Title

Sex Differences in Testing for Pulmonary Embolism Among Emergency Department Patients Aged 18—49 by Chief Complaint

Journal

Clinical Therapeutics, 46(12)

ISSN

0149-2918

Authors

Jarman, Angela F

Maughan, Brandon C

White, Richard

et al.

Publication Date

2024-12-01

DOI

10.1016/j.clinthera.2024.10.008

Peer reviewed

HHS Public Access

Author manuscript

Clin Ther. Author manuscript; available in PMC 2025 January 23.

Published in final edited form as:

Clin Ther. 2024 December ; 46(12): 995–1000. doi:10.1016/j.clinthera.2024.10.008.

Sex Differences in Testing for Pulmonary Embolism Among Emergency Department Patients Aged 18–49 by Chief Complaint

Angela F Jarman, MD MPH[1], **Brandon C Maughan, MD MSPS**[2], **Richard White, MD**[3], **Sandra L Taylor, PhD**[4], **Zainab Akinjobi**[4], **Bryn E Mumma, MD MAS**[1]

[1]Department of Emergency Medicine, University of California, Davis,

[2]Department of Emergency Medicine, Oregon Health and Science Internal Medicine,

[3]Department of Internal Medicine, University of California, Davis

[4]Department of Public Health Sciences, University of California, Davis

Abstract

Background—Women undergo diagnostic testing for pulmonary embolism (PE) in greater numbers than men, despite the disease incidence being higher in men overall. It is unknown if testing for PE varies based on patient chief complaint.

Methods—This retrospective cohort study was conducted at two academic tertiary care hospitals. Non-pregnant adult patients (aged 18–49 years) were included if they presented to the ED between 1/1/2016 and 12/31/2018 with non-traumatic mechanisms and any of the following chief complaints: chest pain, shortness of breath, hemoptysis, or syncope AND had objective testing for PE. Data were obtained from the electronic medical record and analyzed descriptively. Four outcome variables were assessed: receipt of D-dimer testing, D-dimer positivity, receipt of pulmonary vascular imaging, and diagnosis of PE.

Results—We studied 1,991 unique patient encounters, most of whom (63%; 1,256/1,991) were female. Overall, female patients had higher odds of receiving D-dimer testing than male patients (OR 1.30, CI 1.06–1.59, p=0.015), while they had lower odds of being diagnosed with PE (OR 0.57, CI 0.36–0.90, p=0.019). However, this trend varied by chief complaint. Among patients with chest pain, females had higher odds of having a D-dimer performed (OR 1.35, CI 1.01–1.80, p=0.049) and lower odds of being diagnosed with PE (OR 0.36, CI 0.18–0.70, p=0.003) than males.

Conclusions—Both patient sex and chief complaint were associated with trends in diagnostic testing for PE. Among patients with chest pain, females are significantly more likely to be tested with a D-dimer and less likely to be diagnosed with PE.

Corresponding Author: Angela F Jarman MD MPH, Associate Professor of Emergency Medicine, University of California, Davis, 4150 V St, Suite 2100, Sacramento CA 95817, afjarman@ucdavis.edu.

Author Contributions

This work was conceived by AFJ and BCM. The manuscript was drafted by AFJ and BEM. RW provided conceptual feedback to the study and critical editing of the manuscript in its entirety. ZA and SLT performed and supervised statistical analysis. Final editing was performed by AFJ and BEM.

Keywords

Pulmonary Embolism; Sex Differences; Venous Thromboembolism; Health Disparities; Diagnostic Testing

Introduction

Rates of testing for pulmonary embolism (PE) have increased exponentially in the last several decades, in part due to the increasing availability of advanced imaging techniques like computed tomography (CT). Although CT pulmonary angiography (CTPA) is easily accessible in most modern emergency departments (ED), it carries potential risks from significant radiation exposure,[1,2] complications related to iodinated contrast,[3,4] and risks of false positive findings (including those associated with systemic anticoagulation).[5,6] Unnecessary testing, including both laboratory and imaging studies, among low-risk populations also contributes strain to a health system that is struggling to meet the acute care needs of patients.[7,8] Over-testing for PE has negative effects for both patients and health systems, and investigating and mitigating over-testing has become a priority across specialties.

Significant sex differences exist in testing for PE. Despite PE being more common overall in men,[9] women are historically tested in higher numbers than men and as such have lower yields of testing.[10–12] The reasons for this relative over-testing in women are complex and not entirely understood. It was recently shown that sex differences in adherence to evidence based diagnostic guidelines was not contributing to this difference in diagnostic testing patterns, as women were more likely to receive guideline consistent care.[13]

It is not known what role patient presentation and chief complaint have on testing patterns for PE. It is possible that women and men describe their symptoms differently, leading providers to test women more frequently. Among patients with acute myocardial infarction (AMI), female patients are more likely to describe multiple concurrent symptoms.[14] Little is known about the effects of patient chief complaint and symptom descriptions on testing patterns among ED patients suspected of PE, and whether this effect varies by patient sex. This study serves to fill this gap by evaluating testing patterns, both laboratory and imaging, by both patient sex and chief complaint.

Methods

This is a planned secondary analysis of a retrospective cohort study conducted at two US academic tertiary care hospitals. Patients between the ages of 18 and 49 were included if they presented to either participating ED between January 1, 2016 and December 31, 2018 with any of the following primary chief complaints: chest pain, shortness of breath, hemoptysis, syncope and had objective testing for PE (plasma D-dimer, computed tomography pulmonary angiography [CTPA], or ventilation/perfusion [V/Q] scan) as a part of their ED evaluation. This age range was chosen because young patients are at much lower risk of PE and higher risk from radiation exposure than older patients,[11,15] and they are also eligible for the PERC decision rule.[16] The detailed methodology, including all definitions,

has been previously published.[13] Pregnant patients and those with primarily traumatic mechanisms were excluded. Patients who did not have complete ED encounters (those who left without being treated [LWBT], eloped, or left against medical advice [AMA]) were also excluded. In patients with multiple qualifying encounters during the study period, only the index encounter was included as an independent observation. This study was approved by each local institutional review board and a mutual data sharing authorization agreement was approved by both institutions.

Data were obtained retrospectively from the electronic medical record (EMR). Demographic characteristics, vital signs, laboratory, and imaging data were directly extracted from the EMR by a trained data analyst. The accuracy of extracted data was validated by senior study personnel at each site. The revised Geneva Score (rGS) was utilized as a validated measure of pre-test risk of PE,[17] given the challenges of using the Well's Score for PE retrospectively. Additional clinical data, including the elements of the rGS, were manually abstracted by study authors and trained research assistants using a standardized data collection form and protocol; a subset (>10%) of all abstracted data were verified by senior authors.

Our outcomes were (1) D-dimer testing, (2) D-dimer positivity, (3) imaging acquisition, and (4) overall yield of testing (defined as the proportion of patients diagnosed with PE divided by the number of patients tested [laboratory or imaging]), stratified by both chief complaint and patient sex. Patient characteristics, outcomes, and testing patterns were summarized descriptively by patient sex. Categorical variables are reported as counts and percentages. Quantitative variables are reported as means with standard deviation or medians with interquartile range, as denoted in Table 1. For categorical variables, to account for site strata, a Cochran-Mantel-Haenszel was used to evaluate differences in the odds of each outcome measure by sex. An Analysis of Variance was utilized to evaluate sex differences for continuous outcome variables with study site included as a blocking variable. A multiple logistic regression model was fit to identify factors associated with each of the four outcome variables; study site was included as a fixed effect. Covariates in this model included chief complaint, patient age, patient sex, an interaction term between patient sex and chief complaint, provider gender, provider years in practice, and rGS risk category. Of note, dyspnea was chosen as the referent group for chief complaint because it is the most common chief complaint among those diagnosed with PE.[18,19] Hypothesis tests were two-sided and evaluated at a significance level of 0.05. Data analysis was performed using R Statistical Software version 4.1.2.[20]

Results

Baseline Characteristics

We studied a total of 1,991 unique patient encounters that met inclusion criteria. The majority of these patients, 63%, were female (1256/1991) and 37% (735/1991) were male. Patients of both sexes had similar baseline characteristics, as shown in Table 1; these include demographic, clinical, and historical characteristics, including pretest risk, as measured by the rGS.

Effects of Chief Complaint and Patient Sex

Table 2 shows results for each of the four outcome measures by both patient sex and presenting complaint. In evaluating the overall cohort, females had 30% higher odds of having a D-dimer performed (OR 1.30, 1.06–1.59, p=0.015) than males. There was no difference in the odds of their D-dimer being positive (OR 1.07, 0.83–1.38, p=0.644). Female patients had lower odds of being imaged (OR 0.83, 0.69–1.00, p=0.060) compared with males, though this was not significant. Lastly, female patients had significantly lower odds of being diagnosed with PE than males (OR 0.57, 0.36–0.90, p=0.019).

Chest pain and shortness of breath were the most common presenting chief complaints in both sexes. Females tested for PE had slightly higher odds than males of presenting with chest pain (OR 1.19, 0.99–1.43, p=0.07). Conversely, females tested for PE had slightly lower odds of presenting with dyspnea (OR 0.85, 0.70–1.03, p=0.10), though neither of these was statistically significant. Many of the patterns seen in the overall cohort were generally consistent across chief complaints, with some exceptions among patients presenting with syncope and hemoptysis. Overall, no patients presenting with syncope were diagnosed with PE. The yield of testing was much higher among patients with hemoptysis, in which 13.3% of females (2/15) and 12.5% (2/16) of males were diagnosed with PE, though these patients had a higher pretest risk and the absolute number of patients in these strata was quite small.

All significant sex differences occurred among patients presenting with chest pain. In this group, females had higher odds of receiving D-dimer testing than males (OR 1.35, 1.01–1.80, p=0.049) and there was a notable sex difference in yield of testing. Across all other chief complaints, the yield was similar by sex, but among chest pain patients, females had 64% lower odds than males of being diagnosed with PE (OR 0.36, 0.18–0.70, p=0.003). This difference, in fact, drives the significant difference seen in the combined cohort (OR 0.57, 0.36–0.90, p=0.019) and is notably in the setting of equal pretest risk by sex (median rGS 5).

Covariate Adjusted Analyses

Table 3 demonstrates potential predictors of each of the four outcome measures. With adjusting for covariates, compared with the referent group of patients presenting with dyspnea, patients with chest pain were more likely to have a D-dimer performed (aOR 1.79; 1.34–2.38, p <0.001), and it was less likely to be positive (aOR 0.56; 0.39–0.80, p<0.001). Similarly, patients with chest pain were less likely to have imaging performed (aOR 0.58, 0.45–0.75, p<0.001). Predictors of positive D-dimer testing included chief complaints of chest pain or syncope (aOR 2.81, 1.16–6.83, p=0.015). Females with chest pain were also at increased odds of testing compared with males with chest pain (aOR 1.36, 1.01–1.84, p=0.04). Negative predictors of D-dimer testing included age (aOR 0.97, 0.96–0.99, p<0.001) and high pre-test risk (aOR 0.24, 0.12–0.48, p<0.001). Aside from a chief complaint of chest pain, patient age was the only predictor of D-dimer positivity (aOR 1.03, 1.01–1.04, p=0.001). Positive predictors of receiving imaging included increasing pre-test risk (moderate risk aOR 1.25; 1.03–1.53, p=0.023, high risk aOR 4.19; 2.06–9.08, p<0.001) and patient age (aOR 1.03; 1.02–1.04, p<0.001). Increasing pre-test risk was associated

with increasing odds of having PE (moderate risk aOR 1.81, 1.03–3.16, p=0.039; high risk aOR 10.29, 3.82–27.70, p<0.001). Compared with males with chest pain, females had significantly lower odds of being diagnosed with PE (aOR 0.37, 0.19–0.74, p=0.005).

Discussion

This study is the first to evaluate sex-specific testing patterns for PE by chief complaint and revealed several important findings worthy of further study. In this planned secondary analysis, we saw that, overall, women were more likely to receive D-dimer testing and -as a result- less likely to undergo CT imaging, which is a departure from historical data showing that women underwent imaging more often than men.[10,11] We suspect this represents increased adoption of evidence-based clinical decision tools to rule out PE among low- and moderate-risk populations. Interestingly, women remained significantly less likely to be diagnosed with PE despite equal pre-test risk, which suggests there is room for further refinement of the diagnostic algorithm that may incorporate sex-specific factors. We had hypothesized that sex differences in the performance of the D-dimer assay could contribute to this difference in diagnostic yield,[12] but in the multivariable model, rates of D-dimer positivity did not vary based on sex (OR 1.11; 0.70–1.79, p=0.656).

In our study, chest pain was the most frequent complaint for both females and males *tested for* PE. Among patients *diagnosed* with PE in the general literature, however, dyspnea is the most common presenting complaint in both sexes.[19,21] While there is scant literature on sex differences in presentation among patients who are diagnosed with PE, there is some evidence that women are more likely than men to present with dyspnea and men with chest pain,[10,18,19,22] a finding that our study replicates. Syncope is a much less common presentation of PE, and no sex differences are known.[23] In this cohort, no patients of either sex presenting with syncope were diagnosed with PE. These patients were very likely to undergo D-dimer testing (OR 3.19, 1.06–9.59, p=0.039; ref dyspnea), but it was rarely positive and a low proportion of them went on to imaging compared with other complaints. While our cohort included only young patients, it is still worth noting that syncope is a rare presentation of PE.[24] When PE presents with syncope, the syncope is usually accompanied by high risk PE physiology including tachycardia, hypoxia, or hypotension.[25] Hemoptysis, which is the least common presentation of PE, has been shown in two studies to be slightly more common in men;[19,26] we did not see any difference in our study with limited sample size. It is also notable in this cohort that the yield of testing among patients with hemoptysis was significantly higher than other chief complaints, which emphasizes the critical need to consider PE as a potential diagnosis in ED patients with this complaint. These patients also had higher pretest risk (median rGS female 6.5, male 5) than patients with other presenting complaints, which was expected given that hemoptysis does confer points in the rGS.

The yield of testing by sex among patients with chest pain leads us to question whether we are over testing young women with chest pain for PE. When stratified by sex, the yield of testing by sex is similar for other chief complaints, yet among those with chest pain, the yield in females it is dramatically lower (2.0% [15/750] vs 5.4% [22/408], p=0.002). In fact, the sex differences in PE diagnosis seen in the overall cohort are exclusively driven by this chief complaint. This begs the question whether there are sex differences in the

chest pain characteristics, associated symptoms, or additional history (including additional concurrent symptoms) that drive emergency physicians to test women with chest pain for PE. This is an area that has not been investigated in PE but has been investigated extensively in AMI. In young patients (18–55 years) with AMI, women (87.0%) and men (89.5%) *do* usually present with chest pain; in contrast to men, however, women are more likely to describe three or more concurrent symptoms. Furthermore, both young women patients and their providers in this study were more likely to perceive their symptoms as caused by stress/anxiety and not to be heart-related.[14] It is thus hypothesized that gendered heuristics may play a role in the decision to test women with chest pain for PE, as provider may suspect these symptoms are more likely to be related to VTE than AMI. Although VTE is more common in men overall,[9,27] young women's risk is increased during the peripartum period and with exogenous hormone use. We suggest that this risk is greatly exaggerated and may result in the implicit association of young women with VTE. It is also possible that exogenous hormones, particularly combined oral contraceptive pills, may play a role in the decision to test young women with chest pain for PE. Our results beg further investigation of sex differences in all aspects of the clinical presentation and risk factors that may lead physicians to choose to test women with chest pain for PE.

As shown in Table 3, patients with chest pain demonstrated different testing patterns than those with dyspnea. They were more likely to have D-dimer testing, though the odds of it being positive or proceeding to imaging were significantly lower than those with dyspnea; ultimately the odds of being diagnosed with PE were similar. For reference, 75.2% (male) and 80.4% (female) of patients with chest pain that were evaluated for PE had D-dimer testing, compared with 63.7% (male) and 68.9% (female) of patients with dyspnea. Related, rates of D-dimer positivity were lower among patients with chest pain (17.6% male and 20.6% female) compared with those with dyspnea (29.9% male and 29.8% female). It seems then that providers may have had lower suspicion for PE as a diagnosis among patients with chest pain and thus opted for non-invasive testing more often. Given that dyspnea is the most common chief complaint among those diagnosed with PE, this may be a reasonable approach but should be guided by a structured risk assessment. Lastly it is worth noting that patients with chest pain had significantly lower odds of receiving imaging compared with those with dyspnea, though this finding did not vary based on sex.

Age was associated with three out of the four outcomes we evaluated. Increasing age was associated with lower odds of receiving a D-dimer. Given that the incidence of PE is much higher among older patients, who are also more likely to have comorbidities that increase their risk this is not a particularly surprising finding.[9] Age was also a positive predictor of D-dimer positivity, which has been well established and validated.[28] This is an expected finding, however interesting, given that age adjustment does not begin until after age 50, which was not included in our cohort. Lastly, we found increasing pretest risk (rGS) to be associated with increased odds of both having imaging and being diagnosed with PE, both of which are expected findings and confirm that the pretest risk stratification is accurate.[17]

Limitations

This is a retrospective study and as such is subject to unknown confounders or effect modifiers that we are unable to control for retrospectively. Despite the important influence of exogenous hormones on VTE risk, and known sex differences in usage,[29] we were not able to collect reliable retrospective data on current usage; thus we are unable to control for this in the analysis. Likewise, we were unable to reliably collect information about other comorbidities or risk factors, outside of those captured by the rGS, which may have influenced the decision to test. In addition, our analysis is based on primary chief complaint only. As such we are unable to control for the presence of multiple chief complaints. Likewise, we are not able to further characterize the type of chest pain, associated symptoms, etc, which may have influenced the decision to test.

Conclusions

Modern testing for PE has been plagued by low-yield testing, particularly among low-risk groups such as young women. Women with chest pain had higher odds of receiving D-dimer testing and a significantly lower yield of testing despite similar pretest risk. The reasons for this difference are likely multifactorial and should be the focus of future investigation with the ultimate goal of decreasing low-yield testing and improving patient safety, particularly among women patients.

Funding Support

AJ and BM developed the conceptual model of this study and collected data. All authors had full access to the data for this paper and contributed to the data analysis, manuscript development, and critical review. Dr. Jarman is supported by Building Interdisciplinary Research Careers in Women's Health grant 2K12HD051958 at UC Davis. Dr. Maughan is supported by Scholars in Diagnostic Excellence program from the National Academy of Medicine, a Career Development Award from the American Heart Association, and a Pilot Research Grant from the Collins Medical Trust. Dr. Taylor is supported by the National Center for Advancing Translational Sciences, National Institutes of Health, through grant number UL1 TR001860. The contents of this manuscript are solely the responsibility of the authors and do not necessarily represent the official view of NIH.

References

1. Hurwitz LM, Reiman RE, Yoshizumi TT, et al. Radiation dose from contemporary cardiothoracic multidetector CT protocols with an anthropomorphic female phantom: implications for cancer induction. Radiology 2007;245(3):742–50. DOI: 10.1148/radiol.2453062046. [PubMed: 17923509]
2. Mamlouk MD, vanSonnenberg E, Gosalia R, et al. Pulmonary embolism at CT angiography: implications for appropriateness, cost, and radiation exposure in 2003 patients. Radiology 2010;256(2):625–32. DOI: 10.1148/radiol.10091624. [PubMed: 20551182]
3. Roditi G, Khan N, van der Molen AJ, et al. Intravenous contrast medium extravasation: systematic review and updated ESUR Contrast Media Safety Committee Guidelines. Eur Radiol 2022;32(5):3056–3066. DOI: 10.1007/s00330-021-08433-4. [PubMed: 35175378]
4. Cha MJ, Kang DY, Lee W, et al. Hypersensitivity Reactions to Iodinated Contrast Media: A Multicenter Study of 196 081 Patients. Radiology 2019;293(1):117–124. DOI: 10.1148/radiol.2019190485. [PubMed: 31478801]
5. Hutchinson BD, Navin P, Marom EM, Truong MT, Bruzzi JF. Overdiagnosis of Pulmonary Embolism by Pulmonary CT Angiography. AJR Am J Roentgenol 2015;205(2):271–7. DOI: 10.2214/AJR.14.13938. [PubMed: 26204274]
6. Lucassen WA, Beenen LF, Buller HR, et al. Concerns in using multi-detector computed tomography for diagnosing pulmonary embolism in daily practice. A cross-sectional analysis

using expert opinion as reference standard. Thromb Res 2013;131(2):145–9. DOI: 10.1016/j.thromres.2012.11.027. [PubMed: 23245652]

7. Kline JA, Garrett JS, Sarmiento EJ, Strachan CC, Courtney DM. Over-Testing for Suspected Pulmonary Embolism in American Emergency Departments: The Continuing Epidemic. Circ Cardiovasc Qual Outcomes 2020;13(1):e005753. DOI: 10.1161/CIRCOUTCOMES.119.005753. [PubMed: 31957477]
8. Freund Y, Chauvin A, Jimenez S, et al. Effect of a Diagnostic Strategy Using an Elevated and Age-Adjusted D-Dimer Threshold on Thromboembolic Events in Emergency Department Patients With Suspected Pulmonary Embolism: A Randomized Clinical Trial. JAMA 2021;326(21):2141–2149. DOI: 10.1001/jama.2021.20750. [PubMed: 34874418]
9. Silverstein MD, Heit JA, Mohr DN, Petterson TM, O'Fallon WM, Melton LJ 3rd,. Trends in the incidence of deep vein thrombosis and pulmonary embolism: a 25-year population-based study. Arch Intern Med 1998;158(6):585–93. DOI: 10.1001/archinte.158.6.585. [PubMed: 9521222]
10. Robert-Ebadi H, Le Gal G, Carrier M, et al. Differences in clinical presentation of pulmonary embolism in women and men. J Thromb Haemost 2010;8(4):693–8. (In eng). DOI: 10.1111/j.1538-7836.2010.03774.x. [PubMed: 20096004]
11. Mongan J, Kline J, Smith-Bindman R. Age and sex-dependent trends in pulmonary embolism testing and derivation of a clinical decision rule for young patients. Emerg Med J 2015;32(11):840–5. (In eng). DOI: 10.1136/emermed-2014-204531. [PubMed: 25755270]
12. van Mens TE, van der Pol LM, van Es N, et al. Sex-specific performance of pre-imaging diagnostic algorithms for pulmonary embolism. J Thromb Haemost 2018;16(5):858–865. (In eng). DOI: 10.1111/jth.13984. [PubMed: 29460484]
13. Jarman AF, Mumma BE, White R, et al. Sex differences in guideline-consistent diagnostic testing for acute pulmonary embolism among adult emergency department patients aged 18–49. Acad Emerg Med 2023;30(9):896–905. DOI: 10.1111/acem.14722. [PubMed: 36911917]
14. Lichtman JH, Leifheit EC, Safdar B, et al. Sex Differences in the Presentation and Perception of Symptoms Among Young Patients With Myocardial Infarction: Evidence from the VIRGO Study (Variation in Recovery: Role of Gender on Outcomes of Young AMI Patients). Circulation 2018;137(8):781–790. DOI: 10.1161/CIRCULATIONAHA.117.031650. [PubMed: 29459463]
15. White RH. The epidemiology of venous thromboembolism. Circulation 2003;107(23 Suppl 1):I4–8. DOI: 10.1161/01.CIR.0000078468.11849.66. [PubMed: 12814979]
16. Kline JA, Mitchell AM, Kabrhel C, Richman PB, Courtney DM. Clinical criteria to prevent unnecessary diagnostic testing in emergency department patients with suspected pulmonary embolism. J Thromb Haemost 2004;2(8):1247–55. DOI: 10.1111/j.1538-7836.2004.00790.x. [PubMed: 15304025]
17. Le Gal G, Righini M, Roy PM, et al. Prediction of pulmonary embolism in the emergency department: the revised Geneva score. Ann Intern Med 2006;144(3):165–71. DOI: 10.7326/0003-4819-144-3-200602070-00004. [PubMed: 16461960]
18. Tanabe Y, Yamamoto T, Murata T, et al. Gender Differences Among Patients With Acute Pulmonary Embolism. Am J Cardiol 2018;122(6):1079–1084. (In eng). DOI: 10.1016/j.amjcard.2018.05.042. [PubMed: 30072127]
19. McHugh KB, Visani L, DeRosa M, Covezzoli A, Rossi E, Goldhaber SZ. Gender comparisons in pulmonary embolism (results from the International Cooperative Pulmonary Embolism Registry [ICOPER]). Am J Cardiol 2002;89(5):616–9. (In eng). DOI: 10.1016/s0002-9149(01)02310-4. [PubMed: 11867055]
20. Team RC. R: A language and environment for statistical computing. In: Computing RFfS, ed. Vienna, Austria: http://www.R-project.org/. 2013.
21. West J, Goodacre S, Sampson F. The value of clinical features in the diagnosis of acute pulmonary embolism: systematic review and meta-analysis. QJM 2007;100(12):763–9. DOI: 10.1093/qjmed/hcm113. [PubMed: 18089542]
22. Barrios D, Morillo R, Guerassimova I, et al. Sex differences in the characteristics and short-term prognosis of patients presenting with acute symptomatic pulmonary embolism. PLoS One 2017;12(11):e0187648. DOI: 10.1371/journal.pone.0187648. [PubMed: 29107971]

23. Keller K, Hobohm L, Munzel T, Ostad MA, Espinola-Klein C. Syncope in haemodynamically stable and unstable patients with acute pulmonary embolism - Results of the German nationwide inpatient sample. Sci Rep 2018;8(1):15789. DOI: 10.1038/s41598-018-33858-1. [PubMed: 30361542]

24. Oqab Z, Ganshorn H, Sheldon R. Prevalence of pulmonary embolism in patients presenting with syncope. A systematic review and meta-analysis. Am J Emerg Med 2018;36(4):551–555. DOI: 10.1016/j.ajem.2017.09.015. [PubMed: 28947223]

25. Rouleau SG, Casey SD, Kabrhel C, Vinson DR, Long B. Management of high-risk pulmonary embolism in the emergency department: A narrative review. Am J Emerg Med 2024;79:1–11. DOI: 10.1016/j.ajem.2024.01.039. [PubMed: 38330877]

26. Keller K, Rappold L, Gerhold-Ay A, et al. Sex-specific differences in pulmonary embolism. Thromb Res 2019;178:173–181. (In eng). DOI: 10.1016/j.thromres.2019.04.020. [PubMed: 31039477]

27. Heit JA, Spencer FA, White RH. The epidemiology of venous thromboembolism. J Thromb Thrombolysis 2016;41(1):3–14. DOI: 10.1007/s11239-015-1311-6. [PubMed: 26780736]

28. Schouten HJ, Geersing GJ, Koek HL, et al. Diagnostic accuracy of conventional or age adjusted D-dimer cut-off values in older patients with suspected venous thromboembolism: systematic review and meta-analysis. BMJ 2013;346:f2492. DOI: 10.1136/bmj.f2492. [PubMed: 23645857]

29. Alsaloum M, Zilinyi RS, Madhavan M, et al. Gender Disparities in Presentation, Management, and Outcomes of Acute Pulmonary Embolism. Am J Cardiol 2023;202:67–73. DOI: 10.1016/j.amjcard.2023.06.012. [PubMed: 37421732]

Table 1:

Baseline Patient Characteristics

	Male N=735 (36.9%)	**Female N=1256 (63.1%)**
	mean, SD	**mean, SD**
Age	36.5, 8.6	35.7, 8.7
Chief Complaint	n, %	n, %
Chest Pain	408, 55.5	750, 59.7
Shortness of Breath	284, 38.6	437, 34.8
Syncope	27, 3.7	54, 4.3
Hemoptysis	16, 2.2	15, 1.2
Initial Vital Signs	mean, SD, (*n missing)*	mean, SD, (*n missing)*
Heart Rate	98, 22, (*2)*	97, 20, *(3)*
Respiratory Rate	19, 4.5, (*4)*	18.7, 4.1, (*6)*
Systolic Blood Pressure	136.8, 19.7, (*1)*	134.3, 21.4, (*0)*
Diastolic Blood Pressure	84.1, 15.4, (*1)*	82.5, 15.5, (*0)*
Risk Factors	n, %	n, %
Prior VTE	107, 14.6	188, 15.0
Active Cancer	59, 8.0	98, 7.8
Recent Surgery	39, 5.3	70, 5.6
Unilateral Lower Limb Pain	29, 3.9	44, 3.5
Hemoptysis	34, 4.6	33, 2.6
Unilateral Leg Pain & Edema	11, 1.5	18, 1.4
Pretest Risk	Median, IQR	Median, IQR
Geneva Score	5 (3–5)	5 (3–5)
Geneva Risk Category	n, %	n, %
Low	265, 36.1	454, 36.1
Moderate	456, 62.0	779, 62.0
High	14, 1.9	23, 1.8
Outcome Measures	n, %	n, %
Dimer Performed	523, 71.2	956, 76.1

	Male N=735 (36.9%)	**Female N=1256 (63.1%)**
	mean, SD	**mean, SD**
Dimer Positive	115, 22.0	221, 23.1
Imaging Performed	313, 42.6	480, 38.2
PE Diagnosis	39, 5.3	39, 3.1

Table 2

Outcome Measures by Sex and Chief Complaint [Male (ref)]

Chief Complaint	Outcome Measure	OR (95% CI)	P value
All Patients (n=1,991)	**Dimer Performed**	**1.30 (1.06–1.59)**	**0.015**
	Dimer Positive	1.07 (0.83–1.38)	0.644
	Imaging Performed	0.83 (0.69–1.00)	0.060
	PE Diagnosed	**0.57 (0.36–0.90)**	**0.019**
Chest Pain (n=1,158)	**Dimer Performed**	**1.35 (1.01–1.80)**	**0.049**
	Dimer Positive	1.21 (0.85–1.73)	0.327
	Imaging Performed	0.85 (0.66–1.09)	0.217
	PE Diagnosed	**0.36 (0.18–0.70)**	**0.003**
Dyspnea (n=721)	Dimer Performed	0.84 (0.96–1.8)	0.108
	Dimer Positive	1.01 (0.67–1.52)	0.957
	Imaging Performed	0.84 (0.62–1.13)	0.272
	PE Diagnosed	0.92 (0.47–1.80)	0.943
Syncope (n=81)	Dimer Performed	0.61 (0.27–3.64)	0.997
	Dimer Positive	0.56 (0.15–2.11)	0.614
	Imaging Performed	0.61 (0.21–1.77)	0.535
	PE Diagnosed	-	-
Hemoptysis (n=31)	Dimer Performed	3.00 (0.03–0.89)	0.075
	Dimer Positive	1.06 (0.07–15.82)	0.968
	Imaging Performed	3.00 (0.65–13.89)	0.306
	PE Diagnosed	1.29 (0.16–10.25)	0.808

* Pretest risk equal by sex across all chief complaints

Bold: p<0.05

Table 3:

Predictors of PE Testing and Diagnosis

Outcome Variable	**D-dimer Performed**		**D-dimer Positive**		**Imaging Performed**		**PE Diagnosis**	
Covariate	**aOR (95% CI)**	**p**	**aOR (95% CI)**	**p**	**aOR (95% CI)**	**p**	**aOR (95% CI)**	**p**
Chief Complaint; Dyspnea (ref)								
Chest Pain	**1.79 (1.34–2.38)**	**<0.001**	**0.56 (0.39–0.80)**	**<0.001**	**0.58 (0.45–0.75)**	**<0.001**	0.64 (0.36–1.31)	0.156
Syncope	**2.81 (1.16–6.83)**	**0.015**	0.54 (0.22–1.34)	0.303	**0.37(0.18–0.77)**	**0.003**	-	-
Hemoptysis	0.64 (0.23–1.81)	0.684	0.52 (0.09–3.01)	0.771	1.45 (0.54–3.89)	0.77	2.98 (0.79–11.32)	0.133
Study Site; Site 1 (ref) Site 2	**1.34 (1.09–1.66)**	**0.007**	1.10 (0.85–1.43)	0.465	0.91 (0.75–1.10)	0.338	0.63 (0.39–1.00)	0.052
Patient Age	**0.97 (0.96–0.99)**	**<0.001**	**1.03 (1.01–1.04)**	**0.001**	**1.03 (1.02–1.04)**	**<0.001**	1.01 (0.98–1.03)	0.622
Patient Sex; Male (ref) Female	0.79 (0.47–1.33)	0.381	0.90 (0.42–1.90)	0.773	1.02 (0.64–1.63)	0.924	0.71 (0.33–1.55)	0.393
Dyspnea*Patient Sex (F/M)	1.32 (0.95–1.82)	0.095	1.02 (0.68–1.53)	0.933	0.85 (0.62–1.15)	0.281	0.93 (0.47–1.86)	0.845
Chest Pain*Patient Sex	**1.36 (1.01–1.84)**	**0.04**	1.24 (0.86–1.78)	0.252	0.86 (0.66–1.11)	0.24	**0.37 (0.19–0.74)**	**0.005**
Syncope*Patient Sex	1.02 (0.28–3.80)	0.974	0.51 (0.14–1.92)	0.321	0.59 (0.20–1.72)	0.333	-	-
Hemoptysis*Patient Sex	0.22 (0.05–1.01)	0.052	1.00 (0.07–14.16)	0.998	2.57 (0.59–11.22)	0.21	1.04 (0.13–8.60)	0.97
Geneva Risk; Low (ref)								
Moderate	0.81 (0.65–1.01)	0.058	1.25 (0.96–1.63)	0.098	**1.25 (1.03–1.53)**	**0.023**	**1.81 (1.03–3.16)**	**0.039**
High	**0.24 (0.12–0.48)**	**<0.001**	1.93 (0.64–5.32)	0.214	**4.19 (2.06–9.08)**	**<0.001**	**10.29 (3.82–27.70)**	**<0.001**
Physician Gender Male * Patient Sex (F/M)	0.68 (0.39–1.18)	0.172	0.98 (0.44–2.16)	0.957	1.09 (0.66, 1.80)	0.731	0.65 (0.27–1.53)	0.322
Physician Gender Female* Patient Sex (F/M)	0.92 (0.52–1.64)	0.787	0.82 (0.36 – 1.84)	0.628	0.96 (0.58, 1.60)	0.873	0.79 (0.30–2.05)	0.621
Attending Years of Experience	0.99 (0.98–1.01)	0.268	1.00 (0.99–1.02)	0.599	1.01 (1.00–1.02)	0.306	1.00 (0.98–1.03)	0.825

Bold: p<0.05