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Acculturation and Asthma Management and Outcome among Californian Hispanic Adults

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2020

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An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Science in Public Health
in Health Policy and Management
2023

Abstract

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BACKGROUND: In the United States, asthma is both prevalent[1] and expensive.[2] Hispanics in the U.S. bear a disproportionate burden of asthma.[3,4] Compared to non-Hispanic whites, Hispanic adults have lower odds of being prescribed preventive medication for asthma[3] and a much higher urgent care visit rate due to asthma.[4] Even within the Hispanic populations, there exists tremendous heterogeneity in asthma prevalence and management.[1,5] Puerto Ricans also have much higher prevalence of both asthma diagnosis and self-reported asthma attacks than Mexican/Mexican Americans.[1]

Acculturation describes the multidimensional process of cultural adaptation, and it has been found to affect Latino health through various mechanisms,[6] including those shown to be associated with asthma management and outcomes. Previous research has also presented mixed results on how proxies of acculturation associate with asthma. However, no studies have examined how acculturation as a composite measure correlates with asthma management and outcomes for Hispanic adults.

METHODS: This study used California Health Interview Survey data from 2011 to 2016, and the final sample included 1,997 self-identified Hispanic adults with current asthma at time of survey. Acculturation index was derived from three proxies: birthplace, U.S. residency, and language at home. Dependent variables included preventive medication use for asthma, self-reported asthma attacks, and emergency department (ED) use due to asthma. We ran logistic regressions on weighted sample, adjusting for individual and contextual confounders, and reported odds ratios.

RESULTS: Significantly positive association was found between acculturation and taking daily preventive asthma medication, when controlling for individual and contextual confounders and years (OR=1.67; 95% CI = 1.06-2.66). The two acculturation groups had no significant difference in the odds of having asthma attacks or ED visits due to asthma in the past 12 months in fully adjusted models.

CONCLUSIONS: Among Californian Hispanic adults with current asthma, more acculturated individuals were significantly more likely to take preventive medication for asthma, but they did not have significantly better asthma outcomes in terms of asthma attacks and ED use due to asthma. This suggests the need for policymakers and researchers to tailor interventions to reduce asthma burden base on acculturation levels.

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I. INTRODUCTION

Poor management of asthma can lead to asthma attacks, which are episodes of trouble breathing due to airway tightening.[4] Of the 25 million people living with asthma in the United States, over 40% experience one or more asthma attacks in an average year,[1] which results in 1.8 million emergency department visits, 340,000 hospitalizations, and 3,500 deaths.[7] In addition to the associated morbidity and mortality, the nationwide economic burden of medical care expenses due to asthma attacks is also huge—estimated to cost over $1.5 trillion in the next 20 years.[2]

Hispanics in the U.S. bear a disproportionate burden of asthma,[3,4] and even within the Hispanic populations, there exists tremendous heterogeneity in asthma prevalence and management.[1,5] Compared to non-Hispanic whites, the odds for Hispanic adults to be prescribed preventive medication for asthma is 40% lower.[3] Hispanics also have a much higher ED visit rate due to asthma symptoms than non-Hispanic whites.[4] In addition, while the prevalence of asthma among Hispanics in the U.S. is 6.7%, which is comparable to the national prevalence at 7.7%, the difference in prevalence among Hispanic populations ranges from 5.3% among Mexican/Mexican Americans to 14.9% among Puerto Ricans.[5] Among those with current asthma, Puerto Ricans also have much higher prevalence of self-reported asthma attacks in 2018 (52.4%) than Mexican/Mexican Americans (38.5%).[1] Given the asthma disparities *between* Hispanics and non-Hispanic whites and the heterogeneity in asthma prevalence and outcomes *within* the Hispanic populations, further investigation of these differences is needed.

Studies have shown that, in addition to clinical risk factors for asthma, socioeconomic and cultural factors—such as low health literacy, inadequate access to healthcare, and chronic stress—also worsen asthma outcomes.[8-11] Acculturation is a socio-cultural concept that describes the multidimensional process of cultural adaptation and it has been found to affect Latino health

through various mechanisms, [6] including those that have been shown to be correlated with asthma management and outcomes. For example, acculturative stress describes the persistent pressure and psychological conflict an immigrant experiences as they learn the cultural norms of the new country while letting go of their old ones.[12] Higher acculturative stress of the caregivers has been shown to correlate with worse pediatric asthma outcomes,[13] although its effect on asthma outcomes among adults has not yet been explored. Another study also found that migrants of low socioeconomic status have a poorer understanding of asthma, which was used to explain the apparent paradox between the lower perceived prevalence of asthma and greater clinical asthma severity in this group. In contrast, higher acculturation is also associated with higher health literacy,[15] which predicts better asthma outcomes.[10] Such opposing effects of different mechanisms through which acculturation could affect asthma provokes the question of what the overall correlations between acculturation and asthma management and outcomes will be.

In addition to the potential mechanisms through which acculturation could affect asthma, previous research has also presented mixed results on how proxies of acculturation associate with asthma management and outcomes. Since acculturation is a multifaceted and dynamic construct that is difficult to measure directly, it is typically derived from proxies such as country of birth, length of time in the U.S., language spoken at home, and etc.[14] One study found that being born in the U.S. and a longer U.S. residency are both positively associated with asthma diagnoses among Latino children,[15] which suggests better diagnosis of asthma that may be going undiagnosed in those who have not lived in the US as long. In contrast, English proficiency, another proxy of acculturation, has been shown to be positively correlated with asthma control and predicts better asthma outcomes in two studies that focused on urban Hispanic communities.[16,17] Due to such mixed correlations between proxies of acculturation and asthma, it is necessary to investigate how

acculturation, as a summation of proxies, affects asthma control and outcomes for the U.S. Hispanic populations.

In spite of the potential mechanisms through which acculturation could affect asthma and mixed findings on how acculturation proxies correlate with asthma, no studies have examined how acculturation correlates with asthma management and outcomes for Hispanic adults. Given the disproportionate asthma burden on Hispanics, the tremendous heterogeneity of asthma prevalence and outcomes across Hispanic populations, and the growing evidence of association between acculturation and asthma, there seems to be a major gap in the literature. To address this research gap, this study aims to understand whether higher acculturation is associated with higher odds of taking daily preventive medication for asthma, having self-reported asthma attacks, and using ED services due to asthma among adult Hispanic populations in California.

II. Background and Review of the Literature

Background on Asthma and Asthma Attacks

Asthma is a long-term condition characterized by inflamed and narrowed lung airways that causes coughing, wheezing, chest tightness, and shortness of breath.[18] Asthma is diagnosed in all age groups through a review of personal and medical history, physical exam, and lung function tests.[19] While asthma cannot be cured, it can be effectively managed through medicine and other interventions such as healthy lifestyle changes.[18] Without control or proper management, asthma attacks or episodes can result in emergency department (ED) visits, hospitalizations, and deaths.[18] Common asthma triggers include allergens, tobacco smoke, physical activity, air pollution, emotional anxiety, cold air, and infections, but they also vary from case to case.[20]

Although asthma is often considered a life-long disease, studies have shown that clinical remission of asthma, or prolonged absence of asthma symptoms without medication control, is

possible.[21] Various studies have found that a substantial proportion of children with childhood-onset asthma will outgrow asthma by middle age, especially for those who had mild symptoms.[22] For the adult asthma population, the prevalence of remission varies from 2% and 52%.[23] Although there exist controversies over the clinical definitions and biomedical standards of asthma remissions, it is commonly recognized that remission is not cure, which would require reversal to the normal pathological state of airways.[23] Nonetheless, asthma remission could potentially serve as a "therapeutic endpoint" in the studies of asthma treatments.[21]

Asthma Prevalence and Burden: Nationwide vs. California

With more than 25 million people in the U.S. living with asthma, of whom 41.2% had one or more asthma attacks in the past 12 months, asthma is a major public health issue.[2,24] Beyond the morbidity and mortality from asthma, the economic burden incurred from more than 1.8 million ED visits, 2,200,000 hospitalizations, and 3,500 deaths per year is also huge, and the estimated national cost for asthma in the next 20 years is over $1.5 trillion.[2]

While the prevalence of adult self-reported current asthma in California (9.3%) is comparable to the U.S. average (9.2%) as of 2020, it has the highest number of people living with asthma across all fifty states.[25] Among the 4.7 million Californian adults who have been diagnosed with asthma, 2.8 million had current asthma in 2020.[25] With such a huge population affected by asthma, California also spends more on this disease than any other states; in 2014, the state's total 5-year costs of associated with asthma was projected to be $26.3 billion.[26]

Public health interventions for asthma have shown success in reducing the costs: for example, the National Asthma Control Program saved $23.1 billion nationwide from 2001 to 2013 by strengthening existing public health services such as education on asthma self-management and home visits for trigger reduction.[27] Understanding more about how acculturation levels impact

Hispanic adults in California with current asthma would help extend the reach and enhance the effectiveness of health interventions on a populational level.

Acculturation Status: Definition and Measurement

Acculturation describes the socialization process through which groups and individuals in the groups change their original cultural patterns, such as language, customs, diet, and social relationships, to adopt those of a dominant culture after continuous direct contact.[28] Since acculturation is a multifaceted and dynamic construct that is difficult to measure, it is typically derived from proxies such as country of birth, length of time in the U.S., age of arrival, and language spoken at home (citations). However, some researchers have criticized the reliance on these individual proxy measures for acculturation, arguing that they under-represent the acculturation process and de-contextualize individuals' experiences.[14,29] Despite these concerns about proxy measures, they are widely used due to the limitations of quantitative analyses on secondary data.

Acculturation Status and Health

Acculturation may be positively or negatively correlated with health outcomes. It is a risk factor for obesity and associated chronic diseases such as diabetes and hypertension.[30] It has also been shown that mental health illness may be exacerbated during the acculturation process, possibly due to the psychosocial stress from the pressure to acculturate.[31] In contrast, acculturation has been shown to be positively associated with improved access to care and use of preventive health services.[6] However, it is important to point out that mixed or even contradictory results have been found regarding how acculturation affects health even when similar populations were examined: for example, some studies have shown that lower acculturation status increases the risks of hypertension among Chinese immigrants, while other studies have shown the opposite effect or

no effect at all.[28] One possible reason behind such inconsistency is that both health and acculturation are complex and multifaceted constructs to be defined or measured precisely.[28]

Current Literature and Gaps on Acculturation and Asthma

Among the proxies for acculturation, such as birthplace, language, and parent/guardians' acculturation levels, some have shown to have different or even opposite associations with asthma diagnosis and/or asthma attacks. There is a need to examine how acculturation levels, as a summation of these proxies, correlate with asthma management and outcomes for adult Hispanic populations. While this study aims to address this research gap, these previous studies still shed light on potential methods and frameworks for a further look into acculturation and asthma.

Cultural Barriers as Risk Factors for Asthma

In addition to the clinical risk factors for asthma—including genetic susceptibility, exposures to allergens and infections, tobacco and marijuana use—socioeconomic and cultural factors also contribute to asthma and asthma attacks.[32] For example, numerous studies have shown that low health literacy predicts poorer clinical outcomes for asthma.[8-10] For ethnic minority groups, culturally-relevant and family-based factors such as acculturative stress, medication beliefs and concerns, and use of home remedies have also been shown to affect treatment strategies and asthma outcomes.[33] Such findings suggest there exist various cultural barriers to asthma management, indicating that acculturation level as a composite measure of different proxies could affect asthma management and outcomes through various culturally relevant mechanisms.

Birthplace & Length of Time in the U.S.

Based on the National Health and Interview Survey (NHIS) data from 2001 to 2009, Iqbal et al. found asthma diagnosis is positively associated with both being born in the U.S. and a U.S. residency longer than 10 years.[15] This result aligns with previous findings that asthma prevalence

is higher in Western developed countries.[34] Iqbal et al. postulated a potential role of acculturation in asthma because longer U.S. residence also correlates with behavior and lifestyle changes that lead to a higher rate of obesity and smoking.[15] Their finding justifies the need to further examine the correlation between asthma and acculturation and suggests obesity and smoking are two possible covariates to consider. In addition, Iqbal et al. included different racial/ethnic groups and a wide age span in a national representative sample, which leaves a research gap to look specifically at the Californian Hispanic adult population.

English Proficiency

One study that examined 318 Hispanic adults with persistent asthma at two large inner-city clinics found a correlation between limited English proficiency and poorer asthma control, increased resource utilization, and lower quality of life scores.[16] In another study that focused more specifically on the elderly Hispanic populations with asthma in New York City and Chicago, lower English proficiency was also found to be associated with poorer medication adherence and worse health outcomes.[17] As one proxy measurement for acculturation levels, language proficiency seems to be positively associated with asthma management—as opposed to the two other proxy measurements described above, birthplace and length of U.S. residence.

Acculturation Levels

There are only two asthma studies, to my knowledge, that examined acculturation as a composite measure among U.S. Hispanic populations and both targeted pediatric patients. The first one was a 2007 study by Martin et al. that looked at the association between asthma prevalence and burden among Mexican American schoolchildren and the acculturation level of their parents/guardians. While Martin et al. targeted the pediatric population, its definition and measurement of variables as well as statistical methods are applicable for exploring acculturation's

association with asthma in the adult population. In their study, acculturation was defined as the process of culture-learning and behavioral adaptation when exposed to a new culture, and it was evaluated based on three proxies: the length of time in the U.S., language preference, and country of birth. Martin et al. identified a strong positive association between parents/guardians' level of acculturation and increased asthma diagnosis and total asthma burden for the child. Among the three proxy measures, foreign birth was found to be the most predictive. Social factors, most significantly parents/guardians' life stress, were also shown to mediate the association between parents/guardians' acculturation level and pediatric asthma outcomes.[13] This finding suggests that acculturative stress could also act as one of the mechanisms through which acculturation affects asthma among Hispanic adults.

The other study, titled GALA II, examined asthma and pulmonary function among 1,849 Latino youths aged 8-21 from four U.S. urban areas.[35] In addition to a list of individual acculturation-relevant proxy measures—including nativity status, age moved to the U.S., language preference, and generation status—an acculturation index was also created as a composite measure of language preference and generation in the U.S. The GALA II study found higher acculturation index to be associated with higher odds of asthma, higher pulmonary function, and decreased bronchodilator response among Latino youths. However, the authors did not provide a justification for using only two of the four acculturation proxies in this study to derive the acculturation index. Moreover, this study and the Martin et al. study described above both focused on the pediatric population and neither examined asthma preventive care or incidences of asthma attacks. Therefore, they provide limited insights into how acculturation as a composite measure, rather than individual proxies, associates with asthma management and outcomes among the adult Hispanic populations.

III. Methodology

Theoretical Framework (Figure 1)

To examine the relationship between acculturation and asthma management among the Hispanic populations in the U.S., I developed a conceptual model (Figure 1) based on the Andersen Behavioral Model for Health Care Utilization.[36] The Behavioral Model for Health Care Utilization describes how one's use of health care services is determined by their predisposing characteristics, enabling resources, and need for services on both individual and contextual levels .[36] According to Andersen, predisposing characteristics describe social and biological factors that place one in a position that is more or less likely to use health care services, which include one's demographics, social structure, and health beliefs.[36] Enabling resources are factors that enable or impede health care utilization.[36] Need-related characteristics refer to both perceived need and evaluated need and can directly influence subsequent health care use.[36] In addition to these individual-level factors, Andersen's model also includes contextual characteristics at the community level.[36] I also draw on economic theory and prior literature from health services research to derive the predictive +/- signs on the arrows for the relationships between the constructs in the diagram. Unmeasured constructs are labeled with dotted lines.

Focal Relationships

This conceptual model depicts three focal relationships between acculturation and its associations with the use of preventive medication for asthma, self-reported asthma attacks, and urgent ED use due to asthma, respectively. According to the Andersen model, acculturation—the multidimensional process of cultural adaptation[6]—can be classified as an individual-level predisposing characteristic.[36] All three dependent variables are outcome measures of health care utilization due to asthma. The first dependent variable, preventive medication, refers to the action

of taking a daily medication to control asthma that was prescribed or given by a doctor.[37] Preventive medication, which could be oral medicine and inhalers, is different from inhalers used for quick relief.[37] The dependent variable in the second focal relationship is self-reported asthma attacks—that is, the respondent reports having had an episode of asthma or an asthma attack in the past 12 months.[37] The dependent variable in the third focal relationship is urgent ED use due to asthma, which captures whether a respondent reports having had to visit a hospital emergency room because of asthma in the past 12 months.[37]

Mechanisms

Across the three focal relationships, the proposed mechanisms through which acculturation affects each dependent variable include acculturative stress, health literacy, and asthma awareness. All three mechanisms are hypothesized to be positively associated with acculturation. As for their relationships with the dependent variables, acculturative stress is hypothesized to be negatively associated with asthma preventive medication use while positively associated with self-reported asthma attacks and ED use due to asthma. Health literacy has exactly the opposite associations with dependent variables, as it is hypothesized to be positively associated with preventive medication use but negatively associated with self-reported asthma attacks and ED visits due to asthma. Asthma awareness, on the other hand, is hypothesized to have positive correlations with all three dependent variables. All three mechanisms could not be measured, as shown by the dotted line.

Acculturative Stress

Acculturative stress—the persistent pressure and psychological conflict an immigrant experiences as they learn the cultural norms of the new country and relinquish their old ones[5]—is predicted to be positively associated with acculturation. As individuals become more acculturated,

they are more likely to experience a higher level of acculturative stress due to increasing awareness of discrimination and rejection, loss of their old cultural norms, experience of intergenerational family conflicts, and weakened social ties with communities from the home country.[38,39] The increasing acculturative stress during the prolonged process of acculturation is further supported by research findings showing that higher acculturation is associated with worsened mental health[40] and increased substance use and abuse[41,42] among the Hispanic populations.

Higher acculturative stress is hypothesized to predict worse asthma management and outcomes among Hispanic adults based on findings of a pediatric study that examined asthma morbidity in Latino children.[13] This pediatric study found that higher acculturative stress of the caregivers was associated with worse pediatric asthma outcomes, including a greater likelihood of having an asthma diagnosis, more frequent ED visits due to asthma, and higher asthma morbidity.[13] Although the effect of acculturative stress on asthma outcomes among adults has not been explored, a similar relationship between acculturative stress and asthma management and outcomes can be hypothesized. Therefore, acculturative stress is predicted to associate with lower likelihood of taking asthma preventive medication and higher likelihood of having self-reported asthma attacks and ED use due to asthma.

Health Literacy

The second mechanism through which acculturation is proposed to be correlated with asthma management and outcomes is health literacy. Health literacy refers to the ability to "obtain and translate [health-related] knowledge and information" to achieve good health outcomes and should be "appropriate to the individual and system contexts"[13]. People with higher levels of acculturation are likely to have accumulated more comprehensive knowledge of the health care system as they have internalized more of the host culture's norms. Indeed, previous research has

shown that lower acculturation is correlated with worse health literacy[14]. Inadequate health literacy, in turn, has been identified as a risk factor for numerous health conditions[15-17], including asthma[17]. Therefore, low health literacy is hypothesized to mediate the associations between low acculturation and worse asthma management (i.e., lower likelihood of taking preventive medication for asthma) and worse asthma outcomes (i.e., higher likelihood of self-reported asthma attacks and ED visits).

Asthma Awareness

A closely related but distinct mechanism is asthma awareness, which specifically refers to the knowledge of asthma-related health information—such as risk factors, diagnosis, and management—as well as the close monitoring of one's own asthma symptoms.[43] Just like how greater acculturation is associated with better health literacy, a similar positive association between acculturation and asthma-specific awareness is expected because asthma-related knowledge is likely to increase as one's overall health knowledge increases. In a study that focused on ethnic minorities of low socioeconomic status, researchers found that this group sometimes has a poorer understanding of asthma, which means they underestimate the importance of its control and often fail to recognize underlying asthma symptoms.[43] This finding not only further supports the proposed positive association between acculturation and asthma awareness, but also explains why people of low asthma awareness could have better self-reported asthma outcomes while presenting worse clinical severity for asthma.[43] Thus, compared to those with a poorer understanding of asthma, more acculturated immigrants are hypothesized to be more likely to take preventive medication, report respiratory symptoms as asthma attacks, and seek emergency care in a timely manner, due to heightened asthma awareness.

It is important to note that while health literacy and asthma awareness are highly correlated, they have opposite effects on asthma outcomes as shown in the second and third focal relationships. This is because self-reported asthma attacks and ED use reflect whether someone recognizes and rates their symptoms as an asthma attack and seeks care without delayed presentation to medical attention. While people with better health literacy are less likely to experience asthma emergencies, they are also more likely to recognize, report, and act on early signs of asthma symptoms due to higher asthma awareness, which explains why these people may end up reporting more incidences of asthma attacks and ED use due to asthma in retrospective survey questions.

Confounders to the Focal Relationship

Both individual and contextual confounders are included in this model. Individual characteristics are predisposing characteristics, enabling factors, and need-related characteristics that vary from person to person, whereas contextual confounders are two other characteristics on the community or environmental level. The confounders across three focal relationships are kept the same for consistency.

Predisposing Characteristics:

The individual-level predisposing characteristics included in this model are gender, age, and marital status. Previous studies found that men have higher levels of acculturation and are less likely to have severe asthma.[44] Men have also been shown to be more likely to use and adhere to preventive medication for cardiovascular disease,[45] although the gender difference in the use of asthma preventive medication has not yet been explored.

As for age, while the correlation between acculturation and age is undetermined, both prescription drug use[46] and medication adherence increase with age,[47,48] which suggests a positive association between age and preventive medication use for asthma. Prior research also shows that

the probability of severe asthma increases with age among asthmatic adults[49] and asthma attacks are more likely in people in the 35-64 age group,[50] suggesting an overall positive associations between age and asthma attacks/ED use for asthma.

Turning next to marital status, although no studies have examined marriage rates by acculturation levels among Hispanic adults, a 2016 report from the U.S. Census Bureau found foreign-born people to be more likely to have ever married than native-born counterparts (76% vs. 67%) and less likely to have ever divorced (20% vs. 36%) or widowed (7% vs. 7%).[51] Higher acculturation, commonly measured by the proxy of being native-born, can be predicted to associate with lower likelihood of being married. Married individuals are more likely to use preventive care[52] and report better physical and mental functioning;[53] a similarly positive association can be hypothesized for being married and having better asthma preventive care as well as outcomes.

Enabling Factors:

Enabling factors on the individual level include education, health insurance, employment status and income. Greater acculturation has been shown to be positively associated with educational attainment as greater identification with U.S. cultural values improves the likelihood that adolescents achieve higher educational achievement.[54] Since education level is positively associated adequate asthma control,[55] acculturation is predicted to be positively associated with asthma management and negatively associated with incidences of asthma attacks or urgent ED use due to asthma symptoms.

As for health insurance, Hispanic individuals with higher acculturation are more likely to have insurance coverage and use different types of healthcare services,[6] which include prescription drugs for asthma prevention. Moreover, insurance coverage is associated with improved health outcomes, while having no insurance coverage remains a barrier to asthma management.[56] Among

those insured, private insurance predicts fewer asthma-related ED visits when compared to public insurance like Medicaid.[57]

Greater acculturation is significantly positively associated with higher likelihood of being employed for Hispanic adults in California.[58] For individuals with asthma, full-time employment has been found to associate with less asthma medication use but also less symptomatic asthma.[59] In addition, being unemployed has been shown to associate with a higher likelihood of having ED visits in the past 12 months among those who have chronic diseases such as congestive heart disease and stroke;[60] a similar positive association between unemployment and a higher likelihood of ED visits for asthma can be hypothesized.

Highly acculturated U.S. Latino adults also have higher income compared to their less acculturated counterparts.[61] Such income disparity across acculturation levels is a major confounder in this study because lower income not only contributes to perceived financial burden with asthma medication, but also acts as a risk factor for adverse asthma outcomes, even when holding constant race, education, and stress, for both children and adults.[62,63]

Need-Related Characteristics:

Perceived health status, diagnosed comorbidities, current smoking status, and psychological distress are included in this model to represent perceived need and evaluated need, respectively. According to Andersen, perceived need for health services is people's own view of their "general health, functional state and illness symptoms," while evaluated need describes "professional assessments and objective measurements of patients' health status."[36] Acculturation is associated with both improved perceived health status[6], higher likelihood of smoking,[64] more psychological distress,[65] and increased diagnoses for comorbid conditions such as hypertension[66] and obesity[67], among the Latino populations.

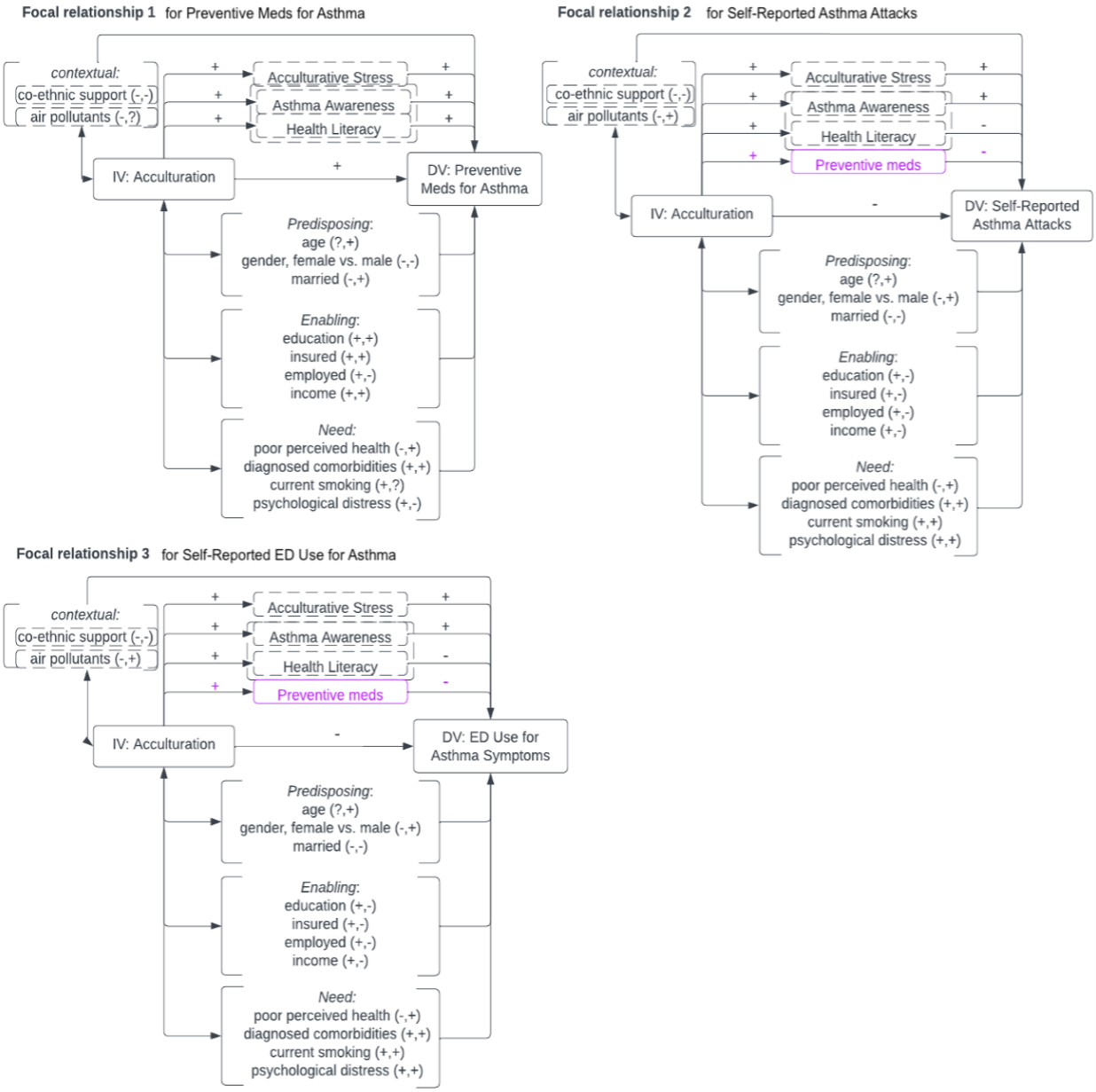
Despite similarly positive associations with acculturation, these four need-related characteristics are predicted to have different effects on asthma management and outcomes. Since individuals with better perceived health likely view themselves in good functional states and thus have fewer asthma-related concerns, they are less likely to take preventive medication or report incidences of asthma attacks and ED visits. On the other hand, comorbidities increase overall medication adherence,[68] which would imply a positive association between comorbidities and asthma preventive medication use. Moreover, comorbidities like obesity have been shown to be risk factors for asthma attacks[69] as well as subsequent asthma ED visits. While it is unknown how smoking affects asthma preventive medication use, smoking has long been proven to worsen asthma symptoms, trigger asthma attacks, and damage lung functions in the long term.[70] As for distress, psychological problems have been shown to positively correlate with difficulties in achieving the objectives of asthma therapy suggested by current guidelines and worse asthma outcomes, and a bidirectional influence could potentially explain the interplay between psychological distress and negative asthma outcomes.[71]

Contextual-Level Characteristics:

Two contextual-level characteristics, co-ethnic support and air pollutants, were also included in this study. Co-ethnic support refers to "a collection of [social] ties…for people of the same racial and ethnic origin" and it has been shown to be diminishing as one becomes more acculturated.[72] Diminished co-ethnic support could exacerbate acculturative stress,[32] one of the proposed mechanisms in this model through which higher acculturation might worsen asthma management and outcomes. Turning next to air pollutants, previous research found that lower acculturation is associated with higher risk of exposure to air pollutants,[73] which has been

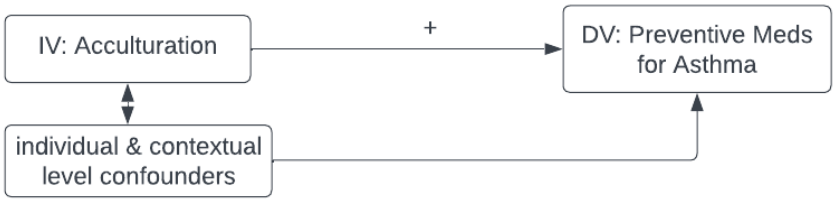
identified as a barrier to effective asthma management and a risk factor of asthma atatcks.[74] Both contextual-level constructs included in this study are unmeasured, as labeled with dotted lines.

Figure 1: Conceptual Framework

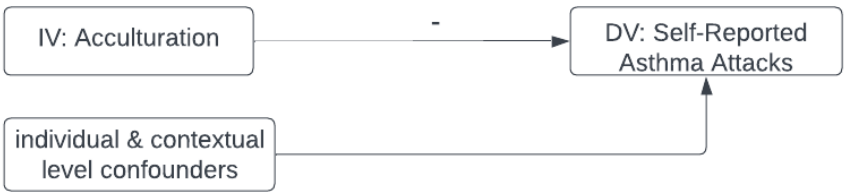


Testable Hypotheses

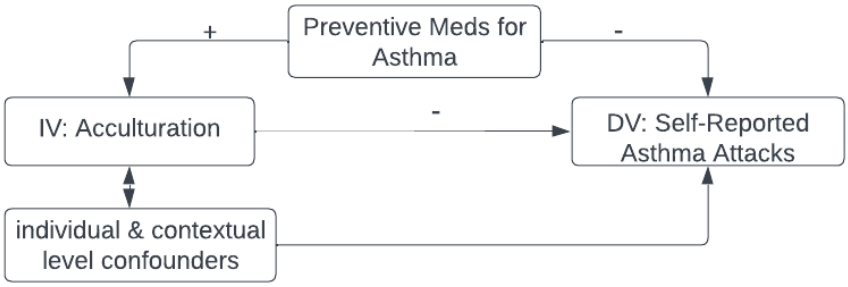
H1: Among Hispanic adults with current asthma, individuals with higher acculturation are more likely to take daily preventive medication for asthma.



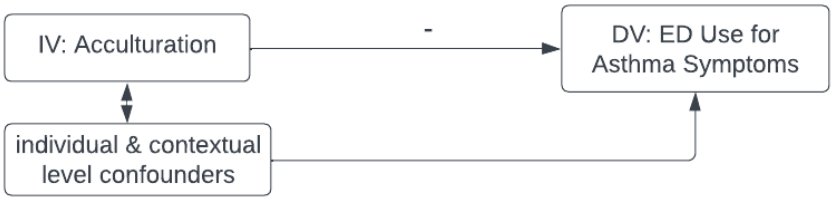
H2: Among Hispanic adults with current asthma, individuals with higher acculturation are less likely to report having had asthma attacks.



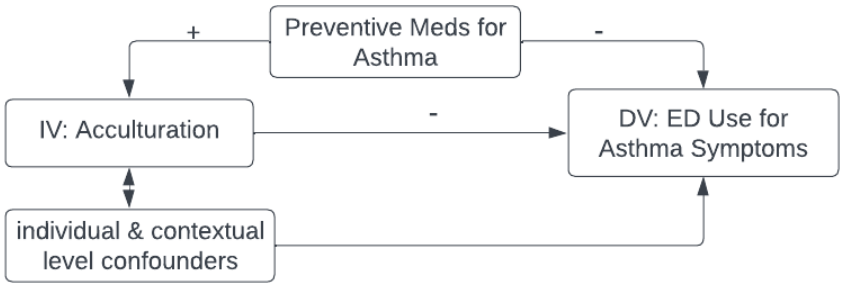
H3: The hypothesized positive relationship between acculturation and self-reported asthma attacks is weakened by whether an individual takes preventive medication for asthma.



H4: Among Hispanic adults with current asthma, individuals with higher acculturation are less likely to report using ED due to asthma.



H5: The hypothesized positive relationship between acculturation and self-reported ED use for asthma symptoms is weakened by whether an individual takes preventive medication for asthma.



Data Description & Analytic Sample

I used the California Health Interview Survey (CHIS), which is a state-level cross-sectional household interview survey with a target population of non-institutionalized individuals living in residential households within 58 counties of California.[75] The timeframe I used for this study was from 2011 to 2016. Prior to 2019, CHIS selected samples based on the dual-frame random-digit-dial (RDD) technique within geographic stratum.[75] CHIS also strategically oversampled certain ethnic, gender, and immigrant groups to better represent minorities. Considering the diverse immigrant populations in California, interviews were conducted in six languages (English, Spanish, Chinese, Korean, Vietnamese, and Tagalog) through computer-assisted telephone interviewing (CATI) system, continually over two-year cycles.[76] The adult questionnaire took 42 minutes on average to complete, which potentially contributes to the low overall adult response rate between 5%-15% from 2011 to 2016.[77-80] The publicly available data files, as well as survey questionnaires, can be downloaded from the UCLA portal for free.

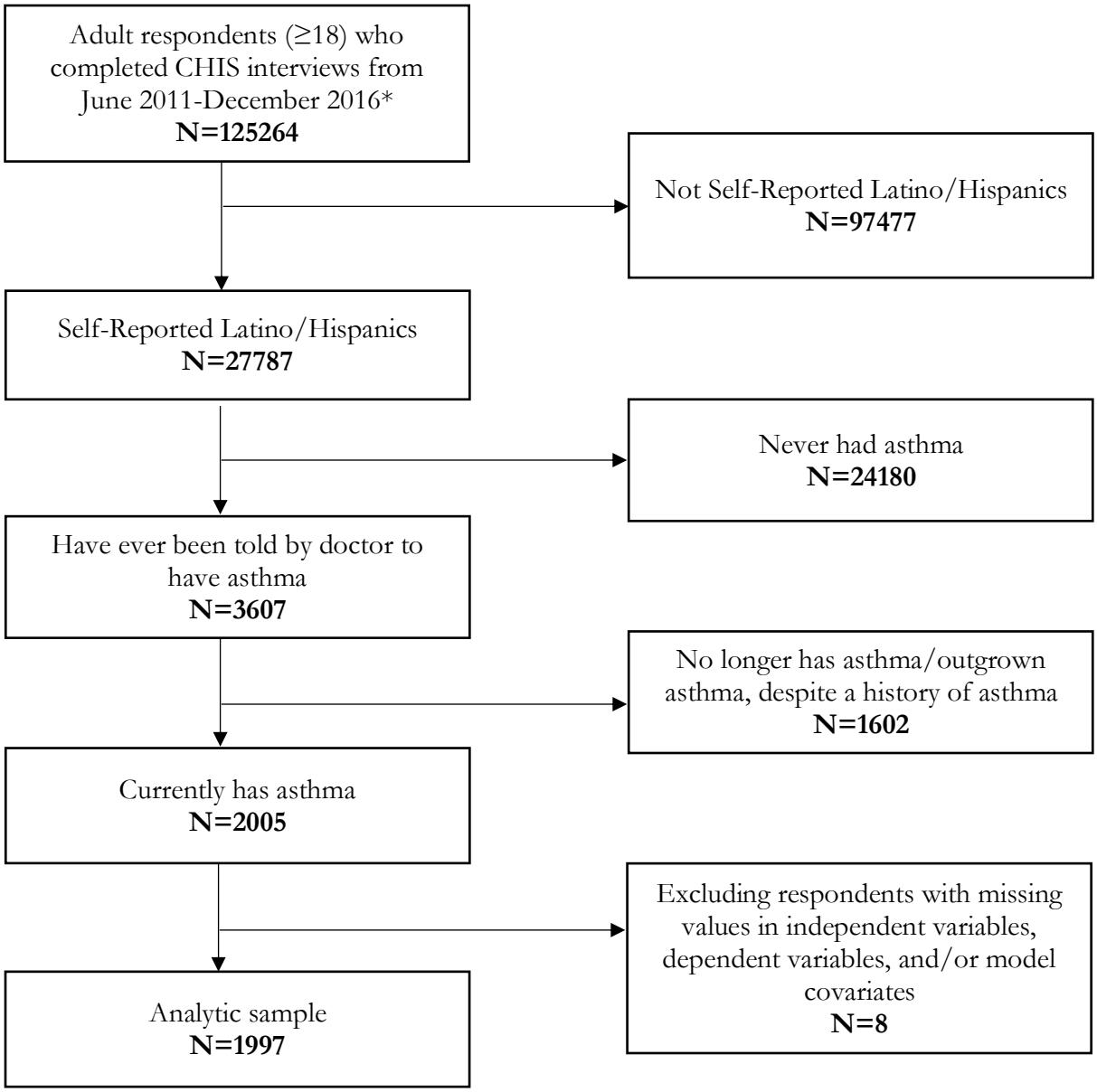
This study combined four cycles of adult data from 2011 to 2016. More recent data, including CHIS 2017-2018 and the cycles afterward, were not used because two outcome variables for this study (i.e., preventive medication use for asthma, ED service use due to asthma) were

removed from PUFs for confidentiality purposes. The analytic sample comprised individuals aged 18 and above who self-identified as Latino/Hispanic and had current asthma. Among these individuals, those with missing responses to any measures of the independent variable (i.e., acculturation) or the dependent variables (i.e., asthma preventive medication, self-reported asthma attacks, and ED use due to asthma) were also excluded.

Analytic Sample Derivation

After pooling adult sample data files of our study period, we identified a total of 125,264 adult respondents (ages ≥18 years) who completed CHIS interviews between June 2011 and December 2016. We then restricted to respondents who self-reported to be Latino/Hispanic (N=27,787). Of these, we further restricted to those who have ever been told by doctor or other healthcare professional to have asthma (N=3,607). Moreover, we excluded those who answered no to the survey question "whether you still have asthma as people can outgrow childhood asthma when they get older or experience remissions despite an asthma diagnosis in the past." We restricted our sample to respondents with current asthma (N=2,005) because this study examined asthma management and related outcomes, which did not apply to those who no longer experience asthma symptoms or need asthma treatment. None of these respondents had missing values for any measures of the key independent variable (i.e., acculturation) and the dependent variables (i.e., asthma preventive medication, self-reported asthma attacks, and ED use due to asthma). Eight respondents were excluded due to missing values in one of the model covariates (i.e., psychological distress in the past year). The final analytic sample included 1,997 respondents who self-identified as Latino/Hispanic and had current asthma at the time of survey.

Figure 1. Analytic Sample Derivation using 2011-2016 California Health Interview Survey



*More recent data, including CHIS 2017-2018 and the cycles afterward, were not used because the outcome variables (i.e., preventive medication use for asthma, ED service use due to asthma) were removed from public use files (PUF) to confidential data.

Measures (Table 1)

Acculturation. Acculturation was derived from three measures, birthplace, U.S. residency, and language at home, using the algorithm from a 2021 acculturation study based on CHIS.[40]

Although the 2021 study has been cited by more than ten papers, this algorithm has not undergone a validation study. The total acculturation score is between 0 to 5, with 0 being the least acculturated and 5 being the most acculturated, and it can be further broken down into two parts. First, birthplace & U.S. Residency together generate a score between 0-3: foreign-born with a U.S. residency less than 5 years is 0; foreign-born with a U.S. residency between 5 to 9 years is 1; foreign-born with a U.S. residency longer than 9 years is 2; U.S. born is 3, and length of U.S. residency is not asked because these people are U.S. citizens. Secondly, language at home has a score between 0-2, and it is measured using the survey question, "What languages do you speak at home?"[81] From the responses of my analytic sample, I constructed three ordinal categories: Spanish only is 0, Spanish & English is 1, and English only is 2.

Adding up the scores from birthplace & U.S. residency (0-3) and language at home (0-2) was the total acculturation score, with ordinal levels from 0 to 5. The acculturation score was further dichotomized into the "less acculturated" group for those between 0 to 3 and the "more acculturated" group for those who scored 4 or 5.

Preventive medication for asthma. This dependent variable was a binary outcome measure that was operationalized by the survey question, "Are you now taking a daily medication to control your asthma that was prescribed or given to you by a doctor?" According to the question description, the interviewer also clarified the definition of preventive medication as oral medicine and inhalers "different from inhalers used for quick relief."[81] It was only asked for individuals with asthma diagnosis. The response options were "Yes" or "No."

Self-reported asthma attacks. This dependent variable was also a binary outcome measure, using the survey question, "During the past 12 months, have you had an episode of asthma or an asthma attack?"[81] The interviewers were not instructed to explain what signs or symptoms count

as an asthma attack, and thus its definition was open to interpretation by the respondent. This question was only asked for those with asthma diagnosis, and response options were "Yes" or "No."

ED use due to asthma. This dependent variable was also a binary outcome measure, using the survey question, "During the past 12 months, have you had to visit a hospital emergency room because of your asthma?" This question was under the "asthma" section and specifically asked about ED use due to asthma, not ED use in general. It was only asked for those with asthma diagnosis. Response options were "Yes" or "No."

Mechanisms. All three mechanisms, acculturative stress, health literacy, and asthma awareness, were unmeasured. Due to the limitation of using secondary data, no survey questions in CHIS can be appropriately operationalized to measure these three mechanisms.

Predisposing characteristics. The *gender* measure used self-identified gender from the survey and was constructed as a female indicator (female =1, male=0). The second construct, *age*, was an ordinal measure as respondents' self-reported ages were only reported as a recoded range of five years in the publicly available files. This study further recoded age ranges into four ordinal groups: 18-24, 25-34, 35-64, and 65+. Turning next to *marital status*, a 4-category constructed variable in CHIS was recoded into three categories: 1) married/living with partner, 2) widowed/separated/divorced, 3) never married. Since the protective effects of marriage on health has been theorized to act through social, psychological, and economic support,[52] "married" and "living with partner" were combined because both could reflect such support to some extent.

Enabling factors. *Education* was assessed as an ordinal measure through operationalization of the question, "What is the highest grade of education you have completed and received credit for?" The responses were organized into four ordinal levels: less than high school =1, high school graduate =2, some college/vocational =3, college graduate or higher =4. As

private insurance has been shown to produce better asthma outcomes than public insurance,[57] *Insured* was a categorical variable that described the current insurance type at the time of survey: 1) private insurance coverage; 2) public insurance coverage only; 3) Uninsured. Turning next to *employment*, it was a full-time employment indictor variable (full-time employed=1, not full-time employed=0). Only respondents who reported working for more than 21 hours per week at the time of survey were coded as full-time employed; elsewise, those who were unemployed, employed but not at work, working part-time (≤ 20 hours per week) were coded as 0. and The final enabling factor, *income*, was a using a constructed variable in CHIS that recoded respondents' best estimates of their household's total annual income from all sources before taxes in the previous year in percentage to the federal poverty line.[81] Since this study combined six years of data from 2011 to 2016, having an income measure in percentage of federal poverty at the time of survey would eliminate time-series effects such as inflation.

Need-related characteristics. The construct of *perceived health status* was binary, recoding the survey question, "Would you say that in general your health is excellent, very good, good, fair, or poor?"[81] The response options were a five-point scale: poor =1, fair =2, good =3, very good =4, and excellent =5. Poor and fair were recoded into an indicator for poor perceived health (perceived health as poor/fair=1), and good, very good, and excellent were recoded as 0 for the indicator perceived health as poor or fair. *Smoking* was measured as an indicator variable, using a survey question asking if respondents were current smokers at the time of survey (Smoking=1, Non-smoking=0). *Psychological distress* was also an indicator variable using a constructed variable in CHIS that determines whether someone likely had psychological distress in the past year, based on the Kessler (K6) scale: if score was equal to or larger than 13, psychological distress=1; if lower than 13, psychological distress=0. *Diagnosed comorbidities* was also measured

as an indicator variable (comorbidities ≥1 =1, no comorbidities =0) if an individual has reported any diagnoses of hypertension, diabetes, any kind of heart disease, and heart failure/congestive heart failure (CHF), all of which could potentially exacerbate asthma outcomes.

Contextual-level characteristics. Both *co-ethnic support* and *air pollutants* were unmeasured. Co-ethnic support could not be operationalized from any measures in CHIS. On the other hand, air pollutants could be proxied using zip codes, but this level of geographic identifiers has restricted access in CHIS data files and thus could not be obtained. Potential bias from unmeasured confounders will be further discussed in the "limitations" section.

Table 1: Table of constructs and their associated measures

Construct	Measures Available	Hypothesized Relationship with Dependent Variables
Acculturation	Acculturation level, ordinal ▪ Less acculturated (index⩽3)=0 ▪ More acculturated (index⩾ 4)=1 Acculturation Index Algorithm Birthplace & U.S. Residency (0-3) ▪ Foreign born, U.S. residency < 5 years =0 ▪ Foreign born, U.S. residency 5-9 years =1 ▪ Foreign born, U.S. residency > 9 years =2 ▪ U.S. born (3) Language at home (0-2) ▪ Spanish only =0 ▪ English and Spanish =1 ▪ English only =2	(+) for preventive meds, self-reported asthma attacks and ED use due to asthma
Preventive Meds	Taking a daily preventive medication for asthma (not the inhaler for quick relief), binary ▪ No =0 ▪ Yes =1	N/A
Self-Reported Asthma Attacks	Have had one or more asthma attacks in the past 12 months, binary ▪ No =0 ▪ Yes =1	N/A
ED Use Due to Asthma	Visited the hospital emergency room for asthma in the past 12 months, binary ▪ No =0 ▪ Yes =1	N/A

Acculturative Stress	Unmeasured	(-) for preventive meds (+) for self-reported asthma attacks and ED use due to asthma
Health Literacy	Unmeasured	(+) for preventive meds (-) for self-reported asthma attacks and ED use due to asthma
Asthma Awareness	Unmeasured	(+) for preventive meds, self-reported asthma attacks and ED use due to asthma
Gender	Self-reported gender, binary ▪ Male =0 ▪ Female =1	(-) for preventive meds (+) for self-reported asthma attacks and ED use due to asthma
Age	Self-reported age at time of survey, continuous	(+) for preventive meds (+) for self-reported asthma attacks and ED use due to asthma
Marital Status	Marital status, categorical ▪ Married/living with partner ▪ Separated/widowed/divorced ▪ Never married	[married] (+) for preventive meds (-) for self-reported asthma attacks and ED use due to asthma
Education	Education attainment, ordinal ▪ Less than high school =1 ▪ High school graduate =2 ▪ Some college/vocational school =3 ▪ College graduate or higher =4	(+) for preventive meds (-) for self-reported asthma attacks and ED use due to asthma
Employment	Full-time employment, binary ▪ Full-time employed (≥21 hours/week) =1 ▪ Not full-time employed =0	(+) for preventive meds (-) for self-reported asthma attacks and ED use due to asthma
Insured	Current Insurance Type, categorical ▪ Private insurance coverage ▪ Public insurance coverage only ▪ Uninsured	[private insurance] (+) for preventive meds (-) for self-reported asthma attacks and ED use due to asthma
Income	Household annual income (in % to federal poverty line)	(+) for preventive meds (-) for self-reported asthma attacks and ED use due to asthma
Perceived Health Status	Perceived health status as fair or poor, binary ▪ Poor/Fair =1	(+) for preventive meds

	▪ Good/Very Good/Excellent =0	(+) for self-reported asthma attacks and ED use due to asthma
Smoking	Current smoker indicator ▪ Current smoker =1 ▪ Current non-smoker =0	(+) for self-reported asthma attacks and ED use due to asthma
Psychological Distress	Likely had psychological distress in past year ▪ Psychological distress =1 ▪ No psychological distress =0	(-) for preventive meds (+) for self-reported asthma attacks and ED use due to asthma
Diagnosed Comorbidities	Indicator for any diagnoses of hypertension, diabetes, any kind of heart disease, and heart failure/congestive heart failure ▪ Comorbidities ≥1 =1 ▪ Comorbidities= 0 =0	(+) for preventive meds (+) for self-reported asthma attacks and ED use due to asthma
Co-ethnic Support	Unmeasured	(+) for preventive meds (-) for self-reported asthma attacks and ED use due to asthma
Air Pollutants	Unmeasured	(?) for preventive meds (+) for self-reported asthma attacks and ED use due to asthma

Analytic Plan

Logistic regression model was used since all three outcome variables were dichotomous indicators. Regression models incorporated survey weights to correct for unequal selection probabilities and differential nonresponse in CHIS sampling and data collection. The basic models for the three focal relationships are:

$$\boldsymbol{Pr(\text{Preventive Meds}=1) = \beta_0 + \beta_1 X_A + \beta_2 X_C + E}$$

$$\boldsymbol{Pr(\text{Self-Reported Asthma Attacks}=1) = \beta_0 + \beta_1 X_A + \beta_2 X_C + E}$$

$$\boldsymbol{Pr(\text{ED Use Due to Asthma}=1) = \beta_0 + \beta_1 X_A + \beta_2 X_C + E}$$

where X_A represents the acculturation score, X_C represents all confounders, and E represents the error terms. The three basic models aim to test H1, H2, and H4. To test H3 and H5 in the second

and third focal relationship, the following two models expanded on the basic models to include a dummy X_P, for the use of asthma preventive medication, as a control variable:

$$\boldsymbol{Pr(\text{Self-Reported Asthma Attacks}=1) = \beta_0 + \beta_1 X_A + \beta_2 X_C + \beta_3 X_P + E}$$

$$\boldsymbol{Pr(\text{ED Use Due to Asthma}=1) = \beta_0 + \beta_1 X_A + \beta_2 X_C + \beta_3 X_P + E}$$

All regression models were performed in Stata Version 17.0. Odds ratios would be reported to present the predicted probabilities of taking daily preventive medication for asthma, having self-reported asthma attacks, and visiting ED due to asthma for each acculturation level.

IV. RESULTS

Results of Descriptive Analyses

Sample Characteristics

Table 1 presents weighted descriptive characteristics of the analytic sample and bivariate comparisons in outcomes and covariates by acculturation level. The study sample included 1,997 respondents who were self-identified Latino/Hispanic with current asthma at the time of survey, equivalent to a weighted N=572,316 individuals in California (Table 1). The majority were female (66.4%) and aged between 35-64 years old (47.4%). Approximately 64.8% of the weighted study sample were classified as having an acculturation score of 4 or 5 (i.e., "more acculturated"), while the remaining 35.2% were classified as having an acculturation score of 0-3 (i.e., "less acculturated").

Individuals in the more acculturated group were more likely than those identified as less acculturated to speak English only at home (51.5% vs. 0%) and be born in the U.S. (97.8% vs. 6.7%) ($p<0.001$). No one in the more acculturated group spoke non-English only at home (vs. 51.9%

in the less acculturated group) or spent less than nine years in this the U.S. (vs. 6.3% [2.3% less than five years and 4.0% between five to nine years] in the less acculturated group) ($p<0.001$).

Outcome Measures by Acculturation Level

Overall, almost half of the respondents reported taking daily preventive medication for asthma (45.9%) and having had asthma attacks in the past 12 months (47.3%), while 14.2% visited ER or urgent care for asthma in the past 12 months.

The proportions of individuals who took daily preventive medication (44.6% vs. 48.3%, $p=0.45$), having had any asthma attacks in the past 12 months (44.3% vs. 52.8%, $p=0.069$), and having visited the ER for asthma symptoms (12.2% vs. 18.0%, $p=0.16$) were lower in the more acculturated group than in the less acculturated group. However, these differences were not statistically significant.

Key Covariates by Acculturation Level

Compared with the more acculturated individuals, those in the less acculturated group were poorer (44.1% with a household income below 100% FPL vs. 23.3% in the more acculturated group, $p<0.001$), older (16.0% aged 65 years or older vs. 7.4% in the more acculturated group, $p<0.001$), and less educated (53.1% with an education level lower than high school vs. 12.0% in the more acculturated group, $p<0.001$). The majority (63.0%) of the less acculturated individuals were married or living with a partner (vs. 42.7% in the more acculturated group), and 16.7% were never married (vs. 42.2% in the more acculturated group) ($p<0.001$). More than half (52.3%) of the more acculturated individuals were employed full-time (vs. 36.3% in the less acculturated group, $p<0.001$). While both groups had low uninsurance rates (16.9% and 11.6% for the less and more acculturated groups, respectively), the more acculturated group was more likely to have private insurance (50.8% vs. 30.8% of the less acculturated group).

Individuals in the more acculturated group were less likely than those in the less acculturated group to report "fair" or "poor" health (33.9% vs. 62.5%, p<0.001) and have one or more comorbid conditions (33.8% vs. 52.9%, p<0.001). The more acculturated group also had a smaller proportion of individuals who reported having had psychological distress in past year (13.6% vs. 18.8% in the less acculturated group, p=0.11). More acculturated group was also almost three times as likely to be current smoker (13.8% vs. 4.9% in the less acculturated group, p=0.0012).

Results of Regression Analyses

Asthma preventive medication use

In unadjusted analysis, no significant association between acculturation level and asthma preventive medication use was found (odds ratio (odds ratio [OR]=0.86, 95% CI = 0.59-1.26; Table 2). After controlling for sociodemographic characteristics, need-related factors and years, the association between acculturation and asthma preventive medication use became significant; more specifically, the odds for individuals in the more acculturated group to take daily medication to control asthma was 1.67 times the odds for less acculturated individuals (95% CI = 1.06-2.66; Table 3). This finding persisted when further adjusting for any asthma attacks in the past 12 months (OR=1.69; 95% CI = 1.06-2.68) or any ER visits due to asthma in the past 12 months (OR=1.69; 95% CI = 1.07-2.66).

In adjusted models, household income levels as percent to federal poverty line (FPL) was negatively associated with asthma preventive medication use (Table 3). Females were more likely to use preventive asthma medication than males (p=0.0421). Compared to individuals who were married or living with a partner, those who were widowed, divorced, or separated were also more likely to take preventive asthma medication (p=0.033). In addition, as shown in Model 2, having had asthma attacks in past 12 months had a significantly positive association with taking asthma

preventive medication (OR=2.10; 95% CI = 1.43-3.08). Similarly, Model 3 shows that having visited the ER for asthma in past 12 months was positively associated with taking asthma preventive medication (OR=2.88; 95% CI = 1.42-5.83).

Asthma attacks in past 12 months

Unadjusted analysis showed no statistically significant association between having had asthma attacks in the past 12 months and acculturation level (OR=0.71, 95% CI = 0.50-1.02; Table 2). As shown in Table 4, the association between acculturation levels and having had asthma attacks in past year remained nonsignificant in Model 1 controlling for sociodemographic and need-related factors, (OR=0.96, 95% CI: 0.62-1.47), and in Model 2 that further adjusted for taking daily medication to control asthma (OR=0.87, 95% CI: 0.56-1.34).

In the fully adjusted model, age and gender were significantly associated with having had asthma attacks (Table 4, Model 2). Specifically, the odds of reporting any asthma attacks in past 12 months for people aged between 35 and 64 years old were at 2.67 times the odds for those between 18 and 25 years old (95% CI =1.53-4.68). The odds for females to have had asthma attacks in past 12 months was 2.09 times the odds for males (95% CI = 1.36-3.20). In addition, taking daily medication to control asthma was positively associated with having reported any asthma attacks in past 12 months (OR=2.13; 95% CI = 1.44-3.15).

ER visits for asthma in past 12 months

We found no statistically significant association between acculturation and ER visits for asthma in the past year in unadjusted model (OR=0.63, 95% CI = 0.34-1.15). As shown in Table 5, the association between acculturation levels and having visited ER for asthma in past year remained nonsignificant in Model 1 controlling for sociodemographic and need-related factors

(OR=1.07, 95% CI, 0.48-2.37), and in Model 2 that further adjusted for taking daily medication to control asthma (OR=0.98, 95% CI: 0.44-2.22).

In the fully adjusted model, current smoker status and perceived health status were significantly associated with having had any ER visits for asthma (Table 5, Model 2). Specifically, for current smokers, the odds of visiting the ER for asthma in past 12 months were 0.18 times the odds for current non-smoker (95% CI, 0.06-0.54). For people whose perceived health status was "fair" or "poor," the odds to have any ER visits due to asthma in past 12 month was 2.35 times the odds for those with good/very good/excellent perceived health status (95% CI = 1.12-4.94). In addition, taking daily medication to control asthma was positively associated with having visited the ER for asthma in past 12 months (OR=2.81; 95% CI = 1.44-5.46).

Table 1 Weighted Descriptive Statistics for Pooled Sample of California Hispanic/Latino Adults with Current Asthma, CHIS 2011–2016

Sample Characteristics	Total	Less Acculturated [a]	More Acculturated	P [b]
Sample size, n (%)	1,997	714 (35.8)	1283 (64.2)	
Weighted frequency, n (%)	572,316	201,251 (35.2)	371,064 (64.8)	
Outcomes				
Taking daily preventive asthma medicine, %	45.9	48.3	44.6	0.45
Asthma attacks in past 12 months, %	47.3	52.8	44.3	0.069
Visited ER for asthma in past 12 months, %	14.2	18.0	12.2	0.16
Variables Used to Construct the Acculturation Score				
Language(s) spoken at home, %				<0.001
English only	33.4	0	51.5	
English and Other	48.3	48.1	48.5	
Non-English only	18.3	51.9	0	
Birthplace & Length of time in the US. %				<0.001
<5 years	0.8	2.3	0	
5-9 years	1.4	4.0	0	
>9 years	32.0	87.0	2.2	
Born in the US	65.8	6.7	97.8	
Predisposing Factors				
Age, %				<0.001
18-25 years	24.1	7.0	33.4	
26-34 years	18.0	11.1	21.7	
35-64 years	47.4	65.8	37.5	
≥65 years	10.5	16.0	7.4	
Female, %	66.4	67.8	65.7	0.64
Marital Status, %				<0.001
Married/living with partner	49.9	63.0	42.7	
Widowed/separated/divorced	16.9	20.3	15.0	
Never married	33.3	16.7	42.2	
Enabling factors				
Education, %				<0.001
Less than high school	26.5	53.1	12.0	
High school	25.1	18.2	28.8	
Some college/vocational school	30.2	18.6	36.4	
Bachelor's degree or higher	18.3	10.0	22.7	
Current insurance type, %				<0.001
Uninsured	13.5	16.9	11.6	
Public only [c]	42.8	52.3	37.6	
Private	43.8	30.8	50.8	
Full-time employed, %	46.7	36.3	52.3	0.001
Household income, %				<0.001
<100% FPL	30.6	44.1	23.3	
100-199% FPL	26.8	34.4	22.7	
200-299% FPL	14.6	8.8	17.7	
>300% FPL	28.0	12.7	36.3	
Need-related factors				
Perceived health as fair/poor, %	44.0	62.5	33.9	<0.001
Comorbidities ≥1, % [d]	40.5	52.9	33.8	<0.001
Current smoker, %	10.6	4.9	13.6	0.0012
Any psychological distress in past year, % [e]	15.4	18.8	13.6	0.11

*+p<.1 * p<.05 ** p<.01*

Abbreviations: ER, Emergency Room FPL, Federal Poverty Line

a. Less acculturated group included individuals with an acculturation score of 0-3, while more acculturated included those with a score of 4 or 5.

b. Adjusted Wald test used to compare value for less acculturated group to more acculturated group.

c. Public insurance included Medi-Cal (Medicaid), Medicare, Children's Health Insurance Program (CHIP) and other public programs.

d. Comorbid conditions included were diagnoses of hypertension, diabetes, any kind of heart disease, and heart failure/congestive heart failure.

e. Likelihood of psychological distress in the past year was based on the Kessler (K6) scale (if score was equal to or larger than 13).

Table 2. Weighted Logistic Regressions[a] to Estimate the Unadjusted Association Between Acculturation and Asthma Outcomes using a Pooled Sample of California Hispanic/Latino Adults with Current Asthma, CHIS 2011–2016

	Take daily medication to control asthma		Asthma attacks in past 12 months		Visited ER for asthma in past 12 months	
	OR	95% CI	OR	95% CI	OR	95% CI
Acculturation						
Less acculturated [b]	Reference		Reference		Reference	
More acculturated	0.86	0.59 - 1.26	0.71+	0.50-1.02	0.63	0.34-1.15

*+p<.1 * p<.05 ** p<.01*

Abbreviations: ER, Emergency Room OR, Odds Ratios CI, Confidence Interval

a. The study sample included 1,997 respondents who were self-identified Latino/Hispanic with current asthma at the time of survey, equivalent to a weighted N=573,316 individuals in California. Weighted logistic regression models was performed using the "*svy"* command in Stata 17 statistic software.

b. Less acculturated group included individuals with an acculturation score of 0-3, while more acculturated included those with a score of 4 or 5.

Table 3. Weighted Logistic Regression[a] to Estimate the Adjusted Association Between Acculturation and Likelihood of Taking Daily Medication to Control Asthma, CHIS 2011–2016

	Takes Daily Medication to Control Asthma					
	Model 1 (Controlled for all covariates)		Model 2 (Model 1 + Any asthma attacks in past 12 months)		Model 3 (Model 1 + Any ER visits for asthma in past 12 months)	
	OR	95% CI	OR	95% CI	OR	95% CI
Acculturation						
Less acculturated [b]	Reference		Reference		Reference	
More acculturated	1.67*	1.06-2.66	1.69*	1.06-2.68	1.69*	1.07-2.66
Asthma Outcomes						
Predisposing Factors						
Age						
18-25	Reference		Reference		Reference	
26-34	1.75	0.88-3.47	1.63	0.82-3.23	1.60	0.82-3.10
35-64	1.38	0.79-2.38	1.18	0.68-2.04	1.24	0.72-2.11
65+	1.47	0.69-3.11	1.43	0.66-3.09	1.37	0.65-2.91
Female (vs. Male)	1.54*	1.02-2.33	1.37	0.89-2.10	1.53	1.00-2.33
Marital status						
Married/living with partner	Reference		Reference		Reference	
Widowed/separated/divorced	0.58*	0.35-0.96	.64+	0.38-1.08	0.60+	0.36-1.01
Never married	0.84	0.50-1.41	.90	0.54-1.51	0.83	0.50-1.40
Enabling Factors						
Education						
Less than high school	Reference		Reference		Reference	
High school	0.93	0.54-1.61	0.86	0.49-1.49	0.94	0.54-1.64
Some college/vocational school	0.66	0.37-1.18	0.62	0.34-1.11	0.61+	0.35-1.05

Bachelor's degree or higher	0.65	0.31-1.34	0.59	0.28-1.24	0.60	0.29-1.23
Current insurance types						
Uninsured	Reference		Reference		Reference	
Public only	1.74+	0.92-3.29	1.71+	0.91-3.20	1.71+	0.92-3.16
Private	1.73	0.87-3.43	1.75	0.88-3.47	1.73	0.89-3.39
Full-time employed (vs. part-time employed, unemployed)	0.83	0.55-1.26	0.84	0.55-1.28	0.84	0.55-1.28
Household income						
<100% FPL	Reference		Reference		Reference	
100-199% FPL	0.74	0.45-1.23	0.72	0.43-1.20	0.79	0.48-1.31
200-299% FPL	0.50*	0.27-0.93	0.48*	0.26-0.90	0.48*	0.27-0.88
>300% FPL	0.42**	0.23-0.76	0.42**	0.23-0.77	0.45**	0.25-0.82
Need-related Factors						
Perceived health as fair/poor (vs. good/very good/excellent)	1.35	0.86-2.12	1.26	0.80-1.98	1.22	0.77-1.92
Comorbidities ≥1 (vs. 0) [c]	1.39	0.87-2.21	1.48	0.92-2.39	1.47+	0.93-2.32
Current smoker (vs. current non-smoker)	0.76	0.42-1.37	0.75	0.42-1.34	0.86	0.48-1.57
Psychological distress in past year (vs. no) [d]	1.15	0.70-1.88	1.10	0.67-1.79	1.10	0.66-1.86
Asthma attacks in past 12 months (vs. no)	—	—	2.10***	1.43-3.08	—	—
Visited ER for asthma in past 12 months (vs. no)	—	—	—	—	2.88**	1.42-5.83
Years						
2011	Reference		Reference		Reference	
2012	1.90*	1.16-3.10	2.01**	1.21-3.33	1.87*	1.15-3.04
2013	1.08	0.62-1.89	1.18	0.67-2.08	1.08	0.59-1.96
2014	0.92	0.51-1.65	0.90	0.50-1.62	0.91	0.51-1.61
2015	1.16	0.67-2.02	1.20	0.71-2.05	1.20	0.70-2.06
2016	1.60	0.83-3.09	1.60	0.82-3.08	1.50	0.78-2.87

*+p<.1 *p<.05 **p<.01*

Abbreviations: ER, Emergency Room FPL, Federal Poverty Line OR, Odds Ratios CI, Confidence Interval ref., Reference

a. The study sample included 1,997 respondents who were self-identified Latino/Hispanic with current asthma at the time of survey, equivalent to a weighted N=573,316 individuals in California. Weighted logistic was regression models performed using the "*svy*" command in Stata 17 statistic software, adjusted for predisposing factors, enabling or needs factors.

b. Less acculturated group included individuals with an acculturation score of 0-3, while more acculturated included those with a score of 4 or 5.

c. Comorbid conditions included were diagnoses of hypertension, diabetes, any kind of heart disease, and heart failure/congestive heart failure (CHF).

d. Likelihood of psychological distress in the past year was based on the Kessler (K6) scale (if score was equal to or larger than 13).

Table 4. Weighted Logistic Regressions[a] to Estimate the Adjusted Association Between Acculturation and Asthma Attacks in Past 12 Months using a Pooled Sample of California Hispanic/Latino Adults with Current Asthma, CHIS 2011–2016

	Asthma Attacks in the Past 12 Months			
	Model 1 (Controlled for all covariates)		Model 2 (Model 1+Whether takes daily medication to control asthma)	
	OR	95% CI	OR	95% CI
Acculturation				
Less acculturated [b]	Reference		Reference	
More acculturated	0.96	0.62-1.47	0.87	0.56-1.34
Predisposing Factors				
Age				
18-25	Reference		Reference	
26-34	1.74	0.87-3.49	1.61	0.80-3.24
35-64	2.72***	1.55-4.78	2.67***	1.53-4.68
65+	1.36	0.65-2.86	1.30	0.60-2.78

Female (vs. Male)	2.19***	1.44-3.34	2.09***	1.36-3.20
Marital status				
Married/living with partner	Reference		Reference	
Widowed/separated/divorced	0.51*	0.30-0.86	0.55*	0.26-0.94
Never married	0.68	0.42-1.08	0.68	0.43-1.08
Enabling Factors				
Education				
Less than high school	Reference		Reference	
High school	1.68	0.99-2.84	1.76*	1.03-3.02
Some college/vocational school	1.50	0.89-2.54	1.69+	0.98-2.91
Bachelor's degree or higher	1.65	0.89-3.05	1.83+	0.97-3.47
Current insurance types				
Uninsured	Reference		Reference	
Public only	1.23	0.68-2.23	1.12	0.62-2.01
Private	1.03	0.53-1.99	0.93	0.49-1.78
Full-time employed (vs. part-time employed, unemployed)	0.93	0.60-1.43	0.96	0.62-1.48
Household income				
<100% FPL	Reference		Reference	
100-199% FPL	1.16	0.77-1.76	1.22	0.80-1.87
200-299% FPL	1.17*	0.61-2.24	1.33	0.69-2.57
>300% FPL	0.88**	0.49-1.56	1.03	0.57-1.84
Need-related Factors				
Perceived health as fair/poor (vs. good/very good/excellent)	1.62*	1.05-2.52	1.57+	1.02-2.51
Comorbidities ≥1 (vs. 0) [d]	0.73	0.47-1.12	0.68+	0.47-1.15
Current smoker (vs. current non-smoker)	1.05	0.60-1.84	1.11	0.47-1.46
Psychological distress in past year (vs. no)	1.31	0.80-2.14	1.28	0.79-2.08
Takes daily medication to control asthma (vs. not)	—	—	2.13***	1.44-3.15
Years				
2011	Reference		Reference	
2012	0.78	0.46-1.29	0.69	0.40-1.16
2013	0.61+	0.36-1.03	0.59	0.34-1.01
2014	1.15	0.67-1.97	1.17	0.67-2.04
2015	0.80	0.45-1.44	0.78	0.44-1.36
2016	1.10	0.57-2.13	1.02	0.53-1.95

*+p<.1 *p<.05 **p<.01*

Abbreviations: ER, Emergency Room FPL, Federal Poverty Line OR, Odds Ratios CI, Confidence Interval ref., Reference

a. The study sample included 1,997 respondents who were self-identified Latino/Hispanic with current asthma at the time of survey, equivalent to a weighted N=573,316 individuals in California. Weighted logistic was regression models performed using the "*svy*" command in Stata 17 statistic software.

b. Less acculturated group included individuals with an acculturation score of 0-3, while more acculturated included those with a score of 4 or 5.

c. Comorbid conditions included were diagnoses of hypertension, diabetes, any kind of heart disease, and heart failure/congestive heart failure (CHF).

d. Likelihood of psychological distress in the past year was based on the Kessler (K6) scale (if score was equal to or larger than 13).

Table 5. Weighted Logistic Regressions[a] to Estimate the Adjusted Association Between Acculturation and Any ER Visits for Asthma in Past 12 Months using a Pooled Sample of California Hispanic/Latino Adults with Current Asthma, CHIS 2011–2016

	Visited ER for Asthma in Past 12 Months			
	Model 1 (Controlled for all covariates)		Model 2 (Model 1+Whether takes daily medication to control asthma)	
	OR	95% CI	OR	95% CI
Acculturation				
Less acculturated [b]	Reference		Reference	
More acculturated	1.07	0.48-2.37	0.98	0.44-2.22

Predisposing Factors				
Age				
18-25	Reference		Reference	
26-34	2.85	0.72-11.29	2.49	0.63-9.93
35-64	2.85+	0.82-9.89	2.73	0.75-9.97
65+	2.15	0.56-8.26	2.07	0.50-8.50
Female (vs. Male)	1.18	0.59-2.35	1.07	0.53 -2.15
Marital status				
Married/living with partner	Reference		Reference	
Widowed/separated/divorced	0.66	0.32-1.35	0.75	0.36-1.60
Never married	0.99	0.40-2.50	1.07	0.43-2.67
Enabling Factors				
Education				
Less than high school	Reference		Reference	
High school	0.73	0.32-1.67	0.74	0.32-1.70
Some college/vocational school	1.80	0.68-4.75	1.96	0.77-5.00
Bachelor's degree or higher	1.65	0.55-4.99	1.91	0.63-5.80
Insurance coverage for past 12 months with current insurance types				
Uninsured	Reference		Reference	
Public only	1.40	0.53-3.71	1.25	0.48-3.22
Private	1.22	0.42-3.52	1.06	0.37-3.00
Full-time employed (vs. part-time employed/ unemployed)	0.90	0.51-1.60	0.97	0.54-1.74
Household income				
<100% FPL	Reference		Reference	
100-199% FPL	0.58	0.27-1.26	0.60	0.28-1.29
200-299% FPL	1.05	0.40-2.78	1.18	0.45-3.12
>300% FPL	0.41*	0.18-0.94	0.51	0.21-1.22
Need-related Factors				
Perceived health as fair/poor (vs. good/very good/excellent)	2.43	1.21-4.87	2.35*	1.12-4.94
Comorbidities ≥1 (vs. 0) [d]	0.69	0.30-1.58	0.64	0.28-1.46
Current smoker (vs. current non-smoker)	0.19	0.06-0.56	0.18**	0.06-0.54
Psychological distress in past year (vs. no)	1.62	0.84-3.13	1.63	0.81-3.29
Takes daily medication to control asthma (vs. not)	—	—	2.81**	1.44-5.46
Years				
2011	Reference		Reference	
2012	1.29	0.54-3.13	1.10	0.47-2.58
2013	1.11	0.44-2.81	1.09	0.40-2.95
2014	1.14	0.43-3.04	1.10	0.43-2.83
2015	0.82	0.34-1.98	0.76	0.32-1.79
2016	1.94	0.69-5.48	1.68	0.58-4.81

*+p<.1 * p<.05 ** p<.01*

Abbreviations: ER, Emergency Room FPL, Federal Poverty Line OR, Odds Ratios CI, Confidence Interval ref., Reference

a. The study sample included 1,997 respondents who were self-identified Latino/Hispanic with current asthma at the time of survey, equivalent to a weighted N=573,316 individuals in California. Weighted logistic was regression models performed using the "*svy*" command in Stata 17 statistic software, adjusted for predisposing factors, enabling or needs factors.

b. Less acculturated group included individuals with an acculturation score of 0-3, while more acculturated included those with a score of 4 or 5.

c. Comorbid conditions included were diagnoses of hypertension, diabetes, any kind of heart disease, and heart failure/congestive heart failure (CHF).

d. Likelihood of psychological distress in the past year was based on the Kessler (K6) scale (if score was equal to or larger than 13).

V. Discussion

Significantly positive association was found between acculturation and taking daily preventive asthma medication, when controlling for individual and contextual confounders and years (OR=1.67; 95% CI = 1.06-2.66). As for asthma outcomes, the two acculturation groups had no significant difference in the odds of reporting any asthma attacks and ER visits due to asthma symptoms in the past 12 months in fully adjusted models, and remained non-significant after further controlling for preventive medication use for asthma.

Unlike previous studies that examined the effects of acculturation-relevant proxies on their own, this study used a composite measure of acculturation. This study's finding of the positive association between acculturation and asthma preventive medication use aligned with previous finding on the positive association between English proficiency and adherence to asthma controller medication.[17] However, this study's finding of no significant difference in ED use for asthma between two acculturation groups did not align with a previous finding of negative associations between higher English proficiency and lower resource utilization i.e., outpatient and inpatient management for asthma symptoms including ED visits.[16] There could be two potential reasons that caused this discrepancy: First, the previous study was conducted in 2009 and focused only on inner-city residents,[16] whereas this study used data collected between 2011-2016 and included both urban and rural residents of California. Second, the previous study also included non-Hispanic native speakers of English as a comparison group,[16] whereas this study limited its sample to people who self-identified as Hispanic/Latino.

All three proposed mechanisms—acculturative stress, asthma awareness, health literacy—predicted the same positive relationship between acculturation and preventive medication use, and data analysis results of this study proved this association to be significantly positive (OR=1.67;

95% CI = 1.06-2.66). However, for the associations between acculturation and any asthma attacks and any ED use due to asthma in the past year, only health literacy predicted them to be negative while acculturative stress and asthma awareness predicted them to be positive. The opposing effects between the three proposed mechanism for the two asthma outcome measures could have cancelled out each other, which potentially explains why the coefficients for both were close to one, and neither were significant (for asthma attacks, OR=0.96, 95% CI: 0.62-1.47; for ED use due to asthma, OR=1.07, 95% CI, 0.48-2.37).

There are three factors that might have contributed to the non-significant associations between acculturation and the two asthma outcome variables (i.e., asthma attacks and ER use due to asthma in the past year). First, the study's relatively small sample size of around 2,000 individuals may have limited the power to detect a true difference. Second, the Hispanic health paradox describes how Hispanics often have better health outcomes than White Americans despite having lower socioeconomic status.[82] Since more acculturated individuals have adopted more of the American culture than their less acculturated counterparts, they could be more prone to worse health outcomes—similar to how White Americans have worse health when comparing to Hispanics—which could have diluted the protective effects from preventive care and higher socioeconomic status. Third, there might exist reverse causality between negative asthma outcomes and the use of asthma preventive medication, where those with a negative outcome are more likely to be prescribed preventive medication. Since CHIS dataset is cross-sectional, temporality cannot be determined, which means someone could start taking preventive asthma medication either before or after they had an asthma attack or visited ED for their asthma symptoms. Thus, it is possible that those with more symptomatic asthma were more likely to be

using asthma preventive medication, but they were also more likely to have negative asthma outcomes at the same time.

Findings of this study can inform policymakers about a potential perspective of reducing health care disparities across acculturation levels. For the more acculturated group, despite taking clinical interventions like preventive medicine, they did not have no significantly better outcomes. Thus suggests that a potential focus of public health interventions could be enhancing their social support and non-clinical community engagement. For the less acculturated group, since they are still significantly less likely to take clinical interventions like preventive medication use for asthma, they should be targeted by more clinically focused initiatives to start preventive care to improve outcomes, as well as long-term programs to help navigate the US healthcare system.

This study had several limitations. First, the dataset, California Health Interview Survey, only included information on the state of California, and thus our findings have limited external validity on national level or any other states. Second, as a cross-sectional dataset, CHIS also could not be used to infer causality as a temporal sequence cannot be established. Third, since the response rates of CHIS has been low, there is also potentially non-response bias. Fourth, all independent and dependent variables were self-reported measures, and thus are subject to recall bias. The fifth limitation is that two contextual level characteristics, co-ethnic support and air pollutants, were not measured, and their omissions could bias the results in unpredictable directions. Potentially, they could cancel out each other's effect since they are predicted to have opposite signs with the focal relationships, but this could not be determined because the effects of omitted variables remain unknown.

Despite the limitations, this study was the first to examine acculturation's effects on asthma management and outcomes among Hispanic adults. It sheds light on the asthma burden among

immigrant populations based on acculturation level. To the extent that gaps in asthma management and outcomes exist across acculturation groups, policymakers and public health researchers may tailor interventions to reduce asthma burden among less acculturated populations by helping them navigate preventive and management plans. For future studies, research with bigger sample is warranted to better understand acculturation's associations with asthma through various mechanisms, including exposure to air pollution by measuring pollutants via zip code data. One specific direction of focus could be to investigate the reverse causality between asthma preventive medication use and negative asthma outcomes identified in this study. In addition, different measures of acculturation should also be applied to test the sensitivity of the identified associations between asthma and acculturation, and a validation study is needed to test the algorithm used to derive acculturation index in this study. There is also need for qualitative research to explore non-clinical factors (e.g., co-ethnic support) that affect asthma management and outcomes among Hispanic adults and immigrant populations at large.

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