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# A Survey Evaluating Extent of Undergraduate Medical Education Regarding Sex-based Differences in Pathophysiology

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## ABSTRACT

**INTRODUCTION:** A historical gap in research on sex differences in health outcomes has led to a lack of education on sex-based differences in pathophysiology. The primary objective of this research study was to survey pathophysiology professors of medical schools in the United States (US) to understand the current extent to which the impact of sex on disease is included in the pre-clinical curricula of undergraduate medical institutions in the US.

**METHODS:** A survey tool was created via literature review to assess the extent of education on sex-based differences in pathophysiology. This survey was distributed using the Qualtrics electronic platform to the head professor of pathophysiology at each of the 141 Liaison Committee on Medical Education (LCME) accredited medical schools in the United States.

**RESULTS:** The survey response rate was 14.9%. The most taught topics were epidemiology of most common cancers affecting each sex and risk factors for development of osteoporosis between different sexes. Sex-based differences in zolpidem dosing, smoking cessation, and the physiologic mechanism of narcotic addiction had the least curricular coverage. 28.57% of faculty and 38.10% of faculty agree or somewhat agree that their institution provides faculty development for teaching about topics relating to sex differences in pathophysiology. Medical students are primarily evaluated on their knowledge of sex pathophysiology in the form of written examination, followed by evaluation by standardized patients, and lastly faculty observed patient interactions.

**DISCUSSION:** Curricular topics relating to sex-based differences in pathophysiology are taught to varying degrees in medical school preclinical curricula. Improved efforts can be made to increase instruction on specific topics and to support faculty development in teaching about sex-based differences in disease evaluation and management, enhancing the education of the next generation of physicians and facilitating better care for patients.

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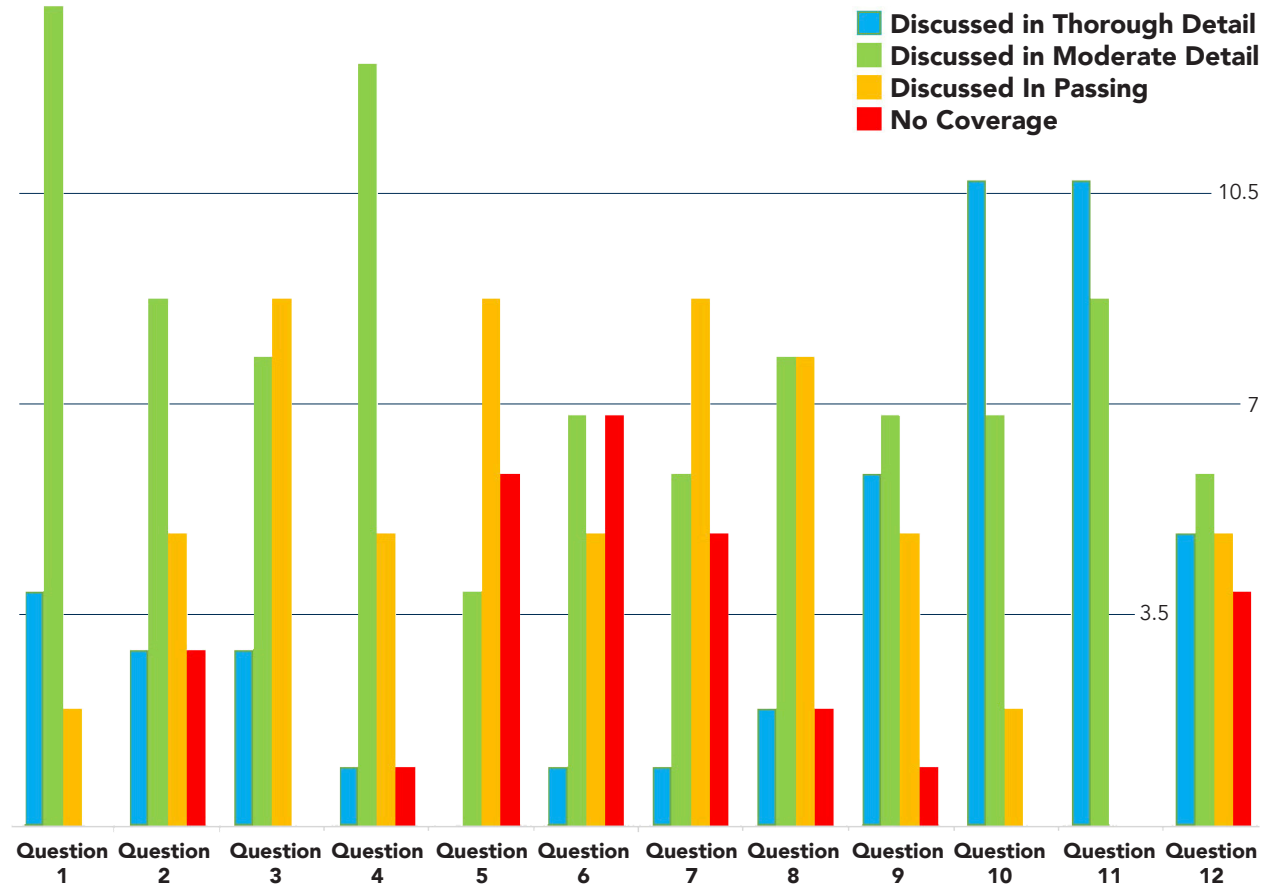
## INTRODUCTION

Although women represent over half the population and have significantly higher healthcare utilization, they have historically been underrepresented in medical research<sup>1</sup>. Prior to the 1960s, research focused exclusively on male models, and only with the 1993 NIH Revitalization Act were clinical trials mandated to include women and minorities in adequate numbers to evaluate for differences.<sup>2</sup>

Despite these research limitations, evidence has shown that there are significant sex-based differences in disease pathophysiology and health outcomes.<sup>1</sup> In 2016, Dr. Marjorie Jenkins and the Texas Tech University Health Sciences Center/Laura W. Bush Institute for Women's Health identified 12 areas where disease pathophysiology varies significantly between men and women, shown in Table 1.6

Despite the evidence demonstrating sex-based variations in disease pathophysiology, medical school education on these differences is inconsistent. In 1995, a study surveying US medical school curricula conducted by the AAMC and NIH Office of Women's Research revealed that only 17% of medical schools had a single course or seminar focusing on women's health, apart from the core OB/GYN clerkship<sup>2</sup>. Later studies have continued to demonstrate a limited focus on sex-based differences in medical education. A 2019 audit of Yale's medical school curriculum revealed less than a quarter of all preclinical education sessions discussed differences in pathophysiology.

**Figure 1.** Extent of Sex-Based Differences in Pathophysiology in Undergraduate Medical Education



**Questions**

1. Presenting symptoms of myocardial infarction between the different sexes
2. The effectiveness of aspirin for the prevention of stroke between different sexes
3. The effectiveness of using aspirin for the prevention of myocardial infarction between different sexes
4. Differences in presenting symptoms of clinical depression between different sexes
5. Dosing of zolpidem between different sexes
6. Physiologic mechanism of addiction relating to narcotic substances between different sexes
7. Smoking cessation between different sexes
8. End-organ toxicity of alcohol use between different sexes
9. Sexual dysfunction in women (as compared to the extent to which sexual dysfunction in men is discussed)
10. Epidemiology of the most common cancers affecting each sex (lung cancer, breast cancer, prostate cancer, colorectal cancer)
11. Risk factors for the development of osteoporosis between the different sexes
12. Outcomes after low impact fractures in adults in different sexes

iology by sex, and just 8.1% discussed these issues in detail<sup>3,4</sup>. Most recently, a 2023 audit of Medical College of Wisconsin’s curriculum revealed 54 percent of courses incorporated some mention of sex and gender medicine, revealing an upward trend of

increased incorporation of sex and gender topics over time<sup>5</sup>. There is a paucity of research on the current state of sex and gender medicine topics taught in all medical school curriculums in the United States. The inadequate education on how diseases can pres-

**Table 1.** Twelve Areas with Significant Sex-based Differences in Pathophysiology

**Twelve Areas with Significant Sex-based Differences in Pathophysiology**

1. Presenting Symptoms of Myocardial Infarction
2. Myocardial Infarction and Stroke Prevention with Aspirin
3. Presenting Symptoms of Clinical Depression
4. Zolpidem Dosages
5. Opioid Use Disorder
6. Smoking Cessation
7. Sexual Dysfunction
8. Cancer Epidemiology
9. Osteoporosis Risk Factors
10. Low-Impact Fracture Outcomes in Adults
11. Domestic Violence Victims
12. Alcohol Use Causing End-Organ Toxicity

Table 1: Twelve Areas with Significant Sex-Based Differences in Pathophysiology. Adapted from Question 11 of the “Sex and Gender Medical Education National Student Survey” developed by Dr. Marjorie Jenkins and the Texas Tech University Health Sciences Center/Laura W. Bush Institute for Women’s Health in 2016.

ent differently in women has led to medical students feeling insufficiently prepared to address the needs of female patients. In a 2008 survey, 1,267 third- and fourth-year medical students described their medical education regarding women’s health and sex and gender topics as “brief to moderate,” rated as an average of 2.53 on a four-point scale<sup>3</sup>. As a result, these same students felt only moderately prepared to take care of women.

Research efforts have been focused on assessments of medical school students and clinical curricula, but there are scant studies of the academic faculty who are teaching these students. For efforts to be accurately aimed at improving education on sex-based differences in medical schools, the scope of the problem must be quantified, which requires input from medical school instructors on how much they cover these topics in their courses. Thus, the primary objective of this research study was to survey pathophysiology medical school professors on the current extent to which sex-based differences in pathophysiology are included in pre-clinical undergraduate medical education in the United States.

**METHODS**

A literature review was performed to determine established survey tools for the assessment of medical school curricula in the context of sex-based differences in pathophysiology. The review identified as a model the validated “Sex and Gender Medical Education National Student Survey” developed by Dr. Marjorie Jenkins and the Texas Tech University Health Sciences Center/Laura W. Bush Institute for Women’s Health in 2016. This survey tool was expert reviewed, pilot tested, and subsequently implemented in a large research study, making for an ideal template. By reframing the questions for faculty, a survey tool was constructed for implementation in this study. After a review process involving contributions from all authors to streamline questions and ensure clarity, a finalized 18-question survey tool was established. The survey tool incorporated twelve areas with significant sex-based differences in pathophysiology with participants asked about the extent to which a topic was covered in their pre-clinical curriculum, demonstrated in Table 1. Answer choices were ‘no coverage,’ ‘discussed in passing,’ ‘discussed in moderate detail,’ and ‘discussed in thorough detail.’

Additional questions were included in the survey to assess support for faculty in teaching sex-based differences in pathophysiology, faculty perception on extent of sex-based differences in pathophysiology incorporation in their curriculum, and methods of student assessment of such topics. Participants were asked to indicate on a 7-Point Likert Scale the extent to which they agreed with a series of statements, with responses ranging from “strongly disagree” to “strongly agree.” The evaluated statements are as follows: the results of research studies are discussed in the context of the sex of cells in basic science research; the results of research studies are discussed in the context of the sex of subjects and the gender of subjects in clinical research; your institution provides faculty development for teaching about topics relating to sex differences in pathophysiology; there is routine mention or discussion about the lack of basic and clinical research surrounding the effects of sex and gender relating to medicine.

Instructors were also surveyed regarding how they measure medical student knowledge regarding sex-based differences in pathophysiology. The primary method of assessing medical students was evaluated as a multiple-choice question with choices including: ‘Written examination’, ‘Faculty-observed patient interactions’, ‘Peer-to-peer evaluations’, ‘Evaluation by standardized patients (patient actors)’, and

**Table 2.** Extent of Sex-Based Differences Pathophysiology in Undergraduate Medical Education

Question	Discussed in Thorough Detail	Discussed in Moderate Detail	Discussed In Passing	No Coverage	Total
1. Presenting symptoms of myocardial infarction between the different sexes	4 (20.0%)	14 (70.0%)	2 (10.0%)	0 (0.0%)	20
2. The effectiveness of aspirin for the prevention of stroke between different sexes	3 (15.0%)	9 (45.0%)	5 (25.0%)	3 (15.0%)	20
3. The effectiveness of using aspirin for the prevention of myocardial infarction between different sexes	3 (15.0%)	8 (40.0%)	9 (45.0%)	0 (0.0%)	20
4. Differences in presenting symptoms of clinical depression between different sexes	1 (5.0%)	13 (65.0%)	5 (25.0%)	1 (5.0%)	20
5. Dosing of zolpidem between different sexes	0 (0.0%)	4 (21.1%)	9 (47.4%)	6 (31.6%)	19
6. Physiologic mechanism of addiction relating to narcotic substances between different sexes	1 (5.0%)	7 (35.0%)	5 (25.0%)	7 (35.0%)	20
7. Smoking cessation between different sexes	1 (4.8%)	6 (28.6%)	9 (42.9%)	5 (23.8%)	21
8. End-organ toxicity of alcohol use between different sexes	2 (10.0%)	8 (40.0%)	8 (40.0%)	2 (10.0%)	20
9. Sexual dysfunction in women (as compared to the extent to which sexual dysfunction in men is discussed)	6 (31.6%)	7 (36.8%)	5 (26.3%)	1 (5.3%)	19
10. Epidemiology of the most common cancers affecting each sex (lung cancer, breast cancer, prostate cancer, colorectal cancer)	11 (55.0%)	7 (35.0%)	2 (10.0%)	0 (0.0%)	20
11. Risk factors for the development of osteoporosis between the different sexes	11 (55.0%)	9 (45.0%)	0 (0.0%)	0 (0.0%)	20
12. Outcomes after low impact fractures in adults in different sexes	5 (25.0%)	6 (30.0%)	5 (25.0%)	4 (20.0%)	20

Survey questions with response number (rate), and total number of participants answered, when asked to which extent certain specific subjects relating to sex and gender medicine were incorporated into their school’s preclinical curriculum.

‘Does not evaluate’.

The survey tool was distributed using the Qualtrics platform. The head professor of pathophysiology of each of the 141 LCME accredited medical schools in the United States were contacted via email address

and asked to fill out the survey tool online. Participants were contacted via email containing a link to the Qualtrics survey tool. Five scheduled follow-up emails were sent over the course of 2 months. The inclusion criteria were faculty professors teach-

**Table 3.** Discussion of Sex and Gender of Cells and Subjects in Research

Question	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree	Total
The sex of the cells in basic science research	0 (0.0%)	2 (10.0%)	4 (20.0%)	5 (25.0%)	2 (10.0%)	5 (25.0%)	2 (10.0%)	20
The sex of subjects in clinical research	3 (14.3%)	7 (33.3%)	9 (42.9%)	1 (4.8%)	1 (4.8%)	0 (0.0%)	0 (0.0%)	21
The gender of subjects in clinical research	2 (9.5%)	5 (23.8%)	3 (14.3%)	1 (4.8%)	3 (14.3%)	6 (28.6%)	1 (4.8%)	21

Response count and rate to survey question 2 about which degree the faculty member agrees that there is routinely discussion of the results of sex of cells and sex and gender of subjects in basic and clinical research respectively.

**Table 4.** Faculty Development for Sex and Gender Pathophysiology

Statements	Strongly Agree	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	Strongly Disagree	Total
Your institution provides faculty development for teaching about topics relating to sex and gender pathophysiology	0 (0.0%)	6 (28.6%)	8 (38.1%)	1 (4.8%)	3 (14.3%)	2 (9.5%)	1 (4.8%)	21

Response count and rate of the statements about which degree the faculty member agrees with the statement about sex and gender pathophysiology.

ing pathophysiology at LCME accredited osteopathic and allopathic medical schools in the United States. Professors at schools not recognized by the Liaison Committee on Medical Education, not in the United States, and not currently accredited by Liaison Committee on Medical Education were not included in the study. The reporting guideline ‘Good practice in the conduct and reporting of survey research’ was referenced and utilized during the research process.<sup>6</sup>

## RESULTS

Our survey tool was sent out to faculty at 141 medical schools. The survey tool was answered by 21 individuals, each from different medical schools, with

a survey response rate of 14.9%. Results from the first section of the survey, which asked the participants to assess the extent to which certain subjects relating to sex and gender medicine were incorporated into their school’s preclinical curriculum, are shown in Table 2.

The topics that were most likely to be taught in thorough detail, as noted by 55% of respondents, were the epidemiology of the most common cancers affecting each sex and the sex-based risk factors for development of osteoporosis. These were followed by sexual dysfunction in women (as compared to the extent to which sexual dysfunction in men is discussed), which was reported to be discussed in thorough detail by 31.6% of responders.

The topics that were reported to be the most dis-

**Table 5.** Discussion of Research Gap in Sex-Based Differences on Pathophysiology

Statements	Strongly Agree	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	Strongly Disagree	Total
“There is routine mention or discussion about the lack of basic and clinical research surrounding the effects of sex and gender relating to medicine.”	0 (0.0%)	5 (23.8%)	6 (28.6%)	3 (14.3%)	5 (23.8%)	1 (4.8%)	1 (4.8%)	21

Response count and rate of the statements about which degree the faculty member agrees with the statement about regarding the research gap sex and gender pathophysiology.

cussed in moderate detail were presenting symptoms of myocardial infarction between the different sexes and differences in presenting symptoms of clinical depression between the different sexes, at 70% and 65% respectively. The topics that had the highest rates of no coverage in curricula were sex-based differences in zolpidem dosing, smoking cessation, and the physiology of narcotic addiction. Table 3 demonstrates the results of the next survey question, which asked participants to agree or disagree on a Likert scale with whether there is routinely a discussion of the results of research studies in the context of the sex and gender of subjects in clinical research, and sex of cells in basic science research. A total of 90.5% of survey responders strongly agree, agree, or somewhat agree that there is routinely a discussion of the results of research studies in the context of subjects’ sex in clinical research. However, only 47.6% responders strongly agree, agree, or somewhat agree that there is routinely mention of the gender of subjects in clinical research. In terms of there being a discussion of the sex of cells in basic science, the percentage who agree to some extent with this statement falls to 30%, with 45% disagreeing (somewhat disagree, disagree, or strongly disagree).

The following question asked participants the extent to which they agree that their institution provides faculty development for teaching about topics relating to sex and gender physiology. As seen in Table 4, most survey responders selected that they ‘somewhat agree’ (38.1%) or ‘agree’ (28.6%) to this statement. No responders chose ‘strongly agree’, while 4.9% chose ‘strongly disagree’ to this statement. Table 5 reveals that over half of respondents ‘agree’ or

**Table 6.** Method of Student Evaluations

Answer	Count (n)
Written examination	8 (38.1%)
Faculty-observed patient interactions	3 (14.3%)
Peer-to-peer evaluations	0 (0.0%)
Evaluation by standardized patients (patient actors)	6 (28.6%)
Does not evaluate	4 (19.1%)
Total	21

Response to survey Question 5 indicating how medical students are evaluated on their knowledge of sex and gender pathophysiology.

‘somewhat agree’ that there exists a routine mention or discussion about the lack of basic and clinical research surrounding the effects of sex difference on pathophysiology.

As seen in Table 6, medical students are primarily evaluated on their knowledge of sex-based differences on pathophysiology in the form of written examination, followed by standardized patient evaluations, and lastly faculty-observed patient interactions. A total of 19.1% said that medical students are not evaluated on this knowledge at all, and 0% marked peer to peer evaluations as a primary evaluation tool.



## DISCUSSION

Although women account for a majority of health-care workers and patients, they continue to experience worse healthcare outcomes across a number of key metrics. For example, women are often diagnosed later than men for the same diseases, reflecting a failure to recognize how sex may affect a clinical presentation.<sup>7</sup> Although gender bias and inadequate inclusion of women in research studies are key factors, undergraduate medical education on sex-based differences in pathophysiology also plays an important role in ensuring the next generation of healthcare providers are adequately prepared to treat diverse patients.

This survey of medical school professors helps to elucidate some of the limitations in medical school curricula. Certain topics with known sex-based differences are better covered. For example, women are known to be more likely to develop osteoporosis, breast cancer, and gynecological cancers, so these established differences were noted to be taught in thorough detail. Despite this findings, further evaluation of the survey responses reveals important caveats. For example, although the increased prevalence of osteoporosis in women was reported as taught in thorough detail, a key sequela of this finding, the increased risk for low impact fractures, was not as consistently taught. Education regarding sex-based differences in adult low-impact fractures revealed wide variability among institutions. Twenty-five percent believed the topic to be discussed in thorough detail, thirty percent said the topic was discussed in moderate detail, twenty five percent believed the topic was discussed in passing, and 20% reported this topic was not covered at all.

Moreover, other diseases with sex-based differences in presentation, such as clinical depression and myocardial infarction, were reported as only taught in moderate detail. This has consequential health repercussions, as depression is significantly more prevalent in women and is a risk factor behind a national uptrend in suicide.<sup>8</sup> Multiple research studies have shown women experience worse outcomes after acute myocardial infarction compared to men, which may be attributed to differences in presenting symptoms that may be missed in female patients.<sup>9</sup> Incorporating medical school education on differences in myocardial infarction presentation in women may improve health outcomes and help physicians to take better care of such patients.

Finally, a few topics were reported as not taught at all in medical schools. Sex-based differences in zolpidem doses, smoking cessation, and narcotic

addiction had the highest percent of survey respondents indicating no coverage of the topic in medical school. This finding is consistent with prior research showing a lack of adequate curriculum time devoted to substance use disorder in undergraduate medical education.<sup>10</sup> This may be due to a higher stigma associated with discussion of addiction and psychiatric disorders. Yet with their increasing prevalence, disproportionately affecting women, sex-based differences in addiction and psychiatric medication dosing should be further incorporated into preclinical medical education.

Part of the limited education regarding sex-based differences in pathophysiology may stem from inadequate institutional support in this area for faculty. No respondents strongly agreed that their institution provides faculty development for teaching topics relating to sex-based differences in pathophysiology. Professors may perceive diminished institutional support for teaching material emphasizing male/female binary sex differences in the context of an increasing understanding of gender as a complex and fluid construct existing on a spectrum.

However, over half of responders agreed or somewhat agreed that faculty development was available, reflecting a burgeoning interest among medical schools to better support faculty in this crucial area. As the literature on sex differences in pathophysiology is ever-growing, there continues to be opportunity for improvement in available resources for faculty development regarding sex-based differences in pathophysiology.

One key limitation of this study is that our survey tool used was not validated prior to distribution. Furthermore, only 14.9% of LCME accredited US medical schools had a faculty member from their institution respond to the survey. Because of the low response rate, the results of this study may not be sufficiently representative of nationwide education on sex-based differences in pathophysiology. Low response rate may be due to faculty having limited time and incentives to answer a survey tool distributed via email.

Another limitation is that survey answers are subject to participant bias and may be inaccurate. Faculty may not know of all the topics that are taught in preclinical medical education outside of their own instructional materials, as multiple instructors often cover separate areas of the curriculum. Also, those who incorporate sex-based differences in pathophysiology in their curricula may be more likely to respond to the survey, which may skew results to suggest these topics are incorporate in medical school curricula to a greater degree than in reality.

However, this study also has several strengths. The survey tool is quick to administer, can be administered electronically and remotely, and requires low time commitment from participants. This survey tool can also be re-administered in the future to track progress and trends regarding education on sex-based differences in pathophysiology in medical schools.

## CONCLUSION

This survey tool is one of few to examine the specific topics relating to sex-based differences in pathophysiology that are taught in the preclinical medical school education. Based on the survey results, certain topics such as myocardial infarction presentation in women and adult low-impact fracture risk by sex can be better covered in medical schools, while other topics related to addiction and psychiatric treatment are often not covered at all. These findings can be used to guide increased efforts focused on incorporating sex-based differences in pathophysiology into preclinical curricula, partly through improving faculty support. Future aims include repeating this survey in the future to see what progress has been made by observing how the answers to these questions change over time and across institutions.

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