Chapter 10

Lifecourse

Mark Tomlinson, Amelia van der Merwe, Marguerite Marlow, and Sarah Skeen

10.1 Introduction

Lifecourse theory was developed in the last 50 years, combining neurobiology, child psychology, developmental psychopathology, sociology, population sciences, and increasingly genetics [1]. Up to the latter part of the twentieth century, the focus was largely on the treatment of infectious diseases, acute illness, and injury within single-cause, simple biomedical models [2]. This was followed by a growing awareness of the roles of social and behavioural influences on illness, and revised bio-psychosocial models were developed that focused on managing chronic diseases over time and shifting unhealthy lifestyle choices [2]. However, health and social services continued to largely function separately, and the integration of physical and psychological health programmes was limited [2].

Lifecourse models take into account the influences of multiple risk and protective factors, operating across health trajectories or pathways throughout the lifespan and across generations [2]. The principles of lifecourse theory include: human agency in the construction of lives, timing (the developmental consequences of life transitions or events, which depend on when they take place in an individual's life), linked or interdependent lives (social and historical impacts are expressed through shared relationships), and human lives in historical time and place [3]. Developmental psychology contributed to the concepts of life stages and turning points, while sociology added the contributions of history, social conditions, and adaptation [1]. Genetics has contributed numerous concepts such as differential susceptibility [4]. A proliferation of research conducted during the early twenty-first century, including a large number of longitudinal studies that monitored continuity and change across the lifecourse, has prompted new ways of thinking about developmental trajectories and entrenched the lifecourse perspective in developmental research [1].

The lifecourse perspective overlaps with a number of theoretical traditions, including sociocultural perspectives that emphasise the social meaning of age and developmental stages, such as the socially defined, age-graded meanings associated with the biological facts of birth, puberty, or death, for example [5]. The concept of the lifecourse can also be historically linked to particular social transitions and to the meanings associated with a specific cohort [5]. Lifecourse theory incorporates some of the principles of interactionist thinking, particularly its emphasis on the interactions between the person and context, and the organisation and shifts in the organisation of social structures and pathways through the lifecourse [5]. Lifecourse theory is also based on Bronfenbrenner's concepts of the ecology of human development, including multi-level influences from the environment, extending from micro- to macro-level influences. The individual lifecourse

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furthermore shares conceptual premises with developmental science with its focus on developmental trajectories and the dynamic interactions between events and processes that occur across time frames in multiple contexts [5].

Previously, studies focusing on continuity and change from childhood and adulthood tended to include only correlational and regression analyses of patterns between measures of outcomes at two time points, typically childhood and adulthood [5]. There was very little exploration of what happened in between and what the mechanisms of change and continuity were. Furthermore, there was limited awareness of individuals as agents of change in their lives [5]. The lifecourse focus brought this into sharp relief and replaced child-based, growth-oriented (ontogenic) explanations of development with theories that account for development and ageing over the lifecourse. This focus emphasised how human lives are organised over time, including patterns of continuity and change, which focus on the developmental effects of social change and transitions [5]. In this chapter, we explore the issues of continuity and change across the lifecourse, developmental trajectories, and a lifecourse theory to investigate how exposures and experiences influence different individuals in different ways, with some more vulnerable or susceptible to risk than others, resulting in significant variability in developmental outcomes.

10.2 Lifecourse Approach to Health

Modern healthcare systems need to synthesise prevention, treatment, and health promotion and set in motion more integrated and networked strategies for designing and implementing multi-level interventions that move beyond the individual to include populations [2]. The lifecourse development perspective shifts our understanding from simple, linear, mechanistic, and reductionist models to models that acknowledge that the development of health is complex, interactive, holistic, and adaptive [2]. It also shifts our focus to inclusive explanations about the developmental origins of health, how stress influences current and future health, and the outcomes associated with dynamic interactions between individuals and their multiple environments across time [6]. Lifecourse perspectives provide a conceptual bridge between constructs that have until recently been assumed to be opposites, such as nature and nurture, mind and body, individual and population, and short-term and long-term change [2].

The lifecourse perspective incorporates pathways, which are constructed by the choices and actions that form individual lifecourses, and their developmental implications and consequences, including potential resources and constraints [5]. Rutter and colleagues argue that pathways involve dependent sequences, to include an exposure/experience at one point in the lifecourse, how it affects the likelihood of others occurring later in the lifecourse, and how this in turn influences health and developmental outcomes, including chains of risk [7]. A number of concepts are relevant to pathways, such as latency, which refers to the association between an exposure or experience at one point in the lifecourse and the related developmental outcome years or decades later, despite the presence of intervening exposure or experience [7]. Cumulative risk is another relevant concept that describes multiple exposures, either to a recurrent single factor or sequential exposures to different factors over the lifecourse, which combine to influence development [7]. These factors relate reciprocally, so that children with multiple exposures (to, for example, low socio-economic status [SES], poor parenting

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style, and residential instability) are likely to have more difficult trajectories than those exposed to single-risk factors [7]. These constructs tend to coexist in the real world. In fact, research conducted by Hertzman and colleagues in 2001 has demonstrated a strong relationship between latency, pathways, and cumulative factors in childhood and self-rated health at age 33 [7]. The current extensive focus on adverse child experiences (ACEs, see also chapter Kenny and Müller) [8] is the next logical step building on the work of Sameroff [9] and Hertzman [7].

Social interactions that are sustained by their consequences (cumulative) and behavioural styles that tend to evoke maintaining reactions from the environment (reciprocal) lead to behavioural continuities across the lifecourse [5]. Thus, both cumulative continuity and reciprocal continuity result in the cumulation of experiences that maintain and further the same behavioural outcome [5]. Conversely, transitional experiences disrupt continuity through individual agency, dispositions, situational constraints and opportunities, and previous experiences that accompany individuals to new situations [5]. This can bring about a significant change in behavioural trajectories and constitute a turning point [5].

10.3 Developmental Origins of Health and Disease (DOHaD)

Research focusing on the Developmental Origins of Health and Disease (DOHaD) began to emerge in the 1970s [10]. Subsequently, researchers began to integrate the new 'fetal origins', and later DOHaD, research outcomes, with results from lifecourse sociology and psychology to create newer lifecourse models of health and disease [2]. The theories on which these models draw, such as evolutionary life-history theory, propose that development during fetal life is designed to prepare the infant for a particular external environment, and so, when conditions in utero match the conditions in infancy, development occurs along pathways originating in utero [11]. However, when a mismatch occurs between the intrauterine and postnatal environments, certain dimensions of development may be compromised, or disadvantaged; for example, when intrauterine undernutrition is followed by an oversupply of nutrients postnatally, it poses risks for metabolic health [11].

The centrality of maternal and child healthcare in DOHaD focuses research and intervention on health trajectories that can improve child health outcomes, as well as health development across the lifespan, and possibly even into subsequent generations [2]. There is substantial research evidence for the notion that maternal physiology, body composition, diet, and lifestyle during pregnancy significantly influence the health of the infant throughout their life, including the presence of cardiovascular and metabolic illnesses (such as hypertension, obesity, and type 2 diabetes), atopic conditions, cancer, and neurological impairment [12].

10.3.1 Biological Embedding and Differential Susceptibility

DOHaD research, framed by a lifecourse perspective, can account for how both ordinary and extraordinary experiences may 'get under the skin' by altering biological functions during developmental windows of opportunity, which can ultimately shift lifecourse trajectories and influence intergenerational health patterns [7]. There are four systems that have the features of biological embedding: the HPA axis and the associated secretion of cortisol; the autonomic nervous system and its relation to epinephrine and

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norepinephrine; the development of the prefrontal cortex (including memory, attention, etc.); the primitive amygdala and locus coeruleus, and associated higher order cerebral connections, mediated by serotonin and other important hormones that are involved in systems of social affiliation [7]. For example, poor nurturance, through the mediation of gene expression, may lead to a disturbed HPA axis, impaired capacity for complex learning, and high age-related declines in learning and memory capacity [7].

Chronic stresses cause wear and tear on the HPA axis, which leads to dysregulation. This, in turn, may result in either hypo- or hypersecretion of cortisol with lifelong implications for health [13, 14]. It is also clear that it isn't either genes or the environment, or even genes and the environment, but gene-by-environment interactions that affect developmental trajectories [7]. Epigenetic processes – for example, DNA methylation – have been identified as important processes through which early environmental signals are altered into conditionally adaptive shifts in key functions in metabolic, endocrine, and neuroregulatory pathways [7, 15]. These changes produce systematic developmental biases towards more adaptive functioning in terms of growth, metabolism, immune responsivity, developmental pace, and behaviour, although changes are not uniformly protective [7]. Epigenetic changes, which occur in response to environmental cues, also play a role in the development of psychopathology and chronic medical conditions [7].

Exposures and experiences affect individuals differently, and there is significant variability in developmental outcomes. Approximately 15 per cent of children may be more biologically reactive to their immediate social environment than other children [7]. The effect of this on pathological outcomes is bivalent, as it can be protective or risk-enhancing depending on context [7]. This has been described as differential susceptibility, which refers to the risk-enhancing or risk-abating character of the social contexts children inhabit [16]. Experimental studies have shown that the majority of children with low autonomic reactivity have only slightly more symptoms in families with high family conflict, while the high-reactivity children display a combination of significantly more symptoms in high-conflict families but markedly fewer symptoms than peers in families with low levels of conflict [16]. As a result the 15–20 per cent of study children with the highest levels of reactivity either demonstrated the worst outcomes or the best outcomes, as a function of the level of conflict in their families [17]. It has been argued that more reactive children were more sensitive to both positive and negative social influences, while children who were low in reactivity were able to function adequately in a variety of contexts [18, 19]. Boyce and Ellis (2005) outline the following principles:

A. Exposure to high-stress childhood environments enhances biological sensitivity to context and increases the child's capacity to identify and respond to environmental threats;
B. Exposure to particularly supportive childhood environments also enhances biological sensitivity to context and increases receptiveness to social supports and resources; and
C. The majority of children are not exposed to environments that are either very stressful or very supportive, which reduces biological sensitivity to context and protects them against stressors [20].

Differential susceptibility is a useful concept to bear in mind when attempting to account for why environmental and intervention effects have been shown to be both variable and

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typically modest in published studies [21]. This is possibly a function of samples including both more and less susceptible individuals, which renders the average effect across all participants an invalid index of intervention effectiveness [16]. For example, distinguishing between short-allele and long-allele carriers was significant in determining the effectiveness of a maternal–infant attachment intervention. Specifically, for infants with one or two copies of the short allele of 5HTTLPR, the intervention improved attachment quality dramatically and significantly, while for those with only the long allele, the intervention produced no significant changes [4]. Differential susceptibility demonstrates in this way that averaging across all participants does not produce meaningful results [4]. Adverse social conditions such as socio-economic disadvantage increase the risk for various and multiple types of pathology by producing a generalised susceptibility [7]. Typically, social adversities include feedback loops that result in one stressful or traumatic event following another, resulting in extremely negative social contexts [22].

Although preconception and intrauterine experience have demonstrated marked effects on later health outcomes, there is a huge body of research that shows that childhood is a critical period for preventive and intervention efforts [16, 23]. Neurobiological susceptibility is not categorical and should be viewed as occurring on a continuum [16]. It is also important to bear in mind that less susceptible individuals may benefit from more intense intervention efforts to obtain results similar to those who are more susceptible [16]. Furthermore, less susceptible individuals may not always stay that way, and individuals may be more or less susceptible in different stages across the lifespan [16]. For this reason, and because equity matters as much as intervention efficacy, certain groups should not be excluded from supportive services [16]. This is in addition to population-level interventions advocated by the lifecourse health perspective to prevent poor developmental outcomes, such as folic acid supplementation during pregnancy. One cross-cutting risk factor that results in a generalised susceptibility or vulnerability to risk which is broadly pathogenic and presents a host of challenges occurring at multiple ecological levels, is socio-economic disadvantage (SED).

10.3.2 A Cross-Cutting Theme: Socio-economic Disadvantage and Exposure to Adverse Childhood Events

Socio-economic disadvantage early in life has repeatedly and robustly been shown to influence health outcomes across the lifespan, even when considering later SES. Socio-economic disadvantage in infancy is associated with higher infant mortality and adverse birth outcomes [24]. In both childhood and adolescence, SED has been linked to an increased risk for asthma, dental problems, and physical inactivity [24]. In terms of psychological health outcomes, a range of researchers have shown that SED is linked to poor language, cognitive deficits, and behavioural difficulties during childhood and higher rates of substance abuse, disruptive behaviours, and depression in adolescents [24].

Heightened stress levels appear to be the most important mediating mechanism underlying the influence of socio-economic disadvantage on health development [24]. Childhood socio-economic disadvantage is linked to greater exposure to stressors, including harsh parenting, exposure to violence, separation from parents, lower school

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quality, negative peer relations, substandard housing, pollutants, noise, and crowding [24]. Meijer and colleagues have also demonstrated that neighbourhood deprivation poses risks, including a lack of access to physical and cultural resources such as fresh fruits and vegetables, open space and other recreational amenities, libraries, and transportation, in addition to higher levels of exposure to violence and crime [25]. Those who have been exposed to SED are significantly more likely to encounter multiple, chronic, and severe stressors, which over time disables individuals' capacity to cope [24].

Exposure to ACEs such as those associated with socio-economic disadvantage is robustly associated with a range of childhood outcomes, including impaired physical growth and cognitive development, higher risks for childhood obesity, asthma, infections, non-febrile illnesses, disordered sleep, delayed menarche, and non-specific somatic complaints [26]. Although these health conditions vary according to ACE characteristics, age of occurrence, and specific types of exposures, it is clear that the more ACEs the child is exposed to, the more likely she or he will have complex health problems, with multiple needs across developmental, physical, and mental health domains [26]. Among ACEs, caregiver mental health is particularly important in terms of child health outcomes and is especially important for children aged under 5 years [26]. Retrospective studies have shown that ACEs also increase the risk of chronic non-communicable diseases, substance abuse, sexual risk-taking behaviours, suicide, domestic violence, and impaired physical and mental health, which may lead to the transfer of ACEs to the next generation [26].

Chronic exposure to cumulative risk factors linked to socio-economic disadvantage 'gets under the skin', by leading to dysfunction in the brain and associated physiological systems, and these dysfunctions impact the likelihood of physical and psychological illnesses [24]. Neurobiological mechanisms of stress emphasise three areas of the brain that are involved in stress perception, appraisal, and regulation, namely, the amygdala, hippocampus, and medial prefrontal cortex [27]. Ulrich-Lai and Herman argue that the purpose of these areas of the brain is to regulate the physiological stress systems, especially the hypothalamus-pituitary-adrenal axis and autonomic nervous system [27]. Chronic exposure to adversity exceeds the neuroendocrine system's ability to maintain homeostasis and, particularly during life stages associated with greater neuroplasticity (from pregnancy to early childhood), influences important components of brain development involved in cognition, self-regulation, and physical and mental health [26]. As we have noted, chronic exposure to stressors can result in hyper- or hypo-responsivity of the HPA axis, which represents impaired adaptation and results in a higher likelihood of eventual exhaustion. Lopez and colleagues cite a multitude of studies that show that HPA-axis dysregulation has far-reaching effects on young children and may manifest as both internalising and externalising behaviours [26].

The allostatic load model is important in this regard, as it suggests that exposure to chronic stress may result in wear and tear in primary stress regulatory systems (the hypothalamus-pituitary-adrenal axis and autonomic nervous system) and, consequently, in secondary physiological stress systems (metabolic processes, inflammatory and immune responses, and cardiovascular responses), which may lead to long-term damage and impairment [24]. Dysregulation of these physiological systems, which is understood in terms of allostatic load, is a strong indicator of health development outcomes in adulthood, including cardiovascular disease, diabetes, as well as cognitive impairment and premature mortality [24].

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10.4 Limitations and Future Directions

Although there have been major strides in lifecourse health research, there continue to be significant gaps and limitations in the available research, particularly in terms of translation to policy and practice [6, 28]. Much of the research on the early biological origins of later health outcomes is based on animal studies, there are few longitudinal studies on preconception and pregnancy, and three-generational data are limited [6]. In addition, most lifecourse and developmental research is based on studies that have not been designed for this specific purpose [6, 28]. Banati (2018) argues, in reference to the cross-sectional measurement of the Sustainable Development Goals, that longitudinal data add depth and complexity in understanding the lifecourse and provide answers to 'why', which is crucial to the nature and timing of interventions [1]. A number of important lifecourse constructs – such as stress, weathering, and allostatic load – are not consistently defined or measured, and we lack knowledge of how these constructs could be best operationalised across different life stages, such as childhood and adolescence [29].

In spite of progress, much of the available research still uses reductionist statistical approaches that focus on isolating causal variables [6, 28]. More sophisticated statistical methods, such as longitudinal growth models to explore health trajectories, and multilevel modelling to better understand contextual contributors to health status, as well as decomposition methods to determine the influence of multiple risk and protective factors at different life stages on future health outcomes are necessary [6, 28]. New methods of analysis based on dynamic systems approaches are more suited to the complexity of the lifecourse health framework, but these have been limited in their application to understanding the roots of health disparities [6, 28]. Dynamic systems methods differ from correlational and regression approaches and include a number of computational approaches that can be applied to model dynamic and shifting interactions between individuals and their multiple environments, as well as complex processes such as feedback loops and non-linear relations [6, 28].

Despite the focus of lifecourse health research on structural and upstream policy and community-level factors influencing health status disparities, most research continues to examine downstream determinants, for example, health behaviours and healthcare [6, 28]. There is still limited knowledge of how complex processes resulting from dynamic interactions between biological, environmental, social, and behavioural factors over time produce disparities in population health [6]. Many debates are unresolved, such as the relative importance of early vs. later exposures and the timing and plasticity of sensitive periods in development [6, 28].

The lifecourse health framework offers a foundation for more integrated, preventative, and developmentally prepared health systems that are developed around the central notion of advancing health and health-promoting environments across the lifespan and across generations [6, 28]. Cross-disciplinary knowledge can only be generated when there is an integration of lifecourse research, greater cooperation, and more collaboration and synthesis of disciplines [6, 28] to allow the development of a common set of principles that promote resilience under stress [30]. This requires integrated, transdisciplinary funding opportunities and research agendas [31].

A lifecourse perspective is relevant to all dimensions of health but is most relevant to health equity [32]. A lifecourse perspective allows us to examine and understand how

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health disparities develop, are amplified or mitigated, as well as reproduced across generations, which may allow us to intervene more effectively [32]. Specifically, this perspective helps us understand how social risks and opportunities create vulnerability or resilience at each life stage, and how they accumulate, or are reduced across lives and generations [32]. The lifecourse perspective highlights stark disparities – children from relatively more wealthy contexts have benefitted the most, while there has been a limited impact on the poorest, who continue to need more resources and safety nets to mitigate the effects of the multiple vulnerabilities they face [1].

In this chapter, we have drawn attention to how socio-economic disadvantage contributes to pathology across the lifecourse and beyond. The findings have far-reaching implications for policymakers and interventionists. In the spirit of equity, the lifecourse perspective and DOHaD theory suggest that early, population-level intervention (at critical or sensitive periods) may prevent the consequences of exposure to socio-economic disadvantage and all its associated risks. In addition, and perhaps in combination with population-level interventions, the concept of differential susceptibility suggests the importance of identifying risk indicators that render some more vulnerable than others and the urgency of conducting more research on the factors that influence responsivity to interventions. Identifying indicators that point to both additional risk or vulnerability and heightened responsivity to intervention will allow for the more efficient implementation of targeted services. This approach may be our best chance at addressing the probability of socio-economically linked disease outcomes and its repercussions, which are likely to be felt across multiple lifetimes.

References

1. Banati P. Bringing life course theory to the sustainable development goals. In: Verma S, Petersen A, editors. Developmental Science and Sustainable Development Goals for Children and Youth. Cham, Switzerland: Springer International Publishing; 2018. pp. 313–328.
2. Halfon N, Larson K, Lu M, Tullis E, Russ S. Lifecourse health development: Past, present and future. Matern Child Health J. 2014;18(2):344–65.
3. Elder GH. The life course as developmental theory. Child Dev. 1998;69 (1):1–12.
4. Morgan B, Kumsta R, Fearon P, Moser D, Skeen S, Cooper P, et al. Serotonin transporter gene (SLC6A4) polymorphism and susceptibility to a home-visiting maternal-infant attachment intervention delivered by community health workers in South Africa: Reanalysis of a randomized controlled trial. PLoS Med. 2017;14(2): e1002237.
5. Elder GH, Shanahan MJ. Handbook of Child Psychology. Lerner RM, editor. New Jersey: John Wiley & Sons; 2006.
6. Halfon N, Forrest CB, Lerner RM, Faustman EM, Tullis E, Son J. Introduction to the Handbook of Life Course Health Development. In: Christopher B. Forrest, Neal Halfon, and Richard M. Lerner, editors. Handbook of Life Course Health Development. Cham, Switzerland: Springer; 2018. pp. 1–18.
7. Hertzman C, Boyce T. How experience gets under the skin to create gradients in developmental health. Annu Rev Public Health. 2010;31:329–47
8. Hughes K, Bellis MA, Hardcastle KA, Sethi D, Butchart A, Mikton C, et al. The effect of multiple adverse childhood experiences on health: A systematic review and meta-analysis. Lancet Public Health. 2017;2(8):e356–e66.

https://doi.org/10.1017/9781009201704.012 Published online by Cambridge University Press

9. Sameroff A. A unified theory of development: A dialectic integration of nature and nurture. Child Dev. 2010;81 (1):6–22.
10. Barker DJP. The origins of the developmental origins theory. J Intern Med. 2007;261(5):412–7.
11. Salsberry P, Tanda R, Anderson SE, Kamboj MK. Pediatric Type-2 Diabetes: Prevention and Treatment Through a Life Course Health Development Framework. In: Christopher B. Forrest, Neal Halfon, and Richard M. Lerner, editors. Handbook of Life Course Health Development. Cham, Switzerland: Springer; 2018. pp. 197–236.
12. Fleming TP, Watkins AJ, Velazquez MA, Mathers JC, Prentice AM, Stephenson J, et al. Origins of lifetime health around the time of conception: Causes and consequences. Lancet. 2018;391 (10132):1842–52.
13. McEwen BS. Protective and damaging effects of stress mediators. N Engl J Med. 1998;338(3):171–9.
14. McEwen BS. Effects of adverse experiences for brain structure and function. Biol Psychiatry. 2000;48 (8):721–31.
15. de Kloet ER, Fitzsimons CP, Datson NA, Meijer OC, Vreugdenhil E. Glucocorticoid signaling and stress-related limbic susceptibility pathway: About receptors, transcription machinery and microRNA. Brain Res. 2009;1293:129–41.
16. Ellis BJ, Boyce WT, Belsky J, Bakermans-Kranenburg MJ, van Ijzendoorn MH. Differential susceptibility to the environment: An evolutionary – Neurodevelopmental theory. Dev Psychopathol. 2011;23 (1):7–28.
17. Boyce WT. Epigenomic susceptibility to the social world: Plausible paths to a 'Newest Morbidity'. Acad Pediatr. 2017;17(6):600–6.
18. Boyce WT, Ellis BJ. Biological sensitivity to context: I. An evolutionary-developmental theory of the origins and functions of stress reactivity. Dev Psychopathol. 2005;17(2):271–301.
19. Boyce WT. The Orchid and the Dandelion: Why Sensitive People Struggle and How All Can Thrive. London: Pan MacMillan; 2019.
20. Boyce WT, Ellis BJ. Biological sensitivity to context: I. An evolutionary–developmental theory of the origins and functions of stress reactivity. Development and Psychopathology. 2005;17:271–301.
21. Ellis BJ, Boyce WT, Belsky J, Bakermans-Kranenburg MJ, Van IJzendoorn MH. Differential susceptibility to the environment: An evolutionary–neurodevelopmental theory. Development and Psychopathology. 2011;23(1):7–28.
22. Masten A, Cicchetti D. Developmental cascades. Dev Psychopathol. 2010;22 (3):491–5.
23. Patton GC, Olsson CA, Skirbekk V, Saffery R, Wlodek ME, Azzopardi PS, et al. Adolescence and the next generation. Nature. 2018;554 (7693):458–66.
24. Kim P, Evans GW, Chen E, Miller GE, Seeman T. How socioeconomic disadvantages get under the skin and into the brain to influence health development across the lifespan. In: Halfon N, Forrest CB, Lerner RM, Faustman EM, editors. Handbook of Life Course Health Development. Berlin: Springer; 2018. pp. 463–97.
25. Meijer M, Röhl J, Bloomfield K, Grittner U. Do neighborhoods affect individual mortality? A systematic review and meta-analysis of multilevel studies. Soc Sci Med. 2012;74:1204–12.
26. Lopez M, Ruiz MO, Rovnaghi CR, Tam GK, Hiscox J, Gotlib IH, et al. The social ecology of childhood and early life adversity. Pediatr Res. 2021;89(2):353–67.
27. Ulrich-Lai YM, Herman JP. Neural regulation of endocrine and autonomic stress responses. Nat Rev Neurosci. 2009;10(6):397–409.
28. Halfon N, Forrest CB, Lerner RM. Life Course Research Agenda (LCRA), Version 1.0. In: Halfon N. FC, Lerner R.,

https://doi.org/10.1017/9781009201704.012 Published online by Cambridge University Press

Faustman E., editors. Handbook of Life Course Health Development. Cham, Switzerland: Springer; 2018. pp. 623–45.

29. Halfon N, Forrest CB. The emerging theoretical framework of life course health development. In: Halfon N, Forrest CB, Lerner RM, Faustman EM, editors. Handbook of Life Course Health-development Science. Berlin: Springer; 2017. pp. 19–43.
30. Ungar M. Systemic resilience: Principles and processes for a science of change in contexts of adversity. Ecol Soc. 2018;23(4).
31. Suleiman AB, Dahl RE. Leveraging neuroscience to inform adolescent health: The need for an innovative transdisciplinary developmental science of adolescence. J Adolesc Health. 2017;60 (3):240–8.
32. Braveman P. What is health equity: and how does a life-course approach take us further toward it? Matern Child Health J. 2014;18(2):366–72.

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