Burnett School of Medicine

Pediatric Dermatologic Conditions and Fitzpatrick Skin Tone: Assessment of Diagnostic Accuracy and Associated Familiarity with Dark Skin

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Abstract:

Research Question:

How often do physicians correctly diagnosis pediatric skin conditions between different Fitzpatrick skin types? Further, which skin type(s) have the most correct rate of diagnosis and how is accuracy of dermatological diagnosis in people of color impacted by physicians' skin type?

Introduction and Significance:

Healthcare disparities in the United States are well documented. These disparities disproportionately affect people of color leading to poorer health outcomes across the care spectrum. Dermatology is no exception and has documented delays in care and increased mortality in people of color. Researchers have speculated that lack of familiarity with dermatological conditions in people of color is the primary explanation for this specific issue, as dermatology textbooks often unequally depict fair skin. As the United States becomes more racially diverse, these healthcare disparities, will affect an even greater number of individuals. One previous study has investigated this same issue but quizzed medical students instead of physicians on adult rash presentation. They also did not compare the accuracy of the quiz to the physicians' own skin color.

Materials and Methods:

With the help and direction of Dr. Sloan, my SPT mentor, we developed a survey. This survey quizzes providers on 5 pediatric skin conditions i.e., Giannotti Crosti, Erythema infectiosum, Pityriasis rosea, Scarlatina, and Mollescum contagiosum. Conditions, ranging from benign to urgent, common to rare, that mostly only affect children or adolescents. The survey features different clinical images and associated questions depicting rash presentations in different Fitzpatrick skin types. Ten questions depicting light skin and ten questions depicting darker skin tones. This was sent to pediatricians and urgent care providers across Texas. After completing the survey, Doctors assess their own skin type, as well as provide background information about their familiarity with skin of color.

Results/Conclusions:

Of the 57 physicians surveyed, 47 completed the survey. Contrary to our assumptions and previous studies, our results indicated only one condition with significant difference in

diagnostic accuracy, that being pityriasis rosea in the Fitzpatrick skin group 4-6. Additionally, we intended to compare accuracy with provider's skin color, or attendance of an HBCU, but the sample size was too small for proper statistical power.

Research Question

How often do heath care providers correctly diagnosis pediatric skin conditions between different Fitzpatrick skin types? Further, which skin type(s) have the most correct rate of diagnosis and how is accuracy of dermatological diagnosis in people of color impacted by physicians' skin type?

Hypothesis:

1)There are differences in doctors' rate of correct pediatric conditions diagnosis across the Fitzpatrick skin types.

2)The doctors' rate of correct diagnosis is related to the doctors' skin type.

3)Physicians with more familiarity/experience with dark skin types will achieve higher rates of correct diagnoses than those with less familiarity/experience.

4)Regardless of experience, all physicians will diagnose the lighter skin cases more accurately than the darker skin cases.

Introduction:

Healthcare disparities in the United States unequally affect people of color. In the United States, people who identify as Black have significantly higher cancer mortality rates than all other racial groups for breast, lung, colorectal, and prostate cancer[1]. Incidence of type 2 diabetes is two to six times among African Americans, Hispanics, and American Indian/Alaskans compared to the US non-Hispanic white population[2]. The SARS-COVID-19 pandemic has brought these differences to light yet again. Black and African American populations have 34% of the total mortality in the United States, albeit their 13% population size[3]. Specific racial disparities have been noted throughout research. Black patients were less likely to receive coronary bypass or guideline-based medical therapy compared to white patients[4]. Black patients were less likely to receive radiation therapy after mastectomy and generally less likely to receive a mastectomy[5]. Black patients were also more likely to receive antipsychotic medication and misdiagnosis for bipolar disorder[6]. Regarding dermatological issues, a study in 2012 found that "47% of dermatologists and dermatology residents reported that their medical training (medical school and/or residency) was inadequate in training them on skin conditions in [people with darker skin]" [7].

The United States Census Bureau projects that by the year 2043, the US population will be "majority-minority". This means that non-Hispanic whites will make up the largest subset, but the summation of other non-white race and ethnic groups will be the majority[8]. If healthcare disparities continue, the majority of the US population will face inadequate care. While the issue of disparities is quite complicated, prior studies have suggested that the issue dermatologically is an effect of a lack of educational resources or exposure to skin of color. Under-representation of skin of color in textbooks and medical teaching is well documented. In one review of the 5026 images in two textbooks, the proportion of images depicting skin of color was estimated to be 22–32% in textbooks and 21–38% in the teaching set[9]. An updated study looking at 6 common dermatological teaching books demonstrated the proportion of images depicting skin of color to be 4-18% [10]. A recent review of popular preparatory materials for USMLE exams demonstrated skin of color depicted in 32% of images [11]. Although not much research has been done, a prior study assessed medical students' ability to diagnose common dermatological conditions. They created a survey with 10 different diagnoses and split each condition into dark vs light skin. The medical students were less accurate in diagnosing certain skin conditions in skin of color[12]. A

follow-up study, conducted with interprofessional health care providers (medical students, residents, fellows, attending physicians, and nurses) repeated the demonstrated trend of better diagnostic accuracy in lighter skin, and that diagnostic accuracy in skin of color could be improved with a 15-minute educational module[13]. More research needs to be done that assesses a healthcare provider's ability to identify dermatological conditions and the reasoning behind that competency.

Significance:

As the United States population continues to grow and become more diverse health care disparities will expand. Clearly, exposure to dermatological conditions helps improve the accuracy of diagnosis, but where exactly that exposure comes from is the question. Obtaining objective data from physicians and comparing that to their own history, may be quite influential. Once found, these conditions that improve healthcare can be shared with other health providers. Identifying gaps in the traditional medical education model and demonstrating opportunities for growth will continue to bring to light the importance of acknowledging healthcare disparities. While this has been a troubling issue for hundreds of years, people with influence are just now starting to listen. A study completed now would have the weight of a national movement behind it. As medical schools and residency programs start to adjust their curricula these results may be used to improve equitable training. These results also may be used as a resource for future research regarding continuing medical education.

Materials and Methods:

Subject Identification:

Participants were invited to enroll in the study if they meet the following criteria: Pediatrician or Urgent Care physician currently practicing in the state of Texas. Participants were excluded if they are dermatologists.

Additional Subject Stratification:

Additional classification and information were critical for relevant analysis. Further stratification categories include age, gender, ethnicity, Fitzpatrick skin type, years of practice, location of current practice, demographics of residency patient population, and attendance at an HBCU or residency. Subjects had identifying information removed and be assigned an ID number to ensure confidentiality during analysis.

Survey:

The survey was emailed to the participants via Qualtrics software. Participation waiver started the survey. Ten questions of light skin and 10 questions of darker skin followed. Two for each disease i.e. Gianotti Crosti, Erythema infectiosum, Pityriasis rosea, Scarlatina, and Molluscum contagiosum. Rashes that present in children or adolescents. Participants were shown images of each Fitzpatrick skin type to compare to their own skin color. They were also asked for information regarding the stratification categories.

Demographic questions

1. What race/ethnicity do you identify as?
    a. American Indian or Alaska Native
    b. Asian
    c. Black/African American
    d. Native Hawaiian or Pacific Islander
    e. White
    f. Do not wish to answer

2. What is your gender?
   a. Male
   b. Female
   c. Non-binary
   d. Do not wish to answer

3. Identify the Fitzpatrick skin type that you feel most represents yourself?

The Fitzpatrick Scale

TYPE I	TYPE II	TYPE III	TYPE IV	TYPE V	TYPE VI
Light, pale white	White, fair	Medium, white to olive	Olive, moderate brown	Brown, dark brown	Black, very dark brown to black
Always burns, never tans	Usually burns, tans with difficulty	Sometimes mild burn, gradually tans to olive	Rarely burns, tans with ease to a moderate brown	Very rarely burns, tans very easily	Never burns, tans very easily, deeply pigmented

4. How many years have you been practicing medicine?

5. Have you attended one of these schools? ->

   Howard University, East Carolina University (Brody), University of Chicago (Pritzker), Emory University, University of California—Los Angeles (Geffen), Duke University, Eastern Virginia Medical School, Rutgers Robert Wood Johnson Medical School, Temple University (Katz), University of Florida, Ohio State University, University of Connecticut, Meharry Medical College, Morehouse School of Medicine, or Charles R. Drew University of Medicine and Science (CDU).

6. What is your primary pediatric practice location list ->

   academic, low-income clinic/public hospital, private clinic, emergency department, hospitalist, and urgent care.

7. How comfortable do you feel diagnosing pediatric skin rashes? 1-5

8. How comfortable do you feel diagnosis rashes on people of color? 1-5

Identify the correct pediatric dermatological condition in the photos below
Pick the diagnosis you feel is most likely based off the image.

Question 1:

   a) Gianotti crosti (acropapular dermatitis of childhood)
   b) Atopic dermatitis
   c) Contact dermatitis
   d) Rubeola

Question 2:

   a) Gianotti crosti (acropapular dermatitis of childhood)
   b) Hand foot and mouth disease
   c) Erythema infectiosum
   d) Atopic dermatitis

Question 3:

a) Gianotti crosti (acropapular dermatitis of childhood)
b) Atopic dermatitis
c) Contact dermatitis
a) Rubeola

Question 4:

a) Gianotti crosti (acropapular dermatitis of childhood)
b) Hand foot and mouth disease
c) Erythema infectiosum
d) Atopic dermatitis

Question 5:

a) Pityriasis rosea
b) Nodulocystic acne
c) Psoriasis
d) Roseola

Question 6:

a) Pityriasis rosea
b) Contact dermatitis
c) Rubeola
d) Tinea corporis

Question 7:

a) Pityriasis rosea
b) Nodulocystic acne
c) Psoriasis
d) Roseola

Question 8:

a) Pityriasis rosea
b) Contact dermatitis
c) Rubeola
d) Tinea corporis

Question 9:

a) Scarlatina
b) Contact dermatitis
c) Keratosis pilaris
d) Atopic dermatitis

Question 10:

a) Scarlatina
b) Ichthyosis vulgaris
c) Dyshidrotic eczema
d) Atopic dermatitis

Question 11:

a) Scarlatina
b) Contact dermatitis
c) Keratosis pilaris
d) Nummular eczema

Question 12:

a) Scarlatina
b) Ichthyosis vulgaris
c) Dyshidrotic eczema
d) Nummular eczema

Question 13:

    a) Mollescum contagiosum
    b) Verruca vulgaris
    c) Drug eruption
    d) Varicella

Question 14:

    a) Mollescum contagiosum
    b) Erythema infectiosum
    c) Pityriasis rosea
    d) Impetigo

Question 15:

a) Mollescum contagiosum
b) Verruca vulgaris
c) Drug eruption
d) Impetigo

Question 16:

a) Mollescum contagiosum
b) Erythema infectiosum
c) Pityriasis rosea
d) Varicella

Question 17:

a) Erythema infectiosum
b) Gianotti crosti (acropapular dermatitis of childhood)
c) Hand foot and mouth disease
d) Erysipelas

Question 18:

a) Erythema infectiosum
b) Rubella
c) Scarlatina
d) Contact dermatitis

Question 19:

    a) Erythema infectiosum
    b) Gianotti crosti (acropapular dermatitis of childhood)
    c) Hand foot and mouth disease
    d) Erysipelas

Question 20:

    a) Erythema infectiosum
    b) Rubella
    c) Scarlatina
    d) Contact dermatitis

Results:

Table 1: Describes participant characteristics. Broken down further into race/ethnicity, gender, Fitzpatrick skin type, primary practice location, years practicing medicine, comfort diagnosing pediatric rashes, and comfort diagnosing rashes on people of color.

Table 2: Demonstrates the diagnostic accuracy of the survey regarding the 5 pediatric skin conditions when compared on light vs dark skin. Further chi squared analysis produced a p-value to determine significant difference between the studied conditions.

Table 3: Demonstrates results of a between subjects t-test between light and dark conditions. Features the mean, standard of deviation, standard error of the mean, and 95% confidence interval.

Figure 1: Demonstrates a graphic representation of table 2. Light vs Dark comparisons for each of the 5 pediatric skin conditions examined.

Table 1: Study Participant Characteristics

Participant Characteristics	n (%)(N=47)
Race/Ethnicity	
White	38 (80.8)
Black/African American	1 (2.13)
Asian	3 (6.38)
Latino/x	4 (8.51)
Other	1 (2.13)
Gender	
Female	35 (74.5)
Male	12 (25.5)
Fitzpatrick Skin Type	
Type 1	14 (29.8)
Type 2	16 (34.0)
Type 3	13 (27.7)
Type 4	4 (8.51)
Primary Pediatric Practice Location	
Academic	15 (31.9)
Emergency Department	2 (4.26)
Hospitalists	5 (10.6)
Low Income Clinic	2 (4.26)
Private Clinic	21 (44.7)
Urgent Care	2 (4.26)
Years Practicing Medicine	
0-10	8 (17.0)
11-20	20 (42.6)
21-30	14 (29.8)
31-40	4 (8.51)
41+	1 (2.13)
Comfortability Diagnosing Pediatric Skin Rashes	
Extremely Comfortable	15 (31.9)
Somewhat Comfortable	25 (53.2)
Neither comfortable nor Uncomfortable	3 (6.38)
Somewhat Uncomfortable	4 (8.51)
Extremely Uncomfortable	0 (0.0)

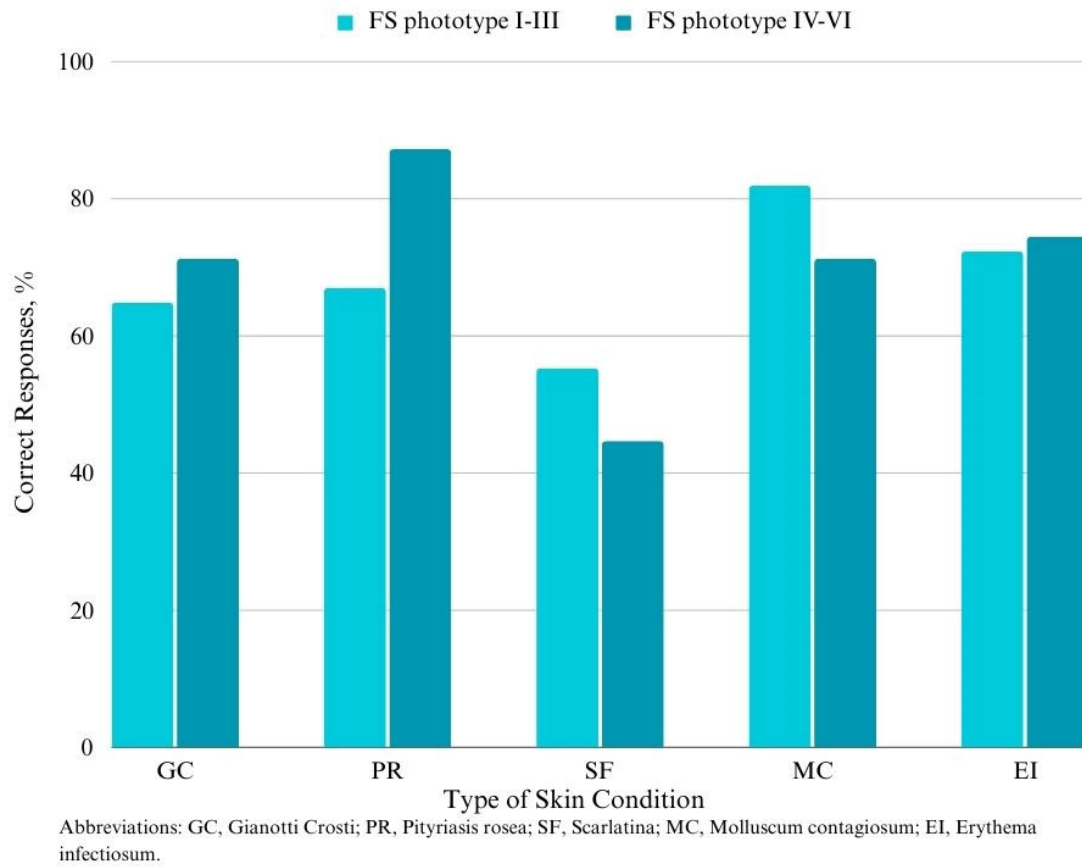| Comfortability Diagnosing Rashes on People of Color	
Extremely Comfortable	7 (14.9)
Somewhat Comfortable	24 (51.1)
Neither comfortable nor Uncomfortable	9 (19.1)
Somewhat Uncomfortable	7 (14.9)
Extremely Uncomfortable	0 (0.0)

Table 2: Survey Diagnostic Accuracy

Condition	FS phototype I-III % correct	FS phototype IV-VI % correct	χ^2	P value
Gianotti Crosti	61/94 = 64.89%	67/94 = 71.27%	0.88125	0.347856
Pityriasis rosea	63/94 = 67.02%	82/94 = 87.23%	10.8885	* 0.00096
Scarlatina	52/94 = 55.31%	42/94 = 44.68%	2.12765	0.144660
Molluscum contagiosum	77/94 = 81.91%	67/94 = 71.27%	2.96717	0.084970
Erythema infectiosum	68/94 = 72.34%	70/94 = 74.47%	0.10898	0.741302

Table 3: Results of Subject's Identification between Light and Dark Conditions

Between Subjects T-Test			Mean	SD	SEM	N
Subjects		Light	64.20	9.20	4.12	5
		Dark	65.60	14.57	6.52	5

			95% Confidence	Interval			
	Mean	SEM	Lower	Upper	t	df	Sig. (2-tailed)
Light - Dark	-1.40	7.707	-19.17	16.37	0.1816	8	0.8604

Figure 1: Bar Chart depicting Light vs Dark Comparisons for each of the 5 Pediatric Skin Conditions.

Abbreviations: GC, Gianotti Crosti; PR, Pityriasis rosea; SF, Scarlatina; MC, Molluscum contagiosum; EI, Erythema infectiosum.

Discussion/Innovation:

Discrepancies across the healthcare system are well documented, with numerous studies focused on finding solutions to address the inequalities and improve the overall health of patients. Dermatologically, pervious research has emphasized a pervasive lack in representation of darker skin tones within most research and teaching materials. Furthermore, investigations recruiting medical students and health care providers have demonstrated disparities in diagnostic accuracy across skin tones and hypothesizing that such discrepancies are secondary to limited exposure to diverse cases. In contrast, the data obtained in our survey challenges the established narrative by deviating from prior studies with similar designs,

Generally, there was no significant difference in diagnostic accuracy between the light and dark skin groups, and upon further analysis only the subgroup of pityriasis rosea had a statistically significant difference in diagnostic accuracy if using a p-value of less than 0.05. Surprisingly the images depicting pityriasis rosea on darker skin had a higher correct response percentage. While not statistically significant, Gianotti Crosti and Erythema infectiosum also had higher rates of diagnostic accuracy on darker skin. Given that pityriasis rosea, Gianotti Crosti, and Erythema infectiosum have a similar prevalence across all racial groups, this was an interesting finding [14, 15]. Otherwise, molluscum contagiosum and scarlatina demonstrated slightly better diagnostic accuracy in lighter skin both of which are the only conditions listed that have lasting side effect. The molluscum contagiosum group was trending towards significance, but did not reach 0.05.

This departure from the previous studies is likely a multifactorial effect. Possible explanations include self-selection bias, the hawthorn effect, improved physician awareness, recent educational initiatives, or methodological factors. Pediatricians who are more comfortable in diagnosing pediatric skin conditions would have felt more comfortable participating in this study. The data demonstrates that a majority of participants (85% and 65% respectively) were comfortable diagnosis rashes in children and on people of color. Secondly, the participants could have changed or improved their behavior knowing they were being tested. Known as the Hawthorne effect or observer bias, participants could have spent more time or applied more

effort on the images of darker skin. Participants could have received education regarding pediatric rashes in darker skin prior to testing. There has not been a considerable change in published educational materials since the start of this study in 2021, but individual education and continued education events could have been sought out by participants. Other methodological considerations, such as the use of readily available images, the lack of direct observation during testing, and participant knowledge play a crucial role in data interpretation.

Given that the participants in this selected study did not demonstrate the same deficiency as other groups the question then becomes, does the Fort Worth area demonstrate published differences in health outcomes for people of color. In 2019, UTSW analyzed life expectancy in counties throughout Texas. The data shows that in the counties comprising Fort Worth, black people have a lower life expectancy than their white counterparts[16]. There is a litany of social determinants of health such as poverty, job availability, education level, early childhood education, and access to health care that all come into play. The communities with the worst life expectancy are correlated to have worse social determinants of health [17]. Despite the high barriers to accessing healthcare and environmental factors affecting quality of life, people of color report worse health outcomes even after reaching a doctor [1-7]. We assume that these trends also impact the people within the Fort Worth community. Understanding these regional factors is essential for a comprehensive interpretation of healthcare outcomes. Previous studies that demonstrated differences in diagnostic accuracy hypothesized that patients received worse health outcomes secondary to lack of education which is easily identifiable. We also assumed that our study would follow suit and demonstrate a difference favoring lighter skinned images and conditions. Instead, the opposite was true. Why was the only condition with statistical significance of the images with darker skin? Our study does not align with the hypothesis that the substandard care administered to people of color within the United States is secondary to a lack of education. Within our subset of pediatricians, there was not a lack of education. The results of our study demonstrate a different hypothesis. Building upon existing literature, it raises questions about the influence of unconscious biases in healthcare delivery. This novel perspective challenges assumptions about the role of education and props further investigation into the dynamics of provider bias within the healthcare system.

The study also collected data on participant characteristics to quantify the qualities that led to a higher rate in correct diagnosis. We originally proposed that familiarity with skin of color either through education or one's own experience could lead to higher rates of correct diagnosis. However, due a lack of statistical power, the analysis on this "familiarity index" is unable to be completed.

Future Directions

Further research should explore into the relationship between physician familiarity with population subtypes and diagnostic accuracy and is an increase in accuracy in those doctors who are more familiar. It would be valuable to assess the impact of their exposure to diverse patient populations. This expanded "familiarity index" could be achieved by increasing the sample size and incorporating a wider range of demographic variables, such as geographic location and demographics of patient population. Through this, we may gain a more detailed understanding of how these factors influence diagnostic accuracy in pediatric dermatology.

Another important avenue for future investigation involves a comprehensive review of health outcomes in children with dermatological conditions. A study could offer helpful insight by exploring the potential correlations between skin tone and health outcomes in pediatric dermatology. If the results of such a study reveal no significant disparities in health outcomes among different skin tones, it could suggest our results are in fact valid and there is no difference between testing environments and the real world. On the other hand, documented differences in health outcomes based on skin tone would warrant further scrutiny into potential biases affecting diagnosis and treatment. This could lead to a deeper understanding of the complicated interplay between physician education and bias in the context of pediatric dermatology.

Conclusion

In conclusion, the divergence of our study from existing literature on diagnostic accuracy for people of color warrants careful consideration of potential contributing factors. Previous research has correlated deficiencies in the representation of darker skin tones among educational materials and disparities in diagnostic accuracy, our study indicates a variation from that narrative.

Contrary to expectations, we observed no significant difference in diagnostic accuracy between light and dark skin groups, except for the subgroup of pityriasis rosea, where darker skin images surprisingly exhibited higher correct response percentages. This unexpected outcome prompts a reevaluation of existing hypotheses and suggests a need to explore alternative explanations for the observed diagnostic patterns. Potential contributing factors, including self-selection bias, the Hawthorne effect, improved physician awareness, potential educational initiatives, and methodological considerations, complicate the interpretation of our results.

Recognizing the potential unconscious biases in healthcare delivery emerges as a critical aspect of our study. These results, challenge the previous assumption that healthcare disparities were a result of deficiencies in education. Instead, we offer a more complex explanation of provider bias, and urge the healthcare community to examine and reflect upon the potential for unconscious biases impacting their diagnostic accuracy.

Our study emphasizes the importance of geographical considerations in understanding healthcare outcomes. Life expectancy data in the Fort Worth area reveals disparities between racial groups, indicating that social determinants of health contribute to divergent health outcomes. Interpreting the data through a regional lens becomes crucial and emphasizes the need for a comprehensive healthcare research that integrates geographic and demographic factors.

Looking towards the future, research should explore the relationship between medical education and familiarity with a diverse patient population and diagnostic accuracy. The proposed "familiarity index" could become a valuable tool for assessing the impact of exposure to varied demographic variables on physician education and improve our understanding of the factors influencing diagnostic accuracy in pediatric dermatology. Also, investigations into specific

health outcomes for children with dermatological conditions within Fort Worth presents a possible direction for future research.

In summary, our study differs from the established outcomes and encourages introspection among physicians in the pediatric space. It questions factors previously assumed to be influencing health outcomes and sets the stage for further exploration in this field.

Compliance

The IRB# 2021-232 was approved on November 11, 2021 through TCU. This approval ran though the gathering and analysis of the data and in July of 2023.

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