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Article

Definitions of Resilience in Childhood and Adolescence

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Abstract: Research on resilience has traditionally focused on adults, in relation to their psychosocial and work-related functions. Here, we seek to harmonize the interdisciplinary perspectives of resilience, trace the roots of resilience to infancy and early childhood, move beyond a debate on the binary (state verses trait) characterization of resilience, emphasize resilience over vulnerability across the lifespan, and explore solutions for building resilience in childhood and adolescence. We describe the adaptive and flexible brain synchronization effects of resilience from early childhood to adolescence that shape evolving self-concept clarity and hypothalamic-pituitary-adrenal (HPA) axis regulation. Resilience in the context of age-associated adaptation, thriving, and coping strategies (protective factors) is not merely resistance to adversity. Rather, it may be viewed as prioritization of positive childhood experiences (PCEs) that can alleviate toxic stress, build the neural circuitry supportive of mental stamina, enhance prefrontal control of thoughts, emotions, and actions, and thus, prevent or reduce the childhood health outcomes related to early adversity. A PCEs repertoire is cultivated through the practice of five strengthening orientations: word orientation, religious orientation, belief in family, achievement orientation, and adaptability of family roles. In the absence of PCEs, threat detection, reward-related, and cognitive control processes are linked behaviorally to heightened emotional reactivity, blunted reward responsivity, poor emotion regulation, delayed discounting, and risk-taking behaviors. Resilience is a metric to gauge an individual's reaction to and recovery from daily acute stressors and cumulative chronic adverse conditions.

Keywords: resilience; adverse childhood experiences; positive childhood experiences; neurobiology; biomarkers; adolescence; child development

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1. Introduction

The word resilience stems from a Latin verb 'resilire', meaning "to leap, to spring back, or spring forward". Initially applied in physics, after it was introduced to human psychology, it was readily adopted by various authors; for example, by Abraham Maslow (1948) to explain 'self-actualization' [1], by Viktor Frankl (1985) in '*Man's search for Meaning*' [2], Robert Ewen (2010) in personality theories [3], or Martin Seligman (2011) in '*Flourish*' [4]. The concept of resilience, particularly in the context of adverse childhood experiences (ACEs) and early life adversity (ELA), has garnered significant attention across various disciplines. Collectively, many disciplines recognize

the importance of preventing ACEs and mitigating their effects through effective coping strategies, with resilience being an innate ability to recover and prepare oneself for future potential difficulties. Positive childhood experiences (PCEs) are increasingly recognized to offset adversities as measured by changes in behavior, health outcomes, academic performance, or delinquency [5]. Nevertheless, there remains a lack of clarity in the precise role and definition of resilience [6]. This ambiguity is especially prominent in adolescent development, where individual responses to trauma are notably diverse [7, 8].

A central debate in understanding resilience revolves around its characterization as either a state or a trait. When viewed as a state, resilience is seen as a dynamic attribute that can be developed and strengthened in response to adversity. If considered a trait, it is perceived as an innate quality that determines how individuals recover from stress or trauma. This binary framework, while useful, oversimplifies the complex nature of human development. While we acknowledge this controversy and seek to harmonize the definitions of resilience, we also highlight the importance of moving past this debate to prioritize solutions that build resilience.

The discourse on resilience is further complicated by the varied perspectives of different disciplines like psychology, social sciences, pediatrics, and neurobiology. Each contributes valuable insights confined to their areas of study. Current resilience measurement methods primarily focused on recent behaviors may not fully capture the potential for change in resilience over time. Whether the method is a self-reported assessment or functional magnetic resonance imaging (fMRI) scans of the brain, they often rely on the present perception or condition of participants.

Resilience becomes especially important in adolescence, a transitional period where self-concept clarity develops and peer influence outweighs parental guidance. However, without a consistent definition of resilience, it is difficult to investigate its impact on evolving self-concepts, personality, and quality of life.

This review seeks to redefine resilience with a focus on child and adolescent development using a two-pronged approach: first, by synthesizing current methodologies and theories of resilience from various disciplines (Fig. 1); and second, by acknowledging the unique developmental phases of childhood and adolescence as independent variables (Fig. 2). These phases are defined differently depending on their context: in education, they depend on school behaviors or age-related skills, while therapeutic contexts prioritize social interactions or neuro-biological changes. This paper will focus on the neurobiological developments as observed by the brain synchronization between the child and parent, and later transition to child and peer synchronization [9]. We also explore ways to operationalize resilience, tailored to the specific needs and experiences of adolescents and solutions based on parent-child relationships and spirituality.

2. Interdisciplinary Approaches to Define Resilience

2.1. Psychology/Psychiatry

In psychology, resilience is understood as adaptive coping in response to adversity influenced by social learning from parent-child dynamics, teacher-student relationships, and community environments. These interactions are protective factors that foster resilience, including five strengths: word orientation, religious orientation, belief in family, achievement orientation, and adaptability of family roles. Resilience can be measured through constructs such as social competence and emotional regulation [10].

Distinguishing resilience from resistance to adversity, particularly among communities facing structural racism, was challenging because of the overlap between these two constructs. In psychiatry, researchers observed an association between the long-term effects of adversity and structural discrimination on child psychology and subsequent mental health, coupled with maturational changes in the hypothalamic-pituitary-adrenal (HPA) axis [11]. The HPA axis controls cortisol levels and follows a diurnal rhythm with higher morning levels that gradually decrease during the day. Cumulative stressors can lead to HPA-axis dysregulation, showing a "blunted" or "heightened" cortisol awakening response (CAR) [11-13]. During puberty, hormonal changes mediate cortisol stress reactivity, allowing these endocrine changes to become more visible [13]. Salivary samples are often used to observe diurnal cortisol levels, which is a measure of acute stress and therefore susceptible to behavioral state reactivity [11]. However, cumulative stressors are best measured through hair

cortisol concentrations (HCC) that accurately measure chronic stress [14]. Longitudinal trajectories of HCC measured at yearly intervals showed the direct impact of early life stress (ELS) on children. This allostatic load, or cumulative burden of ELS exposures is directly associated with HPA-axis dysregulation [15, 16] and predicts their later susceptibility to mental health disorders [17, 18].

In addition to biological observations on stress and its impact on mental health, other researchers focus on a patient's current emotional state and attitude. Using psychiatric assessments, such as the 14-Item Resilience Scale (RS-14) that evaluates self-reliance, purpose, equanimity, perseverance, and authenticity, where resilience is defined as a stable trait. Although RS-14 suggests resilience as a stable trait, the wording of questions imply potential variability of responses over time, supporting a more dynamic interpretation of resilience. Other measures like the Strengths and Difficulties Questionnaire that observes current behaviors and the Connor-Davidson Resilience Scale that assesses a patient's ability to handle stress [8, 19] are often measured repeatedly to assess resilience as a dynamic state. Most psychological stressors often have psychosocial consequences, prompting the research on resilience in the social sciences.

2.2. Social Sciences

In the social sciences, resilience is the capacity to adapt and thrive in new environments while preserving cultural heritage and past experiences, particularly when integrating into a new society [20]. It includes overcoming challenges associated with marginalization and managing feelings of hostility or alienation that may arise in unfamiliar settings. Social resilience focuses on maintaining one's quality of life, cultural identity, and family values in the face of change and drawing inner strength from these past experiences.

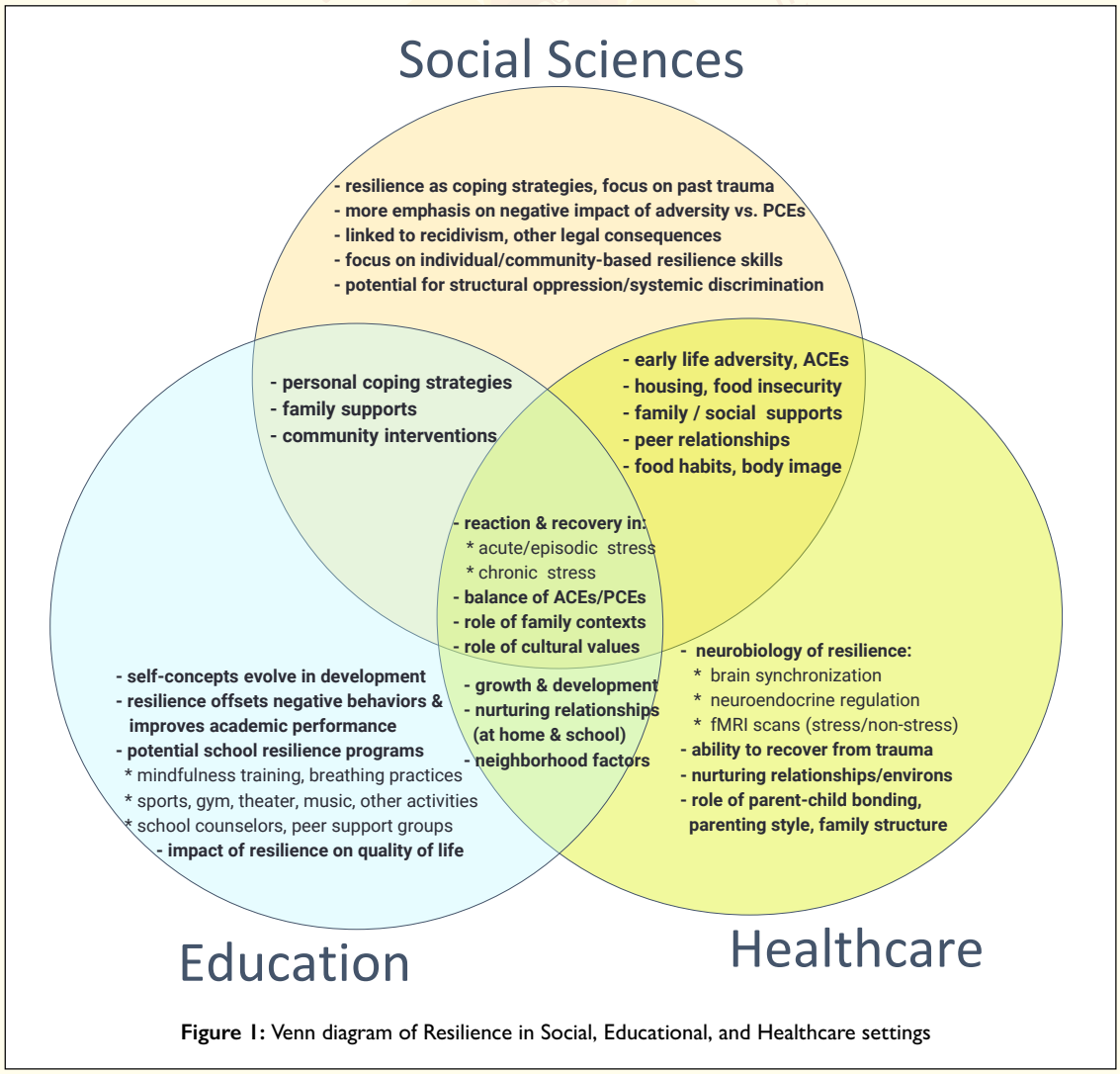

Figure 1: Venn diagram of Resilience in Social, Educational, and Healthcare settings

When applied to social work services or the legal system, resilience is often synonymous with coping strategies where "positive resilience," or "mental stamina," are viewed as qualities that can counteract negative outcomes in individuals who have faced violence or trauma in the past [21]. This interpretation underscores the potential for resilience to be cultivated or strengthened over time. Resilience is often included in discussions of past trauma but not as a solution, because the negative impacts of trauma are emphasized over the potential for change. Criminal justice studies also compare the number of ACEs and PCEs that justice-involved adolescents have experienced [22] and focus on the accumulation of PCEs rather than a single positive experience [23]. These studies have linked high levels of PCEs to reductions in recidivism and other legal consequences [22-24] (Figure 1).

Social supports are often designed to build resilience [25-28], but resilience assessments are not included as outcomes in social programs. In one meta-analysis of 79 anti-bullying programs, resilience only received a cursory mention to prevent bullying. School programs for elementary to high school students generally targeted individual skills such as emotional regulation, along with community-based skills such as empathy and bystander intervention [29], but did not assess changes in student resilience. Most psychological and social interventions to promote resilience in children and adolescents have significant impacts on their physical and mental health, thus prompting research to define and measure resilience in healthcare settings.

2.3. Pediatrics

In pediatrics, resilience is conceptualized as the ability of children to recover from adverse childhood experiences, occurring at different developmental stages, directly contrasted with vulnerability in a child's social ecology [30]. ACEs adversely impact adolescent and adult health, heightening risks of obesity, depression, substance abuse, among many others [31-40]. Consequently, pediatricians focus on PCEs as protective measures to mitigate the long-term outcomes associated with ACEs [5, 41, 42]. For example, the Healthy Outcomes from Positive Experiences (HOPE) framework primarily focuses on the parent-child relationships since adolescents exposed to nurturing relationships often foster resilience [43, 44]. Factors measured under HOPE, including the housing environment and the mother's health, are associated with the child's resilience [45]. For example, in a state-wide sample, adults who reported higher numbers of PCEs had lower rates of these negative mental health outcomes [46]. Similar trends were observed between school success factors, including attendance or engagement where resilience was associated with the balance of ACEs in comparison to PCEs [45, 47]. Research to understand the underlying mechanisms of resilience vs. vulnerability in children exposed to ACEs or other forms of adversity have primarily used the tools and techniques available in epigenetics and neurobiology.

2.4. Neurobiology

In neurobiology, resilience is centered around identifying structural brain markers, such as gray matter volume in areas associated with executive function and emotion regulation [48, 49]. Resting-state fMRI studies suggest that the amygdala and orbitofrontal cortex are key areas of interest, as they play a significant role in the emotional processing associated with resilience [50]. Exposures to ELS accelerate the frontoamygdala development, which regulates socioemotional processing in resilience. Greater ELS severity leads to early emergence of inverse frontoamygdala connectivity, which reflects more mature connectivity and may protect against accelerated biological aging [51].

These changes in neural circuitry, specifically in threat detection, reward-related, and cognitive control processes, are linked behaviorally to heightened emotional reactivity, blunted reward responsivity, poor emotion regulation, and delayed discounting. These promote risk-taking behaviors, such as smoking cigarettes, drinking alcohol, and eating high-fat, high-sugar foods [52]. With heightened neural responses to threats, children have a higher emotional reactivity in threatening environments, but with blunted reward responsivity, they seek out risky high-rewarding stimuli. The frontoparietal executive control network is altered by ELS, and they cannot delay immediate gratification despite its potential consequences. While their fast, reflexive responses were advantageous in adverse environments, these children find it harder to make positive choices with lifelong benefits [52].

Neurophysiology studies have examined concepts such as brain synchronization to investigate child-parent relationships. Behavioral and biological signals during social interactions align with one another in brain synchronization. Technologically assisted communication reduces the inter-brain synchrony, which is often associated with less eye contact and empathic engagement [53]. Remote interactions activated only one significant cross-brain cross-hemisphere link between mother-child pairs, eliminating the robust right-brain-to-right-brain connectivity during social moments that communicate socio-affective signals. Conversely, live interactions created 9 cross-brain links from densely inter-connected frontal and temporal brain areas in mother-child pairs, showing that screen interactions harm brain maturation and development of resilience in infancy [53]. Supportive data for these studies show increased screen time linked to autism [54, 55], language processing delays [56], and other detrimental effects on infant development.

Neuroendocrine studies of resilience focus on oxytocin as the hormone that regulates pro-social behaviors, promotes social interactions, and enhances inter-brain synchrony during social coordination tasks [57]. Due to the pandemic, social media and other online communication methods were especially relied upon; thus, it is particularly important to investigate the impact of these programs on the social interactions of children born during the pandemic [58-60]. It is clear, however, that not all pandemic-born children were affected to the same extent. Pandemic-related effects on social interactions, executive functions, and resilience in early childhood were greatly influenced by parental attitudes, rearing practices, and cultural values in each family [61].

2.5. Cultural Psychology

Resilience is closely tied to self-identification within a community and self-concept clarity, which is a coherent understanding of one's self [62]. Environmental influences, such as neighborhood biases, bullying experiences in school, or affirmation experiences despite marginalization, significantly shape a child's self-image. This, in turn, has a profound impact on their resilience [63, 64].

Cultural psychology offers insight into varying interpretations of resilience across cultures. For example, American culture views resilience as individual strength, while others emphasize the collective attribute, emphasizing family and community support as essential components [65, 66]. Additionally, different cultures may emphasize various coping mechanisms, such as a higher reliance on spirituality among Asians [67]. Like psychiatry, cultural psychology also utilizes various scales and questionnaires to assess factors such as current stressors and coping mechanisms. These tools help to understand resilience in the context of different cultural backgrounds and life experiences.

2.6. Summary of Interdisciplinary Approaches

The interpretations of resilience above highlight four noticeable trends across most fields. First, resilience is increasingly defined as a behavioral state, meaning there is a potential for change over time. Second, the development of resilience or influencing factors begin from birth or early childhood. Third, most measures of resilience do not incorporate the age or developmental stage of the child. Fourth, social programs and community interventions demonstrate that resilience can be learned through observation and active learning through practice. The definition of resilience, gained through self-concept clarity, is the child's innate and/or learned ability to process adversity in the present and to overcome it in the future. In doing so, each child epitomizes the Latin verb 'resilire' – "to leap, to spring forward", to gain mastery and strength from each adverse experience. The following section explores how this happens in early life.

3. Roots of Resilience in Childhood

Through early experiences of infant bonding and brain synchronization between parent and child the modes of developing resilience may change depending on the developmental stage of the child (Figure 2). By studying effects of early caregiving and child temperament on the child's stress and immune systems, Abraham et al. found that greater self-regulation and lower negative emotionality in children were associated with lower baseline levels of secretory Immunoglobulin A (s-IgA, which serves as a critical first line of defense against infections) and salivary cortisol (an acute stress marker) [68]. These relationships were influenced by the quality of early parenting, such that children with low self-regulation had higher s-IgA levels with low parent-infant synchrony, whereas negative emotionality was associated with higher baseline cortisol levels

when parental oxytocin levels were low [68]. This and other studies show that when parental sensitivity and warmth are low, then children manifest higher stress, lower immunity of infection, negative emotionality, and lower resilience. Cortisol regulates the autonomic system to alter physiological responses, and it also contributes to learning from stressful experiences [69, 70]. Salivary (or serum) cortisol levels reflect acute stress [71] but cannot measure cumulative or chronic stress [72-75]. Stress-induced cortisol responses in children are buffered by nurturing parents, at least partially mediated by oxytocin release [75-77]. Multiple lines of evidence suggest that oxytocin inhibits the HPA axis in children and adults [72, 78-81]; it mediates affiliative or bonding behaviors, facilitates parent-infant synchrony, and builds resilience in early childhood [75, 82, 83].

The integrity of subcortical and cortical networks in parents is linked to the child's social outcomes. The development of basic regulatory tactics, more complex self-regulatory strategies, as well as advanced socialization skills in children are impacted by the quality of parenting [84-86]. Similarly, parents' brains also respond (in a coordinated manner) to infant cues. Mothers show higher activations in the amygdala (a region linked to emotional processing), while fathers showed greater activations in social-cognitive circuits. In this study, infant cues were correlated with oxytocin levels for mothers and arginine vasopressin levels for fathers [87, 88].

Thus, recent research highlights the significant role of parent neurobiology and parenting practices in influencing a child's stress-responsive systems, emotions, and social adaptation. This is seen in parent-infant synchrony, which extends beyond mere behaviors, reflecting in their neural activities. The correlations of oxytocin, arginine vasopressin, and cortisol levels between the child and parent already reveal the impact of infant-parent bonding on resilience.

Figure 2: Social drivers of Resilience in childhood development

Biobehavioral synchrony includes behavioral coordination, heart rhythm synchrony, oxytocin release coordination, and brain-to-brain synchrony in social cognition. Most previous research relies on a definition of resilience for their study, regardless of the age group; however, a nuanced definition of resilience must recognize a child's developmental stages [30, 89]. In neonates, resilience hinges on maternal behavior and oxytocin levels. Mothers become aware of the neonate's "moments of alertness," the first step to coordination. Infants engage in "rhythmic" non-verbal communication with mothers, influencing their social, emotional, cognitive, and brain development [90]. Toddlers emphasize creative learning through symbolic play and storytelling, while parent oxytocin levels and early synchrony predict the child's synchrony with their best friend or peers. In later childhood and adolescence, empathic dialogue and verbal interactions predominate, shaping social abilities and resilience in the face of adversity. This period marks a shift in attachment focus from parents to peers, crucial for well-being and the social brain's maturation. In adulthood, the familiar rhythms of early childhood persist, enabling individuals to form trusting and mutual relationships [9, 91, 92].

Brain synchronization reflects parent-child bonding, which is significantly disrupted by maternal depression, transmitting emotional regulation and socialization risks can to the child. While having a mental health condition in the family is listed in the ACEs scale, the impact of maternal depression depends on the severity or duration of depression and the child's

age of exposure [93] – the younger the child, the greater and more long-term is its impact on the child's cognitive and behavioral development, socialization and language skills, physical and mental health, and ability to develop resilience [94, 95]. There is no genetic component for depression in their childhood and adolescence, when the child's unmet needs limit the development of their social and cognitive skills then they are at increased risk for anxiety, depression, and low resilience [85, 96, 97]. The cumulative exposures of the child to ACEs, ELA, poor parenting, and social determinants of health, especially during sensitive periods development, are the main drivers of risk in the stress-diathesis model [94]. Children with a history of such exposures clearly need help in academic, social, and therapeutic settings to build, restore, and promote their resilience.

4. Solutions to Promote Resilience

Many approaches to promote resilience have been proposed and are easily available to adults and employees (e.g., www.resilienceresearch.org; www.resilience-leadership.com, www.resilientoption.com; www.ultimateresilience.co.uk; or others), but few if any are specifically designed for children and youth. Here, we discuss two of the approaches that appear to confer the greatest benefit for building resilience in children and adolescents.

4.1. Parental Relationships

Healthcare professionals can play a significant role in normalizing periods of disorganization in infancy by offering support and by recognizing everyday stressors and the "uneven nature of infants' developmental progress" [98]. With gentle empathetic guidance, parents are better equipped to provide regulatory inputs to their infant, while accurately addressing their child's immediate needs to "repair the child's state." A consistent failure to understand an infant's needs can have impacts akin to severe neglect [98].

Parental stress levels and their perception of the child's stressors are also significant. A caregiver's resilience is inversely related to both their stress and their perception of stress in their child. Interestingly, a father's depressive symptoms have a more pronounced impact on their parenting experiences, as indicated by higher reports of conflict, caregiver burden, and their child's perceived stress level, compared to mothers [99-101]. This research suggests a greater focus on family therapy, rather than individual parents or the child alone [84, 86, 89].

For children with divorced parents, mitigating parental conflict is essential. The tension and anger between parents can diminish their emotional capacity to provide a nurturing environment or responding to their child's needs [102]. Explaining the divorce situation to the child is also beneficial. These needs can be addressed through parent education and divorce education programs offered by community organizations. Additionally, extrafamilial support from teachers, extended family, clergy, and community resources demonstrating attention, warmth, ready availability, and respect for the child is essential. Factors such as a child's temperament, self-regulation, persistence, social responsibility, and independence from peer influence also play a role [103].

A research study on the parent-child interaction and resilient outcomes defines this relationship in terms of parental attitudes, involvement, and guidance, using Baumrind's heuristic distinction in parenting styles (authoritarian, overly permissive, authoritative). Parental attitudes that include caring feelings towards the child and appreciation of the child's abilities, lead to independence, self-esteem, coping skills, and reduced aggression [30, 68, 104]. Parental involvement by setting age-appropriate rules, consistent discipline, encouraging independence, and providing clear family routines boosts the child's self-esteem, internal locus of control, school adjustment and achievement, and greater resilience. Observing parents enjoying themselves or coping positively with life circumstances provides a model for the child to emulate. Resilient parent-child groups are characterized by congruent views of their relationship, underscored by effective parental communication [104]. Acknowledging the presence of an unseen, silent witness to family functioning in the household is also a powerful influence on child resilience as explored in the next section.

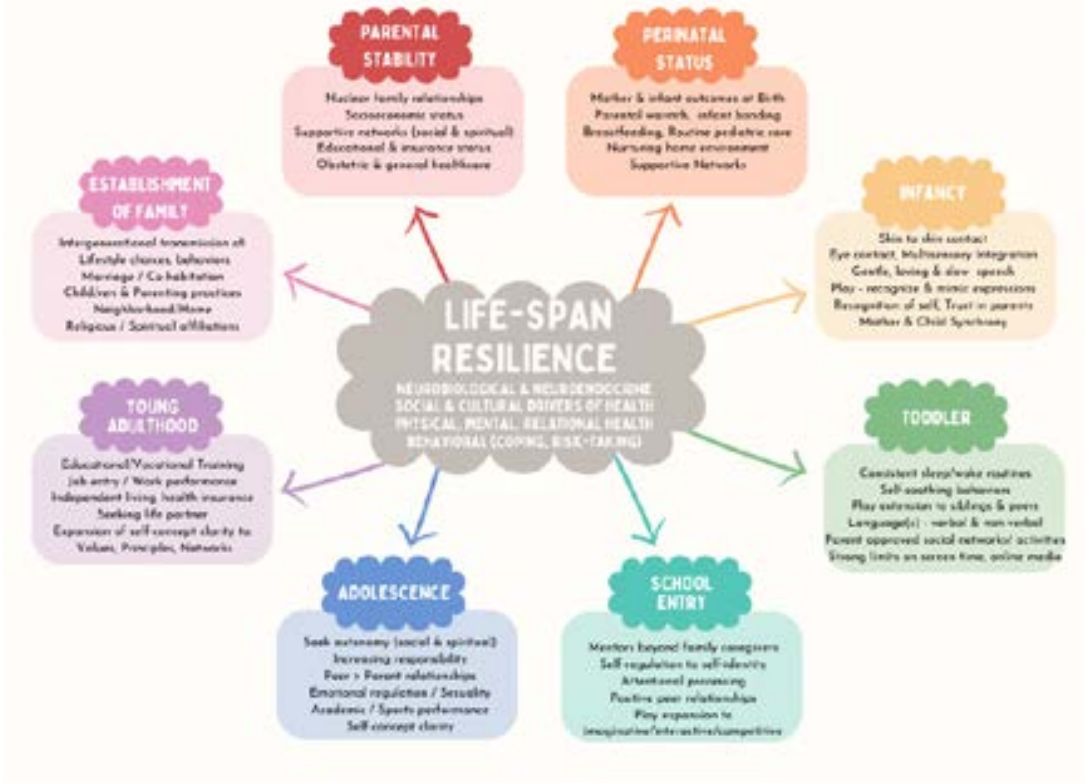

Figure 3: Factors promoting Resilience across the human lifespan

4.2. Spirituality

Spirituality and religion are well-known drivers of self-esteem and self-image showing abundant research on positive coping mechanisms associated with the cultural or personal interpretation of a higher being [105]. One study of Czech adults found that childhood trauma and difficulties in fostering were linked with a less positive image of God, especially in nonreligious participants [106]. Another study of homeless adolescents in Zimbabwe who believed evil spirits were controlling them, their morals and behaviors were tightly linked to evil spirits or super-natural powers, and most children had a negative self-image with negative implications on morality and social relations [107].

The impact of spirituality on resilience in children and adolescents is multifaceted and substantial. For younger children, the experience of spirituality is defined by their relationship with family and openness to new experiences. As they grow older, develop trust in their relationships, greater self-concepts, and their interpretations of reality through abstract thought, this plays a crucial role in their identity formation, self-esteem, social skills, and the ability to overcome adversity (or resilience). During school years, spirituality has a negative association with depression, substance abuse, delinquency, and criminality [108].

Following traumatic experiences, spirituality helps children to recover and redefine life's meaning, thus fostering resilience. It decreases PTSD symptoms by enabling individuals to rebuild their narratives based on healthy perspectives. Positive spiritual/religious coping strategies play a significant role in regaining a sense of control and combating feelings of helplessness, which is a common symptom of PTSD. These strategies include benevolent reappraisal, reinterpreting adverse experiences as lessons, learning forgiveness, fostering gratitude and generosity – all dependent on establishing a spiritual connection. Other methods such as active religious surrender, acknowledging what is beyond one's control, doing what's right and leaving the rest to God, and seeking spiritual guidance are also integral towards developing multisystemic resilience [109-111].

5. Conclusions

Establishing a common definition for resilience across different disciplines must acknowledge the changing ecological contexts from infancy to adulthood (Figure 3). Resilience, explored through interdisciplinary studies, is a metric to gauge an individual's reaction to and recovery from daily acute stressors and from cumulative chronic adverse conditions. This concept encapsulates the ability to reduce the negative consequences of ACEs or ELA without suggesting complete invulnerability to such events. Rather, resilience is measured by responses that fall within the normal expected variability of individuals facing acute, repetitive, and chronic stress with and without positive childhood experiences or nurturing environments. Ungar and colleagues suggest a bio-social-ecological interpretation of resilience with three characteristics:

- Equifinality – many proximal experiences can lead to variable, but equally viable, expressions of child development associated with well-being;
- Differential impact – children face different types and frequencies of ACEs, but their perception of resources available to overcome those risks, and the quality of these resources make proximal processes more or less influential in each child's development;
- Contextual and cultural moderation – different contexts and cultures provide access to different processes associated with resilience as it is defined locally [111].

In clinical settings, objective measures of age-associated biomarkers such as cortisol and oxytocin can monitor HPA-axis (dys)regulation to assess contextual risks vs. resilience. Developmental windows exist for HPA-axis maturation by 4 years of age with temporal peaks in cortisol levels observed perinatally and then again at school entry. In academic or social settings, behavioral adaptation or the way individuals form peer relationships can assess contextual risks vs. resilience. While age-dependent struggles are common, a key aspect is the eventual formation of the child's social networks with stable relationships. Relational health can be measured specifically through the challenges children face in their daily lives on a spectrum of behaviors to assess risk vs. resilience serially over time. Other disciplines may incorporate culturally relevant measures of normality, emotional regulation, self-esteem, or concepts of self-identity by measuring their associations with healthy coping strategies, self-esteem, or self-identity that define resilience. Future research must devote greater efforts to investigate the comparative efficacy of different approaches that can overcome adversity and promote resilience in children and adolescents, to ensure future survival and thriving of the human race.

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