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The Emergence of Life Course Intervention Research: Optimizing Health Development and Child Well-Being

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abstract

Advances in life course health science, systems biology, and epigenetics suggest that health development can be represented as a trajectory affected by multiple risk and protective factors arrayed in a relational developmental ecosystem across child, family, community, and systems levels. Despite tremendous potential for early life interventions at multiple levels of this ecosystem to improve children's life course health trajectories, this potential has not been fully explored. In fact, Life Course Health Development is a low priority for both health care and research funding. Representing the work of the Life Course Intervention Research Network, this supplement to *Pediatrics* reports on the first steps taken to define the emerging discipline of life course intervention research. Articles cover the characteristics of life course interventions together with a research framework and core competencies for this work. Topics include family, community, and youth engagement as vital components of grounding this work in health equity, family health development and its measurement, supporting children after prematurity, and new approaches to early childhood mental health. Schools and telehealth are considered innovative platforms for life course interventions, whereas cross-sector partnerships are recognized as key components of interventions to address childhood adversity. Researchers apply a Life Course Health Development lens to juvenile justice issues, including the minimum age law, and consider potential trade-offs whereby "striving" (education and income mobility) can limit "thriving" (health mobility) for people of color and those raised in low-income families. Finally, we present the Australian experience of embedding life course interventions in longitudinal studies.

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Life course health science is a new field that bridges disciplines (genetics, biology, physiology, sociology, psychology, epidemiology, public health, and medicine), stages of life (preconception, conception, pregnancy, early childhood, middle childhood, adolescence, adulthood, and old age), levels of inquiry (microscopic, macroscopic, individual, family, and community), and time (sensitive periods, life spans, and generations). Over the past century, its foundations were laid by social scientists who were the first to study how the rapid social and environmental changes of the industrial revolution transformed the life pathways of different generations.[1,2] Concurrently, epidemiologists and medical scientists began describing changing patterns of disease, as early-life mortality decreased in part because of better sanitation and treatment of infectious diseases while midlife concerns, such as chronic illness, psychological, social, and environmental challenges increased.[3] Although medical responses initially focused on managing disease, increased understanding of causative pathways and the role of factors such as smoking and alcohol consumption partly shifted the focus to prevention efforts, with prevention interventions often timed around adolescence and emerging adulthood. Pioneering work by David Barker and others began to point to origins even earlier in life for many of these midlife conditions. The discovery that being small for gestational age in fetal life was associated with later-life metabolic syndrome and diabetes led to the "thrifty phenotype" hypothesis in which gene expression can be modified in response to different types of environmental exposures, potentially resulting in biological and behavioral traits that persist across lifetimes and even generations.[4,5]

Halfon and Hochstein[6] built the Life Course Health Development (LCHD) model based on work by Clyde Hertzman and others[7,8] in an attempt to integrate and synthesize findings across multiple scientific disciplines to guide future research. The LCHD model was originally conceptualized as a developmentally aligned successor to Engel's Biopsychosocial Model of health and illness and a way of integrating the developmental orientation of Bronfenbrenner's ecological model of human development into a more robust and explanatory model of human health development. Updated to incorporate new findings from systems biology and epigenetics,[9–12] the authors of the LCHD model view health as a developmental capacity of individuals, with health development represented by trajectories that are affected over time by risk and protective factors arrayed in a multilayered, relational developmental ecosystem. Dynamic transactions between these risk and protective factors and a person's developing biological and behavioral capacities influence these trajectories, especially at sensitive periods in development, such as early childhood and adolescence. These processes are channeled within a "social scaffolding" of culturally linked and socially constructed pathways that influence outcomes. The study of these factors and processes is encompassed under the discipline of life course health science.

Life course approaches often resonate with child health providers. Many chose their careers at least partly because of an interest in prevention and health promotion during childhood, although only more recently has the full potential for improving long-term adult health outcomes been appreciated.[13] However, the health care system has itself been shaped by intrinsic and extrinsic forces operating over time (practical, fiscal, social, and political), which have constrained the ways health care professionals can intervene to improve the health of their patients and clients across the life span.[14] Historically, the lack of a universal health care system designed in an integrated way to support health development throughout the life span, higher payments for procedural interventions compared with preventive care, and the growth of the for-profit pharmaceutical industry have all contributed to this situation. In short, our existing system of care was designed for an era in which there was relatively little understanding of epigenetics, of LCHD, and of the potential for improvements in well-being early in life to affect later-life health outcomes. Rooted in a system designed to treat disease, the shift to a system designed to keep people healthy has been slow[15]; creating a system to actively enable health development has been even slower. A proactive health system that is "developmental by design," wherein providers regard resources to support children's health development as investments rather than expenses, would look very different from the fragmented and disconnected web of reactive illness management services in operation today. Despite committed advocacy efforts and increased attempts to coordinate pediatric primary care and public health initiatives[16] and form community partnerships,[17] child health providers remain constrained by a system that is poorly equipped to enhance health and support lifelong health development, their role largely limited to what can be achieved in brief clinical encounters.

Growing understanding of the drivers of health, especially family, community, and systemic factors

often called the "social and structural determinants of health," is integral to LCHD models, yet this recognition has not resulted in a care system where most of these factors can be readily addressed. Rather, each provider (physician, nurse practitioner, psychologist, social worker, and therapist) does what they can for individuals, sometimes achieving success on a small scale. The larger social and structural issues are reluctantly accepted as both outside their scope of professional responsibility and outside their sphere of influence. In short, providers can screen (eg, for adverse childhood experiences), and even refer, but not necessarily intervene. For many common contemporary health challenges, this approach is not working.[18] The inability to effectively address important child health issues, such as mental health and neurodevelopmental challenges, and body mass indexes in ranges associated with adverse health outcomes, means that those issues are likely to persist into adulthood and are likely to worsen rather than improve population health trends.[19,20] This situation is deeply troubling for providers and families alike and represents a profound failure of our health care systems to adapt to rapidly changing epidemiology and to respond to new scientific evidence with appropriate organizational improvements.

It does not have to be this way. The COVID-19 pandemic and racial justice movement have raised awareness of the importance of systemic factors (eg, racism) and community factors (eg, historical segregation) for health and well-being and of the interconnectedness of our potential to thrive. Strong interest exists in eliminating long-standing health disparities by understanding the pathways that lead from adversity in childhood to premature death and finding ways to disrupt them. Although it can be argued that the pandemic has also heightened awareness of social divisions in our society, a life course approach to understanding health is of interest to everyone, especially in improving understanding of ways in which remarkably inexpensive interventions early in life might prevent the need for much greater expenditures later. The authors of the LCHD approach suggest multiple new avenues of research that might shed light on the development of contemporary health challenges and disparities together with new ways to prevent them or ameliorate their effects.[9,21] Many of the issues encountered in child and adolescent health practice might be better conceptualized not as disorders but as difficulties with biobehavioral adaptation across the life span.[22] In other words, there is a mismatch between people and environments. The solutions are unlikely to lie in "silver bullet" cures or pharmacologic interventions; they may not even lie in individual therapies. Rather, the solutions lie in a creative, integrated intervention approach that not only supports individual adaptations but also incorporates family- and community-based interventions to improve the child's entire ecosystem. Interventions will need to be multilevel (with individual, family, and community components), complex, and repeated or continued over time, in contrast to the relatively simple, time-limited, single-level approaches that (with some notable exceptions) have historically characterized interventions. Research to determine whether these new interventions are feasible, acceptable, and effective will also need to embrace more complex, systems-based designs, with longer-term and/or more comprehensive and rigorous follow-up.

Given the understanding that health development is an active process[9] and that health reserves and resilience[23] accumulated early in life can buffer later health risks, finding new ways to promote health and build each child's developmental capabilities[24] deserves more research attention. Importantly, much more could be done to fortify children against adult health issues, even in the absence of any overt childhood health problems. Policymakers and stakeholders must understand that the route to health equity lies, at least in part, in studying these pathways that link events and experiences early in life with later-life health and finding ways to optimize them. Achievement of health equity will not be possible in the United States across the life span unless there is first a way to actively support "equity from the start."[25] Transforming our health system to achieve equity from the start through a purposeful design and innovation process needs to become a major national policy priority. Given what we now understand about LCHD, such a policy agenda is an important way of not only achieving higher levels of equity and assuring a healthier population, including less burden by preventable chronic health problems, but also bringing down long-term health care and other associated social costs.

The articles presented in this supplement of *Pediatrics* represent the work of the Life Course Intervention Research Network (LCIRN), a collaborative network of >75 researchers, service providers, family and community representatives, and thought leaders committed to improving life course health trajectories and outcomes for children and families. Supported through a cooperative agreement with the US Department of Health and Human Services Maternal and

Child Health Bureau, the LCIRN comprises a national coordinating center; 2 research cores focused on the themes of family and community engagement and of race, place, class, and gender; and 9 current research nodes that tackle adversity and resilience, attention-deficit/hyperactivity disorder, early childhood mental health, family health development, measurement of family functioning, school health, success after prematurity, youth justice, and youth-led participatory action research (YPAR). The network has 4 aims: (1) to develop a national research agenda that will draw on LCHD to close gaps in knowledge about how and when to intervene to have the greatest improvements on lifelong well-being for all; (2) to build the field by expanding research capacity and supporting research nodes to collaborate and implement research in key areas; (3) to accelerate the translation of research into practice and policy by building a transdisciplinary network of researchers, practitioners, family, youth and community stakeholders, and policymakers and supporting the timely dissemination of information and resources; and (4) to train researchers, especially those early in their research careers, to use a life course perspective to conduct intervention research with the aim of transforming systems. The articles in this supplement are reports of the network's first steps and serve as a starting point for conceptualizing this new approach to intervention research.

In the foreword, Foney et al[26] from the Office of Epidemiology and Research at the Maternal and Child Health Bureau outline the substantial investments made over the past decade to advance the LCHD approach and to apply it to the study of contemporary maternal and child health challenges in ways that might improve population health across the entire life span and even across generations. The first 3 articles present the initial results of the LCIRN's deliberations on key questions pertaining to building the field of life course intervention research. Russ et al[27] aim to codify the characteristics of interventions that reflect and respond to LCHD principles. The 12 characteristics include a collaborative, interdisciplinary codesign of interventions with youth, family, and community representatives; the ability of interventions to enable biobehavioral processes that support the emergence of developmental capabilities; a focus on optimizing health; and an emphasis on multilevel interventions designed to improve >1 aspect of the ecosystem in which children live, learn, play, and grow. Contemporary health issues have complex webs of causation and need more complex interventions stacked across individual, family, community, and systemic levels to address them. In a second article, Russ et al[28] combine the characteristics of life course interventions with best practices in intervention research to create a guiding framework for researchers as they plan, design, implement, evaluate, and translate life course intervention research into practice. The current version of the life course intervention research framework is divided into 5 stages of conceptualization and planning, design, implementation, evaluation, and translation/spread and scale, each with a series of detailed steps that incorporate characteristics of life course interventions to guide intervention research from inception to completion. As presented by the authors, the framework represents just the first iteration in an ongoing process of refinement to support high-quality life course intervention research. Hotez et al[29] outline a series of core competencies to support researchers to conduct successful, high-quality life course intervention research. Competencies include the capacity to codesign effective research questions and interventions to address complex topics with stakeholders as well as project management, communication, and team-building skills essential in any team-based research endeavor.

Forming effective partnerships with family, community, and youth representatives is a critical aspect of life course intervention research, not just in terms of codesigning interventions but also in gaining a full understanding of the lived context in which an intervention will be delivered. Hoover et al[30] suggest ways in which life course researchers can more effectively engage families and communities in all stages of intervention studies. Going farther, they make a compelling case for the way in which family and community engagement could contribute to building health equity and eliminating health disparities. By ensuring that the families and communities most affected by a proposed intervention participate as equal partners in the intervention's design and implementation, researchers can develop interventions that are more equitable and effective for those who might benefit most while maintaining the flexibility to be culturally and socially responsive. For example, partnering with people who have experienced racism or other forms of social discrimination can help researchers to identify and address bias in intervention design and delivery, improving the quality and effectiveness of their interventions. Ozer et al[31] offer YPAR as a novel way for youth and researchers to collaborate on

interventions designed for this pivotal stage of life in ways that benefit the youth who work as active members of the research team, as well as the intervention recipients who benefit from these fresh perspectives. This collaboration is particularly important given the growing global trend in youth-led community interventions.

Life course intervention researchers recognize the unique role that families play as incubators, transmitters, and shapers of early health development and aim to enhance family resilience and create buffers to shield children from adverse experiences. Feinberg et al[32] outline a model of family health development that builds toward a new theoretical framework to guide research. The ways in which families support the health development of their child and adult members, or function in ways that pose risks to individual well-being, is an area in need of much additional research. To this end, Ramaswami et al[33] performed a scoping review of measures of family functioning that could be used in life course research both to monitor change over time and to measure responses to interventions. Of 50 measurement tools identified, only 46% measured belief systems and only 54% communication processes, suggesting that opportunities remain to develop or refine measures of family functioning that are more compatible with a life course perspective.

One of the enduring unsolved challenges that most exemplifies the need for an LCHD approach to intervention research is the disparity in outcomes for premature babies who are both biologically and socially vulnerable. One recent California-based study found that Black babies born at 32 to 36 weeks gestation are 60% more likely to die after discharge from the hospital than White babies and that Black and Hispanic very-preterm babies are more likely to be rehospitalized.[34] Many factors likely contribute to this picture, including a need to ensure antiracist care, and clearly, a transformative approach is needed to better support the early life course of these infants. Acknowledging the pivotal role of families, McKenzie et al[35] consider the best ways in which to scaffold parenting, child health, and developmental interventions so that all preterm infants flourish and enter kindergarten ready to learn. Recognizing that >50% of infants born prematurely face at least 1 significant neurodevelopmental challenge by the age of 7 years, they explore how new approaches to coordinated community partnerships and enhanced parent engagement could contribute to improving school readiness and health equity over the life course. In the last article in this section, Buka et al[36] make the provocative case that "the family is the patient," seeking to shift the focus of early childhood mental health interventions to multilevel initiatives that address family functioning and the community context.

Life course interventions are not confined to medical settings but include physical spaces, such as schools, and virtual spaces through telehealth. Wong et al[37] explore the possibility of schools as transformative platforms for turning vicious cycles of risk into virtuous cycles of health development. Developers of school-based interventions who rethink ways to address common developmental challenges could improve both health development trajectories and educational outcomes, potentially changing lives for the next generation of parents. Barkin et al[38] then consider the potential for using the tools of today, including telehealth, to advance the life course interventions of tomorrow. Direct-to-patient video telehealth opens up the possibility of, with family permission, assessing the home setting and using that contextual information to tailor any intervention so that it is potentially more effective for each patient/family.

The next 3 articles consider interventions at the systems and policy levels. Liu et al[39] present a framework for cross-sector interventions to address childhood adversity, resilience, and life course health. They emphasize one of the key characteristics of life course interventions: that they be horizontally, vertically, and longitudinally integrated across services and systems. Authors of effective interventions that address adverse childhood experiences, a priority from a health equity perspective, need to incorporate strategies that operate across the dimensions of time and place and at individual, family, and community levels to address complex social and biological patterns of risk. Barnert et al[40] apply an LCHD lens to Canada's Youth Justice Minimum Age Law under which no child age <12 years can be charged with a crime. Using the principles of LCHD,[10] they give a thoughtful analysis of the impact of Canada's approach, contrasting it with the United States where many states do not have a comparable law. They consider whether the youth justice system intervenes in young people's life trajectories in a developmentally focused way that is responsive to what we know about LCHD. If not, what changes could and should be made? In the final article of this section, Chandler[41] reflects on the relationship between "striving,"

characterized by educational and income mobility, and "thriving," which in this context refers to mobility in mental and physical health across generations. In 2 growing bodies of research known as "diminished health returns" and "skin-deep resilience," researchers suggest that striving (ie, education and income mobility) can limit thriving (ie, health mobility) for people of color and those raised in low-income families.[42,43] Policies to improve educational and occupational opportunities may need to be accompanied by policies aimed at optimizing the developmental scaffolding that supports children on the striving journey to improve their well-being and achieve true equity.

Finally, we welcome a guest perspective from outside the LCIRN. Wake et al[44] reflect on the Australian experience of launching GenV, an ambitious study that offers enrollment to all children born in the state of Victoria and their parents from 2021 to 2023. They discuss the opportunities and challenges of embedding intervention studies within this population-wide longitudinal cohort study, suggesting that despite the inherent difficulties and potential trade-offs, trials and cohort studies indeed belong together, representing a powerful tool in the life course intervention research toolbox.

Life course intervention researchers seek to find new ways to address health problems. The articles in this supplement represent just the beginning of work in this emerging discipline, reflecting the progress of the LCIRN in its first 30 months of operation. The authors of these topics break new ground or suggest new ways of thinking about long-standing health issues. Determining how and when during the life course to intervene to optimize health development trajectories could have transformative effects on population health, but this research is not easy. In many of the articles here, the authors raise as many questions as they answer. As in any new endeavor, there are tensions. Ensuring that families, community members, and youth partner with investigators at every stage of intervention development requires a major change in the way research is funded, organized, and conducted. The need to discover and deliver different approaches to optimizing health development will require new types of measures, research methodologies, and analytic strategies. Some researchers argue for more observational research and a greater understanding of pathways and processes before intervening; others see a need for immediate action based on what we know. Some see model building and testing as the only valid route to understanding and intervening in a complex system; others see a much greater role for exploratory studies with detailed evaluation and documentation of the impact of an intervention on the system itself. Rather than avoiding these tensions, or seeking to resolve them prematurely, the LCIRN seeks to harness them as a source of creativity and energy through which new research questions are suggested and new solutions found.

The LCIRN has had some notable successes. In addition to the >75 researchers actively involved with our leadership structure and research nodes, a regular newsletter connects and informs 2000 researchers and stakeholders nationally who engage with our web-based tools and resources. Already, our research nodes have submitted 1 R34 and 9 R01 applications for National Institutes of Health funding. Our YPAR node has a national network of >20 researchers committed to studying youth participation in research. In its inaugural year, our LCIRN Scholars program has recruited 8 early-career life course intervention researchers from diverse backgrounds.

Significant challenges still remain. The logistics of engaging family and community representatives at the conceptualization stage of research studies and of ensuring that they are appropriately compensated have not been fully resolved. Despite efforts on multiple fronts, the diversity of our steering committee and advisory board structure is not representative of the US population. The research proposed by some of the nodes does not fit neatly into a typical National Institutes of Health or foundation grant structure, being neither amenable to randomized controlled trials nor "implementation ready" with the immediate potential to improve recipients' health. Indeed, much of the planning and conceptualization work for intervention studies does not fall neatly into any funding strategy. This very real problem is one that we believe is vital to address now if forward progress is to be made. Although a full exploration of potential solutions to this problem is outside the scope of this supplement, we hope that raising this issue will spark discussion among both public and private funding entities and even stimulate trials of new funding streams for intervention research planning. So, we press forward, although sometimes this requires taking a step back. For example, before prioritizing topics for intervention research, we need to first address our process for prioritization and ensure that a large and diverse group guides that process moving forward.

Life course intervention research is an approach to studying and changing complex adaptive systems.

It moves beyond a linear process of connecting the dots between early- and later-life health to a recognition that the pathways underlying the development of our most persistent health problems and patterns of health inequity result from complex, nonlinear, and multiple processes whose modification will likely require complex, nonlinear, and multiple intervention strategies.[45] The principles of LCHD (health development, unfolding, complexity, timing, plasticity, thriving, and harmony) derived from a research synthesis of life course health science indicate how health develops within complex family, community, and policy systems in ways that show remarkable developmental plasticity and, hence, potential mutability in response to well-conceived and well-designed interventions.[9,11] These LCHD principles can help to inform how interventions are developed, targeted, and designed to have an optimal impact on lifelong health trajectories. Simple intervention strategies will need to yield to more complex and comprehensive approaches that integrate interventions across individual, family, and community levels and across time to improve population health. Complex systems analyses may reveal pivot points in systems that should be a priority for these interventions.

Clearly, the LCIRN is at the beginning of what will be a very long process of changing the way we think about intervention research. Through the collaborative use of incremental, disruptive, and transformational strategies, the LCIRN aims to improve the development of health, reduce health disparities, and build health equity across the life span. Recognizing that there is much still to be learned, we hope that these articles spark discussion and debate. They are presented not as conclusions but as representations of work that will continue to evolve. That work will be informed by the results of nascent intervention studies by the LCIRN research nodes and elsewhere and by the further development of life course theory. The work presented here is intended to be provocative and to spark debate. We welcome new members to join the network and to become active contributors to our nodes (https://lcirn.ucla.edu). This supplement is a first step toward defining the emerging discipline of life course intervention research and establishing its place in efforts to improve child health.

ABBREVIATIONS

LCHD: Life Course Health Development
LCIRN: Life Course Intervention Research Network
YPAR: youth-led participatory action research

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