



# Squaring the Curve of Cardiovascular Health From the Beginning of Life

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In 2010, the American Heart Association (AHA) set strategic impact goals for 2020, with a bold new focus on promoting cardiovascular health (CVH), moving beyond simply preventing cardiovascular events. Ideal CVH was defined positively as the simultaneous presence of 4 ideal health behaviors and 3 ideal health factors, collectively known as “Life’s Simple 7”: healthy diet, optimal physical activity, nonsmoking, healthy BMI, and optimal levels of blood pressure, cholesterol, and glucose.<sup>1</sup> Ideal CVH in adulthood is prospectively associated with substantial reductions in all-cause mortality, cardiovascular disease events, and all the chronic diseases of aging; compression of morbidity; better cognition, mood, and quality of life; and reduced health care costs.<sup>1,2</sup> However, ideal CVH is exceedingly rare in adults: <1% of US adults (age  $\geq 20$  years) have all 7 and just 5% have 6 CVH metrics at ideal levels.<sup>2</sup>

In 2016, the AHA published a scientific statement regarding pediatric CVH to review the current US status of CVH, underscore its significance, and clarify its measurement in children and adolescents.<sup>3</sup> By ages 6 to 11 years, one-third of US children have lost ideal status for BMI, and this loss is a key initiator of risk development and further decline in CVH.<sup>2</sup> By ages 8 to 11 years, only 39% have 3 of 4 measured CVH metrics (diet, BMI, blood pressure, and cholesterol) at ideal levels; ideal diet is most rare (<1%).<sup>4</sup> For US adolescents ages 12 to 19 years, 41% have  $\geq 5$  of the 7 CVH metrics at ideal levels, compared with 17% of US adults.<sup>2</sup> The distribution of CVH is thus more favorable in US children compared with adults, but the majority of children do not have ideal CVH, and CVH worsens with age.

Current normative aging in the United States thus delivers most children to young adulthood with a depleted stock of CVH. Our challenge is to extend the “health span” of the current generation of children by squaring that CVH curve: that is, maintaining a high stock of CVH from birth throughout childhood and adulthood, with a short (compressed) period of morbidity before death in old age (Fig 1).

Primordial prevention, or preventing the development of risk factors rather than waiting to prevent clinical events once risk factors develop, is key to achieving this goal.<sup>3</sup> Although CVH can be modified, it is widely known that following beneficial lifestyle patterns is more difficult in

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Dr Perak conceptualized and designed the work, drafted the initial manuscript, and reviewed and revised the manuscript; Drs de Ferranti and Marino helped design the work and critically revised the manuscript; and all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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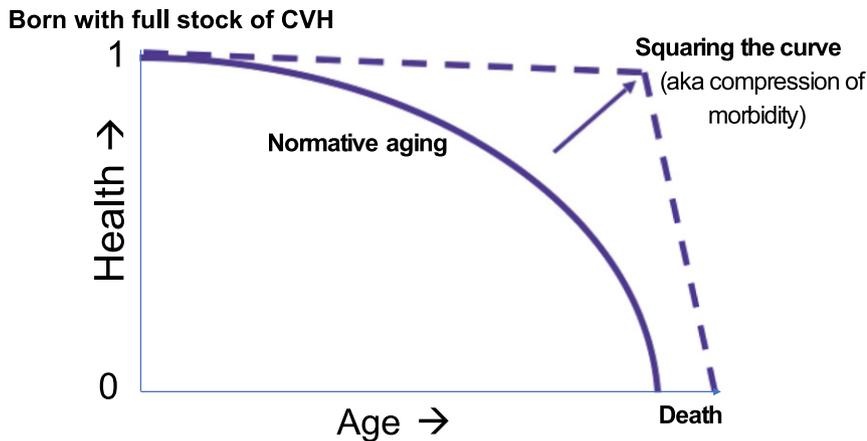
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**FIGURE 1**  
The cardiovascular health curve. In contrast to the steady decline in health that defines normative aging, squaring the curve requires maintaining high levels of cardiovascular health from birth throughout childhood and adulthood, with a compressed period of morbidity before death in old age. aka, also known as; CVH, cardiovascular health.

adulthood than in childhood, that moving from harmful to protective lifestyle behaviors is harder than maintaining protective patterns, and that pharmacologic control of risk factors cannot fully restore the low-risk state of ideal CVH. Conversely, children who reach adolescence with a greater number of CVH metrics at ideal levels have lower risks of hypertension, metabolic syndrome, elevated low-density lipoprotein cholesterol, and high-risk carotid intima-media thickness in adulthood (21 years later).<sup>5</sup> Moreover, those who make it to adulthood with ideal CVH enjoy the full range of benefits in mortality, morbidity, quality of life, and costs.<sup>1,2</sup> We as pediatric providers, advocates, and scientists can play a critical role in squaring the curve of CVH by helping children and their families recognize the importance of preventing its progressive loss during childhood and adolescence.

To achieve this, we need the 3 M's: we must be able to Measure, Monitor, and Modify CVH at the beginning of the life course. After infancy, measurement of Life's Simple 7 is generally

straightforward and applicable to a broad range of pediatric patients. Each metric can be characterized as poor, intermediate, or ideal on a 0-to-2-point scale (Supplemental Table 1)<sup>3</sup> to provide a summary score of 0 to 14 points that is readily understood by families. A modified score can be calculated for younger children, in whom cholesterol and glucose are generally not measured. Given the stepwise improvement in outcomes with greater CVH scores,<sup>2,6</sup> children and their families should be encouraged to strive for the highest score possible. Monitoring of CVH over time can be accomplished by repeating the scoring process at each subsequent visit throughout childhood (eg, with an electronic medical record-based tool), which provides a platform for clear and consistent messaging about lifestyle recommendations. For example, the smoking metric provides an opportunity to assess and address secondhand smoke exposure at ages before child smoking becomes relevant. Modification of CVH trajectories in childhood is also possible. In the Special Turku Coronary Risk Factor Intervention Project for

Children trial, children randomly assigned to repeated dietary counseling from infancy through adolescence had higher CVH scores compared with control participants, and a high CVH score was in turn associated with a 44% reduced risk of having high aortic intima-media thickness.<sup>6</sup>

Admittedly, the CVH construct is not yet perfect. First, cut points for categorization of Life's Simple 7 in children rely on population percentiles rather than association with disease outcomes, such as myocardial infarction or stroke. This is a general limitation for cardiovascular risk factors in childhood<sup>7</sup> rather than specific to CVH. Second, direct application of the metrics may be challenging at the youngest ages. For example, healthy diet criteria are clear but must be scaled for caloric intake, and physical activity is hard to quantify in toddlers. Third, Life's Simple 7 metrics as currently defined exclude some exposures that may be particularly important in childhood, such as sleep patterns, screen time, secondhand and electronic cigarette smoke, neurodevelopmental health (executive functioning, behavioral regulation, and attention), and social environmental factors (eg, adverse childhood experiences and stress).

Still, the concept of CVH is here to stay. Development of the AHA 2030 Strategic Impact Goals is underway, and refinement of Life's Simple 7 is likely to be part of that process. The AHA has also recently funded Strategically Focused Children's Research Network centers to fill the early-life gaps in our understanding of CVH. But as pediatric providers, advocates, and scientists, we need not wait. We have always promoted prevention, and we can work to combat systemic threats to

CVH in childhood, preserve what precious stock of CVH is present, and restore it where it has been lost. We will learn how to best measure, monitor, and modify Life's Simple 7 from the beginning of life. Delivering our children to adulthood with ideal

levels of these metrics is the first necessary step if we are to square the curve of CVH.

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#### ABBREVIATIONS

AHA: American Heart Association  
CVH: cardiovascular health

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