



## Editorial

## Implications of Adolescence for Adult Well-Being: 25 Years of Add Health Research



The National Longitudinal Study of Adolescent to Adult Health (Add Health) has been a data treasure for understanding the implications of adolescence for adult health and well-being. Add Health is a nationally representative U.S. sample of more than 20,000 adolescents in grades 7–12 in 1994–1995 who have been followed for 25 years to early midlife over five interview waves [1]. Novel features of the Add Health study make it especially rich for understanding the long-term consequences of adolescent contexts and behavior, both risky and resilient, on health and well-being into early midlife. The innovative multilevel design collected direct measures of the social contexts of adolescent and young adult life, including school, peer network, friendship, romantic dyad, family, neighborhood, and community contexts. Developmental outcomes in health, health behaviors, cognition, achievement, and relationships are tracked across the key life stages of adolescence, early adulthood, young adulthood, and early midlife. Biological data have been integrated into the longitudinal waves of data collection appropriate to the developmental stage of the cohort and relevant biosocial processes. Add Health furthermore portrays the full diversity of the U.S. population for this cohort with national representation of all population subgroups by gender, race, ethnicity, immigrant status, sexual identity, socioeconomic status (SES), and geographic location. This supplement issue of the *Journal of Adolescent Health* includes literature reviews of the major topical areas of research findings in Add Health. Below we describe in more detail the data and design of Add Health to provide a background for the reviews.

Add Health used a school-based design in which 80 high schools and a paired feeder school was selected from a list of all high schools in the United States in 1994. An in-school questionnaire was administered to more than 90,000 students in grades 7–12 who attended these schools during the 1994–1995 school years, and school administrators also filled out a questionnaire about the school. From the school rosters, a grade-stratified and gender-stratified sample of adolescents and one of their parents was selected from each school pair, representing a self-weighting nationally representative main sample of 12,105 American adolescents in grades 7–12 in

1994–1995. Based on responses to the in-school survey, specific subpopulations were oversampled for research on vulnerable and otherwise rare populations, including ethnic (Cuban, Puerto Rican, and Chinese), genetic relatedness to siblings (identical/fraternal twins, full/half siblings, and unrelated adolescents living in the same household), adoption status, and disability samples. Black adolescents with at least one college-educated parent were also oversampled. For two large schools and 14 small schools, interviews with all enrolled students were attempted to create a saturation sample. The main sample plus the special samples yielded a total of 20,745 adolescents. The Wave I in-home sample represents the national cohort of adolescents in grades 7–12 in the United States in 1994–1995 that is followed prospectively.

The Add Health multilevel design facilitated direct measurement of the social contexts of adolescent life [2,3]. School context data come from the school administrator and in-school survey in which all students participated. Peer network data come from respondent nominations of friends and romantic and sexual partners from school rosters during the Wave I in-school and in-home survey, enabling researchers to link survey and other data of nominated peers who were also participating in Add Health to the Add Health respondent [4]. The peer (up to 10 friends were nominated in the in-school survey) and dyad context data constitute the social network data, including information on friendship networks, sexual networks, and friendship and relationship dyads [5–8]. Extensive extant neighborhood-level and community-level data have been merged to individual records using the respondent's address. Family-level data come from parent interviews and siblings in the sample. This multilevel design provides unprecedented opportunities to explore the role of social environments, including the family, neighborhood, community, school, friendships, peer groups, and romantic relationships, in trajectories of health and human development from adolescence to midlife.

The Wave I in-home adolescent cohort has been followed for 25 years in four subsequent waves in 1996 (Wave II, ages 13–20 years), 2001–2002 (Wave III, ages 19–26 years), 2008–2009 (Wave IV, ages 24–32 years), and 2016–2018 (Wave V, ages 33–43 years) [1]. Several supplemental samples have been gathered across the waves. A supplemental sample of 1,507 partners of Add Health respondents were randomly selected during the Wave III in-home interview and interviewed, filling quota samples of about 500 married, 500 cohabiting, and 500

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dating partners [9]. The Add Health Parent Study completed a 20-year follow-up of a subset of the parents of Add Health respondents during 2015–2017 [10,11].

Information on respondents' social, economic, psychological, and physical well-being appropriate to their developmental stage has been gathered over time. Biological data have been collected across waves, including height and weight at all waves, DNA beginning at Wave III, saliva and urine specimens to test for sexually transmitted infections and HIV at Wave III, and an expanded set of anthropometric, cardiovascular, metabolic, inflammatory, immune, renal, and pharmacoepidemiologic measures, and additional genomic markers, at Waves IV and V [12–14]. The longitudinal multilevel design of Add Health provides a biosocial data resource that spans society to cells and everything in between for integrative, transdisciplinary research [15,16].

This supplement issue has assembled reviews by leading scholars who have used Add Health data extensively to conduct research in six topical areas including substance use, violence and victimization, sexual behavior and health, union and family formation, mental health, and physical health. These topics represent the most heavily researched areas using Add Health data based on our review of the 4,600+ peer-reviewed publications across hundreds of different disciplinary journals. Authors of the reviews were asked to focus on central themes of Add Health research that exploited the key design features of Add Health, prioritizing longitudinal analyses, the role of social context in health and behavioral outcomes across the life course (e.g., neighborhoods, schools, parents, peers, romantic partners, policies), research that uses a biosocial design integrating biological and/or genetic data with social and behavioral data, and research that explores the diversity of developmental and health processes as per age, sex/gender, race/ethnicity, immigrant status, sexual minority status, and geographic location. Below we provide brief overviews of review authors' key insights about Add Health research in their topic areas and end with future opportunities for research using the Add Health data.

### Substance Use

Substance use is a longstanding and increasing public health challenge in the United States. Add Health data have facilitated a more rigorous examination of the complex and interacting factors that contribute to substance use, through longitudinal design, extensive and repeated survey items regarding substance use, and the collection of biological and contextual data that cross multiple domains. In "An illustrative review of substance use-specific insights from the National Longitudinal Study of Adolescent to Adult Health" Austin et al. summarize illustrative articles from the extensive research that has used Add Health data to study substance use, and its implications, across the life course [17]. They find significant linkages between a variety of adverse experiences and both concurrent and later substance use. Austin et al. also demonstrate important linkages between a key contributor to health, economic stressors such as downward social mobility, and substance use. Their review highlights the ongoing discussion about the likely bidirectionality of relationships between substance use and mental health in particular. Austin et al. also report research about protective and resilience factors in relation to substance use, such as connectedness to parents, schools, and prosocial peers. The diverse Add Health sample has allowed for examination of substance use trajectories

across the life course, noting differences by race/ethnicity, gender, and sexual orientation that can inform prevention and intervention efforts. Demonstration of the multilevel complexity of factors that both contribute to and protect from problematic substance use underscores the need for inter-related individual and systemic approaches to improve substance use prevention efforts, an important direction for future research.

### Violence Exposure

In "Exposure to Violence and Victimization: Reflections on 25 Years of Research from the National Longitudinal Study of Adolescent to Adult Health," Turanovic uses a multilevel framework to examine findings from Add Health related to exposure to violence and the ways that such exposure can alter development [18]. As the author notes, the scope of violence assessed in Add Health is quite broad, as is the contextual lens, providing opportunities for both focused and intersectional examination of violent experiences. She notes that individual characteristics such as risky behavior and heightened vulnerability (e.g., linked to disability) are associated with violence experiences and tend to be the focus of much of the violence research using Add Health. However, contextual factors such as peer networks, family relationships, and broader neighborhood factors are also key. Turanovic comments "Add Health research has reinforced that violence is a product of individual and family disadvantages that are rooted in community structural problems." As with substance use, Add Health's longitudinal design allows for a life course examination of patterns of violence experiences and their consequences. Turanovic cites research linking violence experiences to mental health and physical health as indicated by somatic symptom reports and biomarkers capturing sequelae of chronic stress and weathering. A potential consequence of violence that is life changing, but perhaps less often considered, is precocious role transitions out of adolescence. Non-normative transition points have the potential to change trajectories in education, social networks, and family formation, for example, that have significant developmental and health outcomes. Furthermore, characteristics such as race, gender, and cultural context affect the potential implications of violence. Turanovic concludes that the design strengths of Add Health continue to provide opportunities to address ongoing gaps in this literature such as identification of "age-graded" risk and protective factors and the implications of timing and sequencing of violent experiences for adverse outcomes.

### Sexual Health and Behavior

In a third review article, "Sexual Behavior and Health from Adolescence to Adulthood: Illustrative Examples of 25 Years of Research from Add Health," Vasilenko provides illustrative findings related to both the prediction of sexual behavior and the consequences of various developmental patterns [19]. She notes that the prospective longitudinal data available in Add Health provide an opportunity to approach the onset and patterns of sexual behavior as a normative developmental process, in addition to the historically more common risk behavior perspective. Vasilenko provides information about the prevalence of multiple sexual behaviors across the life course and diverse patterns of sexual initiation. Again, the diversity of the Add Health sample allows researchers to investigate differences in behavior and consequences linked to gender, race/ethnicity, and sexual

orientation. Taking advantage of the multiple levels of information collected by Add Health, researchers of sexual behavior and romantic relationships, like those who study the other topics reviewed in this supplement, can investigate the many contextual factors that interact with individual and social characteristics to contribute to sexual development. Contextual factors include family, peer, school, and neighborhood factors and partners. As Vasilenko notes, the strengths of Add Health have facilitated documentation of the many contributors to sexual patterns and unintended outcomes such as sexually transmitted infections and pregnancy and demonstration of the absence of long-term effects for some outcomes (e.g., mental health) and the complex implications for other aspects of relationship health. Vasilenko concludes by highlighting underused aspects of Add Health such as dyadic data at Waves I and III and opportunities to learn about sexuality across broad spans of the life course.

### Union and Family Formation

Similar to the research on sexual health and behavior, a strength of Add Health is its prospective longitudinal data on union and family behavior including dating, cohabitation, marriage, and childbearing among a diverse and contemporary nationally representative cohort of young people. In “Union and Family Formation during Young Adulthood: Insights from Add Health,” Brown reviews Add Health research on the trends, precursors, and health consequences of union and family formation, commenting that much of what we know on these topics come from Add Health [20]. Illustrative findings on patterns of union and family formation provide continuing evidence of a retreat from marriage and increases in cohabitation and non-marital childbearing. Brown highlights how the unique design features of Add Health contribute new knowledge in several areas. The detailed partnership histories for both different-gender and same-gender relationships have expanded the “knowledge base on the dynamics of same-sex partnerships during young adulthood.” The racial and ethnic diversity of the sample has produced research that examines both group differences and within group variation in family behaviors. This is invaluable, Brown notes, because the longstanding racial and ethnic differences in cohabitation, marriage, and childbearing, coupled with the growth in the non-White and multiracial population, underlie increasing levels of interracial unions, including intermarriage and childbearing. Brown reviews research that explores how the social contexts of adolescent life influence subsequent union and family formation patterns, citing findings on the importance of the number, types, and developmental timing of family structure change; neighborhood mate selection opportunities; and teen romantic and sexual experiences that result in continuity between adolescent romance and young adult union formation. She concludes that early marriage seems to offer few health benefits and cohabitation does not seem to confer health advantages either but that it will be important to assess the long-term consequences of early union formation as the cohort ages.

### Mental Health

In “25 Years of National-Level Research on Adolescent and Young Adult Mental Health,” Crosnoe and Thorpe use both a developmental and population perspective in their review of Add Health findings on two indicators of mental health: depressive

symptoms and suicidal ideation [21]. In their developmental framework, the authors reviewed research that considered mental health as a dynamic trajectory that unfolds over time, occurs within ecological contexts, and is influenced by genetic processes with attention to gene x environment interplay. They incorporate a population lens of mental health by focusing on disparities research as per sociodemographic characteristics, including race, ethnicity, gender, sexuality, immigrant status, and SES. Findings on developmental trajectories of mental health suggest an average pattern whereby depressive symptoms tend to decline after adolescence but begin to creep back up as the cohort reaches their mid to late 30s, but the pattern varies for men and women. Crosnoe and Thorpe show, however, that the use of different methodologies in studying trajectories may result in different patterns. Research on ecological influences in mental health development indicates the importance of family context (e.g., family belonging, closeness with parents) and documents school and peer contagion patterns of suicide ideation and depressive symptoms. The authors describe how “mental health issues can become a feature of schools, not simply an individual condition, which is not surprising given that adolescence is a developmental period of heightened susceptibility to social influence in an institutionalized setting that is an arena for such influence to play out.” Pointing out the value of longitudinal data, they also cite findings in which the relationship between social contexts and mental health may shift across stages of the life course. For example, among girls, dating in adolescence was found to be associated with higher depressive symptomatology, whereas in young adulthood, the mental health risks of dating faded. From a population perspective, the authors highlight research that has exploited the rich diversity and large sample size of Add Health, enabling finer-grained analysis of mental health disparities, including research on the intersections of race, ethnicity, and gender; LGBTQ status; immigrant generation; and the interaction between social context and genes. Crosnoe and Thorpe conclude by encouraging a translational role in future research on mental health to identify levers of mental health intervention.

### Physical Health

In the final review article, “Explaining Physical Health Disparities and Inequalities over the First Half of the Life Course: An Integrative Review of Add Health Studies,” Wickrama et al. structure their review of research on physical health as per the research design and methods employed in illustrative studies [22]. They focus in particular on pathways linking early socioeconomic adversity in childhood and adolescence to physical health outcomes in young adulthood. Physical health measures based on biomarker data are primarily available in later waves of Add Health, when the cohort was in their late 20s and 30s, thus most research using biomarker data to measure such outcomes as diabetes, hypertension, adiposity, and inflammation exploit the longitudinal data to identify early life course predictors in developmental pathways that influence physical health in adulthood. Wickrama et al. also reviewed research that studies trajectories of physical health across the life course, including self-reported health and body mass index and obesity, which are measured across all waves. The authors summarize association studies that explore the role of socioeconomic adversity in social-ecological context (e.g., school, community, and family contexts) and individual characteristics (e.g., genes, birth weight,

breastfeeding early health problems) in early life in relation to trajectories of health or later life physical health, noting consistent findings of worse health with greater early life adversity. They then summarize extensive research that models the pathways through which early life factors influence physical health to explain health disparities, including physiological (e.g., self-rated health, physical pain, body mass index), stress (e.g., psychological distress, health behavior, victimization), and resource (e.g., social integration, self-esteem, educational attainment) mechanisms. The authors note other important research on physical health that examines the moderating role of individual resources/vulnerabilities as factors that can protect against or amplify health inequalities stemming from social-ecological context and individual characteristics. They conclude by advocating for continued longitudinal analysis of continuity and change in pathways of physical health over the second-half of the life course.

There are several exciting new opportunities on the horizon for future research in Add Health. The Sexual Orientation/Gender Identity, SES, and Health across the Life Course study will disseminate new data in early 2023 on sexual and gender diverse individuals (i.e., “individuals who identify as or exhibit attractions to people outside of the traditional male-female gender binary”) [23]. The sample (N = 2,614) includes a subset of the Add Health cohort including individuals who report same sex romantic or sexual activity, identify as something other than heterosexual, whose sex assigned at birth and gender identity are discordant, or are gender nonconforming, and a comparison sample of cisgender heterosexuals. The new data will add information about formative experiences more specific to sexual orientation and gender development and enhance existing prospective information about SES and determinants of SES. SES is a fundamental contributor to health and disease across the life course, yet is understudied in these populations. Given its large and diverse population-based sample, its early measurement of sexual orientation, and long-term prospective longitudinal data, Add Health is an ideal study to build our knowledge base about the factors that underlie well-documented disparities.

Add Health has pioneered the collection and dissemination of genetic data for social and health sciences research from its origins [16,24]. Genome-wide Single Nucleotide Polymorphism data were generated from archived saliva samples collected at Wave IV from more than 11,000 young adult respondents and deposited into the database for Genotypes and Phenotypes. Using the summary statistics from published Genome-Wide Association Studies, Add Health has constructed and released an inventory of polygenic scores, facilitating unprecedented opportunities to explore gene by environment interactions in biological processes using the rich longitudinal contextual data in Add Health [25–28]. Additional genomic data are in process and will be disseminated to the scientific community in the coming years. Based on a venous blood draw during the Wave V interview in 2016–2018, gene expression (mRNA) data have been sequenced and epigenome-wide (DNAm) data have been generated for the subset of Add Health participants who provided blood (N~4,800). With gene expression and epigenetic data, researchers will have the rare opportunity to model how environmental exposures across the life course affect epigenetic processes and, in turn, gene expression in developmental pathways, while controlling for fixed DNA profiles.

From the Wave V venous blood, Add Health assayed novel “biomarkers of aging” to gain an insight into early aging

processes involving immune dysregulation and inflammation and early indicators of potential cognitive decline. Immune and inflammatory biomarkers included C-reactive protein, IL-6, IL-10, and TNF- $\alpha$ , interleukins, and cytokines associated with immune-related processes (e.g., generalized inflammatory response, suppression of immunity, and complement pathways) that have also been implicated in cognitive impairment and Alzheimer’s Disease [29,30]. Biomarkers of neurodegeneration and neuropathology included neurofilament light and Tau, both of which have been shown to be early predictors of neural dysfunction, cognitive impairment, and eventual dementia [31,32]. These biomarkers of immune dysregulation and neural dysfunction make it possible to identify those at risk of future disease and cognitive impairment in early midlife, before disease and impairments are manifest. Add Health biomarkers of aging will be released in 2023.

In the Wave V survey, Add Health gathered data on state of birth and attempted to collect birth records of respondents who were born in a subset of six states. Add Health has harmonized data from birth records across these states and will begin to release these data in 2023, including such measures as respondents’ birthweight, gestational age, method of delivery, Appearance, Pulse, Grimace, Activity and Respiration scores, age and education of mother, and any complications of birth.

When Add Health was fielded in the mid-1990s, increasing public and scholarly attention was turning to racial and ethnic disparities in health. In 1998, President Clinton launched the “President’s Initiative on Race” in which he committed federal funds to eliminate racial and ethnic disparities in health by the year 2010. In response, the National Institutes of Health developed an National Institutes of Health-wide strategy to promote research on the sources of health disparities, focusing in particular on inequitable opportunities and treatment of racial and ethnic minorities. Over the following decades, Add Health data have been used to advance knowledge on individual and contextual factors in health disparities. The burgeoning health disparities research has furthermore increased our awareness of the role of structural factors that operate in and across our societal institutions of criminal justice, education, labor force, and housing and contribute to the pernicious persistence of disparities over the 25 years of the Add Health Study. This progression of knowledge has led to the development of new extant data sources of structural racism measured at multiple levels of society that are being merged to all possible waves of Add Health data. The release of these new measures in the coming years will make possible novel multilevel analyses of racial and ethnic disparities in health.

This series of reviews of Add Health research highlights how innovative aspects of Add Health’s design have been used to broaden our holistic understanding of multiple health and developmental topics over the life course from adolescence to early midlife. These reviews describe illustrative findings and do not capture the full impact of Add Health in advancing scientific knowledge on how adolescent contexts, experiences, and behavior impact adult health and well-being. To date, more than 4,600 peer-reviewed publications and 175 books and book chapters have been published using Add Health data, to which more than 350,000 citations have been made. Add Health is an ongoing study; data collection in Wave VI is underway as the cohort is moving through their 40s. As a developmental period of change and plasticity, understanding how early life experiences play out over time provides

impressive opportunities to document how adolescence matters for longer-term health and well-being—the fundamental goal of the Add Health study.

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Kathleen Mullan Harris, Ph.D., M.A.

*Department of Sociology and the Carolina Population Center  
University of North Carolina at Chapel Hill  
Chapel Hill, North Carolina*

Carolyn Tucker Halpern, Ph.D., M.A.

*Department of Maternal and Child Health  
Gillings School of Global Public Health and the Carolina Population Center  
University of North Carolina at Chapel Hill  
Chapel Hill, North Carolina*

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