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Sentiment Analysis of Letters of Recommendation for a United States Pain Medicine Fellowship from 2020-2023

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INTRODUCTION

The pain medicine fellowship is competitive and draws applicants from multiple specialties, particularly from anesthesiology and PM&R. Letters of recommendation (LORs), key in selection, may reflect implicit biases that affect applicant evaluation. This study applies natural language processing (NLP) to analyze LORs for potential bias based on gender, race, specialty, and writer position. By quantifying sentiment in LORs, the study aims to provide programs with insights into how these biases may influence their perception of pain fellowship applicants and inform future candidates on application strategy.

METHODS

This IRB-approved study analyzed 3,488 de-identified letters of recommendation (LORs) for applicants to the Mount Sinai West and Morningside Pain Management Fellowship from 2020 to 2023. Applicant demographics included sex, self-identified race, residency specialty, medical school type, and chief resident status. Each LOR was de-identified using spaCy.

Sentiment was analyzed using VADER and Empath, two NLP tools. VADER assigns a normalized sentiment score from -1 to +1 by considering word valence and intensity, while Empath uses deep learning to score text across 200 sentiment categories. For this study, 15 categories—achievement, positive emotion, negative emotion, masculine, feminine, strength, optimism, work, communication, trust, leader, cheerfulness, valuable, help, and dominant personality—were selected based on prior research on fellowship applications.

Sentiment scores were compared across demographic groups using Wilcoxon rank-sum tests and ANOVA. Significance for VADER and Empath scores was set at 0.003, applying a Bonferroni correction, while word counts were analyzed at a standard threshold of 0.05. Trends from 2020-2023 were examined for significant sentiments (Figure 1).

Table I. Demographics of pain medicine fellowship applicants from 2020 to 2023.

Demographic	2020	2021	2022	2023
Total	200	262	279	223
Sex/Gender				
Male/Man (%)	163 (81.5%)	211 (80.5%)	228 (81.7%)	180 (80.7%)
Female/Woman (%)	37 (18.5%)	50 (19.1%)	51 (18.3%)	43 (19.3%)
Decline to answer (%)	0 (0%)	1 (0.4%)	0 (0%)	0 (0%)
Self-identified race				
Asian (%)	81 (40.5%)	100 (38.2%)	114 (40.9%)	94 (42.2%)
White (%)	61 (30.5%)	88 (33.6%)	99 (35.5%)	66 (29.6%)
Hispanic, Latino, or of Spanish origin (%)	19 (9.5%)	19 (7.3%)	23 (8.2%)	23 (10.3%)
Black or African-American (%)	11 (5.5%)	12 (4.6%)	13 (4.7%)	14 (6.3%)
Other (%)	11 (5.5%)	18 (6.9%)	13 (4.7%)	18 (8.1%)
Decline to answer (%)	17 (8.5%)	25 (9.5%)	17 (6.1%)	8 (3.6%)
Medical School Type				
United States M.D. (%)	102 (51.0%)	133 (50.8%)	129 (46.2%)	110 (49.3%)
United States D.O. (%)	47 (23.5%)	61 (23.3%)	89 (31.9%)	60 (26.9%)
International Medical Graduate (%)	51 (25.5%)	68 (26.0%)	61 (21.9%)	53 (23.8%)
Residency Specialty				
Anesthesiology (%)	119 (59.5%)	147 (56.1%)	144 (51.6%)	98 (43.9%)
Physical Medicine and Rehabilitation (%)	54 (27.0%)	75 (28.6%)	86 (30.8%)	85 (38.1%)
Other (%)	27 (13.5%)	40 (15.3%)	49 (17.6%)	40 (17.9%)
Chief Resident count (%)	16 (8.0%)	29 (11.1%)	25 (9.0%)	18 (8.1%)
Standardized letters	15 (2.11%)	15 (1.59%)	15 (1.49%)	21 (2.59%)

