MEDICAL SCHOOL
UNIVERSITY OF MICHIGAN

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Project Title: Chronic Inflammatory Skin Conditions: Diagnosis in the Eyes of the Beholder?
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Summary (250-500 words):
Over the past decade, electronic health record (EHR) systems have been implemented by most healthcare providers to facilitate the documentation of patient records and linkage of their portals across systems. Recent studies have shown the proportion of physicians who have adopted the usage of EHR in their clinical practice to be steadily increasing over the past decade, with widespread adoption within major health systems and outpatient facilities.Office-based physicians in 2017 who had adopted a form of EHR was estimated to be around 80%. EHR is also proving itself useful and cost effective for clinical research studies.

Since EHR can provide access to large amounts of patient health information, it is utilized as a valuable resource for biomedical research, and can also be combined with biomolecular data, including genetic/genomic information to advance the development of personalized medicine. However, accurate diagnosis is important to provide robust and accurate inferences. The most commonly used approach to profile the associated diagnosis/clinical phenotypes of a patient is to utilize ICD 9/10 codes available. For instance, the diagnosis codes have been used to estimate the prevalence rate of a disease in cross-sectional studies, and to identify comorbidities in epidemiological work. Phenome-wide association studies also took advantage of the ICD9/10 codes to profile the “phenome” of the patients in the health record system, and associate each of the diseases/traits with the genetic variants to reveal disease susceptibility loci, enabling the conduction of GWAS in over 1,000 clinical conditions together (i.e. phenome-wide association analysis, PheWAS).

However, accurate diagnosis of dermatologic conditions usually require thorough physical exams (including skin, hair, and nails) and involve tissue biopsies/laboratory tests (especially in cases of non-textbook presentation). Indeed, previous studies have shown that board-certified dermatologists provide more accurate diagnoses than primary care physicians (non-specialists). This is especially true for patients of color, as

different studies have illustrated accurate diagnosis is less trivial for inflammatory skin (IS) conditions with darker skin tones. Previous epidemiological studies have further indicated the heterogeneity in diagnosis for IS conditions among different ethnic groups, and darker-skinned patients may display atypical presentation of inflammatory skin disease due to location, size, or color of the lesion(s). With EHR systems have become increasingly crucial to providing crucial information for biomedical research, it is important to understand the potential discrepancies between dermatologist versus non-specialist diagnosis, stratified by the context of different ethnic groups. Common inflammatory skin conditions are often found to be comorbid with other systemic diseases such as hypertension, cardiovascular disease, or systemic inflammatory diseases such as lupus. A well-controlled epidemiological study for identifying skin comorbidities is important because

The goal of this study is to address the above unanswered questions. We utilized the University of Michigan Health System DataDirect system to retrieve aggregate EHR data of inflammatory skin cases, and then modeled the different disease comorbidities controlling for the majority ethnic groups (Caucasian and African American) and clinic (specialist and non-specialist) effects.

Methodology:

Data Retrieval

For our study on chronic inflammatory skin conditions, we sought to leverage the electronic health record at the University of Michigan Health System (UMHS), comprising over 3 million patient records. We utilized the DataDirect program, which accessed all the EHR at UMHS. Through this program, we were able to assess patient demographics, clinic sites of patient encounter, the ICD9/10 codes issued for each encounter, and other clinical variables/comorbidities to test our hypothesis that there are discrepancies in CIS condition diagnosis among different ethnic groups in the specialized (i.e. dermatology) versus non-specialized (i.e. primary physician clinic) visits.

To access aggregate patient data, we used DataDirect to determine number of patients diagnosed with each of the following CIS conditions: psoriasis, atopic dermatitis, alopecia areata, acne, vitiligo. Criteria for inclusion are as follows: adult patients seen at University of Michigan Health System from January 1 2000 until March 25 2020, ages 18-99, currently alive, with diagnoses associated with an encounter. The primary diagnosis in question was associated with an outpatient or emergency encounter; inpatient encounters were excluded from our criteria. We added filters specifying race

(Caucasian, African American), as well as filters for clinic of the encounter (UMHS Primary care [Internal Medicine and Family Medicine] clinic sites vs. UMHS Dermatology clinic sites). Patients identified with diagnosis in both primary care and dermatology clinics were assumed to have a diagnosis made or corroborated by a dermatologist and therefore were removed from the primary care data. Primary diagnoses were made using ICD 9/10 codes as follows:

Primary Diagnoses	
CIS Condition	**ICD 9/10 Codes Used**
Psoriasis	*696.[0,1], L40.**
Atopic Dermatitis	*691.8, L20.**
Alopecia Areata	*704.01, L63.**
Acne	*706.[0,1], L70.**
Vitiligo	*709.01, L80, H02.73**

For each sub-group of patients with a specific condition, we were able to identify the number of patients with comorbid conditions including the systemic inflammatory conditions listed below. Comorbid diagnosis with the following conditions was established using ICD 9/10 codes that are listed in the Appendix.

Data Analysis

The primary response variable was whether the patients with CIS conditions have cormobidties diagnosis or not. Thus, the binary response variable is assumed to have only two values that for convenience we code as one or zero. Taking type 2 diabetes and psoriasis as an example, we could define:

y = 1 if the patients with psoriasis also have type 2 diabetes, or

y = 0 if the patients with psoriasis do not have type 2 diabetes.

We view y as a realization of a random variable Y that can take the values one and zero with probability pi and 1-pi, respectively. To understand how the cause variables may affect the response variable, especially the clinical effect, the data was fitted with a generalized linear model and logit link function. The cause variables include basic demographic variables, such as ethnic, gender, and year of birth. Obesity is associated with many dermatological conditions, therefore obesity is included as a binary cause variable. Most importantly, whether the patients' CIS conditions are diagnosed in dermatology clinics or non-dermatology clinics was included in our model as a

covariate, and its interaction with ethnic groups was also studied in our model. Therefore, the generalized linear model that we propose is:

logit(y) = \beta0 + \beta1 * Ethnic + \beta2 * Clinic + \beta3 * Year_of_birth + \beta4 * Gender + \beta5 * Obesity + \beta6 * Ethnic*Clinic

Variable Name	**Definition**
Dependent Variable	
Comorbid condition	0 = without comorbid condition 1 = with comorbid condition
Independent Variables	
Ethnic	0 = Caucasian 1 = African American
Clinic	0 = UMHS Primary care clinic sites 1 = UMHS Dermatology clinic sites
Gender	0 = Male 1 = Female
Year of birth	Continuous variable
Obesity	0 = (BMI < 30) 1 = (BMI >= 30)

Results:

Demographics for skin disease patients

Table 1. Rows are skin diseases, columns are:
Total # of patients / ICD9/10 codes / stratified by those that have diagnosis in dermatology clinic vs those only have diagnosis in non-derm clinic / _then further stratified by gender, mean+-sd age, ethnic groups

SKIN DISEASES	ICD 9/10 CODES	TOTAL PATIENTS	GENDER		AGE OF DIAGNOSES		ETHNICS & CLINICS			
			Male	Female	Mean	SD	Dermatology		Non-dermatology	
							African American	Caucasian	African American	Caucasian
PSORIASIS		8167	3748	4419	53.02	16.37	140	2524	196	5307
ACNE		17057	4552	12505	32.32	14.01	802	6032	1030	9193
ALOPECIA		799	518	281	43.22	15.93	93	419	62	225
ATOPIC DERMATITIS		3357	1304	2053	43.69	18.89	157	479	475	2246
VITILIGO		992	444	548	51.14	17.23	52	373	92	475

Clinic-specific Effect (Psoriasis patients)

Figure 1.

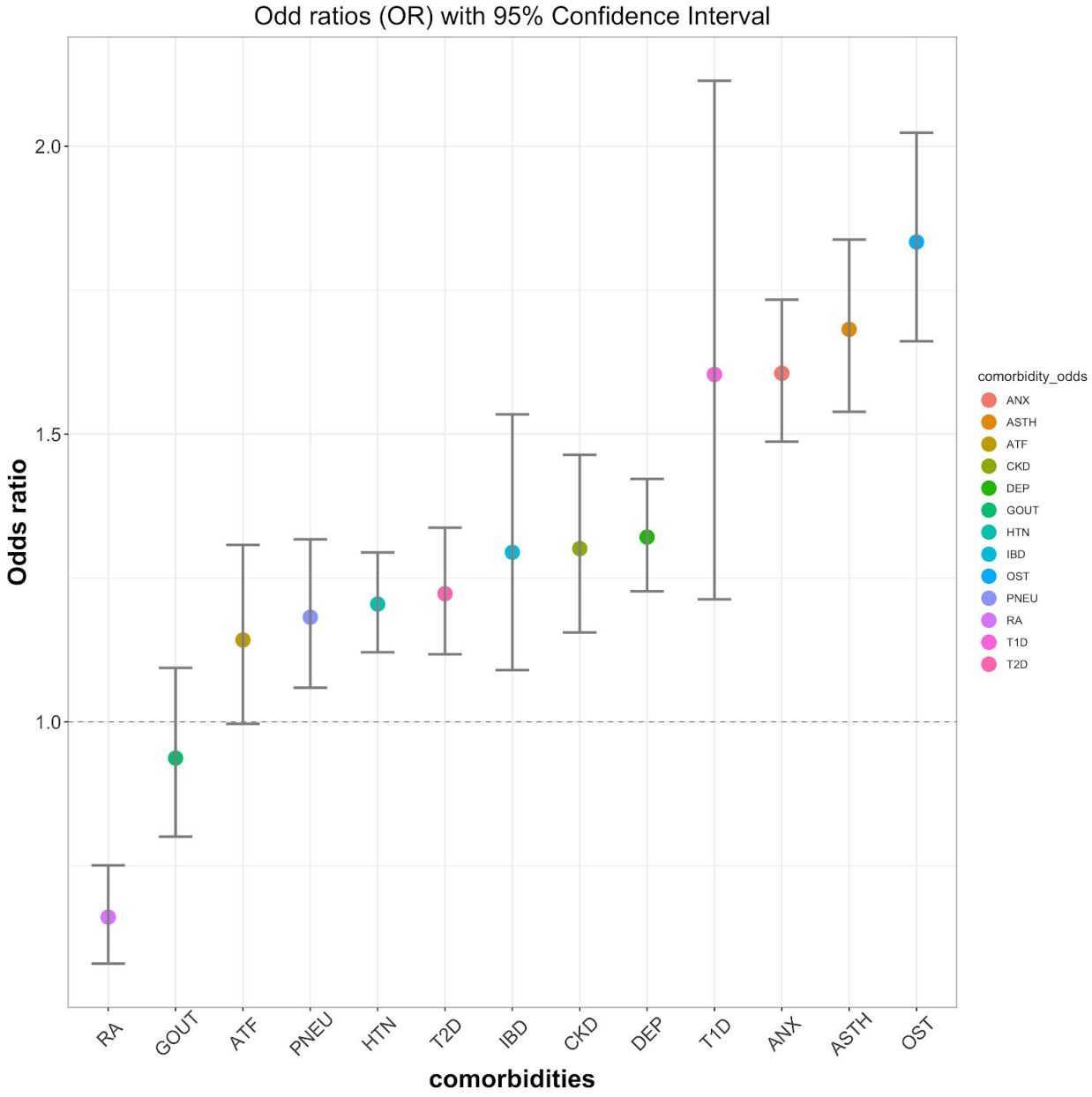

Figure 1 shows that patients diagnosed psoriasis in dermatology clinics are less likely to have rheumatoid arthritis, but more likely to have pneumonia, hypertension, type 2 diabetes, type 1 diabetes, Inflammatory bowel disease, chronic kidney disease, depression, anxiety, asthma and osteoporosis.

Ethnic & Clinic interaction Effect (Psoriasis patients)

Figure 2.

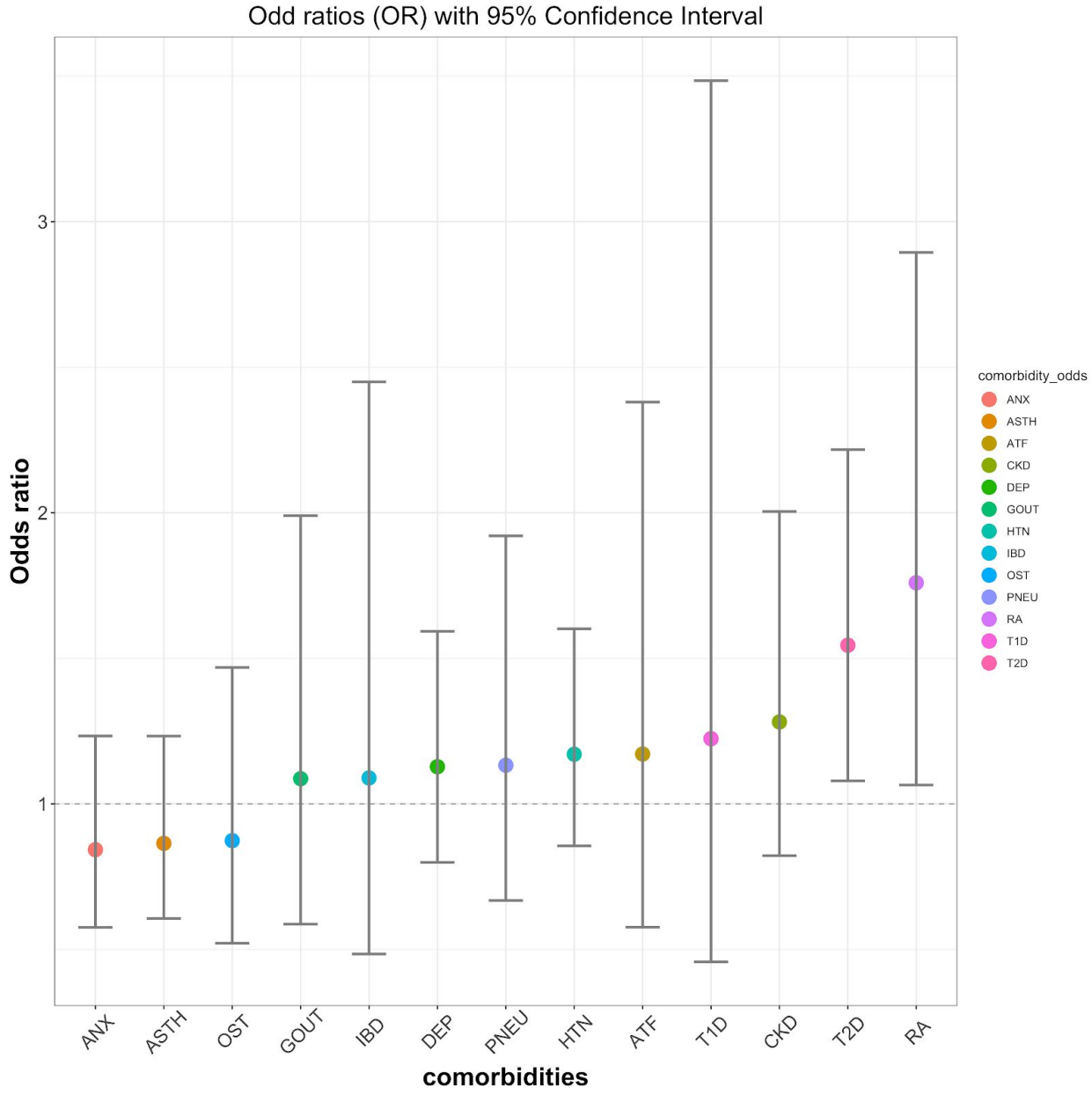

Figure 2 shows that the interaction effects between clinic and ethnic is not significant in most of the common comorbidities except for type 2 diabetes and rheumatoid arthritis.

Conclusion (250-500 words):

This overall objective was to elucidate the differences in diagnosis of common dermatoses (i.e., atopic dermatitis, psoriasis, alopecia areata, acne, vitiligo) between dermatologic specialists and primary care providers. Accuracy of diagnosis is essential

for treatment and improving quality of life for patients with CIS conditions, and this study can guide future interventions on how to improve the quality of dermatologic care for various ethnic groups. In patients with darker skin types, there are higher rates of misdiagnosis or missing diagnoses, which contributes to health disparities in these populations. To focus on dermatologic care, my intent is to improve recognition of CIS conditions in patients with skin of color and deliver culturally-appropriate skin care in the primary care setting. The findings of this study may be used to improve primary care by informing the development of a diverse curriculum for family medicine and internal medicine residents to recognize CIS conditions across a spectrum of skin types.

To quantify the impact of undiagnosed patients with different conditions, a recent study estimated the rate of undiagnosed active psoriasis in the United States to be between 0.4% to 2.28%, corresponding to approximately 600,000 to 3.6 million adults. Patients who remain undiagnosed tend to be racial minorities, with lower education level attained and lower SES. Dermatologic care for minority populations can be poor due to factors such as lower health literacy, barriers to obtaining a referral for a specialist, being uninsured or under-insured, and issues with transportation. In the case of CIS conditions, the current disparities provide an opportunity to improve quality of care received. CIS conditions such as psoriasis, atopic dermatitis, and acne can exhibit a relapsing/remitting course, while conditions such as alopecia areata and vitiligo may become progressively worse over time. The comorbid mood disorders associated with the aforementioned conditions may lead to lower quality of life measures for patients, especially those who go without proper diagnosis and treatment.

This highlights the need for improving dermatology curriculum for non-specialists, since most patients with mild to moderate disease will be seen and treated by their primary care physicians without receiving specialist referral.

Reflection/Impact Statement:

How did the process of conducting this research confront any limitations of your prior thinking? Who could potentially benefit from this CFI project over different timescales and how? What actions will you take afterwards to continue the momentum of this project, and maximise the likelihood of the identified benefits being achieved? What advice would you give to another student completing their CFI?

The process of conducting this research allowed me to identify gaps in knowledge regarding dermatologic health disparities. It also challenged my existing notions on the reasoning for differences in poorer skin health in patients with skin of color; I learned

that simply having lower prevalence of disease is not sufficient explanation for why patients are less often referred and receive lower quality of care. The downstream effects of this project will be to improve culturally-sensitive patient care, add to the existing literature regarding autoimmune comorbidities, and guide medical education. Because this study seeks to assess how diagnoses of CIS conditions vary based on the clinic setting and how they vary for different races, the data will be used to provide important guidance for improving education of non-dermatologic specialists for diagnosis of CIS, especially in skin of color. Furthermore, it will form the basis of future research utilizing the electronic health record system to determine quality of care for patients with chronic skin conditions, which includes rate of referral to a dermatology office when a CIS diagnosis is made in a primary care setting. As a future primary care physician, my goal is to use this experience to move the needle forward in family medicine regarding identification of disease in skin of color. This information needs to be shared with colleagues such as fellow residents, attending, and other mid-level providers who frequently see a diverse patient population. Furthermore, I plan to continue working with Dr. Tsoi's team throughout my residency to identify further trends within the data that can be used to modify medical student/resident education. To future CFI students, I recommend being flexible with the project. At times, it may take turns that are not anticipated, and the data might lead you down a new path of investigation. It is better to pursue the opportunity for knowledge than just sticking to a rigid plan that is not fruitful.