P8130 Biostatistical Methods I Final Project

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Abstract

There are many factors that contribute to the salary of physicians in medical colleges. In this study, a linear model of the mean salaries from 1994 to 1995 is the main outcome and gender is main factor, was fitted to determine whether Houston College of Medicine has engaged in a pattern and practice of discrimination against women in giving promotions and setting salaries. Department, primary emphasis, certification, publication rate and experience were determined to be confounders, while rank was found to be an interaction. Gender demonstrates no association with salary from 1994 and 1995 after adjusting for department affliation, clinical emphasis, board certification status, rank, and experience, which means the data does not support the claim of gender discrimination in setting salaries at Houston College of Medicine.

Introduction

Women being paid less than men is nothing new. In fact, this has been the norm ever since women started entering the workforce. In order to address such inequality, the Equal Pay Act and the Civil Rights Act were both signed into law in 1963 and 1964, respectively, with the purpose of prohibiting wage disparity based on sex and discrimination against employees based on sex, race, national origin, color and religion (Crampton et al, 1997). Despite the efforts to eliminate gender based wage gap, almost half a century later, a woman working full-time still only earns an average of 81.2 cents for every dollar a man working full-time earns in the U.S as of 2018 (United States Census Bureau, 2019).

This issue is not only prevalent in the US, but also happens to transcends to other countries spanning within and between various occupations as well. One particular field of interest is in academic medicine. In the age of modern medicine, the diversity of medical practitioners has progressed substantially with more than one-third of physicians being women in a historically male dominated field, however compensation inequality still remains to be an issue that seeks improvement (Butkus, 2018). It was reported in a study conducted in 2016, that female physicians makes 90 cents for every dollar that a male physician makes in academic medicine (Freund et al, 2016). In addition to the wage disparity between male and female physicians, the lack

of advancement in a female physician's career, despite the growing number of women entering the medical field, remains significant (Butkus, 2018). Many factors have been considered to contribute to such disparities such as speciality choice, hours worked, years of experience, and publication counts.

These differences in wage and lack of promotions for female physicians can only be perceived as unfair and will eventually lead to a lawsuit. A few years ago, all the female physicians at Houston College of Medicine filed a lawsuit against the college for violating the Civil Rights Act of 1964 by engaging in consistent patterns and practice of discrimination against women faculty members in giving promotions and setting salaries. To address this situation, this paper explores the data set that the female faculty members presented of the different faculty positions held and salaries earned by the male and female physicians at Houston College of Medicine. Additional factors such as department affiliation, gender, board certification status, clinical or research emphasis, publication rate, and years of experience as a practicing physician, were also provided and examined. The goal is to find the associations that could support the claim of gender discrimination in the salary determination at this university hospital.

Methods

The dataset contains 7 factors that are potentially associated with the salaries of the Houston College of Medicine faculty. These are department, gender, primary emphasis (clinical or research), certification (board certified or not certified), publication rate (publications on CV/ years between CV date and MD date), years since obtaining MD and rank (supplemental table 1. The mean salary for the 1994 academic year and the salary for the 1995 academic year (salary after increment to the 1994 income) are the outcomes. Histograms were were made to visualize the distribution of the outcomes. A natural logarithmic transformation was performed to attentuate for the right skewedness (supplemental figure 1). Since gender was the main variable of interest, models were analyzed in R studio (RStudio Team, 2015) to test for associations between gender and salary. A simple linear regression model was developed using mean salaries for the 2 years provided and gender. Using this model as the reference point, other variables in the dataset were analyzed as potential confounders or interactions.

After extensive research on this particulary issue, it was obvious to us that there are many factors that could either interact, confound or not impact the relationship between salary and gender. Three main variables in this data set were selected based on our research for further examination as effect measure modifiers: department, rank, and experience. Confounders were also identified and adjusted for. Correlation of the variables were analyzed to address any multicollinearity between the variables. Model selection was

made using criterion-based procedures. Once the final model was determined (supplemental table 2), residuals vs fitted values plot, quantile-quantile plot, scale-location plot and residuals vs leverage plots were used to diagnose the model (supplemental figure 2) and ANOVA was used to determine overall significance taking into account of the categorical levels in the data (supplemental table 3).

Results

Several of the other variables (department, primary emphasis, certification, publication rate and experience) were determined to be confounders, while rank was found to be an interaction. High collinearity was found between publication rate and primary emphasis as well as publication and department, therefore publication rate was dropped from the model. The final model shows that gender is not significant in determining salary (p-value 0.186) when controlling for department, primary emphasis, certification, experience and rank. Associated p values for other variables are also provided. It is interesting to note that rank, overall as a variable, is significantly associated with salary. However, when examining the individual categories, associate professor was not significant. The model shows an adjusted R^2 value of .9322, meaning that 93% of the variability of the data is represented by the model. Cook's distance, quantile-quantile plot, and residuals plots show that the 184th observation as an outlier and potential influential point (supplemental figure 2). After the observation of significant changes in the coefficients of other variables after the removal of physician 184, it was confirmed that this point is an influential point. This point was kept in the model since the goal was to build a model for association and removal of data does not depict the "truth" of the population.

Conclusion/Discussion

Based on the data set, gender demonstrates no association with salary from 1994 and 1995 after adjusting for department affliation, clinical emphasis, board certification status, rank, and experience. Therefore, we conclude that the data does not support the claim of gender discrimination in setting salaries at Houston College of Medicine. Moreover, department, clinical or research emphasis, board certified or not, and years of experience confound the association between salaries and gender. It's important to note that rank interacts with gender, meaning that salary among male and female physicians differ depending on the position held. The difference in salaries between male and female physicians at the Houston College of Medicine could be due to other factors, particularly rank since the claim on the failure in giving promotions to female faculty member was also in the lawsuit.

Under the assumption that Houston College of Medicine, like most universities, operates under a

tenure system, where salary is based on academic productivity, women in Houston College would get paid less based on the unproportional distribution of male full time professors compared to female full time professors, seen in supplemental table 1 (Reed et al, 2011). Other studies have also shown that differences in salaries between male and female physicians may be due to characteristic differences that are affliated with gender roles such as specialty choice, number of hours worked, practice setting, and work-life balance (Baker, 1996 and Butkus et al, 2018).

Futhermore, it was determined that physician 184 is an influential point based on the standardized residuals. Physician 184 is a male uncertified assistant professor in the department of medicine, with a research emphasis, a 5.1 publication rate, and has 2 years of experience since obtaining his license. With all things considered, physician 184 has an unusually high salary. This could be due to other factors that were not included in this data set, such as the importance of his research or publications of which this particular physician may be involved in or the number of hours he works.

Though this data set does not confirm the claims made by the female physicians in Houston, this does not indicate that gender discrimination based wages does not exist in our current society. It is important to consider the generalizability of this data set and to consider how the lack of association between salary setting and gender is specifically applicable to the Houston College of Medicine.

Supplementary Figures

	Females (N=106)	Males (N=155)
dept		
Biochemistry/Molecular Biology	20 (18.9%)	30 (19.4%)
Physiology	20 (18.9%)	20 (12.9%)
Genetics	11 (10.4%)	10 (6.5%)
Pediatrics	20 (18.9%)	10 (6.5%)
Medicine	30 (28.3%)	50 (32.3%)
Surgery	5 (4.7%)	35 (22.6%)
clin		
Primarily research emphasis	46 (43.4%)	55 (35.5%)
Primarily clinical emphasis	60 (56.6%)	100 (64.5%)
cert		
Not Certified	36 (34.0%)	37 (23.9%)
Board Certified	70 (66.0%)	118 (76.1%)
Prate		
Mean (SD)	5.35 (1.89)	4.65 (1.94)
Median (IQR)	5.25 (3.73, 7.27)	4.00 (3.10, 6.70)
Exper		
Mean (SD)	7.49 (4.17)	12.10 (6.70)
Median (IQR)	7.00 (5.00, 10.00)	10.00 (7.00, 15.00)
rank		
Assistant	69 (65.1%)	43 (27.7%)
Associate	21 (19.8%)	43 (27.7%)
Full professor	16 (15.1%)	69 (44.5%)
Sal94		
Mean (SD)	118871.27 (56168.01)	177338.76 (85930.54)
Median (IQR)	108457.00 (75774.50, 143096.00)	155006.00 (109687.00, 231501.50)
Sal95		
Mean (SD)	130876.92 (62034.51)	194914.09 (94902.73)
Median (IQR)	119135.00 (82345.25, 154170.50)	170967.00 (119952.50, 257163.00)

Table 1 - General descriptive statistics about the data set.

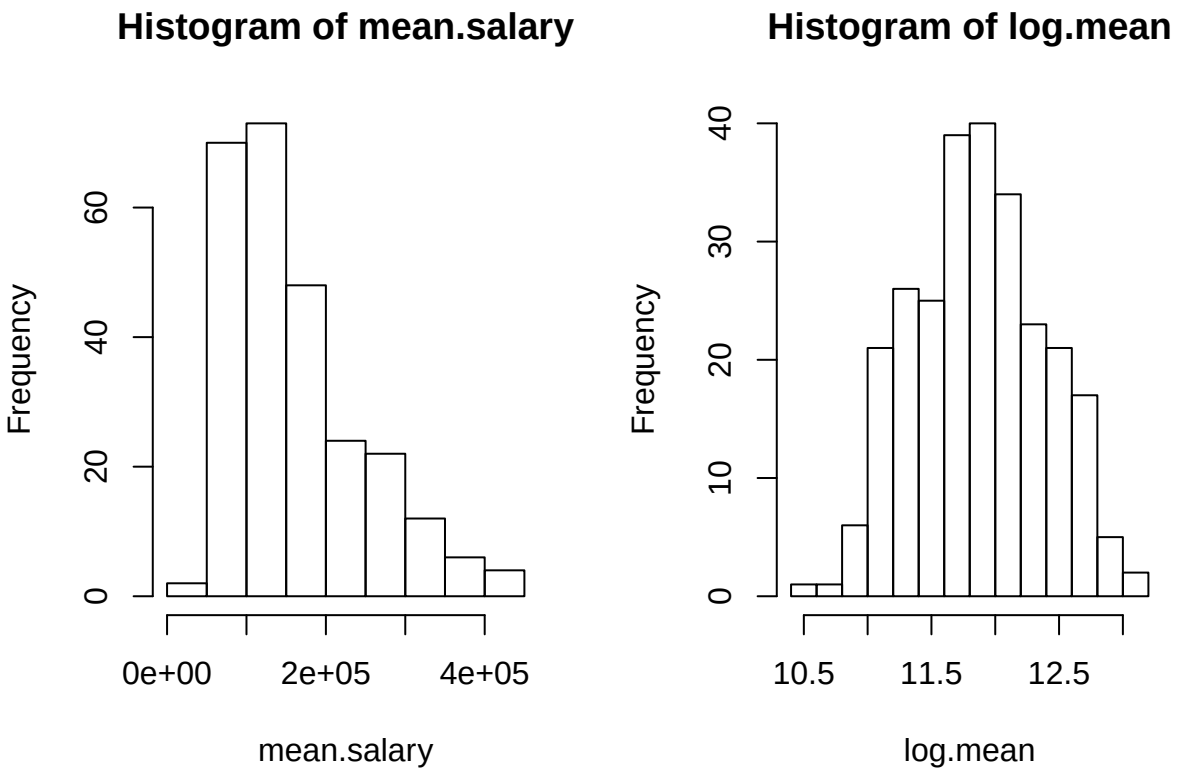

Figure 1 - Average salary distribution of both academic years 1994 and 1995(a) showing right skewedness. Log Transformation (b) shows a normal distribution.

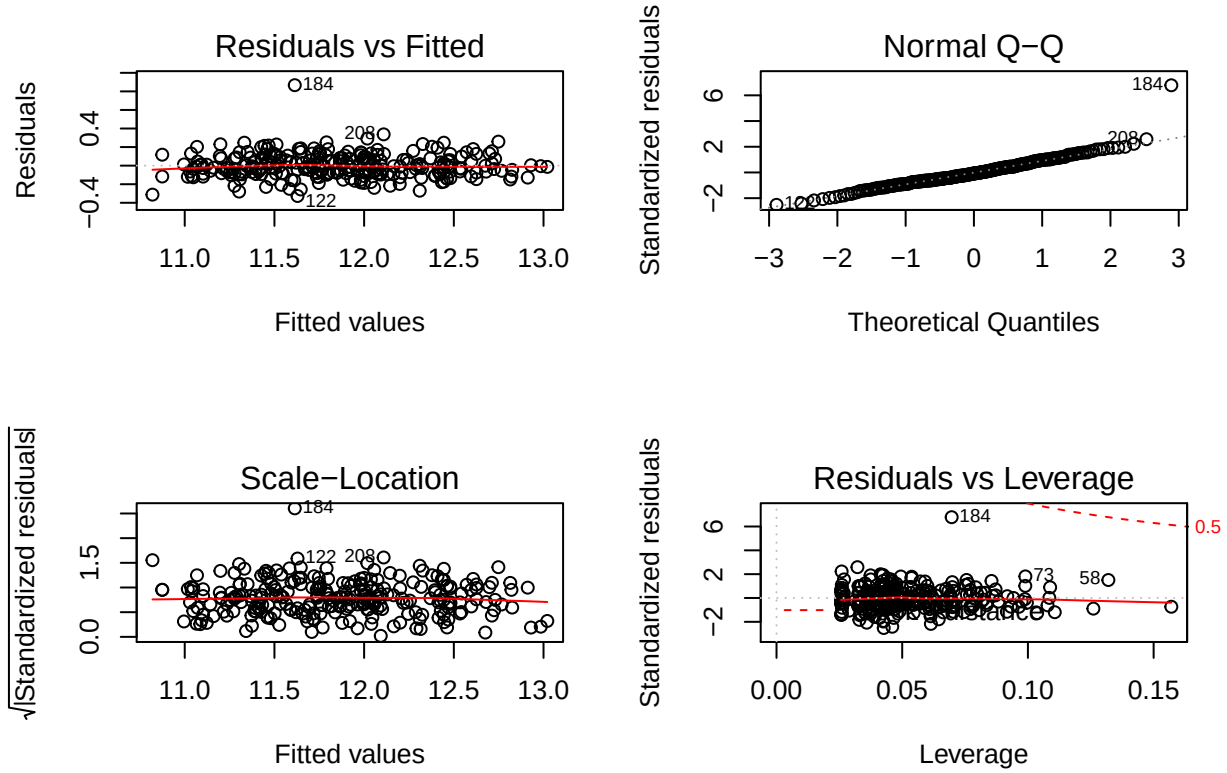

Figure 2 - Residuals vs. Fitted (a), quantile-quantile plot(b), scale location plot(c) and Cook's distance plot(d) all show the 184th observation is an outlier and potential influential point

term	estimate	std.error	statistic	p.value
(Intercept)	10.9593348	0.0279356	392.307104	0.0000000
deptPhysiology	-0.1755436	0.0288714	-6.080183	0.0000000
deptGenetics	0.1845717	0.0362059	5.097829	0.0000007
deptPediatrics	0.2084679	0.0355285	5.867630	0.0000000
deptMedicine	0.5432042	0.0293638	18.499128	0.0000000
deptSurgery	0.9313875	0.0352673	26.409356	0.0000000
clinPrimarily clinical emphasis	0.1970312	0.0221749	8.885320	0.0000000
certBoard Certified	0.1912134	0.0213626	8.950840	0.0000000
Exper	0.0181712	0.0018056	10.063791	0.0000000
rankAssociate	0.1731415	0.0339042	5.106786	0.0000007
rankFull professor	0.2822813	0.0395941	7.129384	0.0000000
genderMales	0.0744792	0.0275681	2.701648	0.0073777
rankAssociate:genderMales	-0.0829432	0.0447499	-1.853484	0.0650054
rankFull professor:genderMales	-0.1052708	0.0466541	-2.256413	0.0249196

Table 2 - Final model of the data set. Coefficient estimates, standard errors and p values are included.

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
dept	5	48.6084856	9.7216971	553.431530	0.0000000
clin	1	2.4268234	2.4268234	138.152892	0.0000000
cert	1	2.8316533	2.8316533	161.198832	0.0000000
Exper	1	7.4608050	7.4608050	424.724681	0.0000000
rank	2	1.5070418	0.7535209	42.896030	0.0000000
gender	1	0.0308057	0.0308057	1.753690	0.1866376
rank:gender	2	0.1117068	0.0558534	3.179591	0.0433110
Residuals	247	4.3388550	0.0175662	NA	NA

Table 3 - Anova test of the model. The p-value for gender was 0.186. This value means that gender as the main covariate of interest is not a significant contributor to the model when adjusting for department, primary emphasis, certifcation, experience, and rank.

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