 654 101. Reed CE, Vaporciyan AA, Erikson C, et al. Factors Dominating Choice of Surgical Specialty.
18 655 *Journal of the American College of Surgeons* 2010;210(3):319-24. doi:
19 656 10.1016/j.jamcollsurg.2009.11.016
- 20
21 657 102. de Souza LCL, Mendonca VRR, Garcia GBC, et al. Medical Specialty Choice and Related Factors
22 658 of Brazilian Medical Students and Recent Doctors. *Plos One* 2015;10(7):15. doi:
23 659 10.1371/journal.pone.0133585
- 24
25 660 103. Pikoulis E, Avgerinos ED, Pedeli X, et al. Medical students' perceptions on factors influencing a
26 661 surgical career: The fate of general surgery in Greece. *Surgery* 2010;148(3):510-15. doi:
27 662 10.1016/j.surg.2010.01.013
- 28
29 663 104. Ozer U, Ceri V, Carpar E, et al. Factors Affecting the Choice of Psychiatry as a Specialty and
30 664 Satisfaction among Turkish Psychiatry Residents. *Academic Psychiatry* 2016;40(2):299-303.
31 665 doi: 10.1007/s40596-015-0346-5
- 32
33 666 105. Noble J, Hechter FJ, Karaiskos N, et al. Motivational factors and future life plans of orthodontic
34 667 residents in the United States. *American Journal of Orthodontics and Dentofacial Orthopedics*
35 668 2010;137(5):623-30. doi: 10.1016/j.ajodo.2008.03.034
- 36
37 669 106. Noble J. Factors influencing career choice in ophthalmology. *Canadian Journal of Ophthalmology-*
38 670 *Journal Canadien D Ophthalmologie* 2006;41(5):596-99.
- 39
40
41 671 107. Newton DA, Grayson MS, Thompson LF. The variable influence of lifestyle and income on
42 672 medical students' career specialty choices: Data from two US medical schools, 1998-2004.
43 673 *Academic Medicine* 2005;80(9):809-14. doi: 10.1097/00001888-200509000-00005
- 44
45 674 108. Moore HB, Moore PK, Grant AR, et al. Future of acute care surgery: A perspective from the next
46 675 generation. *Journal of Trauma and Acute Care Surgery* 2012;72(1):94-99. doi:
47 676 10.1097/TA.0b013e31823b990a
- 48
49 677 109. Momen AA, Shakurnia A. Factors Influencing Pediatric Specialty Choice among Pediatric
50 678 Residents of Ahvaz Jundishapur University of Medical Sciences. *International Journal of*
51 679 *Pediatrics-Mashhad* 2015;3(3):701-06.
- 52
53 680 110. Mehmood SI, Kumar A, Al-Binali A, et al. Specialty preferences: Trends and perceptions among
54 681 Saudi undergraduate medical students. *Medical Teacher* 2012;34:S51-S60. doi:
55 682 10.3109/0142159x.2012.656753

- 1
2
3
4
5 683 111. Lorient Y, Albiges-Sauvin L, Dionysopoulos D, et al. Why do residents choose the medical oncology
6 684 specialty? Implications for future recruitment-results of the 2007 French Association of
7 685 Residents in Oncology (AERIO) Survey. *Annals of Oncology* 2010;21(1):161-65. doi:
8 686 10.1093/annonc/mdp294
- 9
10 687 112. Lefevre JH, Karila L, Kerneis S, et al. Motivation of French medical students to pursue surgical
11 688 careers: Results of national survey of 1742 students. *Journal of Visceral Surgery*
12 689 2010;147(3):E181-E86. doi: 10.1016/j.jviscsurg.2010.08.004
- 13
14 690 113. Vo A, McLean L, McInnes MDF. Medical specialty preferences in early medical school training
15 691 in Canada. *Int J Med Educ* 2017;8:400-07. doi: 10.5116/ijme.59f4.3c15
- 16
17 692 114. Grasreiner D, Dahmen U, Settmacher U. Specialty preferences and influencing factors: a repeated
18 693 cross-sectional survey of first- to sixth-year medical students in Jena, Germany. *BMC medical*
19 694 *education* 2018;18 doi: ARTN 103
20
21 695 10.1186/s12909-018-1200-8
22
- 23 696 115. Alkhaneen H, Alhusain F, Alshahri K, et al. Factors influencing medical students' choice of
24 697 emergency medicine as a career specialty-a descriptive study of Saudi medical students.
25 698 *International journal of emergency medicine* 2018;11(1):14. doi: 10.1186/s12245-018-0174-y
26 699 [published Online First: 2018/03/09]
27
28 700
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 701 **Legends**
6
7

8 702 **Table 1. Selected Characteristics of the 75 Studies Included in this Systematic**
9
10 703 **Review and Meta-analysis**
11
12

13 704 **Table 2. Meta-analyses of the Factors Influencing Medical Students' Choice of**
14
15 705 **Subspecialty**
16
17

18 706 **Table 3. Meta-regression of the EOI Value Stratified by Study-level**
19
20 707 **Characteristics**
21
22

23
24 708 **Figure 1. Bar Graph of the Meta-analyses of the Factors Influencing Medical**
25
26 709 **Students' Choice of Subspecialty Stratified by Region.**
27
28

29 710 **Figure 2. Bar Graph of the Meta-analyses of the Factors Influencing Medical**
30
31 711 **Students' Choice of Subspecialty Stratified by Survey Year.**
32
33

34
35 712 **Supplements**
36
37

38 713 **Methods S1. Search strategy used in the current systematic review and meta-**
39
40 714 **analysis.**
41
42

43 715 **Table S1. Quality Assessment of the Included Studies.**
44
45

46 716 **Table S2. Meta-analyses of the Factors Influencing Medical Students' Choice of**
47
48 717 **Subspecialty Stratified by Region and Survey Year.**
49
50

51
52 718 **Figure S1. Flow Diagram of the Study Inclusion Process.**
53
54

55 719 **Figure S2. Forest Plot of "Academic Interest".**
56
57

- 1
2
3
4
5 720 **Figure S3. Forest Plot of “Competencies”.**
6
7
8 721 **Figure S4. Forest Plot of “Controllable Lifestyle or Flexible Work Schedule”.**
9
10
11 722 **Figure S5. Forest Plot of “Patient Service Orientation”.**
12
13
14 723 **Figure S6. Forest Plot of “Medical Teachers or Mentors”.**
15
16
17 724 **Figure S7. Forest Plot of “Career Opportunities”.**
18
19
20 725 **Figure S8. Forest Plot of “Workload or Working Hours”.**
21
22
23 726 **Figure S9. Forest Plot of “Income”.**
24
25
26 727 **Figure S10. Forest Plot of “Length of Training”.**
27
28
29 728 **Figure S11. Forest Plot of “Prestige”.**
30
31
32 729 **Figure S12. Forest Plot of “Advice from Others”.**
33
34
35 730 **Figure S13. Forest Plot of “Student Debt”.**
36
37
38 731 **Figure S14. Funnel Plots of the Publication Bias Tests of the 12 Factors.**
39
40
41
42 732
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Table 1. Selected Characteristics of the 75 Studies Included in this Systematic Review and Meta-analysis

First Author, Year	Country	Survey years	Sample size	Average age	Men, No. (%)	Scores
Smith et al, ⁴³ 2015	UK	2012	2,978	NR	NR	6
Cochran et al, ⁴⁴ 2005	USA	2002	408	27.2	214 (52.45)	5
Hauer et al, ⁴⁵ 2008	USA	2007	1,177	NR	NR	6
Johnson et al, ⁴⁶ 2012	USA	2012	622	NR	NR	6
Kiolbassa et al, ⁴⁷ 2011	Germany	2010	1,114	24.1	408 (36.62)	5
Klingensmith et al, ⁴⁸ 2015	USA	2013	792	NR	539 (68.06)	6
Lee et al, ⁴⁹ 2012	USA	2012	100	NR	58 (58)	7
Macdonald et al, ⁵⁰ 2012	New Zealand	2011	134	NR	79 (58.96)	7
Parsa et al, ³⁹ 2010	Iran	2006-2007	137	27.34	49 (35.77)	7
Paiva et al, ⁵¹ 1982	USA	1982	144	NR	NR	6
Ni Chroinin et al, ⁵² 2013	UK	2009-2011	274	NR	112 (40.89)	7
Newton et al, ³⁴ 2005	USA	1998-2004	1,258	NR	642 (51.03)	8
Rogers et al, ⁵³ 1990	USA	1989	266	NR	205 (77.07)	6
Abendroth J et al, ⁵⁴ 2014	Germany	2007-2012	45	NR	14 (31)	7
Alawad et al, ⁵⁵ 2015	USA	2010-2011	45	NR	36 (80)	8
Azizzadeh et al, ⁵⁶ 2003	USA	2002	130	NR	NR	6
Celenza et al, ⁵⁷ 2012	Australia	2009	216	NR	121 (56.02)	8
Dolan-Evans et al, ⁵⁸ 2014	Australia	2013	419	NR	215 (51.31)	8
Boyd et al, ⁵⁹ 2009	USA	2005-2006	5,848	NR	2,982 (50.99)	8
Egerton et al, ⁶⁰ 1985	Ireland	1977-1981	134	30	82 (61.19)	6
Diderichsen et al, ⁶¹ 2013	Sweden	2006-2009	372	27	157 (42.20)	6
Ferrari et al, ⁶² 2013	Italy, UK	2009-2011	45	25	NR	9
Freire et al, ⁶³ 2011	Brazil	2006-2008	290	23	102 (35.17)	7
Buddeberg-Fischer et al, ⁶⁴ 2006	Switzerland	2001-2003	522	31.1	241 (46.17)	9
Dorsey et al, ⁶⁵ 2005	USA	2003	11,029	NR	4,964 (45.01)	6
Ekenze et al, ⁶⁶ 2013	Nigeria	2009-2010	96	25.9	NR	7
Barikani et al, ⁶⁷ 2012	Australia	2008-2009	49	21.7	NR	6
Bittaye et al, ⁶⁸ 2012	Gambia	2011	106	24.1	48 (45.28)	6
Bonura et al, ⁶⁹ 2016	USA	2015	590	NR	321 (54.40)	9
Al-Fouzan et al, ⁷⁰ 2012	Kuwait	2011-2012	144	NR	NR	7
AlKot et al, ⁷¹ 2015	Egypt	2013	451	21.8	NR	7
Borges et al, ⁷² 2009	USA	2001-2005	341	NR	NR	5
Budd et al, ⁷³ 2011	UK	2011	870	22	NR	7
Corrigan et al, ⁷⁴ 2007	Ireland	2007	222	NR	142 (63.96)	7
Davis et al, ⁷⁵ 2016	UK	2016	173	NR	76 (43.93)	7

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Deutsch et al, ⁷⁶ 2015	Germany	2011	659	27.9	NR	8
Gardner et al, ⁷⁷ 2014	Australia	1993-2005	631	NR	NR	7
Dias et al, ⁷⁸ 2013	UK	2013	495	NR	438 (88.48)	5
Goltz et al, ⁷⁹ 2013	USA	2012	102	24.5	34 (33.33)	6
Gupta et al, ⁸⁰ 2013	India	2013	243	NR	179 (73.36)	6
Hanzlick et al, ⁸¹ 2008	USA	2006	161	NR	NR	6
Harris et al, ⁸² 2005	USA	1991-2002	104	NR	53 (50.96)	6
Hauer et al, ⁸³ 2008	USA	2008	80	NR	NR	6
Labiris et al, ⁸⁴ 2014	Greece	2014	111	23.6	55 (49.54)	6
Lambert et al, ⁸⁵ 2008	UK	2007	17,393	NR	NR	6
Shah et al, ⁸⁶ 2012	USA	2011	892	NR	NR	6
Lefevre et al, ⁸⁷ 2010	USA	2008	1,555	NR	589 (37.88)	6
Vicente et al, ⁸⁸ 2013	Chile	2013	30	NR	NR	6
Wiesenfeld et al, ⁸⁹ 2014	Canada	2013	60	NR	NR	7
Lam et al, ⁹⁰ 2016	Hong Kong	2015	228	23	NR	9
Hartung et al, ⁹¹ 2005	USA	2004	192	20.59	74 (38.54)	4
Girasek et al, ⁹² 2011	Hungary	2011	536	NR	NR	5
Zuccato et al, ⁹³ 2015	Canada	2012	37	NR	24 (65)	6
Wilbanks et al, ⁹⁴ 2015	USA	2011-2013	29,227	NR	15,164 (51.99)	9
West et al, ⁹⁵ 2009	USA	2005-2007	14,890	NR	8,700 (58.43)	6
Watmough et al, ⁹⁶ 2007	UK	2005	116	NR	66 (56.90)	4
Thakur et al, ⁹⁷ 2001	USA	2001	56	NR	53 (95)	8
Scott et al, ⁹⁸ 2011	Canada	2002-2004	1,542	NR	NR	6
Schnuth et al, ⁹⁹ 2003	USA	2002	203	NR	72 (53.47)	6
Richards et al, ¹⁰⁰ 2009	UK	2009	150	NR	108 (72.00)	5
Reed et al, ¹⁰¹ 2009	USA	2008	2,022	NR	1,354 (66.96)	9
de Souza et al, ¹⁰² 2015	Portugal	2012	1,303	NR	NR	7
Pikoulis et al, ¹⁰³ 2010	Greece	2006-2007	87	NR	NR	6
Ozer et al, ¹⁰⁴ 2015	Turkey	2013	98	27.7	26 (26.53)	6
Noble et al, ¹⁰⁵ 2004	Canada	2004	21,296	NR	NR	8
Noble et al, ¹⁰⁶ 2010	Canada	2007	120	NR	NR	5
Newton et al, ¹⁰⁷ 2005	USA	2004	1,286	NR	NR	6
Moore et al, ¹⁰⁸ 2012	USA	2011	337	26	179 (53.12)	6
Momen et al, ¹⁰⁹ 2015	Iran	2014-2015	38	35.6	11 (29)	6
Mehmood et al, ¹¹⁰ 2012	Saudi Arabia	2012	550	NR	348 (63.27)	6
Loriot et al, ¹¹¹ 2010	France	2007	44	NR	17 (39)	7
Lefevre et al, ¹¹² 2010	France	2008	522	23.8	198 (37.93)	7
Vo et al, ¹¹³ 2017	Canada	2017	90	22.5	52 (57.78)	5
Grasreiner et al, ¹¹⁴ 2018	Germany	2014-2016	181	24	33 (18.10)	6
Alkhaman et al, ¹¹⁵ 2018	Saudi Arabia	2017	436	NA	250 (57.00)	5

733 Footnotes: scores: quality score of the AHRQ scale.

734

Table 2. Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty

Factor	No. of studies	Total no. of participants	EOI value (%)	95 CI% of EOI value		Cochran's <i>Q</i>	<i>I</i> -square (%)	Tau-square	<i>P</i> -Value
				Lower	Upper				
Academic interests	38	82,366	75.29	66.93	82.11	14719.76	99.70	1.60	<0.0001
Competencies	17	76,515	55.15	33.63	74.90	23572.74	99.90	3.44	<0.0001
Controllable lifestyle or flexible work schedule	44	101,001	53.00	47.90	58.03	8624.46	99.50	0.45	<0.0001
Patient service orientation	37	46,572	50.04	44.65	55.43	2668.79	98.70	0.41	<0.0001
Medical teachers or mentors	32	85,071	46.93	37.77	56.30	15216.32	99.80	1.14	<0.0001
Career opportunities	38	81,923	44.00	32.26	48.78	13553.20	99.70	1.15	<0.0001
Workload or working hours	20	22,051	37.99	29.59	47.19	584.81	98.30	0.69	<0.0001
Income	50	109,791	34.70	28.36	41.62	16952.48	99.70	1.09	<0.0001
Length of training	18	42,046	32.30	27.61	37.37	917.21	98.10	0.20	<0.0001
Prestige	26	30,629	31.17	26.32	37.69	1464.67	98.30	0.52	<0.0001
Advice from others	18	82,692	28.24	22.26	34.23	7679.73	99.80	0.02	<0.0001
Student debt	8	38,917	15.33	10.96	21.03	574.81	98.80	0.27	<0.0001

735

Table 3. Meta-regression of the EOI Value Stratified by Study-level Characteristics

Factor		estimate	95 CI% of estimate		P-Value
			Lower	Upper	
Academic interests	Country	-0.2314	-1.1575	0.6946	0.6302
	Survey years	0.3811	-0.3580	1.1202	0.2711
	Specialty	-0.4892	-1.5345	0.5562	0.4008
	Sample size	0.2362	-0.5488	1.0212	0.6537
Competencies	Country	0.6946	-1.1461	0.8938	0.8376
	Survey years	-1.0418	-2.0950	0.0114	0.0151
	Specialty	0.0904	-1.5786	1.7594	0.9398
	Sample size	-0.5720	-1.8606	0.7166	0.5823
Controllable lifestyle or flexible work schedule	Country	-0.1261	-1.1461	0.8938	0.9614
	Survey years	-0.0001	-0.4052	0.4051	0.9822
	Specialty	-0.8989	-1.4979	-0.3000	0.0035
	Sample size	-0.0518	-0.4396	0.3361	0.7203
Patient service orientation	Country	-0.6238	-1.3118	0.0642	0.0833
	Survey years	-0.0414	-0.6912	0.6083	0.8524
	Specialty	-1.5982	-2.5227	-0.6737	0.0010
	Sample size	-0.1157	-0.7473	0.5159	0.6358
Medical teachers or mentors	Country	0.7395	0.3117	1.1674	0.0007
	Survey years	0.1133	-0.3580	0.5845	0.6376
	Specialty	0.0605	-0.4441	0.5652	0.8141
	Sample size	-0.1202	-0.5567	0.3163	0.5894
Career opportunities	Country	0.1075	-0.7030	0.9179	0.5828
	Survey years	0.3284	-0.3913	1.0480	0.7546
	Specialty	-0.9292	-1.8015	-0.0570	0.0077
	Sample size	0.3654	0.1156	1.5478	0.0081
Workload or working hours	Country	-0.4535	-1.5086	0.6016	0.3981
	Survey years	0.4624	-0.5417	1.4665	0.3922
	Specialty	-0.9878	-2.1727	0.1972	0.1070
	Sample size	0.0982	-0.8589	1.0553	0.8205
Income	Country	0.1058	-0.4665	0.6781	0.7390
	Survey years	0.0999	-0.4379	0.6377	0.8774
	Specialty	-0.6457	-1.3267	0.0352	0.0480
	Sample size	0.0523	-0.4826	0.5872	0.6786
Length of training	Country	-0.1559	-1.2782	0.9664	0.7854
	Survey years	-0.2158	-1.4089	0.9772	0.7229
	Specialty	0.3959	-0.9585	1.7502	0.5667
	Sample size	0.1565	-0.6631	0.9761	0.7082

	Country	-0.3346	-1.0799	0.4106	0.3485
Prestige	Survey years	-0.4513	-1.1378	0.2352	0.0950
	Specialty	-1.0112	-1.8980	-0.1244	0.0172
	Sample size	0.0355	-0.6013	0.6723	0.5214
	Country	-0.0097	-0.0722	0.0529	0.9328
Advice from others	Survey years	-0.0861	-0.1471	-0.0251	0.0057
	Specialty	-0.2017	-0.2790	-0.1244	<0.0001
	Sample size	0.2125	0.1309	0.2941	<0.0001
	Country	2.7853	2.0544	3.5162	0.0001
Student debt	Survey years	-0.1567	-0.6707	0.3573	0.5502
	Sample size	-0.5248	-1.0108	-0.0388	0.0343

736

For peer review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

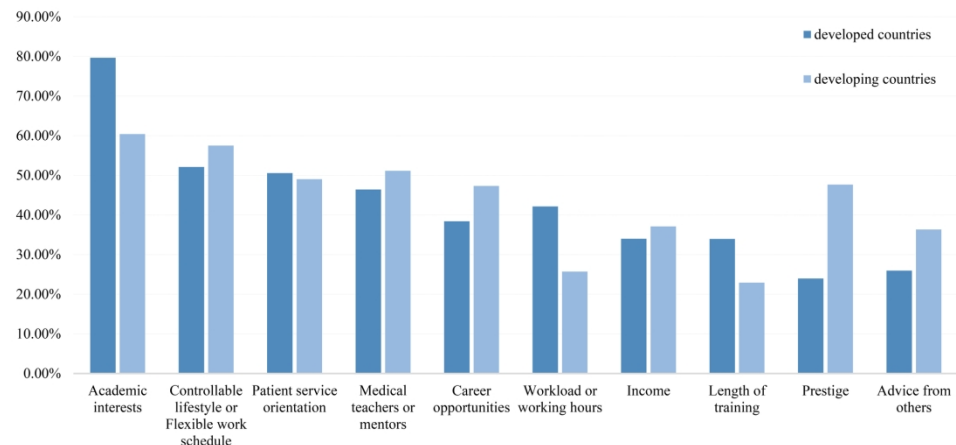


Figure 1. Bar Graph of the Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty Stratified by Region.

190x107mm (300 x 300 DPI)

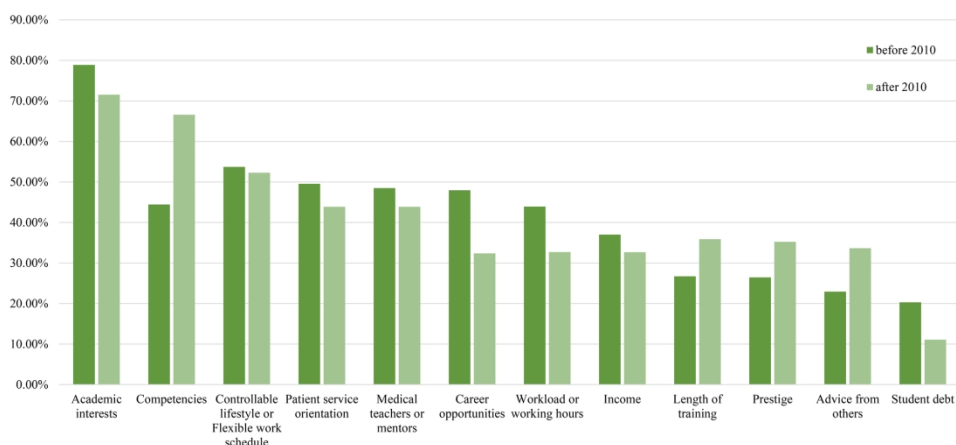


Figure 2. Bar Graph of the Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty Stratified by Survey Year.

190x107mm (300 x 300 DPI)

1
2
3
4 **SI Methods. Search strategy used in the current systematic review and meta-**
5
6 **analysis.**
7
8
9

10
11 ***Medical Students***

- 12
13
14 1. Students, Medical [Mesh]
15
16 2. Medical students
17
18 3. Medical student
19
20 4. Student, Medical
21
22 5. OR / 1 – 4
23
24
25
26
27
28
29

13. Cross sectional study
14. Cross sectional study [Publication
Type]
15. Cross sectional study [Mesh Terms]
16. Systematic review
17. Systematic review [Publication Type]
18. Systematic review [Mesh Terms]

30 ***Subspecialty Choice***

- 31
32 6. Career choices
33
34 7. Choice, Career
35
36 8. Choices career
37
38 9. Specialties
39
40
41
42 10. Sub-specialties
43
44 11. Sub-discipline
45
46
47 12. OR / 6 – 11
48
49
50

19. Meta-analysis [Title/Abstract]
20. Meta-analysis [Mesh Terms]
21. Meta-analysis [Publication Type]
22. OR / 12 – 21

51 ***Factors***

23. Factors

52 ***Combined search***

53 ***Study design***

23. #5 AND #12AND #22 AND #2

54 **Abbreviations:** MeSH, Medical Subject Heading in PubMed
55
56
57
58
59
60

Table S1. Quality assessment of the included studies

Quality assessment criteria	1	2	3	4	5	6	7	8	9	10	11	Scores
1 Smith et al, ⁴¹ 2015	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
2 Cochran et al, ⁴² 2005	Y	U	Y	Y	N	Y	N	Y	N	N	N	5
3 Hauer et al, ⁴³ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
4 Johnson et al, ⁴⁴ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
5 Kiolbassa et al, ⁴⁵ 2011	Y	U	Y	Y	N	Y	N	Y	N	N	N	5
6 Klingensmith et al, ⁴⁶ 2015	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
7 Lee et al, ⁴⁷ 2012	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
8 Macdonald et al, ⁴⁸ 2012	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
9 Parsa et al, ³⁷ 2010	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
10 Paiva et al, ⁴⁹ 1982	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
11 Ni Chroinin et al, ⁵⁰ 2013	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
12 Newton et al, ³² 2005	Y	U	Y	Y	Y	Y	Y	Y	N	Y	N	8
13 Rogers et al, ⁵¹ 1990	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
14 Abendroth J et al, ⁵² 2014	Y	U	Y	Y	N	Y	N	Y	N	Y	Y	7
15 Alawad et al, ⁵³ 2015	Y	U	Y	Y	N	Y	Y	Y	Y	Y	N	8
16 Azizzadeh et al, ⁵⁴ 2003	Y	U	Y	Y	Y	Y	N	N	N	Y	N	6
17 Celenza et al, ⁵⁵ 2012	Y	U	Y	Y	Y	Y	Y	N	Y	Y	N	8
18 Dolan-Evans et al, ⁵⁶ 2014	Y	U	Y	Y	Y	Y	N	Y	N	Y	Y	8
19 Boyd et al, ⁵⁷ 2009	Y	U	Y	Y	Y	Y	Y	Y	N	Y	N	8
20 Egerton et al, ⁵⁸ 1985	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
21 Diderichsen et al, ⁵⁹ 2013	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
22 Ferrari et al, ⁶⁰ 2013	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
23 Freire et al, ⁶¹ 2011	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
24 Buddeberg-Fischer et al, ⁶² 2006	Y	U	Y	Y	N	Y	Y	Y	Y	Y	Y	9
25 Dorsey et al, ⁶³ 2005	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
26 Ekenze et al, ⁶⁴ 2013	Y	U	Y	Y	Y	Y	Y	N	N	Y	N	7
27 Barikani et al, ⁶⁵ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
28 Bittaye et al, ⁶⁶ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
39 Bonura et al, ⁶⁷ 2016	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
30 Al-Fouzan et al, ⁶⁸ 2012	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
31 AlKot et al, ⁶⁹ 2015	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
32 Borges et al, ⁷⁰ 2009	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
33 Budd et al, ⁷¹ 2011	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
34 Corrigan et al, ⁷² 2007	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
35 Davis et al, ⁷³ 2016	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
36 Deutsch et al, ⁷⁴ 2015	Y	U	Y	Y	Y	Y	N	Y	Y	Y	N	8
37 Gardner et al, ⁷⁵ 2014	Y	U	Y	Y	N	Y	N	Y	N	Y	N	7
38 Dias et al, ⁷⁶ 2013	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
39 Goltz et al, ⁷⁷ 2013	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
40 Gupta et al, ⁷⁸ 2013	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
41 Hanzlick et al, ⁷⁹ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
42 Harris et al, ⁸⁰ 2005	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
43 Hauer et al, ⁸¹ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
44 Labiris et al, ⁸² 2014	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
45 Lambert et al, ⁸³ 2008	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
46 Shah et al, ⁸⁴ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
47 Lefevre et al, ⁸⁵ 2010	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
48 Vicente et al, ⁸⁶ 2013	Y	U	Y	Y	N	N	Y	N	Y	Y	N	6
49 Wiesenfeld et al, ⁸⁷ 2014	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
50 Lam et al, ⁸⁸ 2016	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
51 Hartung et al, ⁸⁹ 2005	Y	U	Y	Y	N	Y	N	N	N	N	N	4
52 Girasek et al, ⁹⁰ 2011	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
53 Zuccato et al, ⁹¹ 2015	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
54 Wilbanks et al, ⁹² 2015	Y	U	Y	Y	N	Y	Y	Y	Y	Y	Y	9
55 West et al, ⁹³ 2009	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
56 Watmough et al, ⁹⁴ 2007	Y	U	Y	Y	N	N	N	N	N	Y	N	4
57 Thakur et al, ⁹⁵ 2001	Y	U	Y	Y	Y	Y	Y	N	Y	Y	N	8
58 Scott et al, ⁹⁶ 2011	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
59 Schnuth et al, ⁹⁷ 2003	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
60 Richards et al, ⁹⁸ 2009	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
61 Reed et al, ⁹⁹ 2009	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	N	9
62 de Souza et al, ¹⁰⁰ 2015	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
63 Pikoulis et al, ¹⁰¹ 2010	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
64 Ozer et al, ¹⁰² 2015	Y	U	Y	Y	N	N	Y	N	Y	Y	N	6
65 Noble et al, ¹⁰³ 2004	Y	U	Y	Y	Y	Y	Y	Y	N	Y	N	8
66 Noble et al, ¹⁰⁴ 2010	Y	U	Y	Y	N	Y	N	N	N	Y	N	5
67 Newton et al, ¹⁰⁵ 2005	Y	U	Y	Y	N	Y	Y	N	N	Y	N	6
68 Moore et al, ¹⁰⁶ 2012	Y	U	Y	Y	Y	Y	N	Y	N	N	N	6
69 Momen et al, ¹⁰⁷ 2015	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
70 Mehmood et al, ¹⁰⁸ 2012	Y	U	Y	Y	N	Y	N	Y	N	Y	N	6
71 Loriot et al, ¹⁰⁹ 2010	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
72 Lefevre et al, ¹¹⁰ 2010	Y	U	Y	Y	Y	Y	N	Y	N	Y	N	7
73 Vo et al, ¹¹¹ 2017	Y	U	Y	Y	Y	N	N	N	N	Y	N	5
74 Grasreiner et al, ¹¹² 2018	Y	U	Y	Y	Y	Y	N	N	N	Y	N	6
75 Alkhaman et al, ¹¹³ 2018	Y	U	Y	Y	N	N	Y	N	N	Y	N	5

Quality assessment criteria in detail

1. Define the source of information (survey, record review).
2. List the inclusion and exclusion criteria for the exposed and unexposed subjects (cases and controls) or refer to previous publications.
3. Indicate the time period used for identifying patients.
4. Indicate whether the subjects were consecutive if not population-based.
5. Indicate whether the evaluators of the subjective components of the study were masked to the other aspects of participants' status.
6. Describe any assessments undertaken for quality assurance purposes (e.g., test/retest of primary outcome measurements)
7. Explain any patient exclusion from the analyses.
8. Describe how confounding was assessed and/or controlled.
9. If applicable, explain how missing data were handled in the analysis.
10. Summarize the patient response rates and the completeness of the data collection.
11. Clarify what follow-up, if any, was expected and the percentage of patients with incomplete data or follow-up.

“Y”: Yes; “N”: No; “U”: Unclear.

Table S2. Meta-analyses of the Factors Influencing Medical Students' Choice of Subspecialty Stratified by Region and Survey Year.

Factor		No. of studies	Total no. of participants	Extent of influence (%)	95 CI% of EOI value		<i>I-square</i> (%)	<i>P</i> -Value	<i>Q</i> -Value		
					Lower	Upper					
Academic interest	developed	28	80,000	79.66	70.73	86.39	99.8	0.02	3.51		
	developing	10	2,366	60.41	43.44	75.19	98.0				
	before 2010	29	44,174	78.88	69.04	86.22	99.7	0.40	1.21		
	after 2010	9	38,192	71.54	57.66	82.27	99.6				
Competencies	before 2010	9	43,134	44.40	29.11	60.83	99.8	0.21	1.86		
	after 2010	8	33,381	66.60	34.48	88.31	99.8				
Controllable lifestyle or flexible work schedule	developed	37	100,980	52.11	46.52	57.65	99.6	0.63	0.68		
	developing	7	2,017	57.50	45.81	68.41	95.9				
	before 2010	22	62,945	53.72	47.48	59.84	99.4			0.97	0.05
after 2010	22	40,056	52.29	43.51	60.93	99.2					
Patient service orientation	developed	27	44,235	50.56	44.68	56.42	98.8	0.74	0.48		
	developing	10	2,337	49.02	31.62	66.67	98.1				
	before 2010	18	40,997	49.56	43.29	55.84	98.8			0.70	0.54
	after 2010	19	5,579	43.87	38.62	63.80	98.3				
Medical teachers or mentors	developed	28	84,076	46.43	36.63	56.52	99.8	0.73	0.48		
	developing	4	995	51.14	33.97	68.04	95.4				
	before 2010	21	49,654	48.48	36.93	60.19	99.8			0.70	0.54
	after 2010	11	35,417	43.87	27.94	61.18	99.7				
Career opportunities	developed	31	79,867	38.41	29.61	48.04	99.8	0.60	0.74		
	developing	7	2,056	47.32	30.38	64.91	98.1				
	before 2010	20	43,417	47.97	33.54	62.74	99.8			0.24	1.68
	after 2010	18	38,506	32.38	21.68	45.31	99.5				
Workload or working hours	developed	15	20,970	42.14	31.35	53.72	98.6	0.34	1.39		
	developing	5	1,081	25.72	13.29	43.88	95.3				
	before 2010	9	19,456	43.93	29.43	59.54	98.8			0.41	1.21
	after 2010	11	2,595	32.70	29.43	59.54	97.4				
Income	developed	39	107,091	34.01	26.89	41.93	99.8	0.84	0.29		
	developing	11	2,700	37.11	27.06	48.41	96.4				
	before 2010	25	68,714	37.01	25.95	49.62	99.8			0.41	1.18
	after 2010	25	41,077	32.67	26.04	40.07	98.9				
Length of training	developed	15	41,246	33.95	28.72	39.60	98.4	0.31	1.48		
	developing	3	800	22.92	10.94	41.85	94.0				
	before 2010	7	8,811	26.72	15.89	41.29	98.9			0.28	1.59
	after 2010	11	33,234	35.87	29.67	42.59	96.9				
Prestige	developed	17	27,987	23.96	19.20	29.47	97.3	0.01	4.71		
	developing	9	2,642	47.65	34.41	61.24	97.6				
	before 2010	12	25,542	26.46	20.78	33.03	96.7			0.25	1.67
	after 2010	14	5,087	35.22	24.70	47.40	98.3				
Advice from others	developed	14	81,205	25.95	19.27	32.64	99.8	0.36	1.33		
	developing	4	1,487	36.34	18.91	53.77	98.1				
	before 2010	10	48,319	22.93	17.85	28.01	99.5			0.31	1.47
	after 2010	8	34,373	33.65	25.12	42.18	99.1				
Student debt	before 2010	5	6,610	20.29	15.86	25.57	81.8	0.69	0.59		
	after 2010	3	32,307	11.08	1.58	49.08	99.6				

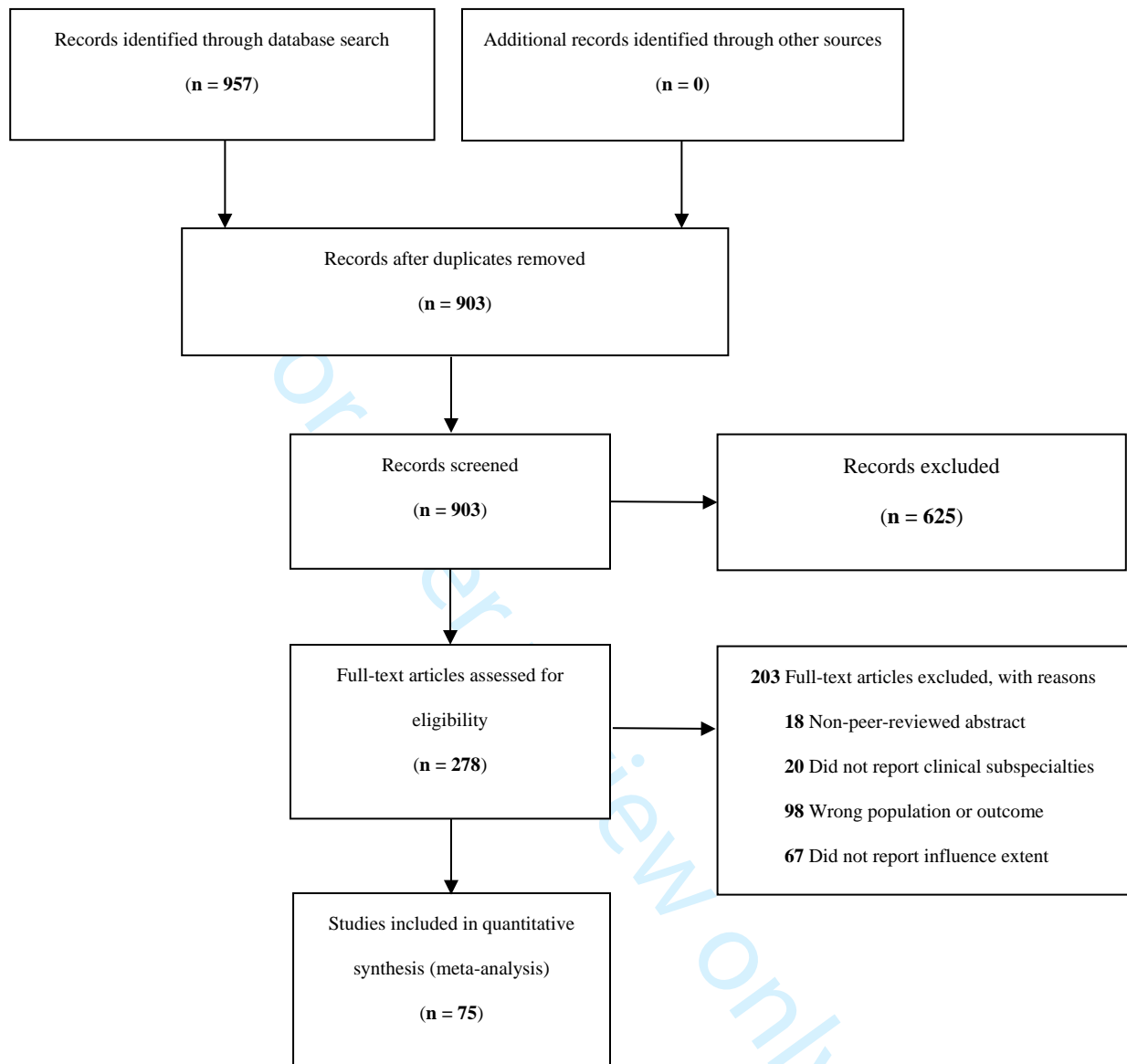
Figure S1. Flow Diagram of the Study Inclusion.

Figure S2. Forest Plot of “Academic Interest”.

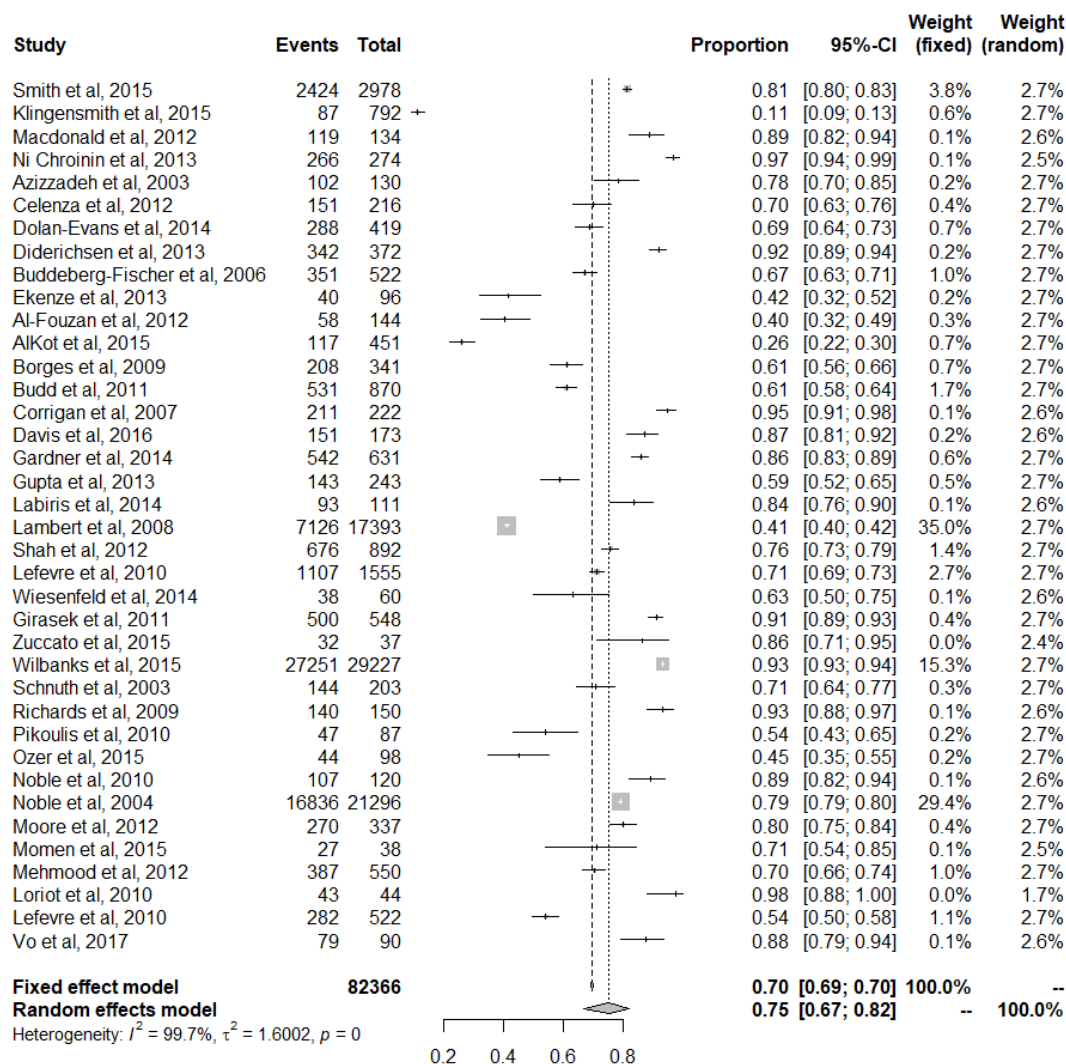
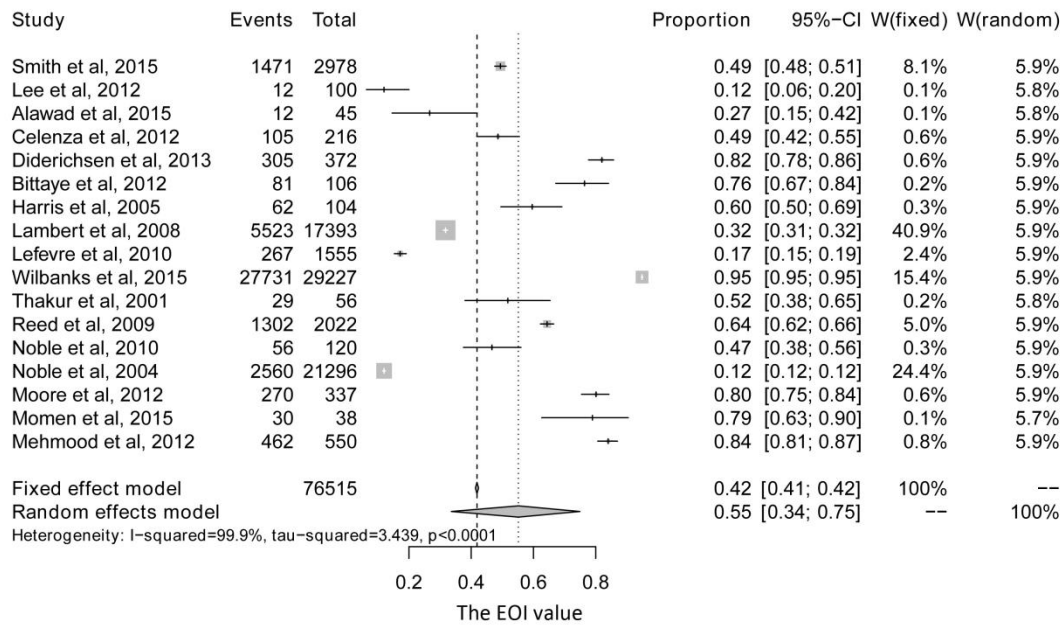


Figure S3. Forest Plot of “Competencies”.



review only

Figure S4. Forest Plot of “Controllable Lifestyle or Flexible Work Schedule”.

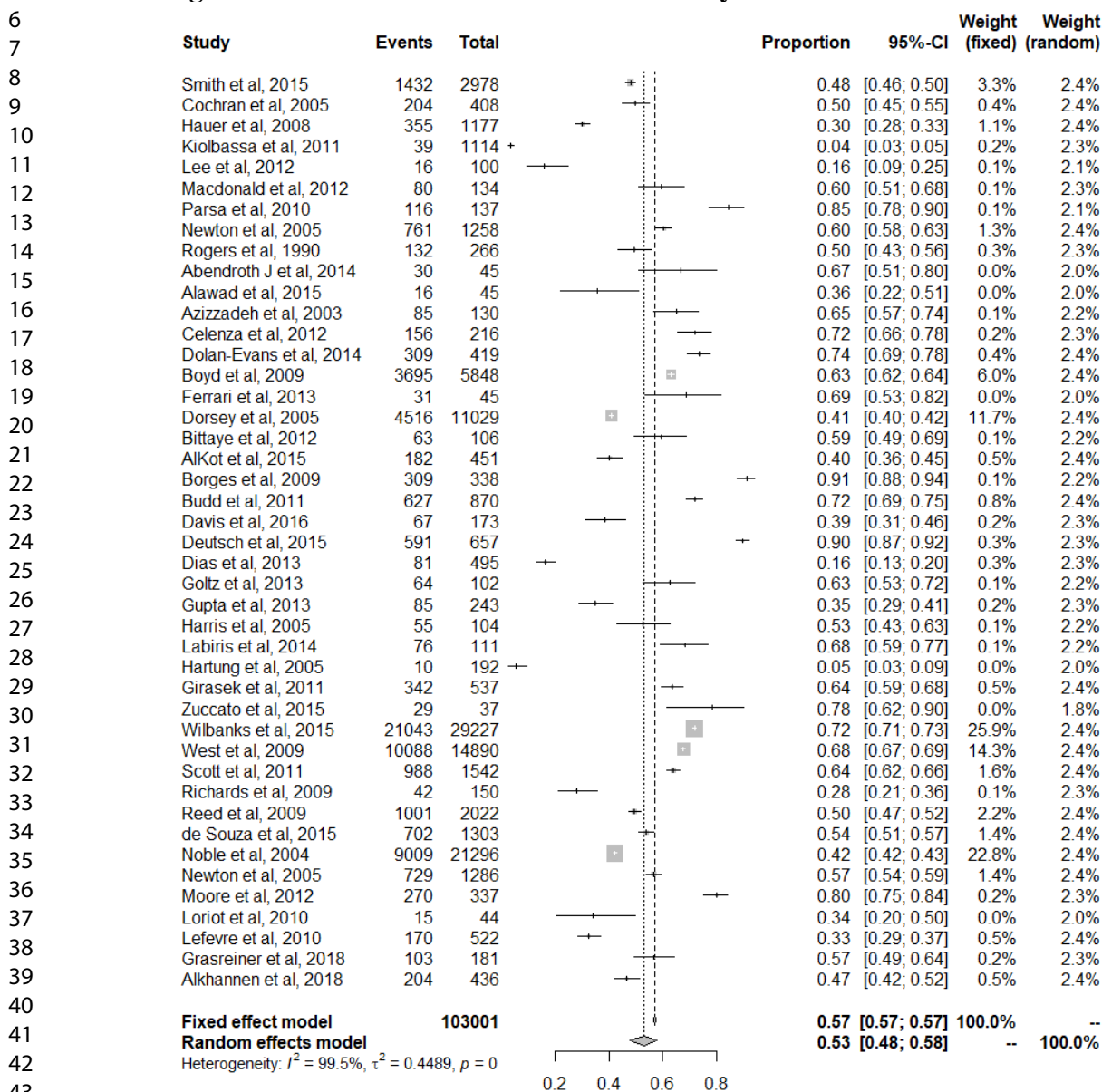


Figure S5. Forest Plot of “Patient Service Orientation”.

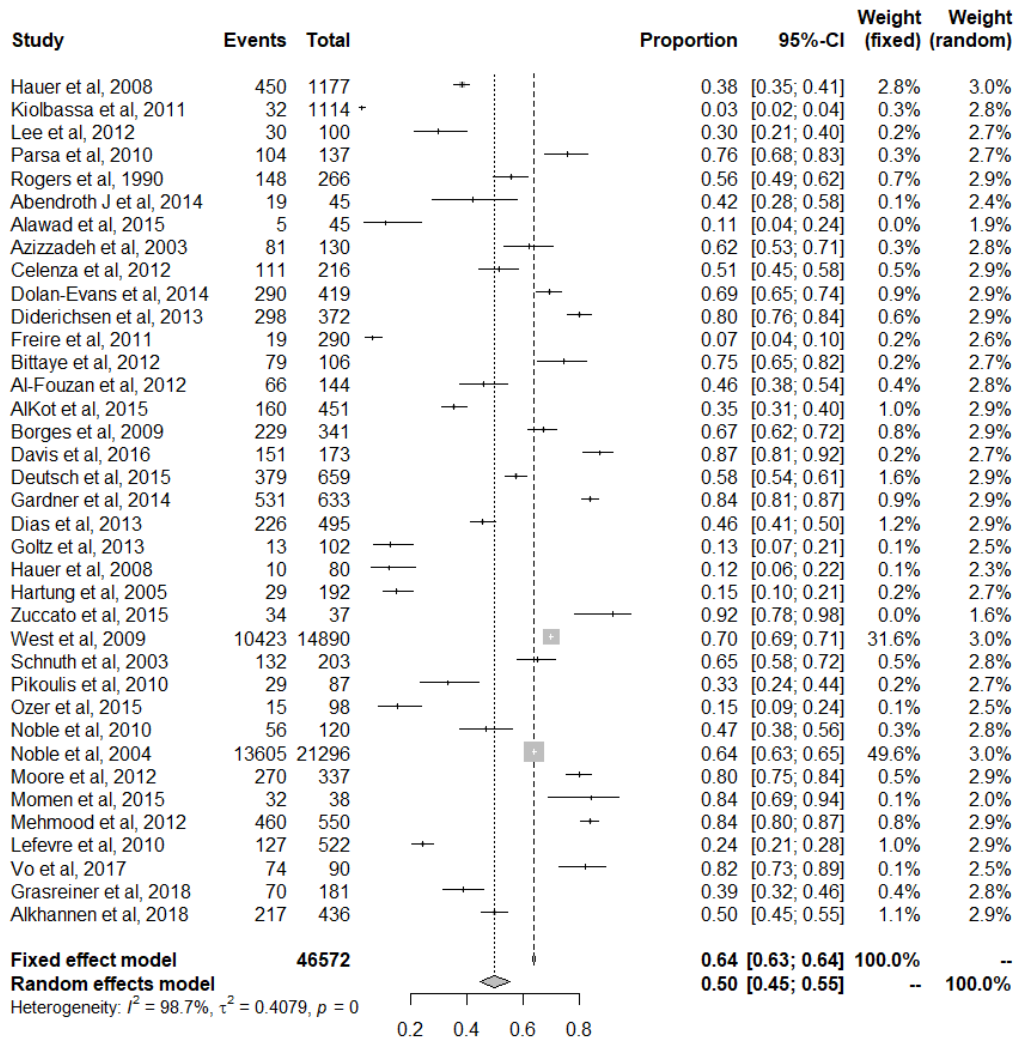


Figure S6. Forest Plot of “Medical Teachers or Mentors”.

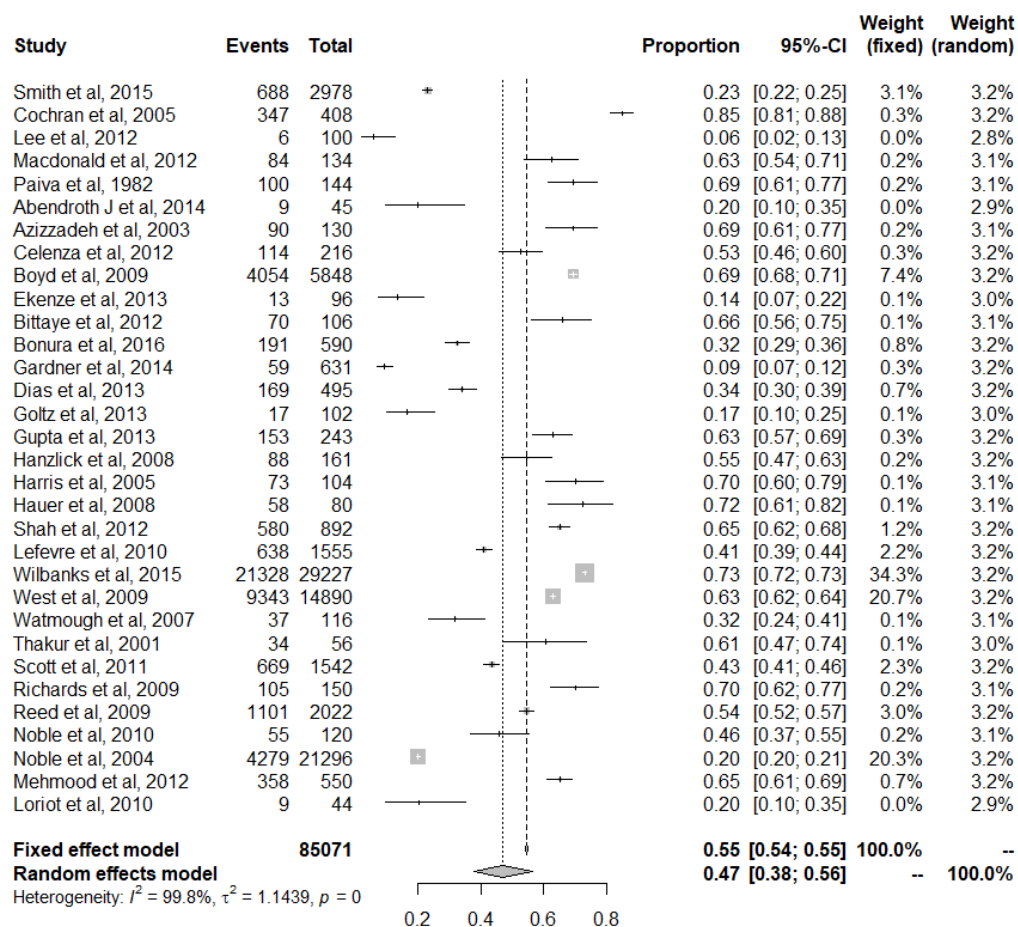


Figure S7. Forest Plot of “Career Opportunities”.

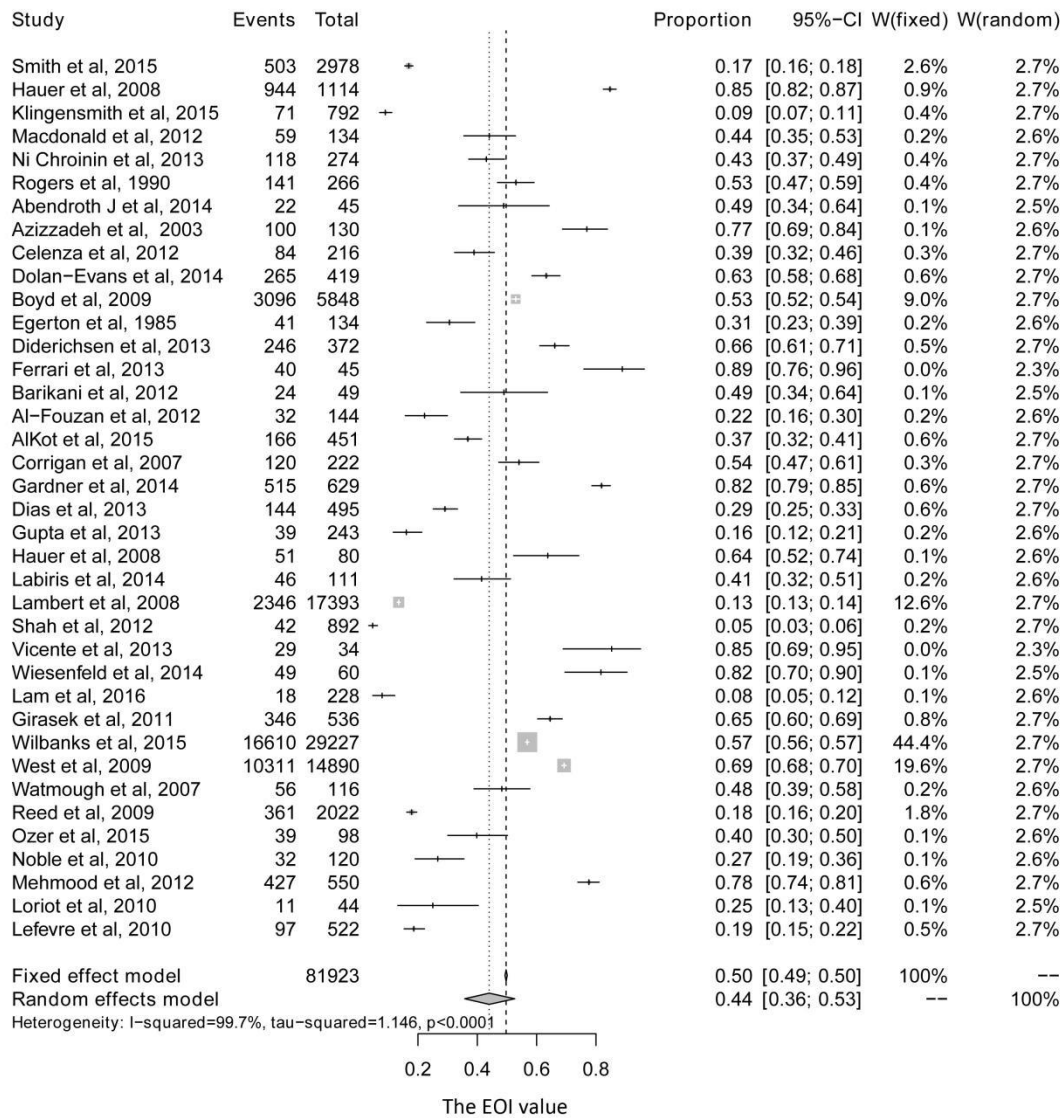


Figure S8. Forest Plot of “Workload or Working Hours”.

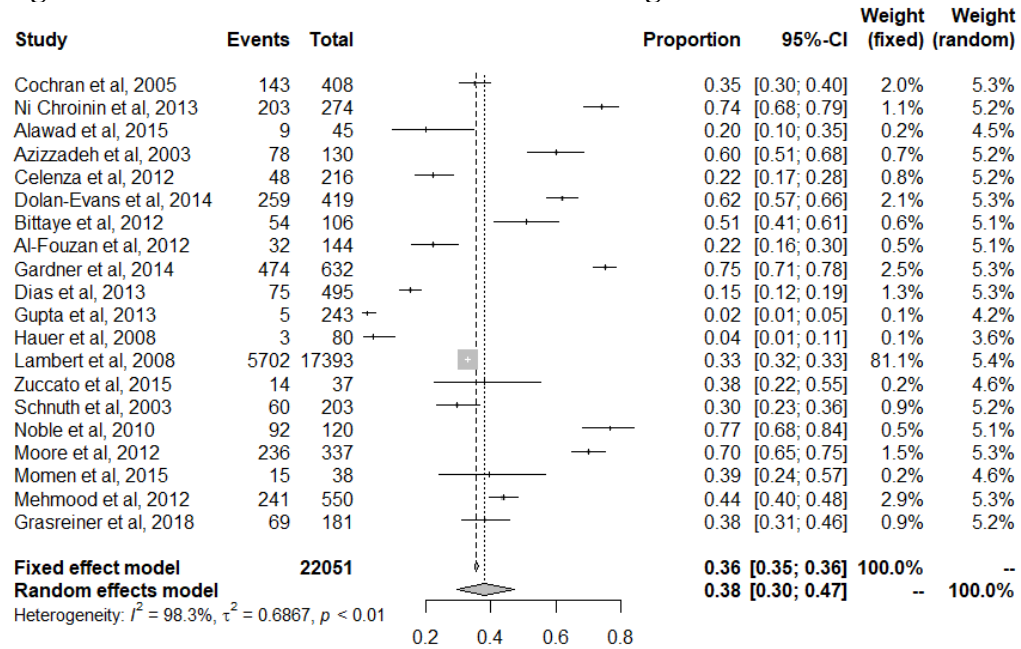


Figure S9. Forest Plot of “Income”.

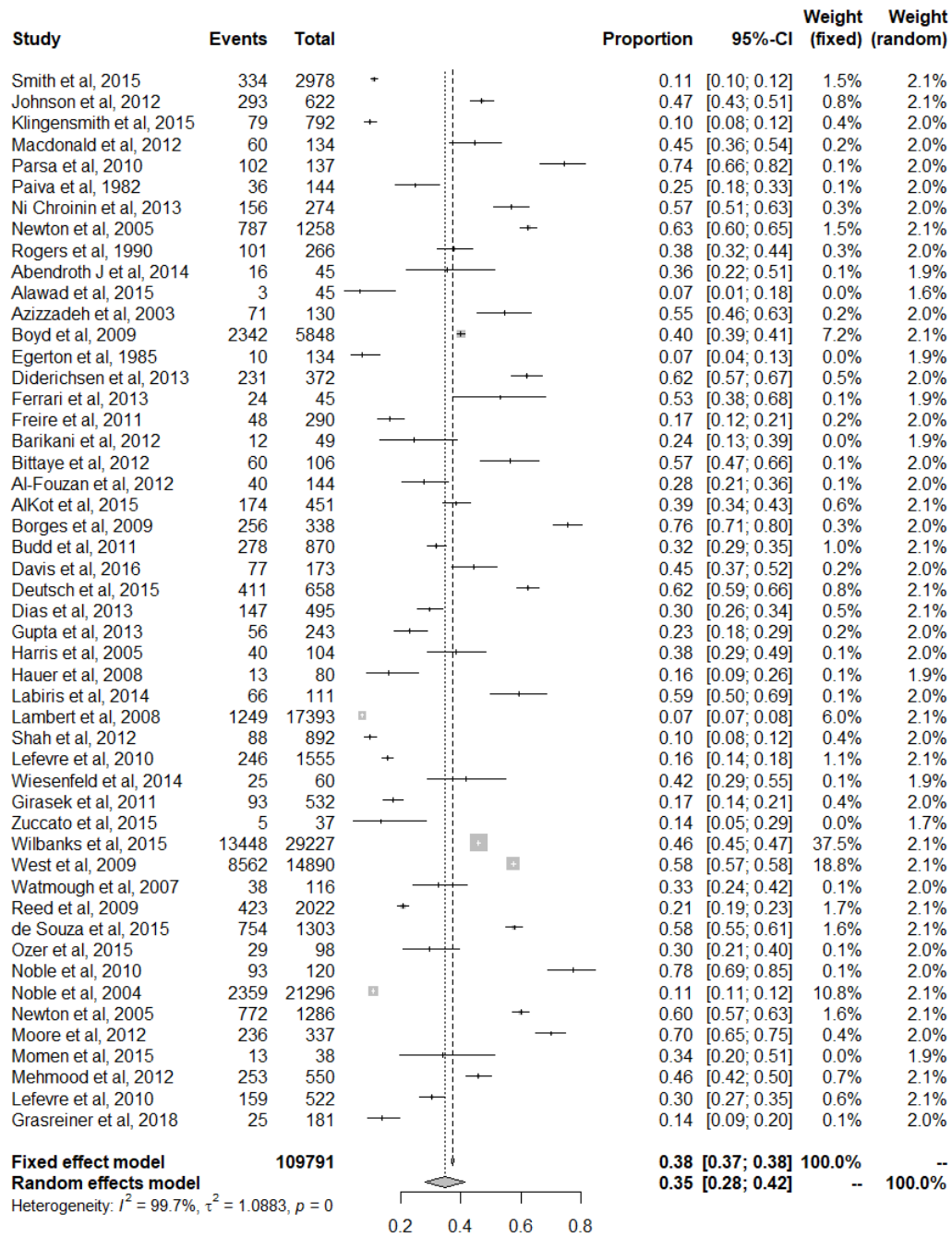
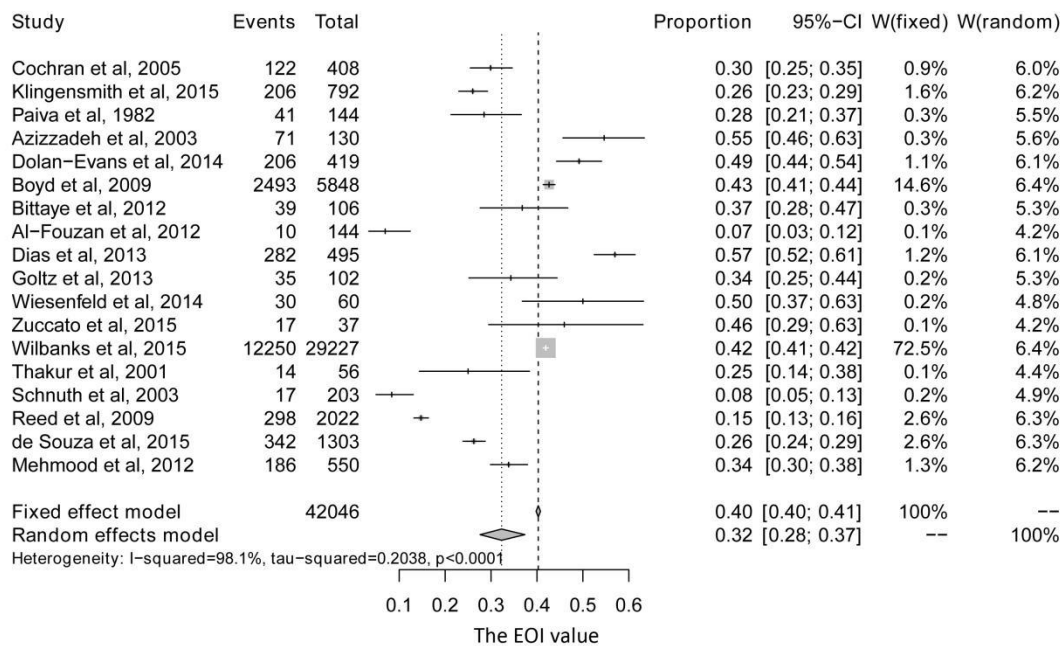
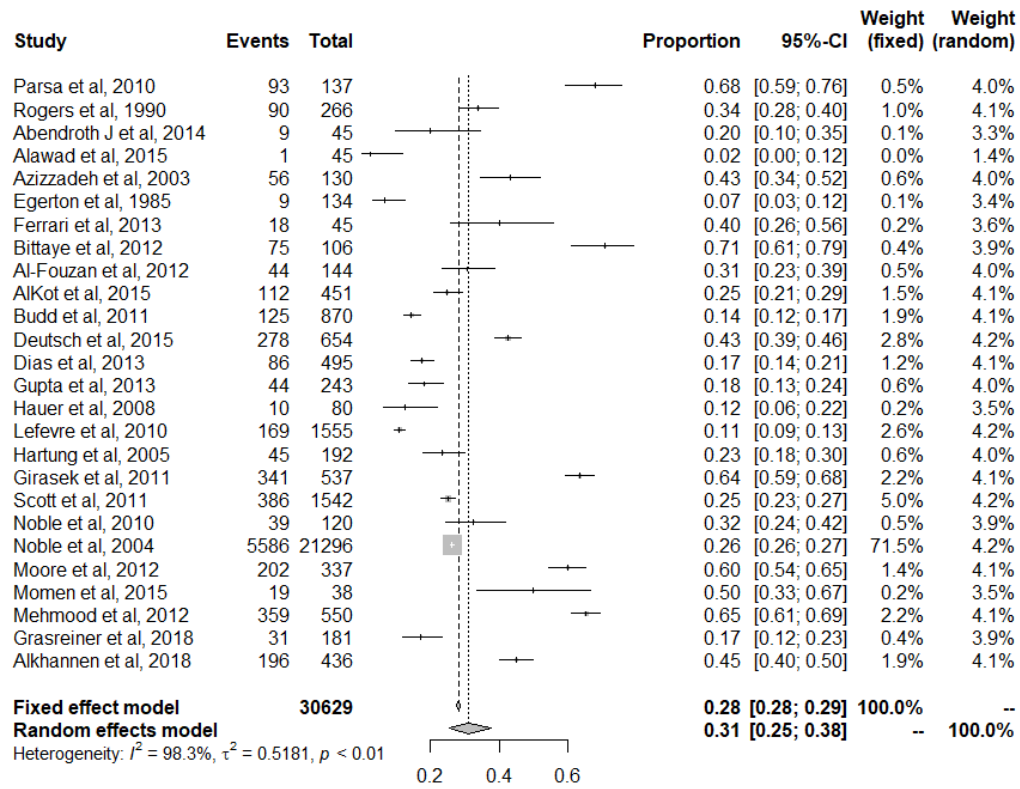


Figure S10. Forest Plot of “Length of Training”.



review only

Figure S11. Forest Plot of “Prestige”.



only

Figure S12. Forest Plot of “Advice from Others”.

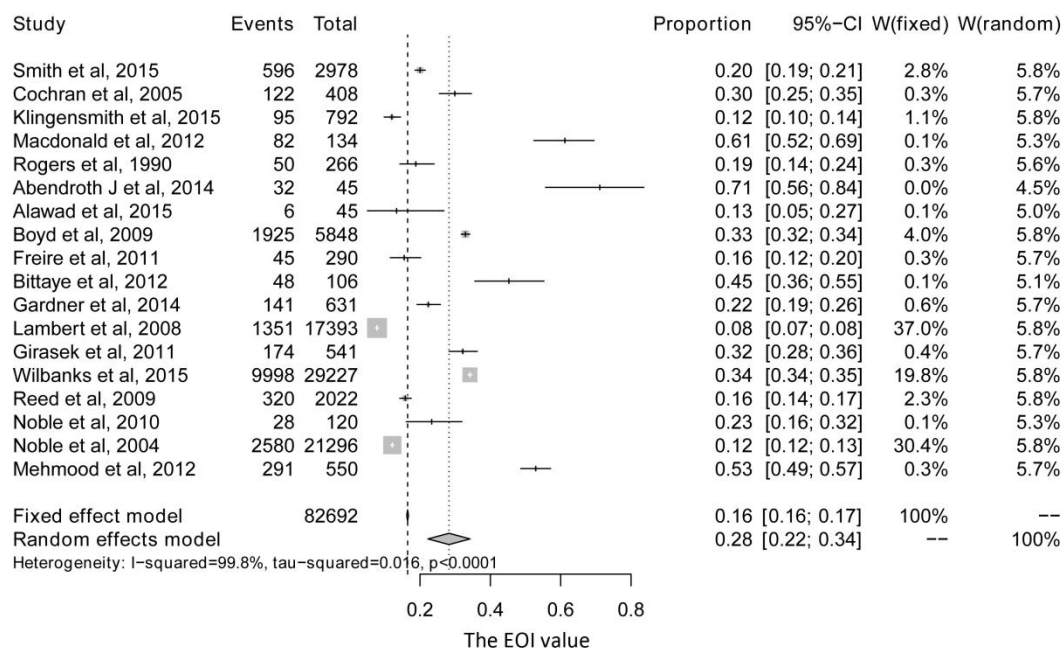


Figure S13. Forest Plot of “Student Debt”.

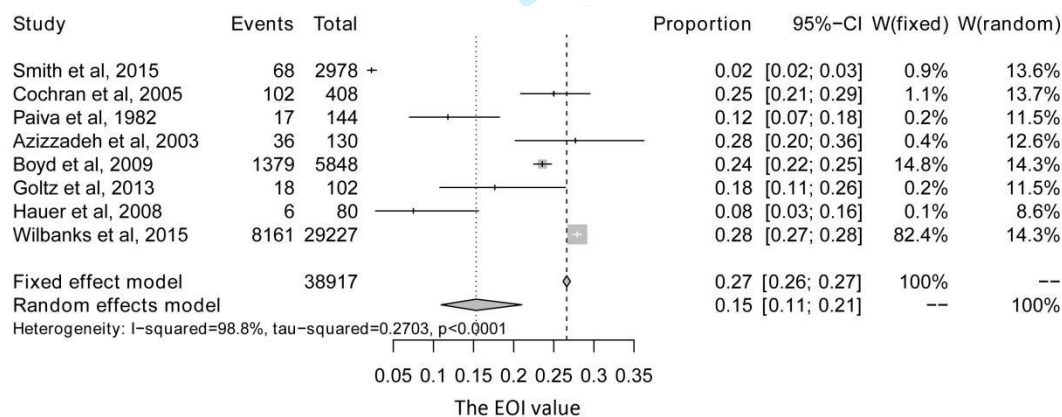
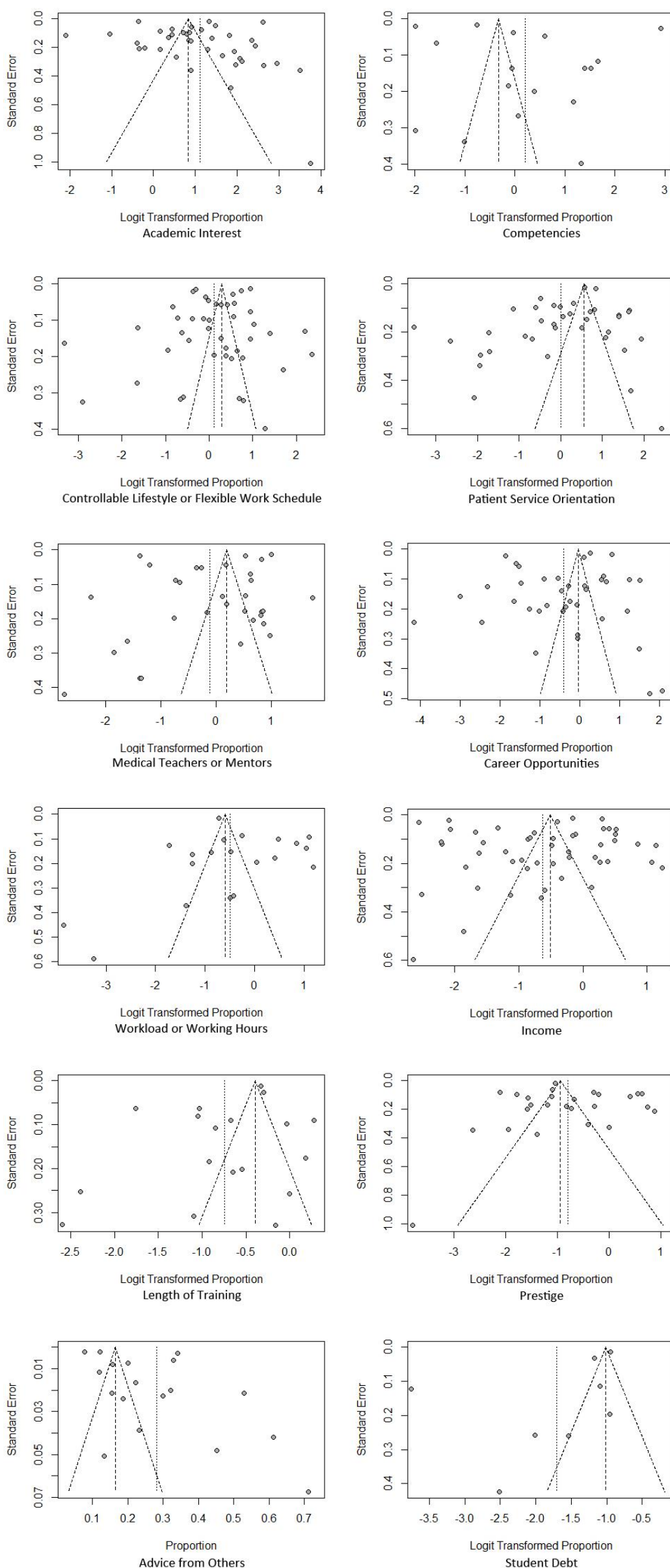


Figure S14. Funnel Plots of the Publication Bias Testing of the 12 Factors.





PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	3
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5-6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6-7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6-7
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	7



PRISMA 2009 Checklist

Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	7
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	7
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	5, 7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7-8
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	8
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	8
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	8-9
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	8-9
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	8-9
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	9-13
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	13
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	14
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	15

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

Page 2 of 2

For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

MOOSE Checklist for Meta-analyses of Observational Studies

Item No	Recommendation	Reported on Page No
Reporting of background should include		
1	Problem definition	5
2	Hypothesis statement	5
3	Description of study outcome(s)	5
4	Type of exposure or intervention used	5
5	Type of study designs used	5
6	Study population	5
Reporting of search strategy should include		
7	Qualifications of searchers (eg, librarians and investigators)	6
8	Search strategy, including time period included in the synthesis and key words	5
9	Effort to include all available studies, including contact with authors	5
10	Databases and registries searched	5
11	Search software used, name and version, including special features used (eg, explosion)	6
12	Use of hand searching (eg, reference lists of obtained articles)	5
13	List of citations located and those excluded, including justification	5-6
14	Method of addressing articles published in languages other than English	5
15	Method of handling abstracts and unpublished studies	5
16	Description of any contact with authors	5
Reporting of methods should include		
17	Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested	6
18	Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	6-7
19	Documentation of how data were classified and coded (eg, multiple raters, blinding and interrater reliability)	6-7
20	Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	6
21	Assessment of study quality, including blinding of quality assessors, stratification or regression on possible predictors of study results	6
22	Assessment of heterogeneity	6
23	Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	6-7
24	Provision of appropriate tables and graphics	5-7
Reporting of results should include		
25	Graphic summarizing individual study estimates and overall estimate	8
26	Table giving descriptive information for each study included	7
27	Results of sensitivity testing (eg, subgroup analysis)	8
28	Indication of statistical uncertainty of findings	7-9

Item No	Recommendation	Reported on Page No
Reporting of discussion should include		
29	Quantitative assessment of bias (eg, publication bias)	13
30	Justification for exclusion (eg, exclusion of non-English language citations)	13-14
31	Assessment of quality of included studies	13-14
Reporting of conclusions should include		
32	Consideration of alternative explanations for observed results	14
33	Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)	14
34	Guidelines for future research	14
35	Disclosure of funding source	15

From: Stroup DF, Berlin JA, Morton SC, et al, for the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) Group. Meta-analysis of Observational Studies in Epidemiology. A Proposal for Reporting. *JAMA*. 2000;283(15):2008-2012. doi: 10.1001/jama.283.15.2008.

Transcribed from the original paper within the NEUROSURGERY® Editorial Office, Atlanta, GA, United States. August 2012.