Alignment of Statistical Content in Medical Licensing Exam Study Resources with Statistical Methodology in Medical Research

W. Connor Haycox, MS4[1]; Dmitry Tumin, PhD[2]

1 Brody School of Medicine at East Carolina University, Greenville, NC; 2 Department of Academic Affairs at Brody School of Medicine at East Carolina University, Greenville, NC

W. Connor Haycox
Brody School of Medicine
East Carolina University
Greenville, North Carolina 27858
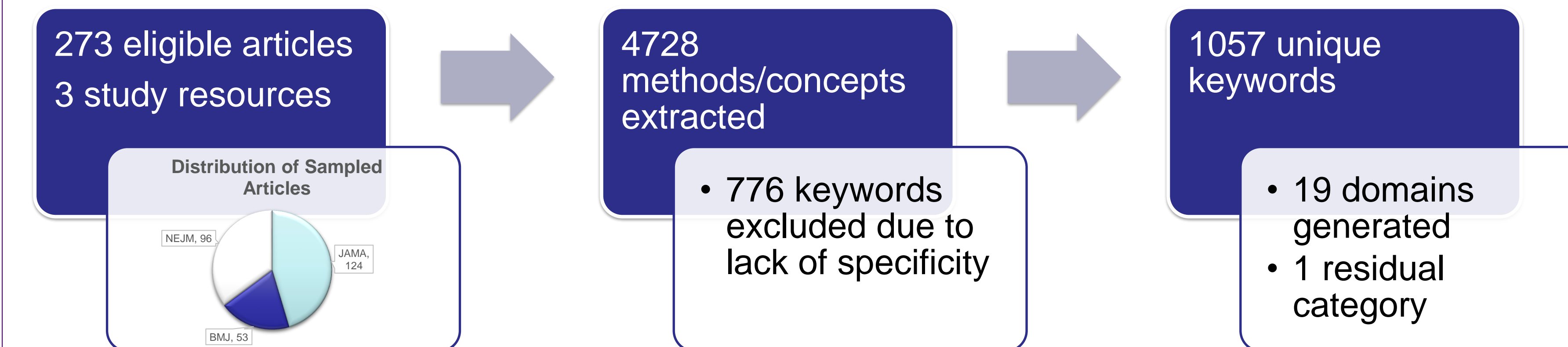haycoxw20@students.ecu.edu

INTRODUCTION

- Statistical literacy is a key medical skillset that facilitates evidence-based clinical reasoning and application of scientific literature and features in national licensing examinations.[1]

- Despite curricular and co-curricular training via self-guided commercial resources, current medical trainees continue to express difficulty with interpreting statistics in clinical literature, especially given increasingly complex or novel biostatistical methods employed in contemporary research.[2]

- It is unknown how well commercial licensing-exam study aids prepare medical trainees for interpreting real-world biostatistics.

- In this study, we aimed to compare statistical methods and concepts found in contemporary biomedical literature to biostatistical concepts covered in commercial study resources to reveal potential deficits in statistics education and inform future redesigns of curricula and study aid materials.
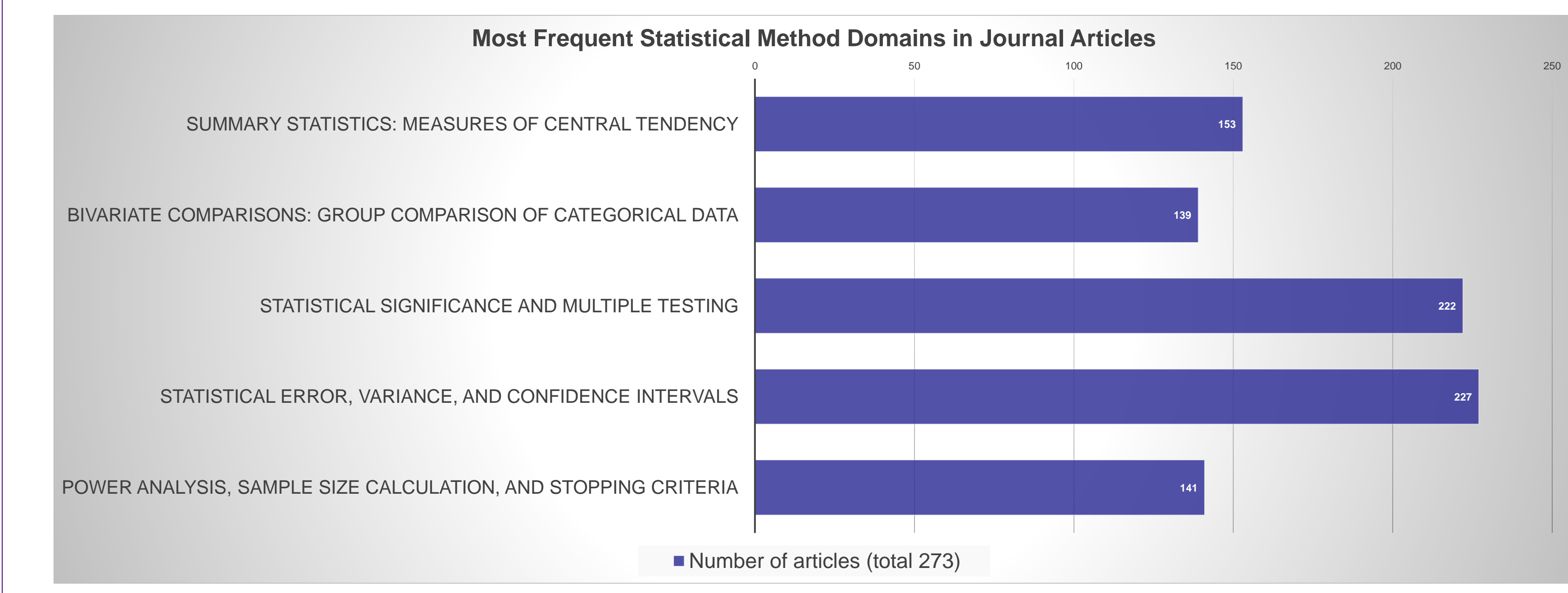
MATERIALS & METHODS

- In this bibliographic content analysis, we compiled a stratified random sample of 72 issues from three major journals from 2023.

- We reviewed any article involving original data analysis and recorded any statistical method or concept described in the methods section of the main text; we also recorded the statistical content of 3 commercial licensing-exam study aids.

- We used a unified list of all discrete methods/concepts to determine overarching coding domains; domain mapping determined the domain's presence and frequency in each article/aid.

RESULTS

Data collection scheme:

- 273 eligible articles / 3 study resources

  Distribution of Sampled Articles: NEJM, 96; JAMA, 124; BMJ, 53
- 4728 methods/concepts extracted
  - 776 keywords excluded due to lack of specificity
- 1057 unique keywords
  - 19 domains generated
  - 1 residual category

Coding Domains & Coverage in Commercial Study Resources

Domain	Examples of words or phrases mapped to domain	A	B	C
Summary statistics: Measures of central tendency	Mean, median	X	X	X
Summary statistics: Measures of dispersion	Standard deviation, interquartile range	X	X	X
Bivariate comparisons: Group comparison of categorical data	Relative risk, chi-square test	X	X	X
Bivariate comparisons: Group comparison of normally-distributed continuous data	T-test, mean difference	X	X	X
Bivariate comparisons: Group comparison of non-normally-distributed continuous data	Rank-sum test, Kruskal-Wallis test			
Bivariate comparisons: Correlation of continuous data	Correlation, Pearson correlation coefficient	X	X	X
Statistical significance and multiple testing	P-value, alpha	X	X	X
Statistical error, variance, and confidence intervals	Confidence interval, standard error	X	X	X
Power analysis, sample size calculation, and stopping criteria	Power, interim analysis	X	X	X
Survival analysis: Univariate and bivariate methods	Kaplan-Meier, log-rank test	X		X
Survival analysis: Multivariable regression methods	Hazard ratio, Cox proportional hazards	X		X
Multivariable regression (excluding survival analysis): Linear regression	Linear regression, R-squared	X		X
Multivariable regression (excluding survival analysis): Generalized linear regression	Logistic regression, Poisson regression			
Multivariable regression (excluding survival analysis): Multilevel regression	Fixed effects, random effects			
Multivariable regression (excluding survival analysis): Effect modification and mediation	Interaction term, effect modifier	X	X	X
Diagnostic test and predictive score performance	Sensitivity, specificity	X	X	X
Missing data and imputation of missing values	Imputation, missingness	X		X
Meta-analysis	Heterogeneity, forest plot	X		
Weighting and complex sampling design	Weighting, inverse probability weighting			
Statistical methods not elsewhere classified	Log transformation, cubic spline	X	X	X

Most Frequent Statistical Method Domains in Journal Articles
- SUMMARY STATISTICS: MEASURES OF CENTRAL TENDENCY — 153
- BIVARIATE COMPARISONS: GROUP COMPARISON OF CATEGORICAL DATA — 139
- STATISTICAL SIGNIFICANCE AND MULTIPLE TESTING — 222
- STATISTICAL ERROR, VARIANCE, AND CONFIDENCE INTERVALS — 227
- POWER ANALYSIS, SAMPLE SIZE CALCULATION, AND STOPPING CRITERIA — 141

■ Number of articles (total 273)

DISCUSSION

- A major discrepancy persists between biostatistical methods frequently occurring in current clinical research and those emphasized in undergraduate medical licensing-exam study resources, reflecting significant learning gaps noted in prior studies.[3]

  - Almost **1/5** of domains were not covered **at all** in commercial study aids, while **63%** of articles included at least one of those omitted domains.

  - Although included in domains, methods covered in study resources did not approach the breadth and complexity of those in the literature.

- All but one domain (generalized linear regression) is in the most recent USMLE and COMLEX-USA content outlines, indicating incomplete preparatory resources across modalities.

  - Even with perfect understanding of biostatistical principles reviewed in study aids, medical trainees are likely underprepared for exams and interpreting and conducting real-world research statistics.

- Possible educational interventions include longitudinal "journal club" sessions, enhanced faculty training, study aid revisions, and incorporating statistics into graduate medical education.[4,5]

- Areas for future study include incorporating analysis of one or several undergraduate medical biostatistics curricula and expanding the content sample size and/or publication range.

SELECT REFERENCES

1. Schmidt FM et al. Statistical literacy and scientific reasoning & argumentation in physicians. *GMS J Med Educ*. 2021;38(4):Doc77.
2. Yi D et al. Statistical Use in Clinical Studies: Is There Evidence of a Methodological Shift? *PLOS ONE*. 2015;10(10):e0140159.
3. Arnold LD et al. Statistical Trends in the Journal of the American Medical Association and Implications for Training across the Continuum of Medical Education. *PLOS ONE*. 2013;8(10):e77301.
4. Evans KH et al. An Innovative Blended Preclinical Curriculum in Clinical Epidemiology and Biostatistics: Impact on Student Satisfaction and Performance. *Acad Med J Assoc Am Med Coll*. 2016;91(5):696-700.
5. Gold JG et al. Clinical reasoning education in the clerkship years: A cross-disciplinary national needs assessment. *PLOS ONE*. 2022;17(8):e0273250.

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