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Mental health outcomes in White patients versus patients with skin of color with psoriasis

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Abstract

Objective: To evaluate the relationship between psoriasis and mental health in patients from different racial backgrounds.

Methods: We performed a nationwide, cross-sectional study evaluating 7,519,662 (weighted) patients, comparing White patients versus patients with skin of color (SOC), using the 2004-2017 Medical Expenditure Panel Survey (MEPS).

Results: Psychological distress (measured by Kessler 6-Item Psychological Distress Scale) was similar between White and SOC patients (4.132 [95% CI,3.679-4.586] and 3.710 [95% CI,2.932-4.488], P=0.407). Depression (measured by Patient Health Questionnaire 2) was similar between White and SOC patients (0.886 [95% CI,0.744-1.027] and 0.748 [95% CI,0.506-0.989], P=0.385). Overall mental health (measured by Mental Component Summary) was similar between White and SOC patients (49.959 [95% CI,48.979-50.939] and 50.257 [95% CI,48.449-52.065], P=0.789). Perceived mental health state (measured by Perceived Mental Health Status) was similar between White and SOC patients (2.159 [95% CI,2.065-2.253] and 2.103 [95% CI,1.911-2.294], P=0.603).

Conclusion: There were no significant differences in mental health outcome scores between White and SOC patients with psoriasis. Clinicians should screen for and manage mental health comorbidities in psoriasis patients of all racial backgrounds.

Introduction

Psoriasis is a common chronic inflammatory disease that has a negative impact on patients' physical health, mental health, and quality of life [1-4]. Psoriatic skin lesions may stigmatize patients and lead to poor mental health outcomes including anxiety, depression, and suicidal ideation [1,5-10].

Researchers have characterized the morphological differences in presentation of psoriatic skin lesions between White patients and patients with skin of color (SOC). For example, in SOC, psoriasis presents primarily as violaceous rather than erythematous plaques and is associated with greater dyspigmentation than White skin [11-14]. Some clinicians underestimate psoriasis severity in patients with SOC owing to under-appreciation of this violaceous presentation [13]. In addition, in patients with SOC, they present with more severe psoriasis characterized by thicker lesions and higher body surface area (BSA) than White patients. However, despite this growing field, a paucity of information is available on the differential impact of psoriasis on mental health outcomes among different races.

Limited evidence suggests that psoriasis patients with SOC bear decreased quality of life than White patients [13-15]. However, little data exist on the impact of psoriasis on mental health among different races. Because clinicians need to act in a culturally sensitive manner to best care for their patients, it is important to understand the relationship between race and mental health among psoriasis patients.

Keywords: mental health, psoriasis, skin of color

This study aims to evaluate the differential impact of psoriasis on mental health in patients from different racial backgrounds. We hypothesized that psoriasis patients with SOC experience worse mental health outcomes than White patients with psoriasis.

Methods

Data source and population selection

This study was a retrospective survey analysis that utilized cross-sectional data from the 2004-2017 Household Component of the Medical Expenditure Panel Survey (MEPS). Medical Expenditure Panel Survey is a publicly available database that serves as a nationally representative, non-institutionalized sample of U.S. adult residents. To select U.S. households to survey, MEPS applies a stratified, multi-staged area probability design to a subsample of households that participated in the previous year's National Health Interview Survey (NHIS). Households are surveyed in intervals over the span of two consecutive years and information collected from households is de-identified. Information collected includes sociodemographic characteristics, health conditions, physical and mental health status, healthcare utilization, and healthcare expenditures [16]. This study was determined to be exempt from the Institutional Review Board at the University of Southern California.

The study population included all adults (≥ 18 years) who reported a diagnosis of psoriasis and reported the Kessler 6-Item Psychological Distress Scale (K6), the Patient Health Questionnaire 2 (PHQ2), the Mental Component Summary (MCS), and the Perceived Mental Health Status (MNHLTH). The MEPS database has been used to evaluate patients with psoriasis [17,18]. Using the Medical Conditions data file, we identified patients with a diagnosis of psoriasis using the *International Classification of Diseases, Ninth Revision (ICD-9)* code 696 or the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10)* code L40. Using the Full-Year Consolidated data file, we obtained the four mental health outcome measures from each psoriasis patient.

Variables

Dependent variable (mental health outcome measures)

The dependent variables were mental health outcomes: 1) psychological distress as measured by K6, 2) depression as measured by PHQ2, 3) overall mental health status as measured by the MCS, and 4) patients' perception of their mental health status as measured by the MNHLTH.

The K6 is a validated 6-item measure of psychological distress [19,20]. Respondents are queried to assess dimensions of nervousness, hopelessness, restlessness, depression, apathy or worthlessness over the past 30 days. Each item is scored on a 5-point Likert scale (0-4, where 0 indicates none of the time and 4 indicates all of the time). The total score ranges from 0 to 24. A score of 13 or more indicates significant psychological distress [20].

The PHQ2 is a validated 2-item screening measure for depression [21,22]. Respondents are asked how often they have been "feeling down, depressed, or hopeless" or have had "little interest or pleasure in doing things" over the past two weeks. Both items are scored on a 4-point Likert scale (0-3, where 0 indicates not at all and three indicates nearly every day). The total score ranges from 0 to 6. A positive screen for a depressive disorder is indicated by a score of 3 or more (sensitivity, 94%; specificity, 75%), [21].

The MCS is a validated screening measure for overall mental health status, capturing both depression and anxiety [23-25]. The MCS is derived from the Short-Form 12 Version 2 (SF-12V2) and calculated according to a standard algorithm that creates continuous variables utilizing information from all 12-items on the SF-12V2 [26, 27]. The global score ranges from 0 to 100; a higher score indicates a better mental health status [28].

The MNHLTH score has been utilized in the literature as a measure of an individual's perceived mental health status [29, 30]. Respondents are asked to rate their perceived mental health state on a 5-point scale (0-5, where 0 indicates excellent and 5 indicates poor), [26].

Independent variable (race)

The independent variable was race. Respondents were asked to select their race from the following options: White, Black, American Indian/Alaskan Native, Asian, Native Hawaiian/Pacific Islander, or Multiple Races. For primary analysis, we classified patients into two main groups: 1) White patients and 2) patients with SOC (consisting of patients who selected all races other than White).

For sensitivity analyses, we utilized two additional, different racial and ethnic classifications. One racial classification consisted of: 1) White, 2) Black, 3) American Indian/Alaskan Native, 4) Asian/Native Hawaiian/Pacific Islander, and 5) Multiple Races. The other racial/ethnic classification consisted of: 1) non-Hispanic White, 2) Hispanic White, and 3) non-Hispanic black.

Covariates

In our analyses, we adjusted for potential sociodemographic confounders such as age, sex (self-reported as female or male), insurance coverage (private, public or uninsured), and poverty level category (family income as percent of the federal poverty level).

Additionally, we adjusted for potential clinical confounders such as cognitive limitations, social limitations and comorbidities. Cognitive limitations were defined as experiencing confusion or memory loss, problems making decisions, or the requirement of supervision for safety. Social limitations were defined as experiencing social, recreational, or family activity limitations secondary to mental or physical impairments. The Charlson Comorbidity Index (CCI), a validated method of estimating risk of mortality from comorbid diseases, was used to assess comorbidities [31]. This index has been adapted for use with 3-digit ICD-9 codes and has been utilized within the MEPS [32-37]. Although the MEPS database does not capture information regarding disease severity, we attempted to adjust for this by including the covariate, treatment (treated with biologic therapy or not).

Statistical analysis

We conducted a descriptive analysis comparing White patients versus patients with SOC regarding

age, sex, insurance coverage, poverty level category, cognitive limitations, social limitations and calculated CCI. We utilized χ^2 analysis for categorical variables and 2-tailed t-tests for continuous data. For analyses comparing more than two racioethnic groups, we applied analysis of variance (ANOVA) for continuous data.

Univariate analyses were performed comparing each of the four mental health outcome measures (K6, PHQ2, MCS, and MNHLTH) between White patients and patients with SOC. We also performed multivariable analyses comparing mental health outcomes and race, adjusting for age, gender, biologic status, cognitive/social limitations, poverty level category, and CCI. Sensitivity analyses were performed using multivariable regression models using different racial classifications.

To account for unequal selection probabilities and non-response weights, we applied person-level sampling weights and a variable estimation stratum; $P \leq 0.05$ was established a priori as statistically significant for unadjusted comparisons. For all statistical analyses, we applied the appropriate survey commands using STATA version 16.1 (StataCorp LLC).

Results

Population Descriptive Analysis

A total of 10,247,982 U.S. adults with psoriasis who reported mental health outcomes during a 14-year-period from the 2004-2017 MEPS database were included in the analysis. Participants with missing data in any of the studied variables (27%) were excluded from the analysis. A comparison of the sociodemographic and clinical characteristics of the original population with incomplete data and the analyzed population with complete data are detailed in [Supplemental Table 1](#).

A weighted total of 7,519,662 U.S. residents with psoriasis were included in this analysis. Among these residents, 6,535,543 were White patients and 984,118 were patients with SOC. The mean \pm SEM age was 52 ± 0.7 years. Females comprised 52% of the

population. The sociodemographic and clinical characteristics of White patients and patients with SOC are summarized in **Table 1**. Score distributions for the mental health outcome measures are detailed for each population in **Figure 1**. Multivariable linear regression analysis results for each mental health outcome measure are presented in **Table 2**.

Kessler 6-Item Psychological Distress Scale

The mean K6 score for the overall population was 3.375 (95% CI, 3.375–4.043). The mean K6 score was 4.132 (95% CI, 3.679–4.586) for White patients and 3.710 (95% CI, 2.932–4.488) for patients with SOC (P=0.407), (**Figure 1**). Our results showed that there was a numeric difference, but no statistically or clinically significant difference in the mean K6 score between White patients and patients with SOC. A multivariable linear regression adjusting for sociodemographic characteristics and comorbidities also did not yield significant differences in mean K6 scores (β =-0.59, 95% CI -1.48 to 0.3) between White patients and patients with SOC (**Table 2**).

Patient Health Questionnaire 2

The mean PHQ2 score for the overall population was 0.733 (95% CI, 0.622–0.845). The mean PHQ2 score was 0.886 (95% CI, 0.744–1.027) for White patients and 0.748 (95% CI, 0.506–0.989) for patients with SOC (P=0.385), (**Figure 1**). Our results showed that there was a numeric difference, but no statistically or clinically significant difference in the mean PHQ2 score between White patients and patients with SOC. A multivariable linear regression adjusting for sociodemographic characteristics and comorbidities also did not yield significant differences in mean PHQ2 scores (β =-0.16, 95% CI -0.43 to 0.12) between White patients and patients with SOC (**Table 2**).

Mental Component Summary

The mean MCS score for the overall population was 50.663 (95% CI, 49.977–51.349). The mean MCS score was 49.959 (95% CI, 48.979–50.939) for White patients and 50.257 (95% CI, 48.449–52.065) for patients with SOC (P=0.789), (**Figure 1**). Our results showed that there was a numeric difference, but no

Table 1. Sociodemographic and clinical characteristics of White patients and patients with Skin Of Color with psoriasis from the Medical Expenditures Panel Survey (MEPS).

Characteristic	White Patients (Weighted N=6,535,543)	Patients with Skin of Color (Weighted N=984,118)	P value
Age, mean (SEM) years	52.11 (0.71)	51.66 (0.96)	0.388 ^a
Gender, female N (%)	3397923 (52)	549083 (56)	0.474 ^b
Not on biologics, N (%)	4138136 (63)	733413 (75)	0.016 ^b
Insurance status, N (%)			
Private	5242354 (80)	776793 (79)	0.06 ^b
Public	960771 (15)	186090 (19)	
Uninsured	332418 (5)	21235 (2)	
Cognitive limitations, N (%)	404666 (6)	50125 (5)	0.628 ^b
Social limitations, N (%)	455211 (7)	61733 (6)	0.762 ^b
Poverty level category, N^c (%)			
Poor	321906 (5)	102542 (10)	0.041 ^b
Near Poor	176901 (3)	16049 (2)	
Low income	537476 (8)	86463 (9)	
Middle income	1948417 (30)	237858 (24)	
High income	3550844 (54)	541207 (55)	
CCI, mean (95% CI)	1.02 (0.03)	1.15 (0.04)	0.042 ^a

CCI, Charlson Comorbidity Index; CI, Confidence Interval; MEPS, Medical Expenditures Panel Survey; SOC, Patients with Skin of Color; SEM, Standard Error of the Mean.

^a2-tailed t-tests of the differences between U.S. adult White patients and patients with Skin Of Color with psoriasis.

^b χ^2 of the differences between U.S. adult White patients and patients with Skin Of Color with psoriasis.

^cPoverty level category was measured as percent of federal poverty level (FPL).

statistically or clinically significant difference in the mean MCS score between White patients and patients with SOC. A multivariable linear regression adjusting for sociodemographic characteristics and comorbidities also did not yield significant differences in mean MCS scores ($\beta=-0.67$, 95% CI -1.32 to 2.67) between White patients and patients with SOC ([Table 2](#)).

Perceived Mental Health Status

The mean MNHLTH score for the overall population was 2.08 (95% CI, 1.999–2.162). The mean MNHLTH score was 2.159 (95% CI, 2.065–2.253) for White patients and 2.103 (95% CI, 1.911–2.294) for patients with SOC ($P=0.603$), ([Figure 1](#)). Our results showed that there was a numeric difference, but no statistically or clinically significant difference in the mean MNHLTH score between White patients and patients with SOC. A multivariable linear regression adjusting for sociodemographic characteristics and comorbidities also did not yield significant differences in mean MNHLTH scores ($\beta=-0.06$, 95% CI -0.25 to 0.14) between White patients and patients with SOC ([Table 2](#)).

Sensitivity analysis

We performed a sensitivity analysis by categorizing U.S. residents into two additional racial classifications. One classification consisted of five

groups based on race: 1) White, 2) Black, 3) American Indian/Alaskan Native, 4) Asian/Native Hawaiian/Pacific Islander, and 5) Multiple Races. A weighted total of 7,519,662 U.S. residents with psoriasis were included in this analysis. The sociodemographic and clinical characteristics of the five race populations are summarized in [Supplemental Table 2](#). Our results showed that there was a numeric difference, but no clinically or statistically significant difference in any of the mean health outcome measures scores (K6, PHQ2, MCS, MNHLTH) among the five race groupings ([Table 3](#)). A multivariable linear regression adjusting for sociodemographic characteristics and comorbidities also did not yield significant differences in any of the mean mental health outcome scores among the five race groupings ([Supplemental Table 3](#)).

The other classification consisted of three groups based on race and ethnicity: 1) non-Hispanic White, 2) Hispanic White, and 3) non-Hispanic black. A weighted total of 1,478,797 U.S. residents with psoriasis were included in this analysis ([Supplemental Table 4](#)). We found a numeric difference, but no statistically or clinically significant difference in any of the mean health outcome measures scores (K6, PHQ2, MCS, MNHLTH) among the three race/ethnicity groupings ([Table 4](#)). Multivariable linear regression models yielded similar findings ([Supplemental Table 5](#)).

Discussion

This large, nationally representative study spanning 14 years addressed a knowledge gap by examining the association between race and mental health outcomes in adult patients with psoriasis. We hypothesized that psoriasis patients with SOC would experience worse mental health outcomes than White patients. However, our results indicated that there were no significant differences in psychological distress symptoms, depression, overall mental health status or perceived mental health status between White patients and patients with SOC, as measured by K6, PHQ2, MCS or MNHLTH scores. Furthermore, our results were consistent across two additional sensitivity analyses that

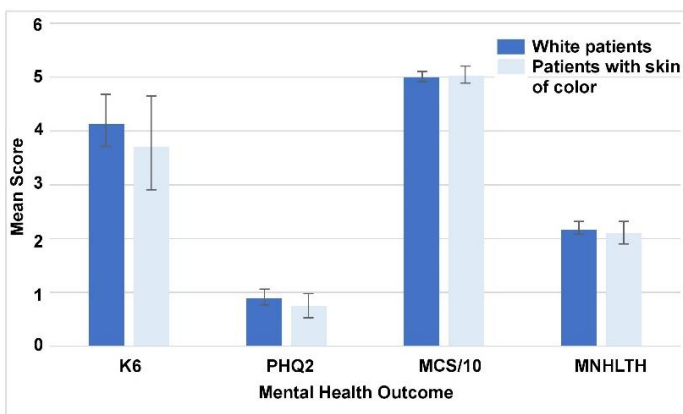


Figure 1. Unadjusted score distribution for mental health outcomes among adult White patients and patients with skin of color with psoriasis from the Medical Expenditures Panel Survey. Error bars represent 95% confidence interval.

K6, Kessler 6-Item Psychological Distress Scale; MCS/10, Mental Component Summary score divided by 10; MEPS, Medical Expenditures Panel Survey; MNHLTH Perceived Mental Health Status; PHQ2, Patient Health Questionnaire 2.

Table 3. Unadjusted score distribution for mental health outcomes among adult patients with psoriasis classified by race groupings from the Medical Expenditures Panel Survey (MEPS).

Instrument	White (Weighted N=6,535,543)	Black (Weighted N=626,522)	American Indian/Alaskan Native (Weighted N=67,381)	Asian/Native Hawaiian/Pacific Islander (Weighted N=240,062)	Multiple Races (Weighted N=50,154)	P value
K6 mean (95% CI) score	4.132 (3.679 to 4.586)	3.522 (2.552 to 3.492)	5.714 (0.545 to 10.883)	3.786 (2.156 to 5.415)	3 (1.479 to 4.521)	0.706 ^a
PHQ2 mean (95% CI) score	0.886 (0.744 to 1.027)	0.761 (0.446 to 1.076)	0.857 (-0.267 to 1.981)	0.643 (0.168 to 1.117)	1 (-0.756 to 2.756)	0.897 ^a
MCS mean (95% CI) score	49.959 (48.979 to 50.939)	50.112 (47.909 to 53.317)	47.09 (35.82 to 58.36)	51.902 (48.087 to 55.717)	47.406 (35.718 to 59.094)	0.767 ^a
MNHLTH mean (95% CI) score	2.159 (2.065 to 2.253)	2.164 (1.929 to 2.399)	2.429 (1.38 to 3.477)	1.893 (1.507 to 2.278)	2 (0.244 to 2.756)	0.642 ^a

CI, Confidence Interval; K6, Kessler 6-Item Psychological Distress Scale; MCS, Mental Component Summary; MEPS, Medical Expenditures Panel Survey; MNHLTH, Perceived Mental Health Status; PHQ2, Patient Health Questionnaire 2; SOC, Patients with Skin of Color.

^aAnalysis of Variance (ANOVA) of the differences between U.S. adult patients with psoriasis classified by all race groupings.

classified race differently; no significant differences in mental health outcomes were observed among these racial or ethnic groups in these sensitivity analyses.

A possible explanation for our findings is that no true differences exist in mental health outcomes across race in psoriasis patients. The impact of psoriasis in White patients and patients with SOC is equally profound. Therefore, clinicians should continue to screen for and manage mental health comorbidities aggressively in all psoriasis patients, because psoriasis patients are disproportionately affected by worse mental health outcomes as compared to the general population [1].

Another explanation we considered for the observed equivalence of the impact of psoriasis on mental

health outcomes among different races was the possibility of differences in the disclosure of and stigmatization surrounding mental health symptoms between White patients and patients with SOC. However, this remains an area of future research, as the literature differs on whether or not differences in mental health symptom stigmatization and reporting exist between these two groups [38,39].

Overall, our results indicate that psoriasis patients of all races appear to suffer similarly from mental health conditions. Therefore, it is important that we actively screen for and manage these mental health symptoms. Studies have shown that greater psoriasis severity is associated with higher rates of depression and psychological distress in all races [1,40,41].

Table 4. Unadjusted score distribution for mental health outcomes among adult patients with psoriasis classified by race and ethnicity from the Medical Expenditures Panel Survey (MEPS).

Instrument	Non-Hispanic White (Weighted N=932,868)	Hispanic White (Weighted N=541,745)	Non-Hispanic Black (Weighted N=13,185)	P value
K6 mean (95% CI) score	3.839 (2.732 to 4.946)	5.315 (3.9 to 6.73)	5 (-10.513 to 20.513)	0.299 ^a
PHQ2 mean (95% CI) score	0.857 (0.498 to 1.216)	1.315 (0.895 to 1.735)	1.667 (-2.128 to 5.461)	0.241 ^a
MCS mean (95% CI) score	50.122 (47.522 to 52.721)	46.804 (44.244 to 49.365)	42.343 (20.585 to 64.101)	0.13 ^a
MNHLTH mean (95% CI) score	2.411 (2.151 to 2.67)	2.342 (2.105 to 2.58)	3.333 (1.899 to 4.768)	0.237 ^a

CI, Confidence Interval; K6, Kessler 6-Item Psychological Distress Scale; MCS, Mental Component Summary; MEPS, Medical Expenditures Panel Survey; MNHLTH, Perceived Mental Health Status; PHQ2, Patient Health Questionnaire 2; SOC, Patients with Skin of Color.

^aAnalysis of Variance (ANOVA) of the differences between U.S. adult patients with psoriasis classified by all race groupings.

Controlling psoriasis in patients of all races has been found to result in improved mental health [17,42-44]. However, many patients with SOC, especially African Americans, face difficulties accessing quality dermatological care and effective anti-psoriatic therapies [14,45,46]. Thus, clinicians need to advocate for improved access to care and therapies for patients with SOC.

Limitations

The study results need to be interpreted in the context of the MEPS design. The MEPS database does not contain information on psoriasis severity. However, we used psoriasis medications as a surrogate for disease severity and adjusted for the use of systemic anti-psoriatic medications when evaluating mental health outcomes.

Conclusion

The study findings suggest that no significant differences in psychological distress symptoms, depression symptoms, overall mental health status or perceived mental health status existed between White patients and patients with SOC. It is important that clinicians screen for and manage mental health

comorbidities in psoriasis patients of all racial and ethnic backgrounds. Because literature shows that treatment of psoriasis often is associated with improvement of mental health, a future research direction can be focused on advocating for better access for all economically disadvantaged patients from various racioethnic backgrounds.

Acknowledgements

Data utilized in this study was publicly available and de-identified. Data was obtained from the Agency or Health Care Research and Quality's (AHRQ) Medical Expenditure Panel Survey (MEPS).

Potential conflicts of interest

Alison H. Kohn, Sarah P. Pourali, Yasmin Gutierrez, Madison E. Jones, Jeffrey R. Rajkumar, and Charlotte Read declare that they have no financial interests. April W. Armstrong has served as a research investigator and/or scientific advisor to AbbVie, BMS, Incyte, Leo, UCB, Janssen, Lilly, Novartis, Ortho Dermatologics, Sun, Dermavant, Dermira, Sanofi, Regeneron, Pfizer, and Modmed.

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Table 2. Adjusted multivariable regression analyses of the association between race and mental health outcome differences among adult White patients and patients with skin of color with psoriasis (adjusted for age, gender, treatment, insurance coverage, cognitive and social limitations, poverty level category and comorbidities).

Independent Variables	Dependent Variables (Weighted N=7,519,662)							
	K6		PHQ2		MCS		MNHTLH	
	β coeff. (95% CI)	P value	β coeff. (95% CI)	P value	β coeff. (95% CI)	P value	β coeff. (95% CI)	P value
Race								
White	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
SOC	-0.59 (-1.48 to 0.3)	P=0.193	-0.16 (-0.43 to 0.12)	P=0.269	0.67 (-1.32 to 2.67)	P=0.507	-0.06 (-0.25 to 0.14)	P=0.572
Age	-0.02 (-0.04 to 0.004)	P=0.109	-0.003 (-0.01 to 0.004)	P=0.427	0.09 (0.04 to 0.14)	P=0.001	0.002 (-0.003 to 0.01)	P=0.064
Gender								
Male	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Female	0.27 (-0.44 to 0.97)	P=0.458	-0.04 (-0.18 to 0.26)	P=0.704	-0.71 (-2.29 to 0.87)	P=0.378	-0.08 (-0.23 to 0.08)	P=0.326
Treatment								
Biologics	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Not on biologics	-0.54 (-1.27 to 0.2)	P=0.151	-0.12 (-0.35 to 0.11)	P=0.318	1.64 (-0.01 to 3.29)	P=0.052	-0.04 (-0.2 to 0.12)	P=0.644
Insurance								
Private	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Public	0.79 (-0.22 to 1.8)	P=0.125	0.4 (0.09 to 0.72)	P=0.012	-1.42 (-3.68 to 0.85)	P=0.220	0.1 (-0.12 to 0.32)	P=0.379
Uninsured	0.93 (-0.7 to 2.56)	P=0.264	0.56 (0.05 to 1.07)	P=0.03	-0.87 (-4.53 to 2.79)	P=0.641	0.2 (-0.15 to 0.56)	P=0.264
Cognitive Limitations								
No limitations	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Limitations	-4.34 (-5.82 to -2.87)	P<0.001	-1.53 (-1.99 to -1.07)	P<0.001	9.37 (6.06 to 12.68)	P<0.001	-0.67 (-1 to -0.35)	P<0.001
Social Limitations								
No limitations	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Limitations	-3.01 (-4.4 to -1.62)	P<0.001	-0.75 (-1.18 to -0.31)	P=0.001	4.23 (1.11 to 7.35)	P<0.001	-0.86 (-1.16 to -0.55)	P<0.001
Poverty level category								
High income	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Middle income	2.93 (-.91 to 4.94)	P=0.005	0.56 (-0.06 to 1.19)	P=0.078	-3.91 (-8.44 to 0.62)	P=0.09	0.6 (0.15 to 1.04)	P=0.009
Low income	2.17 (0.97 to 3.36)	P<0.001	0.5 (0.13 to 0.87)	P=0.009	-3.76 (-6.45 to -1.07)	P=0.006	0.43 (0.18 to 0.7)	P=0.001
Near poor	0.83 (0.01 to 1.64)	P=0.046	0.33 (0.08 to 0.59)	P=0.011	-1.51 (-3.35 to 0.31)	P=0.104	0.22 (0.04 to 0.4)	P=0.018
Poor	3.92 (2.52 to 5.32)	P<0.001	1.1 (0.66 to 1.54)	P<0.001	-8.11 (-11.27 to -4.96)	P<0.001	0.66 (0.35 to 0.97)	P<0.001
CCI	0.12 (-0.4 to 0.64)	P=0.646	0.04 (-0.12 to 0.2)	P=0.647	-0.3 (-1.47 to 0.87)	P=0.615	-0.08 (-0.19 to 0.04)	P=0.18

Constant	10.98 (8.6 to 13.36)	P<0.001	2.88 (2.13 to 3.62)	P<0.001	33.52 (28.17 to 38.87)	P<0.001	3.41 (2.88 to 3.93)	P<0.001
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CCI, Charlson Comorbidity Index; K6, Kessler 6-Item Psychological Distress Scale; MCS, Mental Component Summary; MEPS, Medical Expenditures Panel Survey; MNHTLH, Perceived Mental Health Status; PHQ2, Patient Health Questionnaire 2; SOC, Patients with Skin of Color.

Supplemental Table 1. Comparison of sociodemographic and clinical characteristics of adults with psoriasis with complete versus incomplete data from the Medical Expenditures Panel Survey (MEPS).

Characteristic	Population with complete data			Population with incomplete data		
	White (Weighted N=6,535,543)	SOC (Weighted N=984,118)	P value	White (Weighted=8,962,202)	SOC (Weighted=1,285,780)	P value
Age, mean (SEM) years	52.11 (0.71)	51.66 (0.96)	0.388 ^a	53.12 (0.59)	50.78 (0.8)	0.054 ^a
Gender, female N (%)	3397923 (52)	549083 (56)	0.474 ^b	4877009 (54)	756,547 (59)	0.311 ^b
Not on biologics, N (%)	4138136 (63)	733413 (75)	0.016 ^b	5,637,396	934,115	0.0186 ^b
Insurance status, N (%)						
Private	5242354 (80)	776793 (79)	0.06 ^b	7192137 (80)	1006433 (78)	0.0415 ^b
Public	960771 (15)	186090 (19)	47988 (71)	1395167 (16)	258112 (20)	
Uninsured	332418 (5)	21235 (2)	0 (0)	374898 (4)	21235 (2)	
Cognitive limitations, N (%)	404666 (6)	50125 (5)	0.628 ^b	549291 (1)	69158 (5)	0.673 ^b
Social limitations, N (%)	455211 (7)	61733 (6)	0.762 ^b	671088 (1)	109543 (9)	0.595 ^b
Poverty level category, N^c (%)						
Poor	321906 (5)	102542 (10)	0.041 ^b	458741 (5)	151195 (12)	0.01 ^b
Near Poor	176901 (3)	16049 (2)	14239 (21)	204672 (2)	25162 (2)	
Low income	537476 (8)	86463 (9)	17281 (26)	771178 (8)	118385 (9)	
Middle income	1948417 (30)	237858 (24)	5132 (8)	2530576 (28)	298338 (23)	
High income	3550844 (54)	541207 (55)	11142 (17)	4997034 (56)	692701 (54)	
CCI, mean (95% CI)	1.02 (0.03)	1.15 (0.04)	0.042 ^a	0.91 (0.03)	1.05 (0.04)	0.019 ^a

CCI, Charlson Comorbidity Index; CI, Confidence Interval; MEPS, Medical Expenditures Panel Survey; SEM, Standard Error of the Mean; SOC, Patients with Skin of Color.

^a2-tailed t-tests of the differences between U.S. adult White patients and patients with skin of color with psoriasis.

^b χ^2 of the differences between U.S. adult White patients and patients with skin of color with psoriasis.

^cPoverty level category was measured as percent of federal poverty level (FPL).

Supplemental Table 2. Sociodemographic and clinical characteristics of adult patients with psoriasis classified by race groupings from the Medical Expenditures Panel Survey (MEPS).

Characteristic	White (Weighted N=6,535,543)	Black (Weighted N=626,522)	American Indian/Alaskan Native (Weighted N=67,381)	Asian/Native Hawaiian/Pacific Islander (Weighted N=240,062)	Multiple Races (Weighted N=50,154)	P value
Age, mean (SEM) years	52.11 (0.71)	53.05 (1.65)	46.70 (4.13)	50.43 (2.85)	46.76 (4.96)	0.790 ^a
Gender, female N (%)	3397923 (52)	393820 (63)	56239 (83)	77903 (32)	21121 (42)	0.016 ^b
Not on biologics, N (%)	4138136 (63)	545606 (87)	19392 (29)	122818 (51)	45598 (91)	<0.0001 ^b
Insurance status, N (%)						
Private	5242354 (80)	515579 (82)	19392 (29)	204122 (85)	37699 (75)	0.0011 ^b
Public	960771 (15)	89708 (14)	47988 (71)	35939 (15)	12455 (25)	
Uninsured	332418 (5)	21235 (3)	0 (0)	0 (0)	0 (0)	
Cognitive limitations, N (%)	404666 (6)	29231 (5)	0 (0)	20893 (9)	0 (0)	0.737 ^b
Social limitations, N (%)	455211 (7)	40669 (6)	0 (0)	13165 (5)	7899 (16)	0.577 ^b
Poverty level category, N^c (%)						
Poor	321906 (5)	62708 (10)	19585 (29)	15692 (7)	4557 (9)	0.003 ^b
Near Poor	176901 (3)	1809 (0.3)	14239 (21)	0 (0)	0 (0)	
Low income	537476 (8)	45220 (7)	17281 (26)	16062 (7)	7899 (16)	
Middle income	1948417 (30)	169963 (27)	5132 (8)	46199 (19)	16565 (33)	
High income	3550844 (54)	346821 (55)	11142 (17)	162109 (67)	21134 (42)	
CCI, mean (95% CI)	1.02 (0.03)	1.20 (0.04)	1.74 (0.09)	0.99 (0.08)	0.58 (0.18)	0.003 ^a

CCI, Charlson Comorbidity Index; CI, Confidence Interval; MEPS, Medical Expenditures Panel Survey; SEM, Standard Error of the Mean.

^a2-tailed t-tests of the differences between U.S. adult White patients and patients with skin of color with psoriasis.

^bAnalysis of Variance (ANOVA) of the differences between U.S. adult patients with psoriasis classified by all race groupings.

^cPoverty level category was measured as percent of federal poverty level (FPL).

Supplemental Table 3. Adjusted multivariable regression analyses of the association between race and mental health outcome differences among adult patients with psoriasis classified by race groupings (adjusted for age, gender, treatment, insurance coverage, cognitive and social limitations, poverty level category and comorbidities).

Independent Variables	Dependent Variables (Weighted N=7,519,662)							
	K6		PHQ2		MCS		MNHTLH	
	β coeff. (95% CI)	P value	β coeff. (95% CI)	P value	β coeff. (95% CI)	P value	β coeff. (95% CI)	P value
Race								
White	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Black	-0.77 (-1.85 to 0.32)	P=0.166	-0.14 (-0.48 to 0.2)	P=0.421	0.49 (-1.95 to 2.93)	P=0.694	0.02 (-0.22 to 0.26)	P=0.847
American Indian/ Alaskan Native	0.67 (-2.49 to 2.83)	P=0.677	-0.24 (-1.22 to 0.75)	P=0.638	-1.41 (-8.51 to 5.7)	P=0.698	0.24 (-0.46 to 0.93)	P=0.501
Asian/Native Hawaiian/ Pacific Islander	-0.21 (-1.8 to 1.37)	P=0.792	-0.18 (-0.68 to 0.31)	P=0.468	1.82 (-1.75 to 5.38)	P=0.317	-0.25 (-0.6 to 0.1)	P=0.158
Multiple Races	-2.08 (-5.73 to 1.57)	P=0.264	-0.12 (-1.26 to 1.02)	P=0.842	-0.58 (-8.79 to 7.64)	P=0.891	-0.39 (-1.19 to 0.41)	P=0.341
Age	-0.02 (-0.04 to 0.005)	P=0.115	-0.003 (-0.01 to 0.004)	P=0.424	0.09 (0.04 to 0.14)	P=0.001	0.002 (-0.003 to 0.007)	P=0.518
Gender								
Male	1		1		1		1	
Female	0.26 (-0.22 to 0.97)	P=0.466	0.04 (-0.18 to 0.26)	P=0.709	-0.64 (-2.23 to 0.95)	P=0.431	-0.09 (-0.25 to 0.06)	P=0.244
Treatment								
Biologics	1		1		1		1	
Not on biologics	-0.58 (-1.32 to 0.16)	P=0.122	-0.11 (-0.34 to 0.12)	P=0.334	1.63 (-0.03 to 2.3)	P=0.054	-0.04 (-0.2 to 0.12)	P=0.647
Insurance								
Private	1		1		1		1	
Public	0.76 (-0.25 to 1.78)	P=0.14	0.41 (0.09 to 0.72)	P=0.012	-1.39 (-3.67 to 0.89)	P=0.232	0.1 (-0.12 to 0.33)	P=0.359
Uninsured	0.93 (-0.7 to 2.57)	P=0.262	0.56 (0.05 to 1.07)	P=0.031	-0.85 (-4.52 to 2.82)	P=0.648	0.2 (-0.16 to 0.56)	P=0.284
Cognitive Limitations								
No limitations	1		1		1		1	

Limitations	-4.34 (-5.81 to -2.86)	P<0.001	-1.53 (-1.99 to -1.07)	P<0.0001	9.44 (6.12 to 12.77)	P<0.001	-0.67 (-1 to -0.35)	P<0.001
Social Limitations								
No limitations	1		1		1		1	
Limitations	-3.05 (-4.44 to -1.65)	P<0.001	-0.75 (-1.18 to -0.31)	P<0.0001	4.26 (1.13 to 7.4)	P=0.008	-0.87 (-1.18 to -0.56)	P<0.001
Poverty level category								
High income	1		1		1		1	
Middle income	2.81 (0.76 to 4.86)	P=0.007	0.57 (-0.07 to 1.21)	P=0.080	-3.65 (-8.24 to 0.97)	P=0.121	0.55 (0.1 to 1)	P=0.016
Low income	2.17 (0.96 to 3.37)	P<0.001	0.5 (0.12 to 0.88)	P=0.009	-3.67 (-6.36 to -0.95)	P=0.008	0.43 (0.16 to 0.69)	P=0.002
Near poor	0.85 (0.03 to 1.67)	P=0.042	0.33 (0.08 to 0.59)	P=0.011	-1.48 (-3.32 to 0.36)	P=0.114	0.21 (0.03 to 0.39)	P=0.021
Poor	3.95 (2.54 to 5.35)	P<0.001	1.1 (0.66 to 1.54)	P<0.0001	-8.05 (-11.22 to 4.89)	P<0.001	0.66 (0.35 to 0.97)	P<0.001
CCI	0.09 (-0.44 to 0.62)	P=0.734	0.04 (-0.13 to 0.20)	P=0.643	-0.26 (-1.45 to 0.93)	P=0.666	-0.09 (-0.21 to 0.02)	P=0.115
Constant	11.04 (8.64 to 13.44)	P<0.001	2.87 (2.13 to 3.62)	P<0.0001	33.29 (27.9 to 38.69)	P<0.001	3.46 (2.93 to 2.99)	P<0.001

CCI, Charlson Comorbidity Index.; K6, Kessler 6-Item Psychological Distress Scale; MCS, Mental Component Summary; MEPS, Medical Expenditures Panel Survey; MNHTLH, Perceived Mental Health Status; PHQ2, Patient Health Questionnaire 2.

Supplemental Table 4. Sociodemographic and clinical characteristics of adult patients with psoriasis classified by race and ethnicity from the Medical Expenditures Panel Survey (MEPS).

Characteristic	Non-Hispanic White (Weighted N=932,868)	Hispanic White (Weighted N=541,745)	Non-Hispanic Black (Weighted N=13,185)	P value
Age, mean (SEM) years	53 (0.82)	46.64 (0.79)	59.24 (1.96)	0.057 ^a
Gender, female N (%)	613622 (66)	268714 (50)	13185 (100)	0.003 ^b
Not on biologics, N (%)	418483 (45)	319859 (59)	0 (0)	0.002 ^b
Insurance status, N (%)				
Private	748597 (81)	368999 (68)	11135 (84)	0.002 ^b
Public	140420 (15)	129722 (24)	2050 (16)	
Uninsured	34850 (4)	43024 (8)	0 (0)	
Cognitive limitations, N (%)	56834 (6)	57811 (11)	0 (0)	0.092 ^b
Social limitations, N (%)	74065 (8)	51768 (10)	4131 (31)	0.125 ^b
Poverty level category, N^c (%)				
Poor	56201 (6)	63496 (12)	0 (0)	<0.001
Near Poor	47242 (5)	21095 (4)	0 (0)	
Low income	31179 (3)	55174 (10)	13185 (100)	
Middle income	213698 (23)	200365 (37)	0 (0)	
High income	575547 (62)	201613 (37)	0 (0)	
CCI, mean (95% CI)	0 (0)	0.85 (0.04)	0 (0)	<0.0001 ^a

CCI, Charlson Comorbidity Index; CI, Confidence Interval; MEPS, Medical Expenditures Panel Survey; SEM, Standard Error of the Mean.

^a2-tailed t-tests of the differences between U.S. adult White patients and patients with skin of color with psoriasis.

^bAnalysis of Variance (ANOVA) of the differences between U.S. adult patients with psoriasis classified by all race groupings.

^cPoverty level category was measured as percent of federal poverty level (FPL).

Supplemental Table 5. Adjusted multivariable regression analyses of the association between race and mental health outcome differences among adult patients with psoriasis classified by race and ethnicity from the Medical Expenditures Panel Survey (MEPS), adjusted for age, gender, treatment, insurance coverage, cognitive and social limitations, poverty level category and comorbidities.

Independent Variables	Dependent Variables (Weighted N=7,519,662)							
	K6		PHQ2		MCS		MNHTLH	
	β coeff. (95% CI)	P value	β coeff. (95% CI)	P value	β coeff. (95% CI)	P value	β coeff. (95% CI)	P value
Race								
Non-Hispanic White	1		1		1		1	
Hispanic White	0.83 (-1.45 to 3.12)	P=0.472	0.08 (-0.60 to 0.76)	P=0.81	-0.79 (-5.41 to 2.84)	P=0.736	-0.17 (-0.66 to 0.31)	P=0.48
Non-Hispanic Black	1.2 (-4.41 to 6.82)	P=0.673	1.01 (-0.66 to 2.68)	P=0.23	-10.44 (-21.82 to 0.93)	P=0.072	0.66 (-0.53 to 1.85)	P=0.273
Age	0.02 (-0.04 to 0.08)	P=0.516			0.08 (-0.04 to 0.2)	P=0.188	0.002 (-0.01 to 0.02)	P=0.721
Gender								
Male	1		1		1		1	
Female	0.1 (-1.44 to 1.64)	P=0.9	0.004 (-0.01 to 0.02)	P=0.67	-0.2 (-3.32 to 2.93)	P=0.901	-0.27 (-0.6 to 0.06)	P=0.106
Treatment								
Biologics	1		1		1		1	
Not on biologics	-0.69 (-2.32 to 0.94)	P=0.402	0.1 (-0.39 to 0.58)	P=0.69	2.04 (-1.26 to 5.35)	P=0.223	0.06 (-0.29 to 0.4)	P=0.748
Insurance								
Private	1		1		1		1	
Public	0.98 (-1.21 to 3.18)	P=0.377	0.64 (-0.01 to 1.3)	P=0.053	-3.79 (-8.23 to 0.65)	P=0.94	0.18 (-0.29 to 0.64)	P=0.452
Uninsured	0.91 (-2.12 to 3.94)	P=0.554	0.71 (-0.19 to 1.61)	P=0.12	-0.36 (-6.5 to 5.77)	P=0.907	-0.17 (-0.81 to 0.47)	P=0.602
Cognitive Limitations								
No limitations	1		1		1		1	
Limitations	-4.67 (-7.56 to -1.79)	P=0.002	-1.37 (-2.23 to -0.52)	P=0.002	10.25 (4.4 to 16.1)	P=0.001	-0.11 (-0.72 to 0.5)	P=0.722
Social Limitations								
No limitations	1		1		1		1	

Limitations	0.34 (-2.6 to 2.28)	P=0.818	0.02 (-0.85 to 0.89)	P=0.960	-2.53 (-8.49 to 3.42)	P=0.401	-0.87 (-1.5 to -0.25)	P=0.006
Poverty level category								
High income	1		1		1		1	
Middle income	6.05 (2.38 to 9.72)	P=0.001	1.21 (0.122 to 2.30)	P=0.03	-7.49 (-14.93 to -0.05)	P=0.048	0.34 (-0.44 to 1.12)	P=0.388
Low income	1.54 (-1.29 to 4.36)	P=0.283	0.04 (-0.8 to 0.87)	P=0.94	-0.71 (-6.43 to 5.01)	P=0.807	0.28 (-0.32 to 0.88)	P=0.352
Near poor	-0.34 (-2.28 to 1.61)	P=0.733	-0.01 (-0.59 to 0.56)	P=0.96	1.24 (-2.7 to 5.18)	P=0.534	0.24 (-0.17 to 0.65)	P=0.247
Poor	7.1 *4.37 to 9.83)	P<0.0001	2.05 (1.24 to 2.86)	P<0.0001	-11.07 (-16.6 to -5.55)	P<0.0001	1.06 (0.48 to 1.64)	P<0.0001
CCI	-0.18 (-2.04 to 1.68)	P=0.848	0.23 (-0.33 to 0.78)	P=0.419	-0.31 (-4.07 to 3.45)	P=0.87	-0.01 (-0.41 to 0.38)	P=0.949
Constant	5.81 (0.68 to 10.95)	P=0.027	1.34 (-0.18 to 2.86)	P=0.084	39.57 (29.17 to 49.97)	P<0.0001	3.1 (2.01 to 4.19)	P<0.0001

CCI, Charlson Comorbidity Index; K6, Kessler 6-Item Psychological Distress Scale; MCS, Mental Component Summary; MEPS, Medical Expenditures Panel Survey; MNHTLH, Perceived Mental Health Status; PHQ2, Patient Health Questionnaire 2.