Pathways to Stress: The Effects of Childhood Maltreatment, Perceived Discrimination, and Acculturation Strategies on Allostatic Load among U.S. South Asian Adults

by

Aakanksha Lahoti

A dissertation accepted and approved in partial fulfillment of the

requirements for the degree of

Doctor of Philosophy

in Counseling Psychology

Dissertation Committee:

Atika Khurana, Chair

Anne Marie Mauricio, Core Member

Josh Snodgrass, Core Member

Alayna Park, Institutional Representative

University of Oregon

Spring 2026

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DISSERTATION ABSTRACT

Aakanksha Lahoti

Doctor of Philosophy in Counseling Psychology

Title: Pathways to Stress: The Effects of Childhood Maltreatment, Perceived Discrimination, and Acculturation Strategies on Allostatic Load among U.S. South Asian Adults

Allostatic load (AL) represents the chronic wear and tear of the body over extended periods of time due to prolonged exposure to stress. Exposure to early life adversity, such as childhood maltreatment, as well as subsequent life experiences of chronic or extreme stress can increase risk for high AL and future morbidity and mortality (Chandan et al., 2020). In the United States, immigrant populations, especially South Asians, tend to have high rates of childhood maltreatment and are frequently exposed to discrimination and acculturation-related stressors (Nadimpalli et al., 2016), which in turn have been linked with high AL (Cuevas et al., 2020) as well as AL outcomes, such as cardiovascular risk (Talegawkar et al., 2021). Despite South Asians being the fastest-growing ethnic subgroup in the United States with high levels of mental health concerns and stress exposure (Shah et al., 2023), the longitudinal associations between early and later adverse life experiences and AL risk has not been systematically investigated in this population. This study utilized two waves of data, collected five years apart from a sample of 887 South Asian adults living in the United States (M_{age} = 55.6 ± 9.3 years; 46% female) who participated in the MASALA (Mediators of Atherosclerosis in South Asians Living in America) study to examine the longitudinal effects of childhood maltreatment, perceived discrimination, and acculturation strategies on AL. Both the direct and interaction effects of predictor variables (at baseline) were examined on AL (at follow-up). Also, the potential mediating role of depressive symptoms was assessed given its associations with adverse

life experiences and AL. Analyses revealed that childhood maltreatment (assessed using retrospective reports) was both directly associated with AL at follow-up, as well as indirectly associated through depressive symptoms, with higher maltreatment exposure being linked to greater depressive symptoms and higher AL. The indirect effect of perceived discrimination on AL was also significant, with higher perceived discrimination being associated with more depressive symptoms, which in turn was associated with higher AL. Of the acculturation strategies, individuals who used assimilation strategy had higher AL risk, which was indirect and channeled through depressive symptoms. Significant interaction effects were also observed for the assimilation acculturation strategy. Overall, the findings highlight the long-term effects of childhood maltreatment on AL, as well as the effects of perceived discrimination and acculturation strategies on depressive symptoms and AL in a large longitudinal sample of South Asian adults. The findings have important implications for identifying South Asian adults who may have elevated rates of AL, and addressing the psychological impacts of early adversity, discrimination, and acculturation as one option for prevention and intervention efforts to reduce AL risk. Future research should replicate these findings and examine how variations in acculturation strategy use and mental health impacts AL risk over time, as well as identify other mediators and moderators to better understand how psychosocial risks impact AL in this population.

ACKNOWLEDGMENTS

I would like to thank my advisor, Dr. Atika Khurana, for her mentorship throughout my graduate education. Atika, you have taught me how to be a stronger writer, researcher, and thinker. Across many conversations, you listened with care as I shared how deeply important it was to me to focus my dissertation on South Asian health. You supported my commitment to this work wholeheartedly, standing by me through every setback, disappointment, and challenge along the way. As a South Asian woman mentored by another South Asian woman, writing this dissertation has been an honor and privilege. I will always be grateful to you for taking me on as an advisee. You have encouraged me to build confidence in myself, to take ownership of my accomplishments, to carry myself with conviction, and to live in alignment with both my personal and professional values. Those are the lessons I will carry forward, and the qualities I hope to embody for future mentees one day.

I would also like to thank my committee members, Drs. Anne Marie Mauricio, Alayna Park, and Josh Snodgrass, for their time, insight, and encouragement. Your thoughtful feedback strengthened not only this dissertation, but also my growth as a researcher. Anne Marie, I especially valued working with you at CFC—my passion for child therapy and my confidence in my clinical abilities grew immensely under your supervision. Thank you for your kindness throughout my training.

Pursuing a PhD is both demanding and transformative, and it is not a journey one completes alone. I have been deeply fortunate to be supported and cheered on by a remarkable community of people. There is no Dr. Lahoti without all of you.

To my family—what a gift it is to be loved by you. Thank you for nurturing and guiding me, and encouraging me to shine, just as I am—I can never thank you enough. Mama and Papa,

you are the pillars which support everything that I am. My grandmother Prema, for your prayers, love, and endless supply of both stories and delicious snacks. My aunt Rupali, for being the greatest of godmothers: fiercely supportive and unwaveringly in my corner. I am continually reminded of just how loved I am by you. My uncle Manish, for being my partner-in-crime (and fun) and always being only a phone call away. Krish, little one, you bring immeasurable joy to my life. Being your big sister will forever be one of my favorite roles. To my grandfather Nandkishore, for every school pickup and drop-off. I wish you could have seen me earn this doctorate and finally come home, like you asked me each trip. To my grandmother Rajani and grandfather Yogesh, thank you for watching over me.

All my affection to my dearest friends, who show me how loved I am on a daily basis. Mandy, each day I feel immense gratitude for our shared sense of humor, your insistence on celebrating even the smallest of my wins, and the profound sense of safety I know with you. Jahnvi, ever since that first day in sixth grade, it has always been skateboard season. I am fortunate to know what feels like to experience your protectiveness and to be let into your heart. To both of you—I have never known friendships as effortless as ours, and I am grateful we found our way back to each other. Thank you for your infinite patience with me. To the Talreja sisters, for essentially adopting me; I cannot wait to be neighbors! Hiya, you will always be family to me. Harshita, for championing my academic pursuits and our heartfelt conversations. I am also deeply thankful to my Jai Hind friends—Benaifer, Akansha, and Prerna—for cheering me on from afar and for all the laughter and memories over the years.

This adventure would not have been the same without the solidarity and community I found in my graduate cohort. Celia, thank you for your never-ending support and your enthusiasm for every quirky topic I bring up. Chris, your impressions of Christian Bale as

Batman always brightened up my day. You both made the dissertation process far less lonely. Ang, for being like family in Oregon. We've been through some stuff, haven't we? The sincerest of appreciation to my internship cohort as well. Sukki, I feel incredibly fortunate that our paths crossed. Temi, thank you for our daily check-ins. Elena, I cannot wait to visit you in Italy!

I would be remiss in summarizing my doctoral journey without acknowledging the influences of several professors and clinical supervisors over the years. I express my gratitude to each of you for your significant contributions in my professional growth and shaping the researcher and clinician I am. Finally, my dissertation builds on the contributions of several South Asian scholars before me who have modeled what it means to create representation in research and practice for our community. I am honored to be able to contribute to this growing body of work and follow in their footsteps.

DEDICATION

This dissertation is dedicated to my parents, my greatest champions.

Papa, when I was five years old and you underwent heart surgery, I told you I would become a cardiac surgeon so I could operate on you myself. Though I was too young to understand the impossibility of that promise, it revealed how deeply my world was—and remains—anchored in you. In many ways, this PhD has been as much your dream as mine. From my earliest years, you instilled in me the conviction that I am capable of achieving whatever I set my mind to. You encouraged me to dream boldly and to chase new frontiers with determination, much like the voyages of the starship *Enterprise*. You showed me that intellectual curiosity, discipline, and sustained effort make even the most ambitious aspirations attainable. You also taught me that growth demands sacrifice, sometimes in ways we do not anticipate, and that courage is the decision to continue despite uncertainty. Because of you, I have persisted.

Mama, throughout this journey, I have carried your voice with me. I have drawn strength from your enduring belief that everything I need to keep going already resides within me, that my bravery exceeds my fears, and that resilience is often revealed only when we are tested. When I have been inclined to interpret setbacks as failures, you have guided me back to perspective—celebrating successes, reframing disappointments, and reminding me that my worth extends beyond academic achievement. Even when this pursuit required distance and time away from you, your support never wavered. Your belief in me has remained constant, especially when my own confidence faltered. You are, quite simply, the wind beneath my wings.

To both of you—for your sacrifices, your steadfast examples of integrity and perseverance, and most importantly, your love that has sustained me at every stage of life, I offer my deepest gratitude. This work stands as a testament not only to years of study, but to the

foundation you have provided. Here's to finally coming home, Mama and Papa, and to all the dreams we have shared. I love you endlessly.

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CHAPTER I

KEY TERMS AND DEFINITIONS

South Asians. South Asians are individuals with ancestral or ethnic origins in India, Pakistan, Nepal, Bangladesh, and Sri Lanka, representing a quarter of the world's population (Kanaya et al., 2013). This dissertation sample focuses on first-generation South Asians currently living in the United States.

Adverse Childhood Experiences and Childhood Maltreatment. Adverse childhood experiences (ACEs) refer to stressful and/or traumatic incidents occurring before the age of 18 years, including childhood maltreatment and household dysfunction (e.g., exposure to IPV, substance use, mental illness, and parental separation) (Anda et al., 2010). This dissertation focuses on childhood maltreatment specifically, which encompasses both childhood abuse (i.e., emotional, physical, or sexual abuse) and neglect (i.e., emotional neglect, physical neglect).

Perceived Discrimination. Perceived discrimination includes both everyday experiences of unfair treatment associated with characteristics including sexual orientation, weight, language, gender, age, socioeconomic status, race/ethnicity, immigration status as well as exposure to unjust systems, structures, and institutional policies (Miller et al., 2021).

Acculturation and Acculturation Strategies. Acculturation can be understood as the process of cultural and psychosocial change resulting from the interactions between members of different cultural groups (Berry, 2005). This dissertation uses acculturation strategies as a proxy measure of acculturation. Berry's model (1997) posited acculturation strategies as a framework to understand how immigrants balance cultural preservation and cultural adaptation while navigating a new, host culture. The specific acculturation strategy that an individual adopts is determined based on the degree to which they maintain their origin/heritage culture and engage

with the new dominant culture. Research suggests that some acculturation strategies (e.g., integration of both cultures) can have positive psychosocial implications while others (e.g., separation) can have negative implications (Schwartz et al., 2010). Negative psychological and physiological reactions to the cultural adaptation process are referred to as acculturative stress which can be exacerbated by other factors such as racial/ethnic discrimination and lack of social support (D'Alonzo et al., 2019).

Depressive Symptoms. Depression is a psychiatric disorder characterized by symptoms including persistent sadness or low mood, increased irritability, marked diminished interest in most activities, being easily fatigued, changes in appetite and sleep, feelings of worthlessness, difficulties with concentration, and recurrent thoughts of death or suicide (Park et al., 2020). This dissertation focuses on depressive symptoms, assessed using the Center for Epidemiological Studies Depression (CES-D) Scale, rather than depression as a disorder diagnosed using the Diagnostic Statistical Manual (DSM) criteria.

Allostatic Load. Allostatic load is broadly defined as the chronic 'wear and tear' of the body over extended periods of time in response to prolonged exposure to stress (Alonzo et al., 2019; Doan, 2021). It is generally measured using a composite of biomarkers representing various biological systems, such as the immune, metabolic, cardiovascular, and neuroendocrine systems. This dissertation utilized the following nine biomarkers to assess allostatic load: systolic blood pressure, diastolic blood pressure, glycosylated hemoglobin, high sensitivity C-reactive protein (HS-CRP), total cholesterol, triglyceride, body mass index (BMI), estimated glomerular filtration rate (eGFR), and serum albumin.

CHAPTER II

INTRODUCTION

Allostatic load (AL) is increasingly recognized as a significant predictor of future morbidity and mortality due to its strong association with both physical and mental health issues, including cardiovascular disease, obesity, diabetes, posttraumatic stress disorder, depression, and anxiety (Castagne et al., 2018). AL assessments typically capture relevant biomarkers across numerous physiological systems (e.g., neuroendocrine, metabolic, cardiovascular, and immune systems), making AL a robust measure of stress-related dysregulation and important predictor of overall health (Evans & Fuller-Rowell, 2013). Exposure to early life adversity, including childhood abuse and maltreatment, is linked to high AL (Misiak et al., 2022), characterized by elevated inflammation levels, blunted neuroendocrine and cortisol responses, and greater activation of the hypothalamic-pituitary-adrenal (HPA) axis (Dackis et al., 2012; Danese & McEwen, 2012). Depressive symptoms have been suggested as a potential mechanism by which early adversity can impact later AL (Honkalampi et al., 2021; McClain et al., 2022). In turn, AL-related physiological dysregulations are associated with poor health outcomes such as impaired cognitive functioning, diabetes, and hypertension (Doan, 2021).

Although there is some evidence to suggest that the impact of childhood maltreatment on AL can differ based on genetic predispositions to psychiatric risk, psychosocial experiences, and contextual factors (Dich et al., 2015; Katz et al., 2012), there has been a limited focus on racial-ethnic minorities and immigrants in AL research. In particular, the association between childhood maltreatment and AL is understudied among South Asians in the United States, despite victimization rates for childhood abuse among South Asian women in the United States being as high as 79% (Raj & Silverman, 2002). South Asians are the fastest-growing ethnic

subgroup in the United States with high levels of mental health concerns, exposure to trauma, including intergenerational immigration stress (Shah et al., 2023), as well as a documented history of underutilizing health services, making it both timely and important to understand the unique predictors and mechanisms for the development of AL among this population. To that end, this study used existing data from the 'Mediators of Atherosclerosis in South Asians Living in America' (MASALA) study to examine the longitudinal effects of childhood maltreatment, perceived discrimination, and acculturation strategies (as a proxy for acculturation) on future AL in a sample of South Asians in the United States. The potential mediating role of depressive symptoms was also assessed to better understand the mechanisms of influence.

While Eurocentric frameworks of mental and physical health often conceptualize conditions such as AL, depression, or posttraumatic stress disorder in a biomedical framework, prior findings suggest that South Asian individuals are more likely to attribute these conditions to life circumstances (Karasz et al., 2019). Indeed, South Asians may be exposed to a unique composite of social, political, and immigration-related considerations contributing to prolonged stress, including racial discrimination and marginalization (e.g., anti-Muslim sentiment post 9/11, anti-Asian sentiment during the COVID-19 pandemic), immigration and legal stress, acculturative concerns, and economic stressors (e.g., transnational financial responsibilities) (Contractor et al., 2023). This presents the need to consider relevant psychosocial factors associated with South Asians' experiences as both a racial-ethnic minority as well as an immigrant population. For instance, social factors such as perceived discrimination (Cuevas et al., 2019) and acculturation strategies (Ji & Duan, 2006) have been associated with significantly higher AL in immigrant populations (D'Alonzo et al., 2019); however, this relationship is understudied among South Asian immigrants.

Systematic reviews report that high AL can accelerate chronic disease development, increasing overall mortality and cardiovascular mortality risk by as much as 22% and 31% respectively (Parker et al., 2022). South Asians tend to have higher cardiovascular mortality rate than local populations and other immigrant groups (Kanaya et al., 2013; Talegawkar et al., 2021). Some studies have suggested this may be due to unique discrimination and immigration related stressors experienced by this population in addition to the underutilization of mental health services due to stigma, and lack of awareness and access to culturally responsive services (Ahmed et al., 2022; Contractor et al., 2023). The present study examined how exposure to childhood maltreatment, perceived discrimination and acculturative strategies is linked to future AL in this population, including a focus on depressive symptoms as a potential mechanism. The findings can inform the design of preventive interventions that are tailored specifically for this subgroup, taking into account their unique background, strengths, and challenges.

Allostatic Load

The origins of AL lie in the concept of allostasis, or the body's regulatory systems' efforts to maintain stability and optimize physiological functioning by adapting to physical and behavioral stressors (Lenart-Bugla et al., 2022). Exposure to stress activates the central self-regulation and stress management systems, i.e., the sympathetic nervous system (SNS) and the HPA axis (McCrory et al., 2023). The HPA axis controls the primary mediators of allostasis, including stress hormones such as cortisol, epinephrine, norepinephrine, thyroid stimulating hormone, and cytokines (Juster et al., 2016). Changes in the SNS and HPA axis further activate secondary stress responses across various bodily systems (e.g., increased inflammation, blood pressure, altered glucose metabolism), known as secondary mediators of allostasis, that then work together to optimize energy allocation to the muscles, regulate attention and arousal, as

well as the body's fight or flight response (McEwen, 2008). When the body is exposed to normal levels of stress, these adaptive processes enable it to efficiently recover and maintain allostasis.

However, this allostatic sequence may break down when repeatedly activated and deactivated in the face of persistent stress, resulting in "overload," inadvertently triggering physiological changes that may lead to tertiary, long-term negative health outcomes (Carbone et al., 2022). Thus, the term "allostatic load" was developed by McEwen and Stellar (1993) to illustrate how initially adaptive changes and responses to stress may become maladaptive (i.e., dysregulated) over time, disrupting the functioning of numerous physiological systems. In doing so, it may lead to greater wear and tear of the body as well as increased vulnerability to subsequent disease or illness (Lupien et al., 2006). AL may also develop when the body is unable to shut off the stress response once the stressor has ceased or when the allostatic response is insufficient to deal with the stressor (McEwen, 2006).

There is no gold standard for the operationalization of AL, resulting in substantial variation in the types of biomarkers used to assess AL across studies. A systematic review by Juster et al. (2010) found 51 different biomarkers used to measure AL across 58 studies, with metabolic system biomarkers being most frequently used (34%), followed by neuroendocrine (25%), cardiovascular (20%), anthropometric (11%), and immune system biomarkers (10%). Nevertheless, the literature largely supports the balanced inclusion of both primary (e.g., cortisol) and secondary biomarkers (e.g., blood pressure, cholesterol, BMI) to create a comprehensive AL index (Edes & Crews, 2017). Commonly used markers used to assess AL include heart rate, cortisol, body mass index, systolic blood pressure, diastolic blood pressure, hemoglobin A1c, waist-to-hip ratio, and cholesterol (Beese et al., 2022; Carbone et al., 2022). AL remains understudied among diverse populations and there is only one known study focusing on AL

among South Asians in the United States (Talegawkar et al., 2021). As that study utilized the same dataset as this analysis, the current study incorporated the same biomarkers, which will be described in detail in the Methods section.

Existing literature suggests most studies use one of two primary approaches for the calculation of AL scores. One approach uses clinical cut-offs, in which the researchers determine the high-risk cut-offs for each biomarker based on established clinical thresholds (Bird et al., 2010). Another frequently used method is a quartile or distribution-based cut-off approach where the sample distribution of biomarker data is divided into quartiles and a "high risk" cut-off is determined, which is usually the highest or the lowest quartile depending on the specific biomarker. Across both approaches, each biomarker is then dichotomized and coded as "0" for normal/low-risk scores or "1" for high-risk scores. Following this, the AL index is created by summing together the number of biomarkers for which the individual is considered "high risk" into a single score (Carbone et al., 2022). This study used the high-risk quartile/distributional threshold approach to calculate AL, consistent with previous MASALA studies, given the lack of validated clinical cut-offs with this understudied population.

Childhood Maltreatment and Allostatic Load

South Asians report higher rates of interpersonal traumas such as childhood maltreatment as compared to other index traumas (Saraiya et al., 2019). In particular, Asian populations are especially at risk for higher rates of physical abuse due to strict parenting styles involving physical discipline (Zhai & Gao, 2009) and normative use of physical force against children (Douglas, 2006). This may provide context to higher rates of overall ACEs exposure in Asian communities (Wang et al., 2022) as the lines between reasonable punishment and child maltreatment can be subjective and nuanced (Sudo et al., 2023). These findings are noteworthy

because exposure to childhood maltreatment is considered to be a chronic stressor during development, resulting in impaired daily functioning (e.g., decreased social competence, increased risk-taking), deficits in self-regulation, and persistent emotional and physiological dysregulation (Danese & McEwen, 2012; Lupien et al., 2006). Childhood maltreatment has well-documented longitudinal impacts on mental (e.g., depressive, trauma symptoms) and physical health (e.g., diabetes, autoimmune diseases, cardiovascular risk) outcomes in the general population as well as in Asian subgroups (Forster et al., 2018; Santoro et al., 2021). In the World Mental Health Surveys conducted across 21 countries, 30% of adult mental illnesses were linked with childhood physical abuse or other ACEs (Kessler et al., 2010).

Not surprisingly, there is also consistent evidence that individuals with a history of childhood abuse or neglect demonstrate higher AL in adulthood compared to individuals without such histories (Horan & Widom, 2015; Scheuer et al., 2018). For example, in a large sample of 33,466 women aged 40-70 years, Jakubowski et al. (2023) found that women exposed to childhood maltreatment endorsed higher levels of AL compared to those who were not exposed, with a 4% increase in average AL for every additional maltreatment experience reported. Childhood is believed to be a crucial period of life for the development of behavioral, metabolic, immune, and other biological systems, making these systems especially vulnerable to the effects of stress during this time (Salzmann et al., 2022). The longitudinal association between childhood maltreatment and AL has been reported across samples regardless of sociodemographic differences (e.g., gender, race-ethnicity, socioeconomic status) and other risk factors (e.g., family risk for disease, health risk behaviors) (Gonzalez, 2013), suggesting that these biological systems can be disrupted by early adversity irrespective of other risk factors. One study by Saba et al. (2023) that tracked 253 survivors of childhood maltreatment from

childhood to midlife found evidence of associations between childhood physical abuse and high AL, even after controlling for age, sex at birth, race/ethnicity, and childhood socioeconomic status. Another study by Widom et al. (2015) found that the direct effect of childhood maltreatment on AL persisted across 30 years in a cohort of individuals with documented cases of abuse and neglect who were followed from childhood (ages 0-11) to middle adulthood (mean age 41), even when accounting for effects of mediators such as internalizing and externalizing problems in adolescence as well as social support in middle adulthood.

The above findings together highlight how exposure to childhood maltreatment can negatively impact psycho-physiological development, resulting in high AL (Danese & McEwen, 2012). High AL risk is further linked to subsequent development of diabetes, hypertension, which in turn, are believed to increase morbidity (e.g., cardiovascular disease) and mortality rates (Chandan et al., 2020; Godoy et al., 2021). The lack of research on the link between childhood maltreatment and AL among the South Asian population remains a critical gap, with implications for the development of culturally specific, effective preventive interventions.

Perceived Discrimination and Allostatic Load

While anti-Asian xenophobia and bias in the United States can be tracked back to 19th century laws to ban immigration, the harassment faced by this ethnic group, including subjection to the "perpetual foreigner" stereotype, has only increased in recent years (Armenta et al., 2021). South Asians, in particular, may be especially vulnerable to institutional discrimination (e.g., job applications, equal pay, promotions) compared to White individuals and may be more likely to avoid health care services due to discrimination-related concerns (McMurtry et al., 2019), which may further exacerbate health disparities and lead to unresolved health concerns.

Racial discrimination is increasingly recognized as an important contributing factor to creating health disparities among racial-ethnic minority groups. Indeed, a study conducted by Kim & Epstein (2020) with a nation-wide sample of 310 Asian American adults from various Asian subgroups, including South Asians, illustrated that exposure to discrimination and racism negatively affects Asian Americans' physical and psychological health through racism-related stress. Similarly, another study found that Asians face an increased risk of depressive and substance use disorders, diabetes, obesity, high cholesterol, and deteriorating cardiovascular health, associated with discrimination-related stress, compared to both White and other minority groups (Gee et al., 2009).

Numerous studies have found that perceived discrimination predicts increases in AL among racial-ethnic minorities (Van Dyke et al., 2020), even when controlling for sociodemographic and other risk factors such as health risk behaviors (Currie et al., 2020; Williams et al., 2019). Both Cuevas et al. (2020) and Lawrence et al. (2022) found that increased experiences of discrimination or lifetime discrimination predicted dysregulation in the levels of inflammation markers such as CRP and Interleukin-6. These findings highlight the role of perceived discrimination as a social determinant of stress dysregulation, and by extension, overall health.

Most extant research on perceived discrimination focuses on the implications of membership in racial-ethnic minority groups. However, South Asian experiences of perceived discrimination in the United States are best understood through their dual status both as a racial-ethnic minority as well as an immigrant group, each associated with distinct challenges. For instance, they are often subject to the 'model minority' myth (Kim et al., 2021), that is, they are assumed to be a 'successful' minority unlikely to encounter discrimination. However, in

conjunction with the 'perpetual foreigner' stereotype, this myth has been found to result in internalizing symptoms (e.g., depressive concerns) and poor physiological outcomes (e.g., cardiovascular disease) not explained by traditional risk factors (Nadimpalli et al., 2016). As such, this study also examines the association between acculturation strategies and AL in this sample given the potential effects of their dual status as a racial-ethnic minority group and an immigrant group.

Acculturation and Acculturation Strategies

Immigrants frequently face acculturation-related challenges such as language-related difficulties, balancing different cultures, ways of life, and social values, in addition to the pressure of adapting to a new sociocultural environment (Rodriguez et al., 2002). These demands may result in the experience of acculturative stress. Although challenges with acculturation and acculturative stress have been found to lead to significantly higher AL in immigrant populations (Cuevas et al., 2019; D'Alonzo et al., 2019), this relationship has not been investigated among South Asian immigrants. Because South Asians share a similar vulnerability to persistent psychosocial stressors and pressures to acculturate as other immigrants (Karasz et al., 2019), the lack of research on the association with AL in this population is a critical gap. This section will review findings related to the association between acculturation and AL in other immigrant populations as well as the limited research on acculturation and health disparities (e.g., cardiometabolic health) among South Asians.

The negative association between acculturation, acculturative stress, and health is well documented among immigrant populations. The duration of residence in the United States is often utilized as a proxy measure for acculturation-related indicators (Kanaya et al., 2014) and several studies with US based samples have found a decline in psychological and physiological

health, such as high AL, associated with increased time spent in the United States (Bingham et al., 2016; Peek et al., 2010). Acculturative stress has been proposed as a theoretical explanation for this decline in health, linked with the impact of transitioning from presumably majority status in their country of origin to minority status as immigrants (Doamekpor & Dinwiddie, 2015). Across most immigrant groups, including South Asians (Ahmed et al., 2022), there can be some health advantages or 'protection' against psychiatric distress and AL for recent immigrants associated with access to better health care or quality of life as well as more recent contact with their culture of origin. However, this advantage may diminish over time and across generations as they experience stress associated with acculturation and perceived discrimination (Zheng & Yu, 2022). For instance, in a sample of African immigrants, those who had resided in the U.S. for over 10 years had higher AL compared to more recent immigrants (Hormenu et al., 2020). Importantly, despite this within-group variation, both foreign-born and US-born members of immigrant or racial-ethnic minority groups demonstrate significantly higher AL levels than US-born White individuals (Kaestner et al., 2009), suggesting that immigrant status operates as a risk factor for AL-related outcomes.

As previously noted, acculturation strategies are used as an evidence-supported proxy for measuring acculturation. While the relationship between acculturation strategies and AL itself among South Asians is understudied, recent studies using the same data as this study have reported associations between acculturation strategies and specific AL-related outcomes, such as cardiovascular risk and disease (Al-Sofiani et al., 2020; Needham et al., 2018). These studies utilized Berry's acculturation framework which posits that immigrants typically adopt one of four acculturation strategies- integration, assimilation, separation, and marginalization- while attempting to navigate two cultures (the host culture and the culture of origin) simultaneously

(Berry, 1997; Needham et al., 2017). The integration strategy includes maintaining aspects of one's heritage culture and adopting elements of the host culture; the assimilation strategy involves rejecting one's heritage culture and fully embracing the host culture; the separation strategy is marked by maintaining one's heritage culture and avoiding interaction with the host culture; and the marginalization strategy involves a rejection of both the heritage and host cultures (Needham et al., 2017). Al-Sofiani et al. (2020) found that among female participants in the MASALA study, those who utilized an integration strategy had a healthier cardiometabolic profile, lower prevalence of diabetes and pre-diabetes indicators compared to their female counterparts who tended to use a separation strategy. Across other samples as well, the integration strategy is found to be the most beneficial to mental health outcomes, while the marginalization strategy is the least beneficial, based on a systematic review of 21 studies examining acculturation strategies and mental health (Choy et al., 2020). This study adopted a similar approach to previous studies in using acculturation strategies as the proxy measure of acculturation.

Mediating Role of Depressive Symptoms

All the predictors in this study (i.e., childhood maltreatment, perceived discrimination, and acculturation strategies) have individually been linked to a range of adverse mental health outcomes across various immigrant populations (Lee & Choi, 2018). For instance, in a sample of first-generation Vietnamese immigrants, Nguyen et al. (2017) found that those who adopted an integration acculturation strategy endorsed lower severity of depressive symptoms while participants using a marginalization strategy experienced the highest severity of depressive symptoms as compared to participants using any other acculturation strategy. Childhood maltreatment, and particularly, emotional abuse and neglect, has also been linked with higher

likelihood of developing a depressive disorder during adulthood (Li et al., 2023; Nelson et al., 2017). Further, Santoro et al. (2021) found that depressive symptoms were the most commonly predicted health condition among Asian Indians with histories of ACEs. A growing literature base, including a prior study using the MASALA data (Ahmed et al., 2022), also supports the association between perceived discrimination and depressive symptoms among both South Asians (Tummala-Narra et al., 2011) and immigrant populations more broadly (Gee et al., 2007).

A sizeable body of research also documents the role of depressive symptoms in AL and chronic disease etiology, suggesting it may serve as a mechanism in the pathway between psychosocial risks and AL (Mezuk et al., 2008). That is, depressive symptoms may be associated with physiological and biological dysregulation (Honkalampi et al., 2021) through autonomic, neuroendocrinological, immunoinflammatory and metabolic mechanisms, and compromising HPA axis activity (McClain et al., 2022). For instance, in a study using the MASALA data, Ahmed and colleagues (2022) found evidence of a significant indirect effect of perceived discrimination on AL biomarkers (e.g., HDL and triglyceride levels) that was channeled through depressive symptoms, anxiety, and emotion dysregulation. In fact, the associations of perceived discrimination with health outcomes were mostly indirect and channeled through psychological measures, suggesting the need to examine the potential mediating role of depressive symptoms.

Interactions between Psychosocial Predictors

South Asians are more likely than other minority groups to encounter multiple risk factors simultaneously due to their dual status as immigrants and racial-ethnic minorities. Further, the high rates of childhood maltreatment within this population can also contribute to high AL and mental health risk. Despite some evidence of the individual associations of these risk factors with health outcomes, the interactions between these factors have not been studied in

this population. Nevertheless, there is basis for investigating these interactions. For instance, among the broader Asian population, experiencing both childhood maltreatment and perceived discrimination has been found to increase the risk of depressive and anxiety symptoms more than encountering either risk factor alone (Lee & Choi, 2018). Similarly, there is evidence that immigrant groups who experience discrimination have a greater likelihood of utilizing separation and marginalization acculturation strategies that are linked to poor health outcomes as compared to the more adaptive integration strategy (Ramos et al., 2016; Renzaho et al., 2021; Te Lindert et al., 2008). However, the interactions between childhood maltreatment and acculturation strategies have not been examined before, not even in other immigrant populations. Thus, it is unknown whether South Asian immigrants who have a history of childhood maltreatment are at an even greater risk of poor health outcomes based on the acculturation strategy they use. These are important factors to consider in providing culturally tailored supports that are effective in reducing risk of mortality and morbidity in this population.

Present Study Questions and Hypotheses

The study utilized longitudinal data to address the following research questions among a sample of South Asian adults residing in the United States:

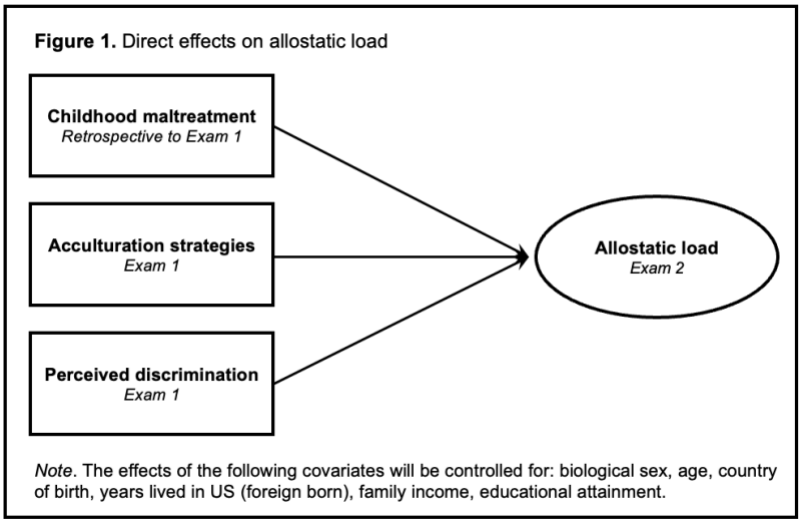
Direct Effects

RQ 1a: Is childhood maltreatment, retrospective to Exam 1, associated with AL at Exam 2?

Hypothesis 1a: Childhood maltreatment retrospective to Exam 1 was expected to be significantly associated with AL at Exam 2 (Figure 1). Specifically, individuals who reported exposure to multiple types of childhood maltreatment (i.e., emotional abuse, emotional neglect, physical neglect) were expected to have higher levels of AL than individuals who reported exposure to fewer types of childhood maltreatment.

RQ 1b: Are acculturation strategies (integration, assimilation, and separation) assessed at Exam 1 associated with AL at Exam 2?

Hypothesis 1b: Acculturation strategies at Exam 1 were expected to be significantly associated with AL at Exam 2 (Figure 1). Specifically, participants who adopted separation and assimilation acculturation strategies were hypothesized to have higher AL compared to those who adopted an integration acculturation strategy.



RQ 1c: Are experiences of perceived discrimination assessed at Exam 1 associated with AL at Exam 2?

Hypothesis 1c: Experiences of perceived discrimination at Exam 1 were expected to be significantly associated with AL at Exam 2 (Figure 1). Specifically, participants who reported higher levels of perceived discrimination were hypothesized to have higher levels of AL than those who reported lower levels of perceived discrimination.

Indirect Effects

RQ 2: Is there evidence of indirect effects of childhood maltreatment, acculturation strategies, perceived discrimination on AL, through depressive symptoms assessed at Exam 1?

Hypothesis 2: The effects of childhood maltreatment (retrospective to Exam 1), acculturation strategies, and perceived discrimination (assessed at Exam 1) on AL (at Exam 2) is hypothesized to be partially mediated by depressive symptoms at Exam 1 (Figure 2), with left-over direct effects. Specifically, while childhood maltreatment, acculturation strategies, and perceived discrimination are hypothesized to have significant direct effects on AL, they are expected to be significantly associated with depressive symptoms, which in turn will be associated with higher AL.

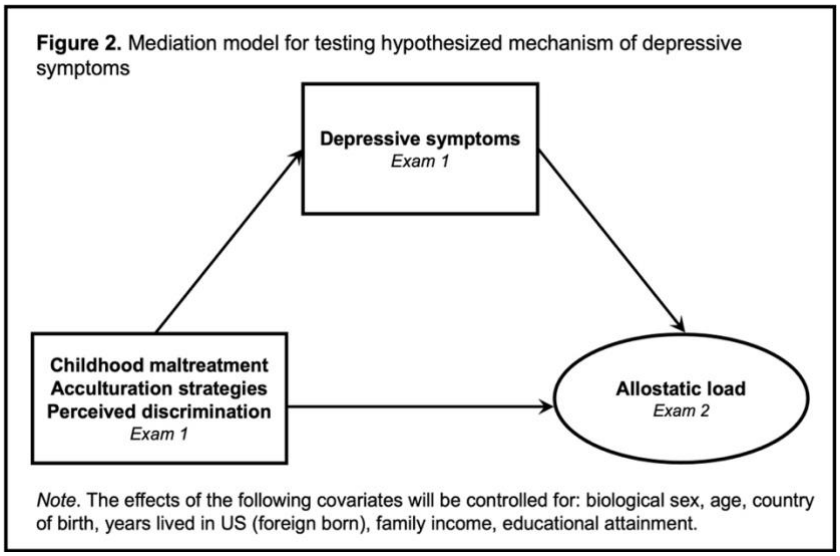


Figure 2. Mediation model for testing hypothesized mechanism of depressive symptoms

Note. The effects of the following covariates will be controlled for: biological sex, age, country of birth, years lived in US (foreign born), family income, educational attainment.

Interaction Effects

RQ 3: Do childhood maltreatment, acculturation strategies (integration, assimilation, and separation), and experiences of perceived discrimination operate as interactive factors to predict AL?

Hypothesis 3: It is predicted that there will be significant interaction effects between childhood maltreatment, perceived discrimination, and acculturation strategies in predicting AL. Specifically,

3a. Childhood maltreatment x perceived discrimination: There will be a significant interaction between childhood maltreatment and perceived discrimination in predicting AL. Participants with high levels of both childhood maltreatment and perceived discrimination

are expected to have higher levels of AL than participants experiencing either risk factor alone.

3b. Childhood maltreatment x acculturation strategies: Participants who report higher childhood maltreatment and use separation or assimilation acculturation strategies are hypothesized to have higher AL than participants with similar maltreatment exposure who use integration acculturation strategy.

3c. Perceived discrimination x acculturation strategies: Participants who report higher perceived discrimination and use separation or assimilation acculturation strategies are hypothesized to have higher AL than participants with similar levels of perceived discrimination who use integration acculturation strategy.

CHAPTER III

METHODS

Parent Study Data Collection and Sample

This study analyzed existing data from the Mediators of Atherosclerosis in South Asians Living in America (MASALA) study, an ongoing longitudinal investigation of the underlying traditional, sociocultural, behavioral, and novel risk factors for cardiac disease among South Asians contributing to higher rates of cardiovascular conditions (e.g., heart attacks, strokes) among this population (Kanaya et al., 2014). MASALA is a multi-cohort study conducted at two clinical sites (University of California, San Francisco and Northwestern University) that utilizes community-based samples of South Asians adults in the United States. To be included in the study, participants had to have South Asian ancestry (defined by having ≥3 grandparents born in India/Pakistan, Bangladesh, Nepal, or Sri Lanka), be aged between 40 and 84 years; and be able to speak and/or read English, Hindi, or Urdu. In addition, only South Asian individuals without a history of, or existing, cardiac concerns or other serious medical illnesses were included in the study. Baseline/Exam 1 data for the first cohort (n = 906) was collected between 2010 and 2013. At this baseline examination, information about participants' sociodemographic characteristics, dietary intake, physical activity, acculturation status, psychosocial factors were collected through in-person interviews. Participants also completed, physical examinations and various laboratory tests to obtain biomarker measurements and physical health data. A detailed description of the recruitment strategies, data collection procedures, and instruments can be found in the initial study report (Kanaya et al., 2014). A follow-up examination (Exam 2) for this cohort was conducted between 2015 and 2018 (n = 749), indicating that 82.67% of participants were retained at follow-up. Baseline data for a new cohort of participants were collected through

Exam 1A between 2017 and 2018, during which participants were administered similar assessments as described above for Exam 1. Follow-up examinations with each of the cohorts are underway (i.e., Exam 3 and Exam 1B, respectively). As final data from both these examinations are not available, data from the last available cohort (i.e., the original cohort) for baseline and follow-up examination, that is, Exams 1 and 2 was used for this analysis. For this study, all AL measures were measured at the Exam 2, the predictors were measured at Exam 1 (acculturation strategies, perceived discrimination) or retrospective to Exam 1 (childhood maltreatment), and the mediator of interest (depressive symptoms) was also measured at Exam 1.

Of the parent sample of 906 participants, 98% of participants were first-generation immigrants to the United States with 84% reporting India as their country of birth. Participants who were not first-generation immigrants (n = 19) were excluded from the present analysis. Measured at Baseline/Exam 1 across both clinical sites, the final sample used for present analysis was comprised of 887 South Asian adults ranging in age from 40 to 84 years (M = 55.6 years, SD = 9.3); approximately 88% of whom reported an education level of a bachelor's degree of higher. 46% of the sample were female. Approximately 63% of the sample reported an annual household income greater than or equal to $100,000. These participants reported having lived in the United States for an average of 27 ± 11 years.

Measures

Outcome Variables

Allostatic Load (AL). An index for AL was created using 9 variables which were measures of cardiovascular, metabolic, and inflammatory biomarkers: 1) systolic blood pressure, 2) diastolic blood pressure, 3) glycosylated hemoglobin, 4) high sensitivity C-reactive protein (HS-CRP), 5) total cholesterol, 6) triglyceride, 7) body mass index (BMI), 8) estimated

glomerular filtration rate (eGFR), and 9) serum albumin. Other than HS-CRP which was only collected at Exam 1 as it is considered to be a stable biomarker that remains generally stable over a period of a few years (Banait et al., 2022), all of the other above biomarkers were measured at Exam 2.

Standardized measurement protocols for all of the above variables were implemented across both study sites. In line with prior MASALA research investigating AL (Talegawkar et al., 2021), quartiles of each component or variable were calculated in order to establish cutoff criteria for high risk levels of each biomarker. Each variable was recoded as a binary 0 or 1 (0= high risk criteria not met, 1= high risk criteria met). For instance, participants whose scores were in the highest quartile for systolic and diastolic blood pressure, glycosylated hemoglobin, CRP, total cholesterol, triglyceride, and BMI were determined to be at high risk and received one point for each of the variables they were in the highest quartile for. However, participants received 1 point and were ascertained to be at high risk if they were in the lowest quartile for eGFR and albumin. In line with Talegawkar et al. (2021), participants who took medications for hypertension, dyslipidemia, or diabetes were assigned 1 point for systolic and diastolic blood pressure, total cholesterol, or glycosylated hemoglobin, respectively, even if their measured values were not in the high-risk quartile. No additional points for medication were assigned if participant scores were in the high-risk quartile as each biomarker can only contribute a maximum of 1 point to the AL composite. These individual points were then summed to create a composite score range of 0-9, with higher scores indicating higher AL.

Blood pressure. Systolic and diastolic blood pressure measurements in mm Hg were taken in a seated position utilizing an automated blood pressure machine (V100 Vital Signs Monitor, GE Healthcare) at Exam 2. Three measures of blood pressure were taken, and the last

two measures were averaged to create the average systolic blood pressure and average diastolic blood pressure for analysis. As mentioned previously in this section, scores or values in the highest quartile were determined to be at high risk, and both systolic blood pressure and diastolic blood pressure values were dichotomized as 1 = meeting the high-risk cutoff and 0 = not meeting the high-risk cutoff.

Glycosylated hemoglobin. A HbA1c test was used to measure glycated hemoglobin. Fasting blood samples were collected by nurses or phlebotomists and HbA1c or glycosylated hemoglobin was measured utilizing an immunoturbidimetry assay / a high-performance liquid chromatography using an automated analyzer. Values in the top/highest quartile were determined to meet the high-risk cut-off and were coded as 1, while the remaining values were coded as 0.

High Sensitivity C-Reactive Protein (hsCRP). This was measured using the BNII nephelometer (N High Sensitivity CRP; Siemens Healthcare Diagnostics, Deerfield, IL). Values in the top/highest quartile were determined to meet the high-risk cut-off and were coded as 1, while the remaining values were coded as 0.

Cholesterol. Two measures of cholesterol were selected for this analysis: total cholesterol and triglycerides. These were both collected as part of a panel of tests conducted to assess the lipid profile of MASALA participants and were measured through enzymatic methods after a 12-hour fast by participants **(**Quest Diagnostics, San Jose, CA). For both total cholesterol and triglycerides, values in the top/highest quartile were determined to meet the high-risk cut-off and were coded as 1, while the remaining values were coded as 0.

Body mass index (BMI). Participants' height and weight were measured by centrally trained study staff using a standardized protocol involving a stadiometer and standard balance-beam scale for height and weight measures respectively. BMI was calculated as weight in

kilograms divided by their height in meters squatted (i.e., BMI = kg/ m2). As was the case for other variables described above, a distribution-based cut-off model was used, and values in the highest quartile were assigned a score of 1 and the rest were assigned a score of 0.

Estimated glomerular filtration rate (eGFR). This was calculated as part of measuring the current functioning of the kidneys, using the CKD-EPI equation (Levey et al., 2009). In contrast to the other variables described above, a reverse scoring approach was used for eGFR with scores or values in the lowest quartile determined to be at high risk. Values in the lowest quartile were assigned a score of 1 and the rest were assigned a score of 0.

Serum albumin. This was measured as part of a comprehensive metabolic panel using spectrophotometry methods (Quest Diagnostics). Specifically, it was measured using Millipore Luminex adipokine panel (EMD Millipore, Billerica, MA). Similar to eGFR, a reverse scoring approach was utilized for serum albumin and scores in the lowest quartile were used for the high-risk cut-off. As such, values in the lowest quartile were assigned a score of 1 and the rest were assigned a score of 0.

Predictor Variables

Childhood Maltreatment. The Child Trauma Questionnaire (CTQ) was used to assess whether participants experienced a history of abuse and neglect in the home during childhood. The clinical items are separated into five subscales with five items each: emotional abuse, physical abuse, sexual abuse, emotional neglect, and physical neglect. This study focused on three types of childhood trauma, that is, emotional abuse (e.g., “People in my family said hurtful or insulting things to me”), emotional neglect (e.g., “My family was a source of strength and support”-reverse coded), and physical neglect (e.g., “I didn’t have enough to eat”), out of the five CTQ subscales. The other CTQ subscales (Physical and Sexual Abuse) were not included in the

present study because the parent study did not collect information about these subscales. The CTQ was administered at Exam 2 at the two data collection sites with data being retrospective to Exam 1 (baseline). On a 5-point scale (1 = never true, 5 = very often true), participants reported the frequency of the childhood traumatic experiences they encountered for five items on each of the three CTQ subscales. Items on the emotional neglect subscale was reverse coded. Scores on each CTQ subscale—emotional abuse, emotional neglect, and physical neglect—were individually summed to create three separate childhood trauma scores. The total score for each CTQ subscale ranges from 5 to 25, with higher scores indicating greater trauma exposure. These subscale scores were combined to create a total or overall measure of childhood maltreatment exposure. Therefore, the final overall childhood maltreatment variable ranged from 15 to 75. All CTQ subscale scores and the overall maltreatment score was treated as continuous variables in the analysis.

Acculturation Strategies. The Traditional Cultural Beliefs scale was created by the parent study to identify acculturation strategies utilized by participants based on acculturation indicators such as attitudes toward South Asian values, practicing South Asian traditions in the U.S., and social interactions and networks that illustrate how participants balance cultural identity and acculturation. At Exam 1, participants reported on a 5-point scale (1 = absolutely, 5 = not at all) how much they wished the following South Asian traditions would be practiced in the U.S.: 1) performing religious ceremonies or rituals; (2) serving South Asian sweets for ceremonies or rituals; (3) fasting on specific religious occasions; (4) living in a joint family; (5) having an arranged marriage; (6) having a staple diet of chapatis, rice, dal, vegetables, and yogurt; and (7) using spices for health and healing. Participants also reported how often they fasted (1 = two or three times per week; 6 = almost never or never), what foods they normally

eat at home and in restaurants (1 = only eat South Asian food; 6 = never eat South Asian foods at home/in restaurants), how often their family shops at South Asian grocery stores or markets (1 = two or three times per week; 5 = almost never or never), and which country or culture most of their friends belong to (1 = only South Asian; 5 = only other ethnic groups). Responses to these questions are summed up to create an overall score ranging between 7-35, with lower scores indicating greater adherence with, or stronger, South Asian beliefs and values. Previous studies using MASALA data categorized participants responses into the following acculturation strategies based on Berry's acculturation framework: Separation (a preference for South Asian culture over U.S. culture), Assimilation (a preference for U.S. culture over South Asian culture), Integration (a similar preference for both cultures) (Al-Sofiani et al., 2020; Needham et al., 2017). They utilized Latent Class Analysis (LCA) to identify the three sub-groups based on acculturation strategies assessed at Exam 1. The poLCA package in the statistical software R was used for the LCA (Linzer & Lewis, 2011), utilizing the same syntax as used by previous studies using this data set (Needham et al., 2017). After these groups were created, acculturation strategies was treated as a nominal variable in Mplus v8 (Muthén & Muthén, 2017) to create dummy-coded variables for the non-reference categories of assimilation and separation to compare them to the reference category of integration.

Perceived Discrimination. Perceived discrimination was assessed utilizing the Everyday Discrimination Scale (EDS; Williams et al., 1997) at Exam 1. The Everyday Discrimination Scale asks participants to respond to a total of 9 items reflecting general, non-race-based experiences of unfair treatment/mistreatment that participants may have experienced, with the intention of allowing participants to account for lifetime exposure to perceived discrimination. Examples of these items include "You are treated with less courtesy than other people are" and

"People act as if they think you are not smart"; participants were required to respond using a 6-point Likert scale, with 0 = never and 6 = almost every day. Item responses were averaged for the analysis and principal component analysis results yielded a one-component scale. The reliability of this instrument, using McDonald's omega estimate, was .88 with this sample (Ahmed et al., 2022). The average perceived discrimination score (ranging from 0-6) was used in the analyses as a continuous predictor.

Hypothesized Mediator

Depressive Symptoms. At Exam 1, participants completed the 20-item Center for Epidemiologic Studies Depression Scale (CES-D) designed to measure symptoms of depression. The CES-D asks about the frequency of symptoms in the past week. Examples of instrument items included "I felt I was just about as good as other people," and "I had crying spells." Participants answered these items using a 4-point Likert scale, with 0 = rarely or none of the time and 3 = most or all of the time. With this sample, the CES-D was found to have a reliability of .77, using McDonald's omega estimate (Ahmed et al., 2022). Item responses were summed to reflect a continuous score between 0-60, with higher scores indicating indicate higher levels of depressive symptoms.

Covariates

Age. As the association between stress-related risk factors and AL can be pronounced with increasing age (Piazza et al., 2019), with older adults more likely to experience decreases in physiological resiliency compared to younger adults compromising recovery from stressful events (Charles, 2010), the potential confounding effect of age was controlled for. Specifically, a continuous measure of age was included as a covariate. The age range of study participants was 40 to 84 years.

Sex. Prior studies have noted differences in AL scores based on sex (Misiak et al., 2022; Yang & Kozloski, 2011); thus, participants' biological sex was included as a binary categorical covariate, with male participants coded as 0 and female participants coded as 1.

Total Years Lived in the U.S. for Non-U.S. Born Participants. Given previously reported positive association between the total years lived in the U.S. and AL scores for foreign-born individuals (Peek et al., 2010), the effect of this variable was controlled for. Participants were asked how many years they had lived in the U.S., and the resulting responses were included as a continuous variable in this study.

Family Income. Family income was assessed based on participants responses to the question "What is your household income?". Responses were categorized as 1 (< $40K), 2 ($40 – 75K), 3 ($75 – 100K), and 4 (> $100K) per year. Family income was included in the analyses as a categorical variable. The effect of family income was controlled for given its significant association with AL (Tavares et al., 2022).

Educational Attainment. The association between psychosocial stressors, such as discrimination, and AL has been found to vary based on education level (Williams et al., 2022). Education is also believed to be strongly correlated with health status in adulthood for racial-ethnic minorities (Howard & Sparks, 2015). As such, educational attainment was included as a covariate with participants being asked to choose one of four categories to describe their educational attainment. Responses were categorized as 1 (< lower than high school), 2 (lower than bachelor's degree), 3 (bachelor's degree), and 4 (higher than bachelor's degree). Educational attainment was included in the analyses as a categorical variable.

Analytic Plan

Prior to model testing, I evaluated if the assumptions for discrete dependent variable models, including independence among observations and multicollinearity, were met using bivariate associations (e.g., correlations), histograms, and density plots in R Version 4.4.1 (R Core Team, 2024). All models were tested using Mplus v8 (Muthén & Muthén, 2017). I also examined the patterns of distributions of data to assess the amount of missingness and if the data were missing at random. Prior MASALA studies have reported missingness under 5%. A power analysis was conducted to assess statistical power for the mediation analysis. For all power analyses, an alpha of .05 and an analytic sample size of 680 (75% of baseline *n*) was used to conservatively account for attrition and potential item non-response. Based on prior studies' reported effect sizes for the relationships between the specified independent variables, mediator, and dependent variable (e.g., Ahmed et al., 2022; Al-Sofiani et al., 2020), there was adequate power ($\geq .80$) for detecting direct and indirect effects.

Main Analyses

Significance tests were examined at $\alpha \leq .05$. Descriptive statistics were conducted to understand the sociodemographic characteristics of participants, these are reported as mean (standard deviation) or median (interquartile range) and percentage for continuous and categorical variables, respectively. Bivariate associations among continuous variables (e.g., childhood maltreatment and AL) were evaluated with Pearson's *r* correlation coefficient. Chi-square tests were be used to assess significance of associations between categorical variables. The effect size of correlation coefficients was interpreted in accordance with Cohen's (1988) conventions for small = .10, moderate = .30, and large = .50 effect sizes. Path models were tested in M*plus* v8.11 to examine direct, indirect, and interactive effects of childhood maltreatment,

acculturation strategies, perceived discrimination, depressive symptoms, and AL. Covariates were included in all models to control for potential confounding effects. The analysis was conducted in three phases, testing direct effects, indirect effects, and interaction effects, organized below by research questions.

Analytic Strategies by Specific Research Questions

RQ 1

To test direct effects of the three predictors- childhood maltreatment, acculturation strategies (integration, assimilation, and separation), and perceived discrimination- on AL, the individual effect of each predictor on AL was tested in a separate model including the covariates. In case of acculturation strategies, a single model was tested with two dummy variables (for assimilation and separation) as main predictors, with integration coded as the reference group. Following testing effects in separate models, a single path model was tested that included all predictors simultaneously. This model assessed whether the predictors were significantly associated with AL after controlling for other predictors and covariates. Multicollinearity between the predictors was assessed using the correlation matrix and variance inflation factors (VIF).

RQ 2

An indirect effects model with depressive symptoms as the mediator was tested by adding depressive symptoms as a mediator in the direct effects model, including indirect effects from all three predictors though depressive symptoms on AL. The significance of indirect effects was tested using the bias-corrected bootstrap resampling method (MacKinnon, Lockwood, & Williams, 2004).

RQ 3

The interaction effects between childhood maltreatment, acculturation strategies, and perceived discrimination on AL were assessed by including interaction terms in the path model (i.e., childhood maltreatment x acculturation strategies; childhood maltreatment x perceived discrimination; perceived discrimination x acculturation strategies). These interaction effects were tested individually by creating joint product interaction terms, with the continuous variables being mean-centered. The interaction terms were added one at a time to the main effects model, which simultaneously tested the effects of all three predictors.

CHAPTER IV

RESULTS

Descriptive statistics and bivariate correlations between study variables are reported in Table 1. Childhood maltreatment was significantly ($p < 0.05$) positively correlated with perceived discrimination ($r = .12$), separation acculturation strategy ($r = 0.08$), and AL ($r = .12$). Childhood maltreatment was not significantly ($p > 0.05$) correlated with the assimilation acculturation strategy ($r = -.04$). Perceived discrimination was not significantly correlated with separation ($r = -.04$) and assimilation ($r = -.05$) acculturation strategies or with AL ($r = -.02$). The separation ($r = .07$) and assimilation acculturation strategies ($r = -.02$) were not significantly correlated with AL. Childhood maltreatment ($r = .13$), perceived discrimination ($r = .39$), separation ($r = .10$) and assimilation ($r = 0.10$) acculturation strategies, as well as AL ($r = .08$) were all significantly correlated with depressive symptoms. No multicollinearity between variables was detected.

Table 1. Bivariate Correlations of Study Variables.

		1	2	3	4	5	6	7	8	9	10	11	12
1	Allostatic Load												
2	Childhood Maltreatment	.12*											
3	Perceived Discrimination	-.02	.12*										
4	Separation[a]	.07	.08*	-.04									
5	Assimilation[a]	-.02	-.04	-.05	-.31**								
6	Sex (Female)	-.13**	-.12*	-.03	.04	.06							
7	Family Income	-.13**	-.20**	-.06	-.32**	.24**	.02						
8	Education	-.09*	-.10*	-.03	-.27**	.13**	-.07*	.32**					
9	Testing Site	-.03	-.01	-.02	-.10*	.10*	.08*	.17**	.06				
10	Age	.30**	.12*	-.10*	.05	-.02	-.09*	-.22**	-.08*	-.02			
11	% of life in the US	-.01	-.01	.04	-.27**	.23**	-.02	.20**	.05	.03	.05		
12	Depressive Symptoms	.08*	.13**	.39**	.10*	-.10*	.08*	-.23**	-.17**	-.07*	.02	-.04	

Note. *p<0.05, ** p<0.001. [a]Integration was omitted as the reference category.

RQ1

For RQ1, the effect of the three predictors on AL was tested in separate models, along with the model covariates. Childhood maltreatment had a significant direct effect on AL, accounting for model covariates. Specifically, participants who reported exposure to more types of childhood maltreatment demonstrated higher levels of AL (B = 0.010, SE = 0.005, ß = 2.26, p = .024), compared to those who reported exposure to fewer types of childhood maltreatment (see Table 2). Of the covariates, participant sex and age were significantly associated with AL, with females having lower levels of AL compared to males (B = -0.126, SE = 0.012, ß = -10.41, p < .001) and older participants having higher AL than younger participants (B = 0.016, SE = 0.002, ß = 8.00, p < .001). None of the other covariates had a significant effect on AL.

In the individual effects model, perceived discrimination was not significantly associated with AL, accounting for covariates (B = -0.002, SE = 0.004, ß = -0.46, p = .649). Of the covariates, participant sex and age were significantly associated with AL, with females having lower levels of AL compared to males (B = -0.136, SE = 0.005, ß = -27.07, p < .001) and older participants having higher AL than younger participants (B = 0.017, SE = 0.002, ß = 7.22, p < .001).

In the last individual effects model, acculturation strategies of assimilation (B = 0.000, SE = 0.050, ß = 0.01, p = .993) and separation (B = 0.005, SE = 0.127, ß = 0.04, p = .971) were also not significantly associated with AL as compared to the reference category of integration. Similar covariate effects were observed with females having lower AL than males (B = -0.135, SE = 0.008, ß = -17.07, p < .001) and older participants having higher AL than younger participants (B = 0.017, SE = 0.002, ß = 6.86, p < .001).

In the full direct effects path model including all three predictors and accounting for their covariances, a significant association was found between childhood maltreatment and AL (B = 0.011, SE = 0.006, ß = 2.00, p = .046) (see Table 2). Perceived discrimination was not significantly associated with AL (B = -0.003, SE = 0.004, ß = -0.62, p = .536). Separation (B = -0.003, SE = 0.116, ß = -0.03, p = .978) and assimilation (B = -0.004, SE = 0.050, ß = -0.09, p = .931) acculturation strategies were also not significantly associated with AL. Of the model covariates, only participant sex (B = -0.126, SE = 0.010, ß = -12.70, p = .000) and age (B = 0.016, SE = 0.002, ß = 8.67, p = .000) had a significant effect on AL, with female participants having lower AL than male participants and older participants had higher AL than younger participants.

Table 2. Direct Effects of Psychosocial Predictors on Allostatic Load.

	B(SE)	ß	*p* value
Direct Effects: Childhood Maltreatment Only			
Childhood Maltreatment	**0.010 (0.005)**	**2.26**	**.024**
Age	**0.016 (0.002)**	**8.00**	**.000**
Sex (Female)	**-0.126 (0.012)**	**-10.41**	**.000**
Family Income	-0.019 (0.076)	-0.25	.800
Education	-0.099 (0.126)	-0.78	.434
% of life spent in the U.S.	-0.014 (0.018)	-0.78	.438
Direct Effects: Perceived Discrimination Only			
Perceived Discrimination	**-0.002 (0.004)**	**-0.46**	**.649**
Age	**0.017 (0.002)**	**7.22**	**.000**
Sex (Female)	**-0.136 (0.005)**	**-27.07**	**.000**
Family Income	-0.039 (0.060)	-0.66	.509
Education	-0.108 (0.116)	-0.94	.349
% of life spent in the U.S.	-0.011 (0.011)	-1.03	.302
Direct Effects: Acculturation Strategies Only			
Assimilation[a]	0.000 (0.050)	0.01	.993
Separation[a]	0.005 (0.127)	0.04	.971
Age	**0.017 (0.002)**	**6.86**	**.000**
Sex (Female)	**-0.135 (0.008)**	**-17.07**	**.000**
Family Income	-0.037 (0.092)	-0.41	.685
Education	-0.108 (0.087)	-1.24	.215
% of life spent in the U.S.	-0.012 (0.018)	-0.64	.521
Direct Effects from Combined Model			
Childhood Maltreatment	**0.011 (0.006)**	**2.00**	**.046**

Perceived Discrimination	-0.003 (0.004)	-0.62	.536
Assimilation[a]	-0.004 (0.050)	-0.09	.931
Separation[a]	-0.003 (0.116)	-0.03	.978
Age	**0.016 (0.002)**	**8.67**	**.000**
Sex (Female)	**-0.126 (0.010)**	**-12.70**	**.000**
Family Income	-0.021 (0.100)	-0.21	.837
Education	-0.098 (0.101)	-0.97	.331
% of life spent in the U.S.	-0.011 (0.015)	-0.75	.456

Note. Values significant at $p < .05$ are highlighted in bold. [a]Integration was omitted as the reference category.

RQ2

The indirect effect of childhood maltreatment on AL as mediated by depressive symptoms was significant, though weak in magnitude ($B = 0.001$, 95% CI = 0.001, 0.001) as compared to the leftover direct effect. Participants who reported exposure to more types of childhood maltreatment had higher levels of depressive symptoms (at Exam 1), which in turn was associated with higher AL at Exam 2. Accounting for the indirect effect, the leftover direct effect of childhood maltreatment on AL was significant ($B = 0.010$, 95% CI = 0.005, 0.016).

The indirect effect of perceived discrimination on AL ($B = 0.003$, 95% CI = 0.003, 0.004), through depressive symptoms, was also significant, with significant leftover direct effect ($B = -0.006$, 95% CI = -0.009, -0.001). Participants who reported high perceived discrimination maltreatment had higher levels of depressive symptoms (at Exam 1), which in turn was associated with higher AL at Exam 2.

The indirect effect from separation acculturation strategy to AL as compared to reference strategy of integration was not significant ($B = 0.000$, 95% CI = -0.005, 0.005). Separation was also not a significant predictor of depressive symptoms ($B = -0.008$, SE = 0.101, $p = .935$), although the pathway from depressive symptoms to AL was significant ($B = 0.055$, SE = 0.002, $p < .001$).

The indirect effect of assimilation acculturation strategy on AL (as compared to integration as reference strategy), through depressive symptoms, was significant, (B = -0.004, 95% CI = -0.004, -0.004). The leftover direct effect of assimilation on AL was not significant (B = 0.000, 95% CI = -0.037, 0.075). Participants who reported adopting an assimilation strategy (as compared to integration) had lower levels of depressive symptoms (at Exam 1), which in turn was associated with lower AL at Exam 2.

RQ3

For RQ3 (interaction effects), childhood maltreatment and perceived discrimination did not have a significant effect on AL (B_{int} = -0.001, SE = 0.002, p = .652). A significant interaction was found between childhood maltreatment and assimilation strategy (B_{int} = 0.009, SE = 0.001, p < .001) such that participants who had high childhood maltreatment exposure and used assimilation acculturation strategy had higher AL as compared to participants with high childhood maltreatment exposure who used integration strategy. The interaction effect of childhood maltreatment and separation acculturation strategy on AL was not significant (B_{int} = -0.002, SE = 0.031, p = .937).

A significant interaction was also observed between perceived discrimination and assimilation strategy (B_{int} = -0.013, SE = 0.003, p < .001). Specifically, the effect of perceived discrimination on AL was significantly different across the assimilation group vs. the integration group. For participants in the assimilation group, the effect of perceived discrimination on AL was negative (i.e., higher perceived discrimination was associated with lower AL), while in the reference group of integration, the association was positive (i.e., higher perceived discrimination was associated with higher AL). However, though the sign of the association was different across

the two groups (positive in one and negative in the other), the effect itself (i.e., the effect of perceived discrimination on AL) was not significant in either of the two groups. The interaction effect between perceived discrimination and separation acculturation strategy on AL was also not significant (*Bint* = -0.003, SE = 0.009, *p* = .762).

Table 3. Interaction Effects between Psychosocial Predictors in Predicting Allostatic Load.

	B(SE)	**ß**	***p* value**
Childhood Maltreatment x Perceived Discrimination	-0.001 (0.002)	-0.45	.652
Childhood Maltreatment x Assimilation[a]	**0.009 (0.001)**	**6.60**	**.000**
Childhood Maltreatment x Separation[a]	0.002 (0.031)	0.08	.937
Perceived Discrimination x Assimilation[a]	**-0.013 (0.003)**	**-4.04**	**.000**
Perceived Discrimination x Separation[a]	-0.003 (0.009)	-0.30	.762

Note. Values significant at $p < .05$ are highlighted in bold. [a]Integration was omitted as the reference category.

CHAPTER V

DISCUSSION

This study examined whether childhood maltreatment (retrospective reports), perceived discrimination, and acculturation strategies (at baseline) were significantly associated with AL (assessed at a 5-year follow-up) among South Asian adults in the United States. The interaction effects between the three predictors on AL were also tested, as were the indirect effects through depressive symptoms (assessed at baseline). Overall, the findings revealed a significant positive association between childhood maltreatment and AL. Further, this association was stronger among participants who used assimilation as their acculturation strategy as compared to those who used integration acculturation strategy. Additionally, there was a significant interaction between perceived discrimination and assimilation, with the association between perceived discrimination and AL being negative in the assimilation group and positive in the integration (reference) group. Nevertheless, the main effect of perceived discrimination on AL remained non-significant in both groups. Finally, the effects of childhood maltreatment, perceived discrimination and use of assimilation acculturation strategy on AL were also indirectly channeled through depressive symptoms. Overall, the findings suggest that South Asian adults' history of childhood maltreatment, experiences of perceived discrimination and the acculturation strategies they use to adapt to the US cultural context can have significant effects on their mental and physiological health long term.

South Asians represent a rapidly growing immigrant population in the United States, with high levels of exposure to childhood trauma and experiences of discrimination (Siddiqui, 2022). Nevertheless, less is known about how these factors contribute to health risk outcomes, especially AL in this population (Ahmed et al., 2022). The present study is the first attempt at

mapping out these associations in a large, longitudinal sample of South Asian adults, and examining mediators and moderators of these effects. The present study builds on findings from previous studies that found a significant association between childhood maltreatment and AL (Jakubowski et al, 2023), perceived discrimination and AL (Currie et al., 2020), and acculturation and AL (Bingham et al., 2016), by (1) examining the unique and combined effects of multiple psychosocial risk factors that are relevant and previously associated with health outcomes among this population, (2) using a comprehensive index of AL as the outcome measure, and (3) examining indirect effects through depressive symptoms. The findings will help inform the design of targeted preventative interventions that can reduce the risk for AL and future morbidity and mortality among this population (Kirkbride et al., 2024). This study also acts as a precursor to a previous study using the same sample that found a significant association between AL and cardiovascular disease – a leading cause of mortality among South Asian adults in the U.S. (Talegawkar et al., 2021).

The main study hypothesis that childhood maltreatment would be significantly associated with AL was supported. South Asians who reported more types of childhood maltreatment (i.e., emotional abuse, emotional neglect, physical neglect) were found to have higher AL as compared to those who reported fewer types of childhood maltreatment exposure. Much of the existing research examining childhood maltreatment among South Asians has focused on its frequency and prevalence (Santoro et al., 2020), with no known studies examining its short- and long-term health outcomes. As such, the current study fills a critical gap in existing research by documenting the association between childhood maltreatment and elevated AL in South Asian immigrants. These findings have relevance for prevention efforts aimed at reducing physiological risk for AL in adulthood. Combined with previous literature highlighting increased

prevalence of childhood maltreatment in this population, the current study's findings underscore the importance of early identification and screening of exposure to traumatic stress among South Asians (Karasz et al., 2019; Saraiya et al., 2025). To the extent that these findings are replicated, efforts aimed at mitigating long-term effects of childhood maltreatment—such as trauma-informed care, stress regulation skills, or culturally tailored psychosocial interventions—may help reduce biological wear-and-tear and promote better long-term health outcomes.

In terms of effects of acculturation strategies, contrary to the main hypothesis, there were no significant direct effect of assimilation or separation strategy on AL in this sample. Some prior research suggests that the acculturation strategies immigrants use may be more dynamic and context-dependent than the standard model of integration, assimilation, separation, may be able to represent (Bierwiaczonek & Kunst, 2021; Ward & Geeraert, 2016). This may have made it difficult to detect the variability in patterns of AL associated with the broad and fixed acculturation categories assessed in the present study. For instance, it is possible that an individual may engage in an integration strategy in one domain (e.g., food or language preferences) but an assimilation strategy in another (e.g., social relationships) (Fedi et al., 2019; Kosic, 2025). Additionally, the strategies individuals utilize to navigate ties to both their culture of origin and the host culture may shift over time in response to external contextual factors (e.g., experiences of discrimination, sociopolitical trends, neighborhood experiences, occupational demands) or internal developmental factors (e.g., aging, evolving identity) (van der Zee & van Oudenhoven, 2022). The domain-specific variation in use of acculturation strategies may mean that single categories do not accurately reflect the experiences driving cumulative physiological stress (Fox et al., 2017). Simultaneously, given that the variability across different strategies may

be linked with distinct stress exposures, coping demands, and protective resources, it underscores the importance of examining acculturation strategies as an important predictor of AL.

Some prior research also suggests that contextual factors such as social support may also buffer the relationship between acculturation strategies and AL (Fox et al., 2017). Prior MASALA study findings have indicated that South Asian immigrants utilizing the separation acculturation strategy (i.e., high value on maintaining culture of origin and minimizing involvement with the dominant culture) reported higher levels of social support than those utilizing the integration strategy (i.e., high value on both maintaining culture of origin as well as engaging with the dominant/host culture) (Al-Sofiani et al., 2020; Needham et al., 2018). It is possible that strong social networks within one's heritage community provide protective effects that mitigate the physiological impacts of acculturation stress (Karasz et al., 2019; Lerias et al., 2024). If strong social support reduces the stress-related physiological burden typically associated with separation, this could help explain why, compared to integration, using a separation strategy was not significantly associated with AL in this sample. Similarly, assimilation strategies may not necessarily result in greater physiological stress if individuals experience acceptance and reduced discrimination when fully adopting the host culture (Choy et al., 2021). Finally, integration strategies, while often theorized as the most adaptive, may not confer protection in environments where systemic barriers limit full participation (Kunst & Mesoudi, 2024), thereby reducing expected differences in AL across groups. A future direction for acculturation strategies research would include assessing whether changes in acculturation strategy predict changes in AL, using domain-specific acculturation measures (e.g., language use, cultural values, social relationships) rather than a single categorical label as well as

measuring how environmental factors (e.g., neighborhood characteristics, workplace diversity) might shape how acculturation strategies relate to health.

Inconsistent with our predictions, the direct effect of perceived discrimination on AL in the main effects model was not significant. Even though individuals who reported higher levels of perceived discrimination were found to have higher AL than those who reported lower levels of perceived discrimination, consistent with prior findings (Miller et al., 2021), these differences were not significant when accounting for model covariates. Discrimination has been linked with AL in several racial-ethnic minority samples including Indigenous Canadian (Ong et al., 2017), Puerto Rican (Cuevas et al., 2019), and African American (Currie et al., 2020) adults; however, this is the first known study to investigate this relationship among the South Asian population. As this study only assessed for experiences of everyday discrimination, it was not possible to operationalize and distinguish between the different types of discrimination (e.g., every day, lifetime, and workplace discrimination) on AL. This distinction has been found to be important in understanding AL with other racial-ethnic minority populations. For instance, Cuevas et al. (2019) found that although lifetime discrimination was associated with greater AL among Puerto Ricans, there was no such association between everyday perceived discrimination and AL. Recent studies have found that South Asians are increasingly vulnerable to structural forms of discrimination (McMurtry et al., 2019; Misra et al., 2021), which are not captured as part of the Everyday Discrimination scale utilized in the current study. As such, a future direction of research could include investigating the association of different types of perceived discrimination with AL to understand more about the potential influence of the frequency of exposure to discrimination as well as the nuances of experiencing different types of discrimination (e.g., comparing lifetime to daily perceived discrimination).

Partial support was also found for the second hypothesis involving indirect effects through depressive symptoms. Even though the indirect effect of childhood maltreatment on AL through depressive symptoms was significant, it was smaller in magnitude as compared to the more robust leftover direct effect. In contrast, perceived discrimination did not have a significant main effect on AL, but the indirect effect through depressive symptoms was significant. These indirect effects are nonetheless small in magnitude, and their clinical relevance remains to be examined. Overall, the indirect effects of psychosocial stressors on AL being channeled through depressive symptoms are consistent with prior research identifying depressive symptoms as a key mechanism linking psychosocial adversity to adverse health outcomes (Slavich & Irwin, 2014; Miller et al., 2011). In line with this dissertation's focus, these findings help elucidate the pathways linking both early and ongoing stressors to health outcomes among South Asians. Immigrant populations such as South Asians are often exposed to multiple, cumulative stressors simultaneously—including intergenerational trauma, marginalization, and racial or religious discrimination—and navigate health systems that are not well equipped to meet their needs through equitable access to culturally responsive, evidence-based healthcare supports (Gee et al., 2019; Williams et al., 2019). As such, these findings also reinforce the argument for integrating a focus on psychological symptomology in health promotion efforts for this population.

There was a significant indirect effect of assimilation strategy on AL through depressive symptoms indicating that assimilation was associated with less depressive symptoms compared to integration, which in turn was linked with lower AL. While this may appear counterintuitive given that assimilation is often linked to psychological costs (Xie et al., 2011), such as identity loss or internalized stigma, the current findings suggest that, for South Asians, assimilation may confer certain psychological benefits for depressive symptoms. It is important to note that no

other known studies have explored this pathway among South Asians, and these findings would benefit from replication in future studies. One possible explanation for these results is that South Asian immigrants perceive benefits to assimilation, for instance, increased social acceptance or improved institutional navigation, to provide some psychological protection, inadvertently both reducing depressive symptoms, and by extension, lowering physiological stress in the form of AL. Taken together, while these results broadly suggest depressive symptoms can be an important mechanism of interest to consider in predicting future health outcomes and the effects of acculturation strategies among South Asians, these relationships are complex and should be examined across a range of contexts. There were no significant indirect effects of the separation strategy on AL (i.e., through depressive symptoms). One possible explanation is that South Asians who minimize or limit engagement with the dominant culture while maintaining strong ties with their culture of origin do not receive either significant psychological risk or protection as a group from such an approach, as compared to those who use the integration strategy, and individual differences may play a bigger role.

The interaction effects hypotheses were partially supported. Specifically, the interaction between childhood maltreatment and assimilation was significant and participants with histories of childhood maltreatment who used assimilation acculturation strategies were found to have higher AL as compared to those with childhood maltreatment histories and integration acculturation strategy. This significant interaction effect suggests that fully adopting the dominant culture (i.e., assimilation) may intensify the detrimental impacts of childhood maltreatment on AL. While the interaction of childhood maltreatment and assimilation acculturation strategies in predicting AL has not been previously investigated to my knowledge, it is possible that for individuals with histories of childhood maltreatment, assimilation strategies

may be a response to early relational trauma, resulting in a disconnection from native cultural experiences or identities. As a coping strategy this would also result in reduced access to culturally oriented or grounded coping resources and may potentially exacerbate the negative impacts of childhood maltreatment on AL. Assimilation acculturation strategies often require suppressing one's cultural identity to fit into dominant/host culture (Choy et al., 2020). It is possible that for individuals already at risk due to early adversity and ACEs, the additional psychological demand of this suppression may further exacerbate the dysregulation in response to chronic stress, leading to elevated or higher AL. Put another way, the physiological costs of identity suppression or cultural incongruence may be especially pronounced among those with early trauma, contributing to elevated AL among highly assimilated individuals with maltreatment histories. These findings also underscore the importance of considering context around acculturation strategies when examining their impact on health, that is, investigating the potential interplay between social experiences and acculturation strategies in determining the prediction of AL.

For the interaction between perceived discrimination and acculturation strategies, although there was evidence that the nature of the association between perceived discrimination and AL varied significantly across the assimilation and integration groups (being negative in the assimilation group and positive in the integration group), the main effect of perceived discrimination on AL was not significant across the two groups. Future research should examine this possible interaction effect to test if adopting an assimilation strategy operates as a buffer reducing the negative impact of perceived discrimination on AL.

No significant interactions were found between childhood maltreatment and separation, or between perceived discrimination and separation, nor between childhood maltreatment and

perceived discrimination. As this is the first known study to investigate the interactions of these factors in South Asians, there is little theoretical or empirical evidence to draw on. However, the lack of a significant interaction between childhood maltreatment and perceived discrimination suggests that the effects of childhood maltreatment and perceived discrimination may be independent and operating through distinct, additive pathways in predicting AL in this sample. This is especially plausible if each exerts its influence via distinct**,** non-synergistic pathways**,** as indicated in previous studies that childhood maltreatment is more strongly associated with HPA axis dysregulation (and early biological embedding) (Danese & McEwen, 2012) whereas perceived discrimination has been linked to inflammatory and immune processes (Cuevas et al., 2019; Lawrence et al., 2022). While the HPA axis and immune-inflammatory systems are biologically interconnected and able to interact, differences in developmental timing as well as modes of stress exposure may yield cumulative additive effects rather than synergistic effects on AL (Niu et al., 2025).

Additionally, these findings also suggest that separation acculturation tendencies may not significantly alter the effects of early or ongoing stress on AL risk. One possible explanation for the lack of interaction effects of perceived discrimination with the separation acculturation strategy may be that since individuals using this strategy tend to minimize their engagement with dominant/host culture, they may be less exposed to contexts in which discriminatory experiences may occur, and by extension, less likely to perceive such experiences as salient stressors. As an early intrafamilial stressor, childhood maltreatment may exert effects that are more proximally expressed within in-group or relational contexts, rather than being amplified by, or operating in the same stress domain as, broader sociocultural stressors such as the separation acculturation strategy. These differences in developmental timing and contextual relevance may result in

childhood maltreatment and separation acculturation strategy contributing to AL in an additive, rather than synergistic manner. MASALA study's previous findings of increased social support among South Asians utilizing the separation acculturation strategy may indicate the presence of tight-knit cultural communities or cultural insultation that reduces exposure to acculturative or identity-related stressors that could interact negatively with histories of childhood maltreatment or ongoing discrimination.

Implications

Study findings highlight the risk of long-term health consequences associated with unaddressed mental health symptoms and chronic stress exposure, presenting an argument that early identification of stress exposure is important. These findings are important to interpret within the broader cultural context of mental health stigma and help-seeking behaviors in South Asian communities. Prior research has consistently documented that South Asian communities underutilize mental health services often due to stigma, lack of culturally relevant resources, and preferences for informal social supports over formal support systems (Menon et al., 2025). As such, these findings underscore the need to engage in non-traditional, interdisciplinary, and culturally responsive intervention pathways. Among Asian and South Asian populations, culturally adapted psychological treatments have demonstrated improved engagement and greater symptom reduction compared to non-adapted approaches, including culturally adapted cognitive behavioral therapy (CaCBT), trauma-informed CBT, and culturally tailored behavioral activation (Naeem et al., 2023). Considering South Asians are more likely to seek help through medical rather than mental health services (Karasz et al., 2019), one recommendation is to equip primary care providers and medical professionals with culturally responsive brief interventions and psychological screening tools. Given study findings of the role of depressive symptoms as a

mediator for the effects of early adversity and maltreatment on AL, providers may consider screening for depressive symptoms and ACEs in particular. This may be especially important in light of prior research findings that South Asians tend to report depressive symptoms as somatic and physical complaints, contributing to them remaining underdiagnosed and untreated even when presented to primary care physicians (Lai & Surood, 2008). The implementation of task-sharing models that foster increased collaboration between medical and psychological providers is likely to be advantageous for this population in light of study findings documenting the physical health impact of psychosocial stressors. Such integrated care models may enhance the early identification of psychophysiological health symptomology and increase access to early mental health support/intervention, which are previously identified barriers to treatment for this population (Karasz et al., 2019).

This study also found that for individuals with a history of childhood maltreatment, the use of assimilation as an acculturation strategy was linked to an even higher risk of elevated AL in adulthood as compared to individuals with childhood maltreatment histories who used integration acculturation strategy. This suggests that interventions targeting trauma in South Asian populations may benefit from explicitly addressing identity-related stress and cultural disconnection. Trauma-informed care approaches that incorporate cultural identity exploration may help reduce the physiological burden of early adversity. Overall, study findings add to the argument that interventions focused on acculturative strategies may benefit from examining the nature of adversity exposure, that is, whether it is childhood maltreatment exposure or perceived discrimination in order to enhance effectiveness on health outcomes for South Asians.

CHAPTER VI

LIMITATIONS

Although the current study addressed important gaps in our understanding of the psychosocial and cultural factors linked to AL risk among South Asians living in the United States, who are an underrepresented and often overlooked population in health disparities research, several limitations should be considered when interpreting the findings. First, participants in this sample were predominantly well-educated and socioeconomically advantaged. Thus, they may not have experienced similar chronic stress exposures or distinct structural challenges as South Asian immigrants with lower income or education levels, impacting the generalizability of study findings. While study findings accounted for family income and education levels as model covariates, it is possible that unmeasured SES-related factors (e.g., housing instability, employment precarity) may have accounted for additional variance in the observed associations.

Second, the MASALA dataset did not include primary stress biomarkers such as cortisol, catecholamines, and HPA axis activity, which are regarded as important indicators of the physiological stress response and often included in measures of AL. As such, the reliance on secondary response biomarkers (e.g., blood pressure, cholesterol, glucose) for AL assessment in this secondary data analysis may not have fully captured the early-stage physiological impacts. Third, although the AL outcome was assessed at a future wave, the predictor variables including (retrospective reports of) childhood maltreatment, perceived discrimination, and acculturation strategies, and the mediator variable of depressive symptoms, were assessed at the same wave, precluding the ability to test time-ordered mediation models. Relatedly, previous research has found that high AL can also lead to depressive symptoms (Oglodek et al., 2014), suggesting the

possibility of a bidirectional relationship between depressive symptoms and AL. However, this study was not able to test these bidirectional effects because the psychosocial predictors and risk factors were only assessed at baseline or retroactive to baseline and AL was only assessed at exam 2. This was because AL biomarker data was only collected at exam 2 while the data on psychosocial predictors were only collected at exam 1 (baseline). As more waves of data are collected for the MASALA study sample, an examination of these bidirectional effects may be an option for future research.

This study may also have limitations related to the measures used. For instance, retrospective reports of childhood maltreatment may be subject to recall bias (Pinto Pereira et al., 2021). Participants may overreport or conversely underreport instances of childhood maltreatment due to memory distortions, social desirability, cultural norms around discussing maltreatment, or repression. Additionally, the acculturation measure utilized in this study does not capture dynamic and context-dependent shifts in acculturation strategies, which precludes assessing the potential fluidity of the acculturation process. As noted earlier, considering that immigrants may switch between using different strategies depending on sociopolitical and physical environments, as well as life stage and how much time has passed since they immigrated (Murray et al., 2014), this is a limitation of the acculturation measure used in the current study.

Finally, existing research also suggests that factors such as prenatal exposure to substances or genetic influences could also contribute to individual differences in AL and depressive symptoms, and the associations between them (Das, 2023). For instance, prenatal substance exposure has been found to impact neurodevelopment and the development of the biological stress regulation response, which may potentially increase risk for depressive

symptoms and AL development independently from psychosocial predictors such as childhood maltreatment (Halabicky et al., 2023). Genetic variations may also influence individual differences in stress responses and HPA axis functioning, which may in turn confound the relationship between depressive symptoms and AL (Hoffman et al., 2023). As the parent MASALA study did not collect data on such factors, the current study is unable to account for alternative mechanisms that may influence stress pathways and responses.

CHAPTER VII

CONCLUSION

The current findings reveal that psychosocial predictors can have significant, long-lasting effects on AL among South Asian adults, using multi-method assessments, and controlling for a range of confounding variables. To our knowledge, this is the first study to examine the direct and indirect effects of these predictors, and the interactions between them, in this population. As such, this study would benefit from replication and future lines of inquiry examining the pathways surrounding these risk factors encountered by South Asians. Additionally, study findings suggest the need to incorporate interventions that are culturally responsive and tailored to this immigrant population to help reduce the risk of higher AL.

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