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Culture and stress biology in immigrant youth from the prenatal period to adolescence: A systematic review

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Abstract

Immigration patterns over the last two decades have changed the demographic composition of the United States; children are growing up in an increasingly multicultural environment. Immigrant youth may face culture-related stressors and leverage culture-related strengths across development that may influence their mental and physical health. Responses to early life stressors may differ across children at the level of stress biology, which can affect how they handle cultural challenges. However, there is limited research on culture and stress biology, which may be a mediator or moderator of culture's effects on immigrant youth. The aim of the present article is to systematically review research that examines the roles of both culture and stress biology from the prenatal period to adolescence in immigrant youth. Specifically, we review articles that examine how stress-sensitive biological systems (hypothalamic pituitary adrenal axis and the autonomic nervous system) and culture-related constructs have been modeled together in immigrant youth. Based on these findings, we note remaining questions and recommendations for future research in integrating measures of cultural processes and stress biology in children.

KEYWORDS

acculturation, autonomic nervous system, HPA axis, immigrant

1 | INTRODUCTION

Several scholars have noted that achieving a balanced emphasis on biological versus environmental factors in research on child development is challenging (Causadias, Telzer, & Lee, 2017; Eisenberg, 2014). These levels of analysis are often examined separately by researchers, yet an understanding of their interconnected and mutual influence on developmental outcomes is becoming increasingly critical. Advances in technology have rendered the study of biological processes more feasible for researchers. At the same time, the rapid influx of immigrant youth and growing ethnic diversification of the United States necessitates deeper study into the role of cultural contexts in development. Immigrant youth face unique stressors and harbor resources tied to their culture, a context that may seem theoretically distant from their stress biology. However, stress biology may modulate or serve as a pathway through which these cultural factors influence mental and physical health outcomes. Thus, integrating the study of culture and stress biology can help elucidate positive developmental trajectories as well as entry points for support for immigrant youth, who comprise a large proportion of the future population and workforce.

The present systematic review synthesizes research that deploys measures of both stress biology and cultural factors in samples comprised of majority immigrant youth. We begin by discussing the status of immigrant youth in the United States to motivate the need for more research with this unique population. Given the salience and prevalence of culture-related stressors this population faces, we highlight the rationale for the study of stress biology and introduce the growing field of cultural neurobiology. We integrate existing models of immigrant youth development and stress biology into our own theoretical framework of how culture and stress biology might jointly shape immigrant youth adjustment. After operationalizing the constructs and describing our literature search methodology, we

provide a narrative review of the studies that meet our inclusion criteria. We conclude with a discussion of implications, limitations, and future directions for this growing area of research.

1.1 | Immigrant youth in the United States

In the past two decades, international migration has occurred at a volume that is historically unprecedented. Current estimates suggest that the United States is the leading destination for immigration compared to other countries (Connor, 2016), with the population of children with at least one foreign-born parent (*immigrant youth*) approximated to 19.6 million (Child Trends Databank, 2017). This number is expected to grow—immigrant youth are projected to represent one in three children by 2050 (Passel, 2011). Given that immigrant youth are one of the fastest growing populations in US public schools (Suárez-Orozco, Rhodes, & Milburn, 2009), educational institutions are developing and adopting new programs and policies to serve their immigrant students. The rapid increase in the number immigrant youth also parallels a growing focus on immigration in national and international politics.

While debates on immigration policy are ongoing, scholars predict that the US population will only continue to diversify with an increasing number of immigrants (Marks & Coll, 2018). Thus, understanding how immigrant youth develop into well-adjusted adults is critical not only for their individual well-being, but also for the future economic health and social cohesion of the United States. (Motti-Stefanidi, 2018). Recognizing this, research on the adaptation of immigrant youth has burgeoned in the past decade, and has recently been summarized in several influential reviews (Kim, Schwartz, Schwartz, Perreira, & Juang, 2018; Motti-Stefanidi, 2018; Suárez-Orozco, Motti-Stefanidi, Marks, & Katsiaficas, 2018). Much of this work has centered around testing the *immigrant paradox*, the proposed trend whereby "as some children of immigrants become 'more American'…the worse their chances are for positive developmental outcomes compared with their less acculturated peers" (p.4; Coll & Marks, 2012). Overall, findings on the immigrant paradox are inconsistent—while some immigrant youth struggle to adjust, many display remarkable resilience and experience positive psychological and academic outcomes. These different trajectories can be best understood by studying the individual risk and protective factors that are specifically relevant for immigrant youth. Such factors are tied to the unique experience of navigating between both a heritage (country of origin) and host (United States) culture, a process termed *acculturation*. Thus, culture can be a source of both risk and protection or asset for immigrant youth, entailing the management of discrimination, xenophobia, bilingual language acquisition, and ethnic identity formation within a larger family context of cultural socialization of values and beliefs.

Given inconsistent findings, increasing relevance, and the complexity of factors involved, researchers have highlighted a need for more research on immigrant youth development. Some authors have specifically suggested the deployment of multiple levels of scientific explanation in future studies. Extant work on immigrant youth largely focuses on characterizing the unique stressors they face. Thus, understanding these youth's stress *biology* and how it modulates youth's response to stressors in tandem with cultural factors is an important area of exploration. For stress biology research, situating the understanding of biological processes within a cultural context is similarly relevant given the increasing population of immigrant youth. This approach of integrating stress biology and culture in the study of human development has led to the emergence of the field of *cultural neurobiology*.

1.2 | The field of cultural neurobiology

Culture has been viewed as a "macro" construct historically operationalized at the level of societies or ethnic groups, and studied separately from "micro" constructs such as an individual's stress biology (Doane, Sladek, & Adam, 2017). Recently, however, researchers have advocated for incorporating biological measures into studies of culture and vice versa (Causadias et al., 2017; Doane et al., 2017; Michalska & Davis, 2019). The newly formed field of cultural neurobiology studies "transactions among cultural processes and central and peripheral aspects of neurobiology", which include stress biology (Doane et al., 2017). The cultural neurobiological approach is motivated by the perspective that stress biology is sensitive to broader environmental contexts such as culture. In addition, stress biology has the potential to underlie associations between cultural stressors and behavior. Studying immigrant youth development through the lens of cultural neurobiology allows for the incorporation of multiple levels of analysis, and thus has the potential to better predict immigrant youth outcomes and explain the underlying mechanisms.

1.3 | Integrating stress biology and culture: Theoretical framework

Bridging the study of culture and stress biology to understand immigrant youth development has challenges, with one being that "there are not many conceptual models available to researchers in psychology that can account for the multiple ways in which these two processes relate" (Causadias et al., 2017). Thus, exploring the juncture of culture and stress biology in immigrant youth requires the integration of several frameworks and theories. One recent, comprehensive framework formulated specifically to understand immigrant youth adaptation is the integrative risk and resilience (IRR) model (Suárez-Orozco et al., 2018). The IRR model itself draws upon several other developmental frameworks, including Brofenbrenner's bioecological theory (Brofenbrenner & Morris, 1998). However, in contrast to Brofenbrenner's original theory, the IRR model does not treat culture solely as a macrosystem that is separate from the individual. Instead, the IRR is in line with Vygotsky's concept of "cultural mediation" whereby culture permeates every aspect of an individual's

life (Vélez-Agosto, Soto-Crespo, Vizcarrondo-Oppenheimer, Vega-Molina, & García Coll, 2017). According to the IRR model, influences on immigrant youth development can be organized into four nested levels: (a) global (e.g., migration patterns, wars, environmental disasters), (b) political–social (e.g., immigration policies, attitudes towards immigration), (c) microsystems (e.g., neighborhood, schools, families), and (d) individuals (e.g., demographic variables, temperament, cognitive resources, biology). Within this framework, stress biology is an individual factor and cultural factors can be conceptualized as embedded in a child's life at the individual (e.g., cultural identity) and microsystems (e.g., family cultural values) levels. Stress biology and culture may contribute independently or in interaction with each other across levels to variations in immigrant youth adjustment.

While the IRR model acknowledges biology as an individual context shaping development, it does not account for *how* it may do so. Drawing from a biological sensitivity to context (BSC) framework (Boyce & Ellis, 2005), stress biology might serve as a moderator of associations between culture and adaptation. According to BSC, stress biology can confer more vulnerability to stressful environmental influences but greater benefits from positive contexts. Applied to immigrant youth, stress biology may help explain why children respond differently to similar levels and types of cultural stressors. According to stress and coping theory, individuals' biological stress responses may be influenced by their appraisals of the stressor and coping strategies and resources (Lazarus & Folkman, 1984). Thus, while stress biology can modulate behavioral responses to cultural stressors, cultural resources (protective and promotive factors) can influence the degree to which an experience is perceived as stressful and the subsequent biological stress responses.

By integrating the perspectives of the IRR model, the BSC framework, and stress and coping theory, we proposed a conceptual framework to guide the present review on how stress biology and culture influence immigrant youth adjustment (Figure 1). While most literature that we review studies cultural factors at the individual and microsystems (neighborhood, school, family) levels, we acknowledge that these are embedded within a larger political–social and global cultural context. In accordance with the IRR model (Suárez-Orozco et al., 2018), we view immigrant youth's ties to their host and heritage cultures as entailing both stressors and resources (Lazarus & Folkman, 1984). Consistent with a stress and coping framework, we conceptualize the balance between the appraisal of these stressors and the available resources as influential to individual biological and psychological stress responses. We acknowledge that an individual's stress biology can also moderate the associations between both negative (stressors) and positive (resources) cultural factors and outcomes "for better or for worse" (Boyce & Ellis, 2005). Taken together, cultural risk and protective factors are hypothesized to jointly influence or interact with an individual's stress biology in shaping immigrant youths' coping and subsequent adjustment.

1.4 | Rationale for integrating the study of stress biology and culture

Researching stress biology and culture simultaneously can have several promising contributions for better understanding and serving immigrant youth. First, stress biology is highly susceptible to early experiences, and is malleable to social buffering processes (Hostinar, Sullivan, & Gunnar, 2014; McLaughlin et al., 2015). Thus, culture-related protective factors can be leveraged in interventions that may positively calibrate children's stress biology and promote subsequent adjustment. Second, the study of stress biology may elucidate the mechanisms underlying associations between cultural factors and immigrant youth outcomes. Evidence suggests that race- or ethnicity-related stressors such as perceived discrimination and stereotype threat can influence stress biology, which in turn affects cognitive processes and academic performance (Levy, Heissel, Richeson, & Adam, 2016). The same pathways may hold for other cultural stressors. Uncovering potential biological mechanisms between cultural factors and mental and physical health outcomes can lend explanatory power to mixed findings on the immigrant paradox phenomenon. Finally, studying stress biology and culture

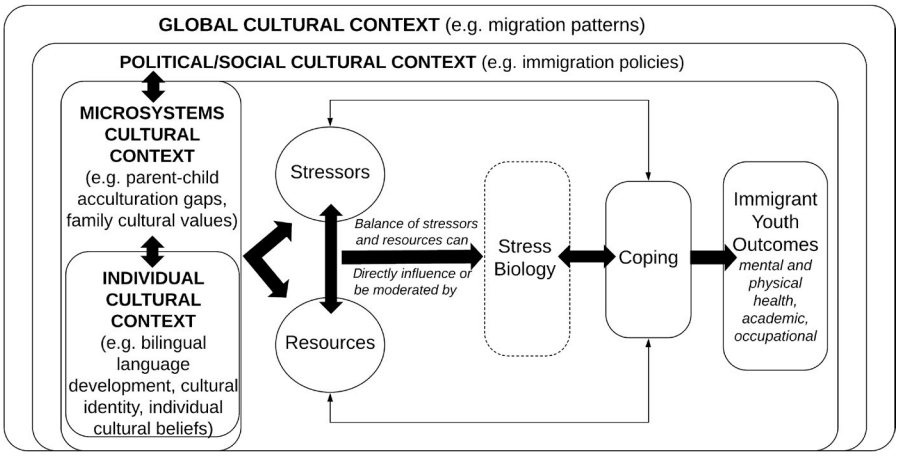

FIGURE 1 A theoretical framework guiding the study of how stress biology and culture influence immigrant youth adjustment outcomes, derived from the integrative risk and resilience model, the biological sensitivity to context framework, and stress and coping theory

together has specific measurement strengths and can help shed light on measurement challenges in cross-cultural research. Several researchers have pointed out that measurement of adjustment in immigrant populations has relied heavily on questionnaires (Doan et al., 2017; Kim, Schwartz, et al., 2018). While these questionnaire measures are extremely valuable, the development of questions that translate reliably across languages is tricky and time-consuming. The use of stress biology as a method alleviates concerns about the cross-linguistic equivalence of certain measures. It is important to note that stress biology as a measurement tool also has limitations. Stress biology experiments often require close contact between the participant and the examiner, and research has shown that interactions with an experimenter of a different race can influence stress biology (Hoggard, Hill, Gray, & Sellers, 2015; West, Koslov, Page-Gould, Major, & Mendes, 2017). Another concern is the cross-cultural validity of the laboratory stimuli and procedures used in stress biology paradigms. The stimuli used may have been developed on a different cultural group, and its interpretation may be influenced by a participant's past experience and cultural background (Hambleton, Merenda, & Spielberger, 2004). Furthermore, a stress biology experiment represents a social situation that may be subject to cultural norms that govern communication and behavioral responses (Ardila, 2005). Together, these cultural factors can influence the degree to which the lab paradigm is stressful, and subsequently can affect stress biology beyond any targeted experimental manipulation. Unfortunately, the majority of stress biology research uses WEIRD (Western, Educated, Industrialized, Rich, and Democratic) samples, so lab paradigms and the patterns in stress biology that they elicit may not generalize across cultures (Ruiz, Sbarra, & Steffen, 2018). Thus, more investigations examining stress biology and cultural factors together is warranted to determine the extent to which stress biology paradigms and interpretations need to be adapted for youth from different cultures.

1.5 | Conceptualizing culture

Culture is inherently challenging to define, and is often entangled with terminology on race and ethnicity (Markus, 2008). Culture refers to shared language, customs, beliefs, and practices that are shared by or associated with a social group (Becher & Trowler, 2001). Thus, the term "culture" can refer to a grouping of individuals by country of origin, but also encompasses a number of constructs that may vary within a cultural group, a family, or even an individual. For immigrant families, language is a particularly important element of culture, as it is the basis for assimilation into a new culture, a potential cultural stressor, as well as a way to communicate and maintain one's heritage culture (Lazear, 1999). Culture also entails a common value and belief system that guides a range of behaviors such as parenting practices, the expression of emotion, navigating the relationship between individual and family, and the extent to which an individual conforms to societal norms. The degree to which these cultural beliefs and values are endorsed by immigrant youth may depend on their level of acculturation or cultural orientation. These processes can also influence their sense of ethnic/racial or cultural identity, the meaning that they derive from their heritage culture, host culture, or both (Umaña-Taylor, 2018). Unfortunately, membership in a certain cultural group may make an individual susceptible to stereotypes and discrimination from individuals outside of that group. Overall, culture includes many constructs and processes that are defined and summarized in Table 1.

There are several research designs that have been used to investigate the role of culture. One method uses a categorical approach to operationalize culture and focuses on comparing predictors or outcomes across groups (Table 1A). This may involve comparing groups from different countries of origin, or individuals from the same heritage country with different birth countries (*nativity status*), different language status (*bilinguals/dual language learners vs. monolinguals*) or different intergenerational histories of immigration (*generation status*). A second approach is to use a within-group study design and examine associations between a continuous cultural construct and variables of interest across individuals from the same group. Most commonly, the continuous cultural construct is some index of *acculturation*, the process of adjusting to a new culture while maintaining ties to one's origin culture (Berry, 2005). These measurements can be domain-general in nature (Table 1B), referring to the degree of endorsement of a specific culture (*cultural orientation*) or the degree of balance between the adoptions of two cultures (*biculturalism*).

Acculturation can also be operationalized as domain-specific indices (Table 1C), including use of or proficiency in the heritage or native language (*bilingualism*), adoption of certain cultural values (e.g., *familism* or *filial piety*), or the sense of identification with one's cultural group (*ethnic-racial identity*). Finally, some research has focused on the stressful or challenging aspects of acculturation and immigration (Table 1D; *acculturative stress*, *immigration stress*), including stressors related to language (*language brokering*), family processes (*parent–child acculturation gaps*), and intergroup contact and attitudes (*xenophobia*).

1.6 | Conceptualizing stress biology

The hypothalamic pituitary adrenal (HPA) axis and the autonomic nervous system (ANS) are two psychobiological systems that are particularly sensitive to environmental stressors (McLaughlin et al., 2015). When the HPA axis is activated in response to a stressor, the hypothalamus secrets corticotropin-releasing hormone which then stimulates the pituitary gland to release adrenocorticotropic hormone. As a result of adrenocorticotrophic hormone being released, the adrenal cortex secretes the hormonal end product cortisol into the bloodstream (Hellhammer, Wüst, & Kudielka, 2009). Glucocorticoids in turn regulate HPA axis stress responses through a fast, negative feedback mechanism (Tasker & Herman, 2011). Cortisol can be measured from urine, blood, saliva, or hair, and can be used to index HPA axis activity through several methods. Common metrics used in research with cortisol include the cortisol awakening

TABLE 1 Descriptions of and methods of measurement for categorical (A), domain-general (B), domain-specific (C), and stressor-related (D) cultural constructs. This list includes common constructs and associated methods of measurement appropriate for young populations but is by no means exhaustive

Construct	Description	Common Method(s) of Measurement
A. Categorical Measurements of Cultural Constructs		
Dual language learner status	A term referring to children who are learning two languages at once (Hammer et al., 2014)	Children living in a household where English is not spoken (Child Trends Databank, 2019) Children who have a native language other than English (National Center for Education Statistics, 2019)
Generation status	A term referring to the intergenerational history of immigration; children may be foreign-born (1st generation), born in the settlement country to a foreign-born parent (2nd generation), or born in the settlement country with foreign-born grandparents (3rd generation; Cowden & Kreisler, 2016)	Country of birth of child, parents, and grandparents
Nativity status	A term referring to whether a person is foreign-born (not a US citizen at birth; includes naturalized US citizens and legal permanent residents) or native-born (is a US citizen at birth)	Dichotomous grouping based on country of birth
B. Continuous and Global Measures of Acculturation		
Acculturation	The process of adapting to a new culture; sometimes conceptualized as having four separate strategies of integration (orientation to both cultures), assimilation (orientation to mainstream culture only), separation (orientation to heritage culture only), or marginalization (orientation to neither culture; Schwartz, Unger, Zamboanga, & Szapocznik, 2010)	Acculturation Rating Scale for Mexican Americans II (Cuellar, Arnold, & Maldonado, 1995) Cultural and Social Acculturation Scale (Chen & Lee, 1996) Vancouver Index of Acculturation (Ryder, Alden, & Paulhus, 2000) Proxy measures: language use, age of immigration, years living in the United States.
Biculturalism	Orientation to two cultures; adopting the behaviors, values, and identities of both cultures (Nguyen & Benet-Martínez, 2013)	Bilinearly (two separate scales of cultural orientation with high scores on both representing biculturalism; Nguyen & Benet-Martínez, 2013) Unilinearly (one scale of acculturation with scores in the middle representing bicuturalism; Nguyen & Benet-Martínez, 2013) Typologically (high scores on the integration component of *acculturation*; Nguyen & Benet-Martínez, 2013)
Cultural orientation	The degree to which individuals endorse the traditions, language and norms of a particular culture, including the extent of social affiliations within that culture (Tsai, Chentsova-Dutton, & Wong, 2002)	Measures listed for "Acculturation" can be broken into subscales to measure cultural orientation (e.g., they provide separate measures of orientation for both mainstream and heritage cultures).
C. Continuous and Domain-Specific Measures of Acculturation		
Bilingualism/ Language Proficiency	A continuum representing fluency in and use of two languages (Edwards, 2004)	Relative proficiency index using receptive vocabulary in both languages (Thomas-Sunesson, Hakuta, & Bialystok, 2018, p.) Caregiver report of child language proficiency (Marchman & Martínez-Sussmann, 2002) Ag of second language exposure (Kovelman, Baker, & Petitto, 2008)
Cultural Values	Shared beliefs that guide what is important or acceptable in a given group; for example, *familism* among Latinx cultures (commitment to the family above the individual; Knight et al., 2010) or *filial piety* among Chinese cultures (obeying, respecting, and eventually caring for parents; Schwartz, Weisskirch, et al., 2010)	Mexican American Cultural Values Scale for Adolescents and Adults (Knight et al., 2010) Filial Behavior Scale (Chen, Bond, & Tang, 2007) Filial Piety Scale (Yeh & Bedford, 2003)
Ethnic-racial identity	The sense of belonging, understanding, centrality, positive feelings, and meaning that individuals perceive in regards to their membership in a racial or ethnic group (Neblett & Roberts, 2013).	Ethnic Identity Scale (Umaña-Taylor, Yazedjian, & Bámaca-Gómez, 2004) Multigroup Ethnic Identity Measure (Phinney, 1992)
D. Culture- or Immigration-related Stressors		

(Continues)

TABLE 1 (Continued)

Construct	Description	Common Method(s) of Measurement
Acculturative stress	The psychological challenge of adjusting or assimilating to a new culture and navigating problems arising from intercultural contact; previously termed "culture shock" (Berry, 2006)	Societal, Attitudinal, Environmental, and Familial Acculturative Stress Scale for Children (SAFE-C; Chavez, Moran, Reid, & Lopez, 1997) Acculturative Stress Inventory for Children (Suarez-Morales, Dillon, & Szapocznik, 2007)
Language brokering	The practice by which children translate or interpret between languages or cultures for their parents (Weisskirch & Alva, 2002)	Language Brokering Inventory (Shen, Seo, Hu, Zhang, & Chao, 2019) Language Brokering Scale (Tse, 1995)
Immigration stress	A broad term encompassing any stressors related specifically to immigration, including social disruption, discrimination, acculturation, language barriers, family conflict (Levitt, Lane, & Levitt, 2005)	Hispanic Stress Inventory—Adolescent Version, Immigration Subscale (Cervantes, Fisher, Córdova, & Napper, 2012)
Parent-child acculturation gaps	Discrepancies between parents and their children in cultural orientation, potentially resulting from different rates of acculturation (Telzer, 2010)	Subtracting parent's cultural orientation/acculturation score from the child's score (Telzer, 2010) A multiplicative term of parent cultural orientation score X child cultural orientation score (Birman, 2006)
Xenophobia	Fear or hostility toward immigrants and/or individuals perceived as foreign; this concept is related to racial discrimination but applied specifically to foreigners (Yakushko, 2009)	Attitudes Toward Immigration Scale (Hovey, 2000)

response (CAR; cortisol levels approximately 30 min after waking), overall cortisol output during waking hours (AUCg; area under the curve with respect to ground), reactive increases in cortisol output (AUCi; area under the curve with respect to increase), and diurnal slope (rate of decline in cortisol throughout the day Fekedulegn et al., 2007; Fries, Dettenborn, & Kirschbaum, 2009; Hellhammer et al., 2009).

The ANS has parasympathetic and sympathetic branches that flexibly coordinate cardiovascular responses to stressors. Respiratory sinus arrhythmia (RSA), the periodic fluctuations in heart rate associated with respiration, is commonly used as an index of parasympathetic nervous system (PNS) withdrawal or activation (Grossman & Taylor, 2007; Katona & Jih, 1975). Pre-ejection period (PEP), the time interval in milliseconds between left ventricular contraction and the opening of the aortic valve, indexes sympathetic nervous system (SNS) activation (Berntson, Quigley, & Lozano, 2007). ANS *reactivity* refers to an individual's physiological response to a stressor compared to a baseline condition, commonly measured as parasympathetic withdrawal and/or sympathetic activation (Alkon et al., 2003). A large body of literature has demonstrated that children's basal and reactive ANS activity can confer vulnerability to or protection against environmental stressors (Alkon, Boyce, Neilands, & Eskenazi, 2017; Cipriano, Skowron, & Gatzke-Kopp, 2011; El-Sheikh & Erath, 2011; Obradović, Bush, & Boyce, 2011; Rudd, Alkon, & Yates, 2017).

1.7 | The present review

In the present review, we join a growing number of researchers who have recently called for studying culture and stress biology together (Causadias et al., 2017; Doane et al., 2017; Michalska & Davis, 2019). These researchers have laid the foundation in making the case for investigating the intersection of stress biology and culture by introducing the field of cultural neurobiology and providing narrative reviews of extant research in adults. To date, however, there is no systematic review of the literature on this topic within immigrant youth who face a range of stressors and for whom culture is a particularly salient context. To address this gap, the present review provides a synthesis of empirical studies focusing on samples in the United States that include measurements of both stress biology and culture from the prenatal period to adolescence. The aim of this review is to identify how culture and stress biology have been investigated together in understanding mental and physical health in immigrant youth. We review empirical studies through the lens of our theoretical framework that combines the integrative risk and resilience model, the biological sensitivity to context framework, and stress and coping theory (Figure 1). Within this model, we focus equally on both stressors and resources associated with cultural constructs and consider studies that conceptualize stress biology as both a mediator and moderator of cultural effects on immigrant adjustment outcomes. The larger goal of this review is to contribute to the developing field of cultural neurobiology and recommend ways in which cultural constructs might be incorporated into future research on stress biology.

While the present review focuses on stress biology and culture-related factors, it is important to acknowledge that there are general stressors that disproportionately affect immigrant families, which are not our main focus here. These stressors include low socio-economic status and trauma and have been shown to have meaningful interactions and associations with children's stress biology (Alkon et al., 2014; Delgado, Nair, Zeiders, & Jones, 2019; Evans & Kim, 2007; Perry, Pollard, Blakley, Baker, &

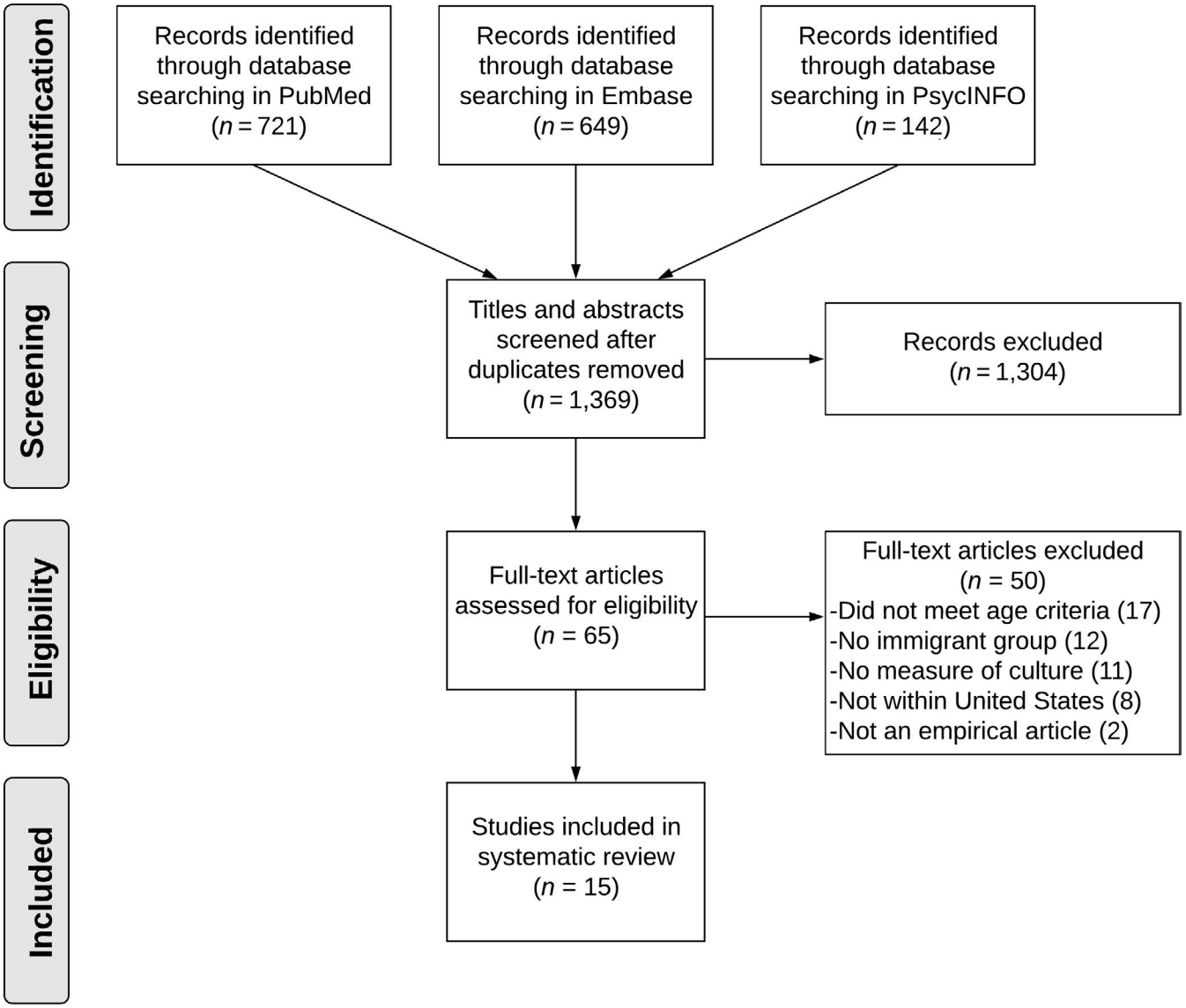

FIGURE 2 PRISMA flow diagram of the conducted search for relevant studies

Vigilante, 1995). Given that the study of culture and stress biology is motivated by the increasing population of immigrant youth who must navigate between two cultures, we include studies that consist of a majority sample of immigrant youth who are either first generation (born outside the United States) or second generation (born in the United States with at least one foreign-born parent). Because studies typically focus on grouping individuals by ethnic-minority status, we expect that some samples will include youth from the same cultural or ethnic minority group who are a mix of first generation, second generation, and third generation and beyond. Still, we focus inclusion criteria on immigration status rather than ethnic minority status given that research has suggested that there are important differences between immigrant generations (Coll & Marks, 2012; Suárez-Orozco et al., 2018). Further, several of the cultural constructs we reviewed (Table 1) are unique to more recent immigrant generations. In other words, research including only ethnic-minority youth who are third generation and beyond may not generalize to immigrant youth who are the focus of the present review.

2 | METHODS

2.1 | Selection of studies

Articles selected for inclusion in this review met the following criteria: (1) published in a peer-reviewed journal; (2) available in English; (3) incorporate both (a) a measure of stress biology representative of HPA axis or ANS resting or reactive activity and (b) a measure of a cultural process, construct, or cultural group comparison; (4) include a sample of participants ranging from the period of pregnancy (prenatal) to adolescence (up to 19 years old); (5) include a full or partial sample of first or second generation immigrant youth, and (6) include a sample within the United States. Exclusion criteria included articles

TABLE 2 Sample demographics and measures used in included studies

First author (Year)	Sample group and size	Age range/mean	Study design	Culture measure(s)	Psychobiological measure(s)	Other variables
D'Anna-Hern (2012)	55 Mexican American*	15 weeks gestation - 12 weeks postpartum	Within Group	Acculturation (SASH)	Diurnal cortisol slopes	Gestational age Birth weight
Doane (2018)[d]	209 Latinx*	18.1 yrs	Within Group	*Familism* values Family assistance behaviors	Waking cortisol CAR Diurnal cortisol slopes	Perceived parental emotional support
Gonzales, Johnson, et al. (2018)[a]	264 Mexican American*	14.2 yrs	Within Group	*Familism* values Bicultural orientation	Cortisol reactivity/ recovery	Family conflict
Kim, Schwartz, et al. (2018)	46 Mexican American*	11.9 yrs	Within Group	Language-brokering Nativity status Language proficiency Discrimination experiences	Cortisol reactivity/ recovery	Maternal hostility
Luecken (2013)[b]	220 Mexican American*	6 weeks postpartum	Within Group	Country of birth	Cortisol AUCg Cortisol AUCi	Partner support Prenatal economic stress Maternal depression
Luecken (2015)[b]	322 Mexican American*	12 weeks postpartum	Within Group	Acculturation (ARSMA II) Country of birth	Cortisol AUCg	Partner support Prenatal economic stress Maternal depression Temperamental negativity
McFayden-Ketchum (2016)[c]	45 Latinx* 120 American	4 yrs 2 mos	Between Group	Nativity status	Cortisol AUCg	Self-regulation Economic stress
Mendoza (2017)[c]	71 Latinx*	4.46 yrs	Within Group	Parent language use Immigration-related stress	Mean salivary cortisol	Economic hardship Child BMI Child behavior problems
Miles (2018)[c]	82 Latinx* 61 Latinx 113 American	4.4 yrs 4.5 yrs 4.0 yrs	Between Group	Nativity status Cultural group	Morning cortisol Diurnal cortisol slopes	Global classroom quality
Ruiz (2013)	470 Mexican American*	22–24 weeks gestation	Within Group	Acculturation (BAS) Years in the US Country of birth	Serum cortisol	Family cohesion
Sladek (2019)[d]	209 Latinx*	18.1 yrs	Within Group	Generation status Cultural values (*familism*, respect, religiosity, gender roles)	Waking cortisol Diurnal cortisol slopes	Diary-reported perceived stress Depressive symptoms Parental education Sleep duration Health behaviors

(Continues)

TABLE 2 (Continued)

First author (Year)	Sample group and size	Age range/mean	Study design	Culture measure(s)	Psychobiological measure(s)	Other variables
Waters (2016)[a]	99 Latinx*	6 months	Within Group	Years in the US	RSA reactivity PEP reactivity	Maternal depression Overcrowded housing Externalizing problems
Zeiders (2012)[e]	100 Mexican American*	15.3 yrs	Within Group	Acculturation (MACVS) Ethnic-racial discrimination	Cortisol AUCg CAR Diurnal cortisol slopes	Health behaviors Life stressors Depressive symptoms
Zeiders (2018)[e]	103 Mexican American*	15.3 yrs	Within Group	Acculturation (MACVS) Ethnic-racial identity Ethnic-racial discrimination	Diurnal cortisol slopes	Life stressors
Zeiders (2019)	42 Latinx*	12.5 yrs	Within Group	Sociopolitical climate Country of birth Parental report of immigration-related concerns	Diurnal cortisol slopes	Positive/negative affect Political preferences Academic stress

Note: * = Denotes full or partial immigrant (foreign-born) population; [a,b,c,d,e] = Overlapping samples; AUCg = total output; AUCi = reactivity; CAR = cortisol awakening response; ARMSA II = Acculturation Rating Scale for Mexican Americans (Cuellar et al., 1995); BAS = Bidimensional Acculturation Scale for Mexican-Americans (Marin & Gamba, 1996); MACVS = Mexican American Cultural Values Scale (Knight et al., 2010); SASH = Short Acculturation Scale for Hispanics (Marin, Sabogal, Marin, Otero-Sabogal, & Perez-Stable, 1987).

that measured stress biology with an immigrant or ethnic-minority group but no specific cultural construct was measured.

To search for articles meeting our criteria, we followed a multistep process consistent with the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines (Moher et al., 2015). Databases searched included PubMed, PsycINFO, and Embase. We combined keywords within the following topic areas in our search: (a) stress biology (*"psychobiolog*" OR "stress biology" OR "HPA axis" OR "cortisol" OR "amylase" OR "autonomic nervous system" OR "heart rate variability" OR "vagal" OR "skin conductance" OR "electrodermal" OR "respiration"*), (b) cultural constructs (*"immigrant" OR "cultur*" OR "acculturat*" OR "bilingual" OR "discrimination" OR "xenophob*" OR "years in US"*), (c) relevant developmental period (*"prenatal" OR "infant" OR "child*" OR "adolescent" OR "youth" OR "teen"*) and (d) relevant geographic setting (*"United States" OR "U.S." OR "America"*).

The search yielded 1,369 unique articles after duplicates were removed (Figure 2). Next, titles and abstracts were screened, resulting in 65 articles that proceeded to full-text screening. Articles were removed during the title and abstract stage if it was evident that they did not meet inclusion or exclusion criteria (described above). Two authors (SH and MS) screened full texts for aforementioned inclusion criteria. The authors initially agreed on decisions for 95% of full-text articles—discrepancies were resolved through discussion. We also cross-referenced citations listed in included articles generated by our search, but no additional articles resulted from this process. Ultimately, 15 peer-reviewed articles were selected for inclusion in the present review.

2.2 | Results of empirical studies measuring culture and psychobiology from the prenatal to adolescent periods

Key characteristics of included articles (*n* = 15) are presented in Table 2. These studies represent nine independent samples. In our discussion of these articles, we grouped studies by developmental period (prenatal, childhood, and adolescence). Within each period, we first briefly review relevant developmental processes that have implications for culture, stress biology, or both. Next, we discuss and summarize findings from the target studies.

2.2.1 | Prenatal and infancy

The prenatal period has been identified as a sensitive window where exposure to stressors can impact perinatal and postnatal outcomes (Shonkoff et al., 2012). Several empirical studies have suggested that maternal biological stress during pregnancy can alter the fetal environment and consequently outcomes in infancy and beyond, a pathway known as "fetal programming" (Barker, 2004; Hobel, Goldstein, & Barrett, 2008). One mechanism in this pathway is gestational biology—maternal cortisol during pregnancy, for example, has been found to mediate between prenatal environmental

stress and fetal development (Diego et al., 2006). Prenatal cortisol has also been linked to infant ANS (DiPietro et al., 2010; Ponirakis, Susman, & Stifter, 1998). Just as maternal and fetal stress biology are intertwined at this stage, cultural processes are also closely linked between mothers and their developing offspring. Thus, examining culture and stress biology across the prenatal to postnatal period can shed light on how cultural influences are transmitted intergenerationally.

Five studies included samples from the prenatal and infancy periods. These studies focused on stress biology and the cultural construct of *acculturation*, the process of adjusting to a new culture while maintaining ties to one's origin culture (Berry, 2005). In a study of women of Mexican descent, acculturation as measured by self-report questionnaire was associated with a flatter diurnal cortisol slope during pregnancy (D'Anna-Hernandez et al., 2012). Moreover, prenatal maternal diurnal cortisol mediated the relationship between higher levels of acculturation and low infant birth weight. In a separate sample of pregnant women of Mexican descent, acculturation was similarly associated with higher levels of serum cortisol, and with increased risk of preterm birth (Ruiz, Pickler, Marti, & Jallo, 2013). These authors measured acculturation using a latent variable of country of birth, years in the United States, and acculturation questionnaire. Importantly, this study also investigated the potential role of family cohesion in predicting preterm birth. Results suggested that family cohesion could play a protective role, but only in the presence of low cortisol. Taken together, these two studies suggest that prenatal maternal cortisol might be a biological mechanism by which the detrimental effects of cultural stressors are transmitted across generations. However, in two other studies using overlapping Mexican–American samples, mothers' country of birth (Luecken et al., 2013) and acculturation measured as language and ethnic affiliation patterns (Luecken, MacKinnon, Jewell, Crnic, & Gonzales, 2015) was not associated with infant cortisol reactivity. Similarly, in a study of 6-month-old Latino infants, maternal years in the United States was not correlated with RSA or PEP reactivity (Waters, Boyce, Eskenazi, & Alkon, 2016).

In summary, indicators of acculturation (a cultural construct) have been associated with prenatal maternal cortisol patterns that are then linked with birth outcomes. This pattern of findings may help explain health disparities between immigrant and native populations (Urquia, O'Campo, & Heaman, 2012), and highlights prenatal stress biology as a potential mechanism in this relationship. However, acculturation has not been shown to be directly linked to stress biology in infancy. One explanation may be that the various ways in which acculturation is measured (e.g., years in the United States vs. acculturation questionnaire) preclude consistent associations with stress biology. Another explanation could be that infant stress biology may depend significantly on other environmental influences, such as economic stress, and have a delayed response. Thus, further research on how acculturation interacts with other stressors to predict stress biology and subsequent outcomes in infancy is needed.

2.2.2 | Childhood (3 to 11 years)

Animal and human studies have shown that by early childhood, children's stress biology is highly regulated by caregiving practices (Gunnar & Donzella, 2002). High-quality caregiving can act as a powerful buffer for biological stress responses during childhood, while less sensitive and responsive care can lead to dysregulated stress responses (Gunnar & Quevedo, 2007; Hostinar et al., 2014). Cultural constructs during childhood such as cultural orientation and cultural values are similarly associated with parenting practices. At this developmental stage, parents socialize children to their culture by teaching cultural practices, norms, and behaviors. During this socialization process, children are unlikely to choose a cultural orientation for themselves (Cowden & Kreisler, 2016). Instead, parent acculturation is often used as a proxy for child acculturation. Another salient developmental process for bicultural children is bilingual development. Children are continuously learning their first language, but immigrant youth often have the added challenge of acquiring a second, non-native language. Moreover, immigrant youth are usually enrolled in formal schooling, which may contrast with their parent's heritage culture in terms of teacher and classroom language and norms (Crosnoe, 2015). Thus, both home and school contexts are salient environments for studying both stress biology and cultural processes during childhood.

We identified three studies that included measures of both culture-related constructs and stress biology in childhood. All of these studies drew from a rich dataset of preschool children who varied both in cultural group (Latinx vs. Non-Latinx) and nativity status (foreign-born vs. native-born). Using a sample of these children from immigrant Latinx families, one study examined the main and interactive effects of economic hardship, immigration-related stress, and parent acculturation in predicting children's mean cortisol levels (Mendoza, Dmitrieva, Perreira, Hurwich-Reiss, & Watamura, 2017). Results showed that high levels of parental acculturation predicted lower mean cortisol levels regardless of economic hardship. Parental acculturation and economic hardship also interacted such that children in a context of high economic hardship and high parental acculturation had the lowest mean cortisol levels. However, the exact meaning of low cortisol levels is unclear—low cortisol levels have not been consistently linked to negative outcomes in children (Shirtcliff, Granger, Booth, & Johnson, 2005). If low cortisol levels are interpreted as indicating dysregulation in line with some animal and human research (Gunnar & Vazquez, 2001), this study suggests that culture-related stressors may compound the detrimental effects of more general hardships on immigrant children's stress biology. A separate study comparing immigrant Latinx children and their non-immigrant peers investigated associations between economic stress and cortisol reactivity to a challenge task while teachers were present (McFadyen-Ketchum et al., 2016). Greater economic stress was associated with elevated cortisol reactivity for immigrant children, but not for their non-immigrant counterparts. One speculation explaining these findings is that a cultural mismatch between immigrant youth and their classroom environment could have required these children to exhibit

higher stress reactivity to help them self-regulate in the school environment. To further characterize the possible stress resulting from a home and school cultural mismatch, another investigation compared morning cortisol and diurnal slopes between home and school contexts across cultural and nativity groups (Miles et al., 2018). While all groups had flatter cortisol decline at school as compared to home, this effect was particularly pronounced for immigrant Latino children. This cortisol patterning indicates that school may have been more stressful for these children than for their non-immigrant or non-Latino counterparts. Importantly, this study also showed that Latino children with a Spanish-speaking teacher exhibited less of a home–school gap in cortisol patterning, and more of a cortisol decline during school days, which is considered a healthier profile. Thus, while home-school culture and language gaps may be stressful for immigrant youth, the presence of a bilingual teacher may act as a buffer.

Taken together, these studies suggest that measures of stress biology can be leveraged to reveal the effects of unique stressors for immigrant youth (e.g., acculturation). Examining children's biological stress profiles can also unveil important promotive or protective factors (e.g., presence of a bilingual teacher). These studies also highlight that categorizing a child's stress biology as adaptive or maladaptive is not always straightforward. Instead, framing biological stress profiles in terms of what is most adaptive for the cultural or environmental context may aid interpretation.

2.2.3 | Adolescence (12 to 19 years)

Adolescence is a developmental window that entails shifts in biological, psychological, and social systems (Casey, Getz, & Galvan, 2008). Hormonal changes in puberty render the social and reward-processing networks in the brain particularly susceptible to social and emotional stimuli at this time (Steinberg, 2007). In parallel with these biological shifts, adolescents begin to develop their own self-concept, resulting in a social identity that is independent of their parents (Casey et al., 2008). For immigrant youth, this means adolescents will start to form their own cultural orientation and cultural identity that may or may not align with their family. In addition, adolescents who have grown up in the US educational system have potentially had more consistent and structured exposure to the English language than their immigrant parents (Phinney, Romero, Nava, & Huang, 2001). This experience, combined with family cultural values, may mean that adolescents will assume a larger role in helping their family. Overall, adolescence brings new psychological and interpersonal challenges for immigrant youth that may manifest in their stress biology.

Of the included studies from the adolescent period (n = 7), two focused on cultural stressors (perceived discrimination and political climate), two focused on orientation/identity processes, and three focused on family cultural constructs. Consistent with prior research linking perceived discrimination to a range of physical and mental health outcomes, a study of Mexican–American adolescents (65% first or second generation) extended this work to examine associations with stress biology (Zeiders, Doane, & Roosa, 2012). Findings showed significant links between perceived discrimination and greater daily cortisol output, suggesting that discrimination is a salient environmental stressor that can activate the HPA axis. Researchers also found that greater perceived discrimination was associated with a steeper cortisol awakening response (CAR). However, interpretation of these relations is somewhat ambivalent: they could reflect adolescents' *anticipatory* vigilance for discrimination stressors, or could reflect a *consequence* of greater HPA axis activation. While this study taps into the physiological consequences of daily discriminatory experiences for Mexican–American adolescents, a separate study examined the influence of a more macrolevel context—the 2016 US presidential election. This study examined diurnal cortisol, mood, and behaviors in a sample of Latino early adolescents (94% immigrant youth) across election week (Zeiders, Nair, Hoyt, Pace, & Cruze, 2019). The authors chose this time period given the salience of rhetoric surrounding immigration policies during election campaigning, which could be potentially stressful for these youth and their families. Results showed increases in cortisol levels in the evening and flatter diurnal cortisol slopes across the week—these changes were not associated with changes in self-reported negative and positive affect. According to the authors, this cortisol patterning (flatter slopes) could indicate difficulty in suppressing nightly cortisol, and has been linked to poor physical and mental health outcomes. Overall, these two studies suggest that discrimination can permeate both macrolevel and microlevel contexts with negative implications for youth's biological stress.

While cultural stressors may be detrimental to youth's physiological and psychological states, cultural resources may have a buffering effect. In a study of Mexican–American adolescents, researchers investigated links between cortisol reactivity to a Trier Social Stress Test and biculturalism (high orientation to both Mexican and Anglo cultures) (Gonzales, Knight, et al., 2018). The authors hypothesized that a bicultural orientation would promote a more positive stress response as these individuals have a wider set of coping strategies and social support from both cultures. Results showed that bicultural youth demonstrated the expected cortisol response, whereas youth strongly oriented to one culture (Anglo or Mexican) were non-responsive. These findings suggest that cultural adaptation has implications for biological stress reactivity in adolescence. The authors further examined the potential mediating roles of *familism* values and family conflict in this association but found no support for these pathways. The authors proposed ethnic-racial identity (ERI) as another possible mechanism to explore that might link bicultural orientation and stress biology. In line with this, a separate study of Mexican–American adolescents found significant associations between greater ERI affirmation (positive feelings about one's ethnic group) and steeper diurnal cortisol slopes, which are considered to be an indicator of positive adaptation (Zeiders, Causadias, & White, 2018). This association held even while controlling for life stressors, acculturation level, and health behaviors. Thus, while acculturation can be a source of significant stress, these studies

highlight two important factors—biculturalism and ERI affirmation—that may confer benefits to adolescent's stress biology.

Familism values are central in Latinx culture and involve components of perceived familial support, obligation to family, and the centrality of family to one's identity ("family as referent"; Knight et al., 2010). Thus, *familism* values can manifest as beliefs, practices, or behaviors. In a study of Latino adolescents, Doane et al. (2018) examined links between components of *familism* and several indices of HPA axis functioning (waking cortisol levels, CAR, and diurnal cortisol slope). Overall, self-reported *familism* values were not associated with any cortisol metric. However, adolescents' perceptions of parental emotional support were associated with greater CAR, a cortisol pattern which may indicate physiological readiness for social challenges. Doane et al. (2018) also examined the potential predictive role of the frequency of family assistance behaviors, including family caretaking, running errands for family, or translating or interpreting for a family member. Family assistance behaviors on one day predicted lower waking cortisol levels and flatter diurnal slopes on the following day, indicating that this cultural practice may be a source of stress for adolescents, with biological consequences. To specifically examine the effects of the family assistance behavior of translating for parents ("language brokering"), one study examined Mexican–American adolescents' cortisol reactivity to a task involving translation of a medical document for their parents (Kim, Zhang, Zhang, Zeiders, Sim, & Gleason, 2018). This task did indeed evoke a significant cortisol response, but the magnitude of this response depended on several individual and familial factors. Specifically, adolescents who felt efficacious in their translation, perceived lower degrees of parental dependence, reported lower maternal hostility, and experienced less frequent discrimination showed a significant rise in cortisol after baseline (the expected trajectory of cortisol response). In summary, while the experience of language brokering may activate stress biology, recovery from this stress response may vary based on individual and interpersonal contexts. Using the same sample as (Doane et al., 2018), a separate article examined links between cultural values and waking and diurnal cortisol activity (Sladek, Doane, Gonzales, Grimm, & Luecken, 2019). In this study, higher host (United States) cultural values were associated with higher waking cortisol and steeper diurnal cortisol slopes, a pattern interpreted to be adaptive in physiologically preparing individuals to respond to anticipated daily demands. In addition, *familism* values moderated associations between daily stress and cortisol production, such that adolescents with stronger Latinx cultural values had lower deviations from diurnal cortisol rhythms even when experiencing higher stress. Overall, these findings further support the notion that biculturalism (endorsement of values from both mainstream and heritage cultures) may enhance adolescents' ability to cope with daily stressors at a biological level.

Taken together, these studies show that adolescence is associated with unique cultural risk, promotive, and protective factors, and that investigating stress biology can help reveal the salience of these factors. Discrimination—whether experienced through daily interactions or through sociopolitical rhetoric—appears to activate biological stress systems with negative effects (Zeiders et al., 2012, 2019). While acculturation is also typically discussed as a risk factor, biculturalism and ERI affirmation are promising as promotive factors for acculturating adolescents, and their positive effects on adjustment may be transmitted through stress biology. Interestingly, two studies found no associations between reported *familism* values and HPA axis functioning (Doane et al., 2018; Gonzales, Johnson, et al., 2018). However, one of these studies (Doane et al., 2018) did find that specific beliefs and practices associated with *familism*, such as family assistance behaviors, showed meaningful associations with cortisol. These associations may be further moderated by individual and environmental characteristics (Kim, Zhang, et al., 2018). Together, these studies show that it is useful to conceptualize broad cultural values in terms of specific practices and to take into account other factors that can influence the magnitude of biological stress responses.

3 | DISCUSSION

The studies included in the present review varied in terms of developmental period, cultural and biological stress measures used, and other variables investigated (Table 2). Of note, all (n = 15) of these studies were published in the past 7 years, 73% (n = 11) were published in the past 5 years, and approximately half (n = 7) were published in the past 2 years. Thus, studies using both cultural and biological stress measures with young samples are relatively new, yet still multiplying. Most of these studies employed a within-group design (n = 13), which is a strength in understanding individual differences in how immigrant children develop and adapt. However, despite a desired focus on both HPA axis and ANS reactivity, only one study used a measure of ANS reactivity—the remainder (n = 14) used cortisol metrics. From our systematic search, we identified several studies of ANS reactivity in children that employed ethnic minority samples, but did not measure any specific aspect of culture or did not specify immigrant status. In addition, in our search, all studies focused on Spanish-speaking samples. Thus, the cultural constructs and associations with stress biology discussed in this review may not generalize to immigrant groups from other cultures.

The goal of the review was to characterize the ways in which culture and stress biology have been modeled together in studies of immigrant youth from the prenatal to adolescent period. Findings generally aligned with our proposed theoretical framework (Figure 1) in several ways. In accordance with the IRR model, cultural constructs manifested at several contextual levels. Cultural factors as operationalized at the individual (e.g., Zeiders et al., 2018), microsystems (e.g., Kim, Zhang, et al., 2018), and sociopolitical (Zeiders et al., 2019) levels showed associations with stress biology. Many of these studies found direct relationships between certain cultural constructs and measures of stress biology (Doan et al., 2017; Doane et al., 2018; Gonzales, Knight, et al., 2018; Zeiders et al., 2018), while other studies found no such associations (Luecken et al., 2013, 2015; Waters et al., 2016). Most studies conceptualized stress biology as

an outcome variable in itself, and not as a mediator. Exceptions to this were studies of the prenatal period that found support for stress biology as a mediator between acculturation and birth outcomes (D'Anna-Hernandez et al., 2012; Ruiz et al., 2013). Unfortunately, there were no studies that investigated children's stress biology as a moderator of culture's effects on psychological or behavioral outcomes. In accordance with a biological sensitivity to context framework, there are robust findings that stress biology can moderate the influences of environmental contexts. Thus, the lack of support for this model from the present review is likely more indicative of a gap in the literature rather than evidence that these relations do not exist. Consistent with stress and coping theory, several studies showed that the *balance* of cultural stressors and resources mattered when considering implications for stress biology (Gonzales, Johnson, et al., 2018; Miles et al., 2018; Zeiders et al., 2018). Taken together, these studies suggest that stress biology may modulate or serve as a pathway by which cultural constructs influence immigrant youth adjustment, although more work is needed to investigate the links between stress biology and specific outcomes.

There are several themes that emerged across studies that have implications for understanding immigrant youth. First, there are unique cultural stressors (e.g., language brokering, acculturation) that have biological manifestations and consequences. However, children's stress biology can also reveal sources of cultural protection and strength (e.g., bilingual teacher, bicultural orientation). Second, even across the same cultural groups, there is significant heterogeneity in cultural orientations, endorsement of cultural values, and biological stress profiles. Within-group approaches to questions of culture and stress biology can therefore aid understanding of individual differences in immigrant youth adjustment. Third, culture and stress biology are not the full story—there are a number of other individual, interpersonal, and contextual factors that interact with culture and stress biology in predicting children's adjustment. In the present review, for example, McFadyen-Ketchum et al. (McFadyen-Ketchum et al., 2016) found economic hardship interacted with cultural factors to influence biological stress outcomes.

3.1 | Limitations, implications, and future directions

Given the heterogeneity in variables employed by included studies, it was not possible to quantitatively pool study results. As this area of literature grows, a quantitative meta-analysis of findings linking specific cultural constructs (e.g., acculturation) with specific stress biology measures (e.g., cortisol) could be informative in understanding broader patterns of results. Another limitation of the present review is inclusion of only Spanish-speaking cultural groups. In our search methodology we did not specify a specific cultural group, yet the studies that met our inclusion criteria only included Spanish-speaking samples. While this may be a reflection that Spanish-speaking groups are the largest linguistic and cultural group in the United States (US Census Bureau, 2015), there are other cultural populations that are rapidly growing (e.g., Chinese). Thus, findings on culture and stress biology as synthesized in this review may not generalize to other cultural groups.

This review is also limited in that the interpretation of patterns of stress biology across several studies is not straightforward. While stressors generally lead to elevations in cortisol, some research suggests that chronically elevated cortisol may lead to long-lasting disruptions in the HPA axis and resulting cortisol output (Hunter, Minnis, & Wilson, 2011). This pattern is part of the process of allostasis, whereby the body adapts to environmental challenges to maintain homeostasis (McEwen, 1998). Studies of children facing more severe or repeated adversity have found both chronically elevated cortisol (hypercortisolism) and chronically low cortisol (hypocortisolism) as a result of allostasis (Badanes, Watamura, & Hankin, 2011; McEwen, 1998). One challenge in studying these responses lies in the finding that biological manifestations of trauma can be inherited across generations (Lehrner & Yehuda, 2018). Because of this, it is difficult to determine whether observed cortisol and cardiovascular patterns in samples of children reflect a temporary biological stress response or a more permanently altered HPA axis or ANS (Badanes et al., 2011; Ehlert, 2013). This ambiguity in interpretation of children's stress biology is a challenge for researchers as a whole, and especially so for those who study immigrant youth. Immigrant youth experience severe traumatic events at a greater rate than their non-immigrant peers (Bridges, de Arellano, Rheingold, Danielson, & Silcott, 2010), and so are susceptible to long-term alterations in their biological stress systems. Moreover, many cultural stressors such as discrimination may be chronic, and so it is unclear whether biological stress responses are temporary adaptations or a consequence of repeated exposure. For example, the finding that greater perceived discrimination was associated with greater cortisol output in Mexican–American youth (Zeiders et al., 2012) could reflect an adaptive state of biological vigilance or hypercortisolism as a result of allostasis. More longitudinal sampling of individuals' stress biology across generations is needed to inform interpretations of stress biology in all children and adolescents, including immigrant youth (Badanes et al., 2011).

The present review highlighted several gaps in this small but growing literature that could provide directions future research. First, more studies employing measures of both immigrant youth's stress biology (especially the ANS) and cultural constructs are needed. While extant studies using cortisol measures are valuable, the HPA axis and ANS can respond independently (Ulrich-Lai & Herman, 2009) and thus may illuminate unique pathways in children's adjustment. Second, there are salient cultural constructs that have not yet been incorporated into stress biology research with young populations—namely, bilingualism and parent–child acculturation gaps. Parent–child acculturation gaps likely have implications for stress biology, given that their presence is associated with internalizing and externalizing symptoms in immigrant youth (Gonzales, Knight, et al., 2018; Kim, Schwartz, et al., 2018). Third, future research should extend the study of culture and stress biology beyond Spanish-speaking samples to other cultural groups. Finally, we did not locate any studies on culture and stress biology with population

age ranges extending between 6 and 10 years. Understanding how culture and stress biology dually influence development during the middle childhood years is an important area of future research.

In addition to these future directions, there are several other recommendations for researchers studying stress biology who wish to incorporate measurements of culture into their work. First, there are many cultural constructs that can be easily integrated into studies using questionnaire measures—common methods are listed in Table 1. Instead of using "proxy" or convenient measures of culture (e.g., ethnicity, nativity, and language preference), researchers should include measures of cultural processes (e.g., cultural orientation, cultural values, intra- or inter-cultural friendships, or social contacts). This approach allows for investigation of the processes in which cultural constructs relate to or interact with stress biology. Second, if using a between-group design, results from previous studies (Miles et al., 2018) suggest that it is important to distinguish between both cultural group (e.g., Mexican vs. Chinese vs. European American) and nativity status (foreign-born vs. native-born). Third, researchers studying stress biology in immigrant youth should consider the cultural appropriateness of certain biological responses when interpreting findings. Cultural norms and values are likely to influence the extent to which children experience certain events as stressful. In other words, certain biological stress profiles may be more or less adaptive depending on the cultural context. Relatedly, researchers should test for measurement equivalence in biological stress indices among different cultural groups just as is done in other psychometric test development (Hambleton et al., 2004).

Finally, as with all research on stress and biology, caution should be taken not to pathologize certain physiological profiles. Children's biological stress responses calibrate to their environments and resources at hand, mobilizing them physiologically to handle challenges (Ellis, Jackson, & Boyce, 2006). Thus, dysregulation in stress biology should be interpreted in light of environmental adversities, rather than individual deficits. In studying cultural minority populations, it is especially important to avoid repeating the history of group biological differences justifying discriminatory practices (Smedley & Smedley, 2005). Cultural differences in stress biology are not indicative of positive or negative qualities of cultural groups, but rather are a reflection of physiological adaptation to different developmental contexts.

As the nation's population of immigrant youth continues to grow, it will be important to understand how culture and individual stress biology jointly influence adjustment. The present review highlighted a small but growing body of literature that has incorporated both cultural and biological stress measures from the prenatal to adolescent periods. Together, these studies showed that culture and stress biology are a powerful pairing in revealing stressors and sources of strength that are unique to immigrant youth. This bridging of historically separate fields has the potential to provide mechanistic accounts of population-level disparities in health and education between immigrant youth and their peers. There are several ways in which culture and stress biology have been understood together, and future research has the capability to define more specific models based on the constructs studied. Ultimately, incorporating cultural measures into stress biology research and vice versa can expand the current state of knowledge on the dynamic process of children's development.

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CONFLICT OF INTEREST

The authors have no conflicts of interests to declare.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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Note: References with asterisks (*) indicate studies included in the systematic review.

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