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Achieving Cardiovascular Health in Young Adulthood Which Adolescent Factors Matter?

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Introduction

Individuals who reach middle age without major cardiovascular disease (CVD) risk factors have a longer life expectancy than age-matched peers.^{1,2} In 2010 the American Heart Association defined “ideal cardiovascular health (CVH)” as the simultaneous presence of three physiologic *factors* (optimal levels of total cholesterol, blood pressure, and fasting glucose without use of medication) and four health *behaviors* (non-smoking, normal body mass index (BMI), adequate physical activity, and healthy diet).³ Unfortunately, while most children are born with ideal CVH, few American adults maintain this healthy state.⁴

Young adults with healthier behaviors are more likely to reach middle age with optimal blood pressure, cholesterol, and glucose levels⁵ and less coronary calcium.⁶ Less is known about childhood factors that promote CVH during the transition to young adulthood. The number of ideal CVH metrics at age 12–18y predicted CVH in adulthood in a Finnish cohort,⁷ but CVH has not been assessed in longitudinal cohorts with greater economic and racial/ethnic diversity. The purpose of this study was to quantify associations between healthy behaviors measured in adolescence and optimal physiologic CVH in young adulthood in a diverse sample of American youth from the National Longitudinal Study of Adolescent Health (Add Health).

Methods

We analyzed data from 15,701 young adults ages 24–32y during Wave IV of Add Health (2007–8), a nationally representative school-based study of adolescents in grades 7–12 at recruitment (Wave I) in 1994–5.⁸ The Boston Children's Hospital Office of Clinician Investigation approved this analysis. We excluded participants missing data for sample

weights (n=901), currently pregnant (n=487) and missing outcome measures (n=1,979) or predictors (n=195) for a final sample of 12,139 participants.

Add Health field interviewers measured blood pressure (BP) using an approved automatic device; second and third measurements were double-entered and averaged for the final result.⁹ Participants provided capillary whole blood via finger prick; 17% were fasting. Dried samples were analyzed for glucose, glycated hemoglobin (HbA1c), and total cholesterol (TC) via standard protocols.¹⁰ TC concentrations (mg/dl) were rank ordered and reported as deciles due to potential bias from assay technologies.¹⁰ Add Health field staff inventoried participant medications in the home and classified them using Lexicon Plus.

We defined young adult optimal physiologic CVH as BP <120/80 mmHg; HbA1c <5.7% and either blood glucose <100 mg/dl (fasting) or <200 mg/dl (nonfasting); TC in the bottom seven (women) or six (men) deciles for the study population; no use of BP, cholesterol, or diabetes medications; and absence of self-reported diabetes or CVD. We chose deciles corresponding to the proportion of young adults with TC less than 200 mg/dl in the National Health and Nutrition Examination Surveys.⁴ We defined adolescent BMI as normal-weight (<85th), overweight (85th and <95th), or obese (95th) using self-reported height and weight; smoking as current (at least one cigarette in the past 30d), former (prior smoking but none in the past 30d), and never; and physical activity as present v. absent if the participant reported moderate/vigorous activity 5 v. <5d/week. Detailed dietary data were not available.

All analysis was performed using STATA SE 13. We accounted for the complex design by employing sampling weights, clustering by the primary sampling unit (schools) and US region. We used weighted logistic regression models to estimate odds of having young adult optimal physiologic CVH measured at Wave IV according to adolescent BMI category, smoking status, and physical activity measured at Wave I. We performed sensitivity analysis by sequentially assuming those missing outcome or predictor measures had the highest or lowest risk category. Models were adjusted for race/ethnicity self-reported at Wave I and for age, sex, educational attainment, and household income self-reported at Wave IV.

Results

Only 1965 of 12,139 (16%) young adults had optimal physiologic CVH. The most common reason for absence of CVH was elevated blood pressure (69%), followed by elevated glucose/HbA1c (37%); 3% reported diabetes and 1% reported CVD. We observed differences in the prevalence of optimal CVH by sex, race/ethnicity, and education (Table 1).

In adolescence, 74% of participants had normal BMI, 15% were overweight, and 11% obese. Sixty-one percent reported moderate/vigorous physical activity five times per week. Forty-one percent were nonsmokers, 31% former/ever smokers, and 28% currently smoked. Young adults with healthy weight in adolescence were more likely to have optimal physiologic CVH (18.4%) than those who had been overweight (9.7%) or obese (6.5%). In models adjusted for sociodemographic factors, participants with healthy weight as adolescents were more than twice as likely as those who had been overweight or obese to

have optimal physiologic CVH in young adulthood (Table 2). Adolescent tobacco smoking and physical activity were not associated with young adult CVH. Findings were robust to sensitivity analyses.

Discussion

Fewer than 1 in 5 Add Health participants had optimal physiologic CVH by young adulthood. Similar to other US^{4,5} and international⁷ cohorts, this healthy state was most prevalent among women, non-Hispanic whites and Asians, and those with higher educational attainment. Adolescent BMI was strongly associated with young adult physiologic CVH in this cohort, although adolescent smoking and physical activity were not.

There are several possible explanations for our findings. While classified as a health behavior by the American Heart Association, BMI reflects complex physiologic processes (e.g. insulin resistance, inflammation) that may be more directly related to the other physiologic factors that comprise ideal CVH. Furthermore, tobacco use and physical activity in early adolescence may not track as strongly as BMI into adulthood.

Strengths of our analysis include the use of a large racially and ethnically diverse cohort followed from adolescence to young adulthood. Limitations include the lack of dietary data, crude measures of physical activity reliant on self-reported sports and exercise participation, self-reported weight and height, and lack of objective measures of tobacco exposure. Due to a lack of physiologic measures at earlier Add Health waves, we were unable to pinpoint when in the life course loss of CVH occurred.

Implications and Contribution

A healthy weight in adolescence is important for reaching young adulthood with optimal physiologic CVH. The overall low prevalence of CVH has sobering implications for the future health of Americans.

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Abbreviations

BP	blood pressure
BMI	body mass index

TC	total cholesterol
HbA1c	glycated hemoglobin
CVD	cardiovascular disease
CVH	cardiovascular health

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Table 1

Adolescent lifestyle components, young adult sociodemographic characteristics and cardiovascular health status of 12,139 young adult participants in the National Longitudinal Study of Adolescent Health, 2007–8

	N for total sample (unweighted)	N with optimal physiologic CVH (unweighted)	% with optimal physiologic CVH (95% C.I.; weighted)
Adolescent BMI category			
Normal <85 th %	8982	1700	18.4% (17.2, 19.6)
Overweight 85 th –95 th %	1783	180	9.7% (7.9, 11.8)
Obese 95 th %	1374	85	6.5% (4.8, 8.8)
Adolescent Smoking Status			
Never smoker	5200	827	15.7% (14.4, 17.0)
No smoking past 30 days	3678	597	15.0% (13.6, 16.6)
Current smoker	3261	541	16.5% (14.8, 18.3)
Adolescent Moderate/Vigorous Physical Activity at least 5x/week			
5 times per week	7478	1176	15.1% (14.0, 16.3)
< 5 times per week	4661	789	16.7% (15.1, 18.3)
Age			
24–28 years	3645	680	18.1% (16.6, 19.8)
29–32 years	8494	1285	14.4% (13.3, 15.5)
Sex			
Female	6404	1608	25.5% (23.8, 27.3)
Male	5735	357	6.3% (5.50, 7.20)
Race/Ethnicity			
White, NH	6651	1172	16.8% (15.6, 18.0)
Black, NH	2342	277	10.9% (9.6, 12.4)
Hispanic	1858	329	16.3% (13.8, 19.1)
Asian, NH	700	101	18.1% (12.0, 26.4)
Native American, NH	73	4	3.9% (1.0, 14.5)
Multi-racial, NH	515	82	13.0% (9.7, 17.2)
Education			
High school graduate	2903	357	11.5% (10.0, 13.3)
Some post-HS	5452	849	15.6% (14.4, 16.9)
College graduate or beyond	3784	759	19.7% (17.8, 21.7)
Household income			
<\$50,000	5831	904	15.1% (14.0, 16.4)
\$50,000	6308	1061	16.3% (15.0, 17.7)

CI=confidence interval. NH = non-Hispanic. All proportions calculated using Add Health survey weights to account for unequal sampling and clustering by school and region.

Table 2

Odds of having optimal physiologic cardiovascular health in young adulthood according to adolescent lifestyle components and young adult sociodemographic characteristics in 12,139 participants in the National Longitudinal Study of Adolescent Health.

	Adjusted Odds Ratio (95% C.I., weighted)
Adolescent BMI category	
Normal <85 th %	2.77 (1.97, 3.89)
Overweight 85 th –95 th %	1.34 (0.90, 2.00)
Obese ≥95 th %	1.00 (ref)
Adolescent Smoking Status	
Never smoker	0.90 (0.77, 1.06)
No smoking for past 30 days	0.91 (0.78, 1.06)
Current smoker	1.00 (ref)
Adolescent Moderate/Vigorous Physical Activity at least 5x/week	
No	1.00 (Ref.)
Yes	0.99 (0.85, 1.14)
Age	
24–48 years	1.00 (Ref.)
29–32 years	0.75 (0.65, 0.87)
Sex	
Male	1.00 (Ref.)
Female	4.89 (4.11, 5.81)
Race/ethnicity	
White, non-Hispanic	1.00 (Ref.)
Black, non-Hispanic	0.65 (0.54, 0.77)
Hispanic	1.09 (0.87, 1.37)
Asian, non-Hispanic	1.02 (0.62, 1.69)
Native American, non-Hispanic	0.26 (0.06, 1.06)
Other race, non-Hispanic	0.75 (0.54, 1.06)
Highest education obtained	
High school graduate or less	1.00 (Ref.)
Some post-high school education	1.21 (0.99, 1.48)
College graduate or beyond	1.46 (1.19, 1.79)
Household income in young adulthood	
<\$50,000	1.00 (Ref.)
≥\$50,000	0.99 (0.87, 1.13)

CI=confidence interval. BMI = body mass index. All proportions calculated using Add Health survey weights to account for unequal sampling and clustering by schools and region. Models adjusted for all adolescent lifestyle components and young adult sociodemographic characteristics included in the table. Odds ratios in **bold** differ significantly from the referent group.