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BRIEF REPORT

Persistence of Skin-Deep Resilience in African American Adults

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Objective: The skin-deep resilience pattern suggests that, for low-socioeconomic-status African American youths, the ability to maintain high self-control and to persist with efforts to succeed may act as a double-edged sword, facilitating academic success and adjustment while undermining physical health. We extend research by following a sample of rural African Americans, asking whether the skin-deep resilience pattern, evident during adolescence, persists into adulthood by increasing susceptibility to metabolic syndrome (MetS) and insulin resistance (IR). ***Methods:*** The sample included 368 11-year-old African Americans, their parents, and their teachers. Parents provided data on family poverty across ages 11–18 years. Teachers provided data on youths' planful self-control across ages 11–13 years. At age 27 years, participants completed questionnaires about educational attainment and psychological adjustment and provided a fasting blood sample from which MetS and IR were assessed. ***Results:*** Regardless of years spent living in poverty, planful self-control during childhood was associated with college graduation ($p < .001$) and with low levels of depressive symptoms ($p = .016$) and antisocial behavior ($p = .028$). For participants exhibiting high levels of self-control, however, living more years in poverty across adolescence was associated with a greater number of MetS components that met clinical cutoff criteria ($p = .018$) and greater IR ($p = .016$) during adulthood. ***Conclusions:*** The skin-deep resilience pattern persists into adulthood, particularly among those who spent more of their adolescence living in poverty, and increases vulnerability to MetS and IR while it also promotes college graduation and positive psychological adjustment.

Keywords: African Americans, insulin resistance, metabolic syndrome, poverty, psychological resilience

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The Strong African American Families Healthy Adult Project (SHAPE) has followed up a cohort of rural African American youths from the ages of 11 to 27 years in an investigation of risk, resilience, and development. Beginning when participants were age 19 years, the SHAPE investigation was expanded to include health relevant biomarkers to address ways in which economic hardship in rural southern communities contributes to young African Americans' health. To date, findings show growing up in disadvantaged rural circumstances to be associated prospectively with young adult levels of allostatic load, a multisystem indicator of chronic disease risk (McEwen, 2005); accelerated cellular aging, indexed through patterns of DNA methylation (Horvath, 2013; Hannum et al., 2013); metabolic syndrome (MetS), a set of risk factors that forecast cardiovascular disease, diabetes, and stroke; and insulin resistance (IR), a precursor of diabetes (Brody et al., 2013; Brody, Yu, Beach, & Philibert, 2015; Brody, Yu, Chen, Ehrlich, & Miller, 2018; Chen, Miller, Yu, & Brody, 2016; Ehrlich, Chen, Yu, Miller, & Brody, 2019; Miller, Chen, Yu, & Brody, 2017).

Recent research with the SHAPE sample has also documented a paradoxical effect whereby rural African American youths from low-income families who are exhibiting high levels of planful self-control and striving hard to succeed experience good mental health but are at elevated risk for adverse health outcomes. Planful self-control is a group of attributes involved in the self-regulation of cognition, emotion, and behavior (de Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012). It involves planning, persistence, and a future goal orientation. The first hints of the paradox came from two analyses of SHAPE participants when they were aged 19 years. We observed that higher planful self-control during childhood among youths growing up in either economically disadvantaged families or impoverished neighborhoods was associated with better psychosocial outcomes at age 19 years, as reflected in less drug use, lower levels of depressive symptoms, and college attendance. In both analyses, however,

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high levels of planful self-control were associated with higher allostatic load scores (Brody et al., 2013; Chen, Miller, Brody, & Lei, 2015). These findings are part of a phenomenon that we call skin-deep resilience, wherein outward indicators of competence co-occur with poor health in upwardly mobile youths. The same skin-deep resilience pattern has been found in other distinct samples involving African American youths and young adults with health outcomes that include cellular aging, diabetes risk, MetS, respiratory infection, and inflammatory profiles among youths with asthma (Brody, Yu, Miller, & Chen, 2016; Chen et al., 2019; Duggan, Jennings, & Matthews, 2019; Gaydosh, Schorpp, Chen, Miller, & Harris, 2018; Miller, Cohen, Janicki-Deverts, Brody, & Chen, 2016; Miller, Yu, Chen, & Brody, 2015).

This collection of findings on skin-deep resilience raises two questions. First, once established, does the skin-deep resilience pattern persist across time among rural African Americans or does it dissipate with age and experience? Second, is the skin-deep resilience pattern most evident among rural African American young adults who spent more of their adolescent years coping with and navigating the stresses and strains associated with living in poverty? We predicted that, when SHAPE participants were aged 27 years, those who spent more of their adolescent years living in poverty but who nevertheless developed planful self-control would evince higher rates of college graduation and better mental health along with worse cardiometabolic health. To evaluate this hypothesis, we assessed rates of MetS and IR.

Method

Participants

Data for this study were drawn from SHAPE (Brody et al., 2013). Starting in 2001, SHAPE enrolled 667 African American fifth-grade children (mean age = 11.2 years; range 11–13 years) and each child's primary caregiver. The families resided in nine rural counties in Georgia, where poverty rates are among the highest in the nation. In 2009–2010, when the youths had reached age 19 years, a subgroup of 500 was randomly selected using a random sampling generator in Excel for a substudy of stress hormones and blood pressure. This selection was necessary because of funding constraints associated with collection of biomarkers. Of the 500 randomly selected participants, 489 took part in the age 19 assessment, and 388 of the age 19 participants took part in the age 27 assessment. Thus, the retention rate across 8 years was 79%. The analytic sample in this study consisted of 368 individuals selected from the subsample of 388. The other 20 participants were not included because they had outlier values for fasting glucose (3.5–25.0 mmol/L) or insulin (20–400 pmol/L). These participants were similar to the subsample on all other study measures. Compared with the age 19 study sample, the analytic sample included a higher percentage of female participants (61.8% vs. 54.2%), the only significant demographic difference. The University of Georgia's Institutional Review Board approved the protocol. Written informed consent was obtained from caregivers at each assessment when the youths were minors and from the participants themselves when they reached adulthood.

Data Collection Procedures

Participants' teachers provided data on children's planful self-control. All other data were collected in participants' homes using a standardized protocol. An African American field researcher, who was also a certified phlebotomist, went to each participant's home to collect self-report data and draw a fasting blood sample from which MetS and IR were assessed.

Measures

Planful self-control. When participants were 11, 12, and 13 years of age, one of each participant's teachers assessed the youth's planful self-control at each of the three waves of data collection. Planful self-control was measured using Humphrey's (1982) well-validated 12-item self-control inventory. Alphas across waves ranged from .94 to .95. Planful self-control was operationalized as the average of the teachers' ratings across these three assessments.

Years living in poverty. When participants were 11, 12, 13, 16, 17, and 18 years of age, caregivers provided data on their families' income to needs ratios based on family size; these data were used to compute household poverty (Semega, Kollar, Creamer, & Mohanty, 2019, p. 49). Poverty statuses at the six assessment waves were summed to determine the number of years participants lived below federal poverty standards.

College degree status, depressive symptoms, and externalizing problems. At age 27 years, participants reported whether or not they had received a bachelor's degree. Also at age 27 years, participants reported their depressive symptoms and externalizing problems. Self-reports of depressive symptoms were obtained using the Center for Epidemiologic Studies–Depression scale (Radloff, 1977). Alpha was .89. Externalizing symptoms were measured using the Adult Self-Report (Achenbach & Rescorla, 2003). Responses to the aggressive, intrusive, and rule breaking subscales were summed to form an indicator of externalizing problems. Alpha was .91.

Metabolic syndrome and insulin resistance. At the age 27 assessment, a phlebotomist visited each participant's home in the morning to draw an overnight fasting blood sample. Blood was drawn into serum separator tubes (Becton, Dickinson and Company, Franklin Lakes, NJ). Specimens were centrifuged on site at 1500 *g* for 20 min. The serum was harvested, divided into aliquots, and immediately frozen on dry ice. Upon arrival at the laboratory, it was placed in storage at −80°C until the end of the project. At the end of the study, serum glucose was measured photometrically using an ultraviolet test on a Roche/Hitachi (Indianapolis, Indiana) Cobas c502 instrument. This assay has a dynamic range of 2–750 mg/dL and intraassay coefficient of variation of 0.7%. Serum insulin was assayed in duplicate using a multiplex, electrochemiluminescent, immunoassay (human leptin/insulin kit, K15164C; MesoScale Discovery, Rockville, Maryland) on a SECTOR Imager 2400A (MesoScale Discovery). This assay has an eight-point standard curve, with a lower limit of detection of 25 pg/mL for insulin. The intraassay coefficient of variation for duplicate pairs averaged 3.8%. High-density lipoproteins and triglycerides were measured on a Roche/Hitachi Cobas c701 analyzer. The average intraassay coefficients of variation for these assays were below 1.6%. The assay's detection ranges are 26–469 mg/dL (triglycerides) and 22–132 mg/dL (high-density lipoproteins). Resting blood

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pressure was monitored with a Critikon Dinamap Pro 100 (Critikon, Tampa, FL) while the youth sat reading quietly. Three readings were taken every 2 min, and the average of the last two readings was used as the resting index. The field researcher used a plastic measuring tape to determine participants' waist circumferences according to the NHANES procedure (National Center for Health Statistics, 2016), at the midpoint of the upper iliac crest and lower costal margin at the midaxillary line.

The presence of adult MetS was defined by International Diabetes Federation guidelines (Cornier et al., 2008). MetS components included (a) central adiposity, defined by ethnic and sex-specific cutoffs for waist circumference (for individuals of African descent, cutoffs are ≥94 cm for men and ≥80 cm for women); (b) high blood pressure (systolic pressure ≥130 mmHg or diastolic pressure ≥85 mmHg); (c) high triglyceride levels (≥150 mg/dL); (d) high fasting-glucose levels (≥100 mg/dL); and (e) low high-density lipoprotein levels (<40 mg/dL in men and <50 mg/dL in women). Two outcomes variables were calculated. Our primary outcome was a measure of the number of metabolic-syndrome components for which the participant met clinical cutoff criteria; these could range from 0 to 5 ($M = 1.57$, $SD = 1.15$). As a secondary outcome, we calculated MetS diagnosis, which included the presence of central adiposity plus at least two of the four additional components described above ($n = 76$, 20.7%). Because, in the literature for young adults (Nolan, Carrick-Ranson, Stinear, Reading, & Dalleck, 2017), a diagnosis of MetS is uncommon, we expected the skin-deep resilience pattern to be evident for the MetS components but not for a diagnosis.

IR was estimated according to the updated homeostasis assessment (HOMA2) model (Wallace, Levy, & Matthews, 2004). As in the original HOMA metric (Matthews et al., 1985), this model derives estimates of IR based on fasting glucose and insulin levels. However, HOMA2 is calibrated to account for variations in hepatic and peripheral glucose resistance, nonlinearities in the insulin secretion curve at high glucose levels, and contemporary assay methods.

Covariates

To provide a partial control for a family history of risk for cardiometabolic disease, parents' body mass indices (BMIs) were included as a covariate in the analyses. All parents reported their height and weight at participants' ages 19, 20, and 21 years. Using these data, parent BMIs at each participant age were calculated, and the three BMI values were averaged. Parents also reported their past-month substance use (cigarette use, alcohol use, binge drinking, and marijuana use) when their offspring were ages 19, 20, and 21 years, and these three values were averaged. At age 27 years, participants reported adverse childhood experiences on the Adverse Childhood Experiences (ACEs) questionnaire (Felitti et al., 1998). An ACEs score was calculated by summing dichotomized responses (*yes* = 1, *no* = 0) across 10 ACEs categories indicating the presence or absence of particular adversities that participants may have experienced before the age of 18 years (i.e., living with someone who was mentally ill or depressed; having parents who were separated or divorced; experiencing physical neglect or emotional neglect). Sex was dummy coded, with male participants coded 1 and female participants coded 0.

Statistical Approach

The study hypotheses were tested using hierarchical linear regression (depression symptoms, externalizing problems, IR, and MetS components as the outcomes) and logistic regression (college graduation status and MetS diagnosis as the outcomes) equations with three sequentially entered blocks of variables: (a) the covariates of participant sex, parents' BMIs, substance use, and ACEs; (b) the main effects of years living in poverty and planful self-control; and (c) a two-way interaction term of years living in Poverty × Planful Self-Control. All statistical tests were two tailed with alpha set to .05.

Results

Main effects of planful self-control emerged for all psychosocial outcomes at age 27 years. These results are presented in Table 1 (top). To the extent that youths displayed better planful self-control, they were more likely to have a bachelor's degree and less likely to experience depressive symptoms or engage in aggressive and rule-breaking behaviors at age 27 years. All of these findings were consistent across years living in poverty. A main effect of years living in poverty emerged for having a bachelor's degree, with more years living in poverty presaging a lower likelihood of obtaining a bachelor's degree.

These analyses were repeated with MetS and IR. The results of a linear regression model predicting MetS components and IR, revealed a significant interaction between years living in poverty and youth planful self-control: MetS components, $F(1, 360) = 5.678$, $\Delta R^2 = .014$, $p = .018$; and IR, $F(1, 360) = 4.374$, $\Delta R^2 = .010$, $p = .037$. These interactions are illustrated in Figure 1, panels A (MetS components) and B (IR). Simple slopes were computed for estimated levels of health outcomes by years in poverty for low (1 *SD* below the mean) and high (1 *SD* above the mean) levels of planful self-control. More years spent in poverty across adolescence were associated with higher levels of MetS components and IR at age 27 years among participants with high levels of planful self-control. Years living in poverty were not associated with either MetS components or IR among participants with low levels of planful self-control. The Johnson-Neyman technique indicated that the simple slope of the association between years living in poverty and MetS components was significant when planful self-control was ≥0.48 *SD* above the mean ($n = 128$), and the simple slope of the association between years living in poverty and IR was significant when planful self-control was ≥0.32 *SD* above the mean ($n = 149$). As expected, the results (see Table 1, bottom) of a logistic regression model predicting MetS diagnosis did not reveal a significant interaction between years living in poverty and youth planful self-control.

Discussion

This study was designed to follow up with SHAPE participants to determine whether the skin-deep resilience pattern, first observed with psychosocial outcomes and allostatic load at age 19 years, would continue to be evident, 8 years later, at age 27 years. To the degree that SHAPE participants developed high levels of planful self-control during childhood, they continued to fare better across multiple domains of psychosocial functioning, as reflected

Table 1
Years in Poverty at Ages 11–18 Years and Planful Self-Control at Ages 11–13 Years as Predictors of College Degree Status, Depressive Symptoms, Externalizing Problems, Insulin Resistance, and Metabolic Syndrome at Age 27 Years (N = 368)

	College degree status		Depressive symptoms		Externalizing problems	
Predictors	*OR*	[95% CI]	*B*	[95% CI]	*B*	[95% CI]
1. Sex, male	0.850	[0.452, 1.599]	−2.342*	[−4.461, −0.222]	0.083	[−1.414, 1.581]
2. Parents' BMI (ages 19–21 years)	1.010	[0.981, 1.039]	0.081	[−0.018, 0.181]	0.042	[−0.028, 0.112]
3. Parents' substance use (ages 19–21 years)	1.428	[0.450, 4.527]	2.467	[−1.485, 6.418]	1.220	[−1.573, 4.013]
4. Childhood adversity (age 27 years)	1.029	[0.849, 1.246]	1.493***	[0.836, 2.150]	1.377***	[0.913, 1.841]
5. Years in poverty (ages 11–18 years)	0.810*	[0.678, 0.968]	0.012	[−0.531, 0.555]	−0.169	[−0.552, 0.215]
6. Planful self-control (ages 11–13 years)	1.083***	[1.040, 1.128]	−0.152*	[−0.276, −0.028]	−0.098*	[−0.186, −0.011]
7. Years in Poverty × Planful Self-Control	1.005	[0.983, 1.027]	0.041	[−0.024, 0.106]	−0.003	[−0.049, 0.043]

	IR		MetS components		MetS diagnosis	
Predictors	*B*	[95% CI]	*B*	[95% CI]	OR	[95% CI]
1. Sex, male	−0.189***	[−0.246, −0.131]	−0.621***	[−0.864, −0.378]	0.545*	[0.304, 0.977]
2. Parents' BMI (ages 19–21 years)	0.005***	[0.003, 0.008]	0.016**	[0.005, 0.028]	1.031*	[1.007, 1.055]
3. Parents' substance use (ages 19–21 years)	−0.032	[−0.139, 0.076]	−0.090	[−0.543, 0.362]	0.580	[0.197, 1.701]
4. Childhood adversity (age 27 years)	0.008	[−0.010, 0.026]	0.030	[−0.045, 0.105]	1.127	[0.958, 1.324]
5. Years in poverty (ages 11–18 years)	0.011	[−0.004, 0.025]	0.033	[−0.029, 0.096]	1.148	[0.997, 1.321]
6. Planful self-control (ages 11–13 years)	0.001	[−0.002, 0.005]	−0.004	[−0.019, 0.010]	1.003	[0.971, 1.035]
7. Years in Poverty × Planful Self-Control	0.002*a	[0.000, 0.004]	0.009*b	[0.002, 0.016]	1.013	[0.996, 1.030]

Note. BMI = body mass index; IR = insulin resistance; MetS = metabolic syndrome; OR = odds ratio; CI = confidence interval.
[a] $F(1, 360) = 4.374$, $\Delta R^2 = .010$, $p = .037$. [b] $F(1, 360) = 5.678$, $\Delta R^2 = .014$, $p = .018$.
* $p < .05$. ** $p < .01$. *** $p < .001$.

in graduation from college, lack of depressive symptoms, and avoidance of antisocial behavior. The opposite pattern emerged from analyses of cardiometabolic health; among these participants, greater planful self-control was associated with more components of MetS that met clinical criteria and higher levels of IR. Importantly, this pattern of diverging outcomes in psychosocial and cardiometabolic health at age 27 years was evident only among the samples' most disadvantaged youths. For youths whose families lived in less dire socioeconomic conditions, planful self-control forecast better psychosocial and cardiometabolic health, as would be expected from the broader resilience literature.

These findings extend previous skin-deep resilience research in two regards. The first is the demonstration of the persistence or durability of the skin-deep resilience pattern. The results indicated that the pattern continued to presage diverging psychosocial and cardiometabolic health outcomes 8 years after they were first identified in the SHAPE investigation. Thus, the phenomenon is not restricted to one point in time. Second, the present study is the first to measure directly living in poverty during adolescence when documenting skin-deep resilience. The interactions support the theory that, for many rural African American youths, it is in the context of struggles with poverty that high self-control produces a diverging profile of better psychosocial outcomes but worse physiological conditions (Miller et al., 2015).

What it is about striving for upward mobility that undermines the health of skin-deep resilient young adults? In this study, most participants were the first in their families to attend college. They feel tremendous pressure to succeed to ensure their parents' sacrifices have been worthwhile. Many feel socially isolated and disconnected from peers from different backgrounds. They may encounter racism and discrimination. Against this backdrop, striving for success in the face of interpersonal, community, and institutional challenges is likely to occasion frequent activation of stress responses from the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system. The hormonal end products of these systems, glucocorticoids and catecholamines, have been found to be elevated in African American youths who grow up in disadvantaged circumstances (Brody et al., 2016). Sustained exposure to high levels of these hormones can promote weight gain, elevate blood pressure, dysregulate lipids, and promote inflammation, all of which could hasten MetS and IR (Cornier et al., 2008). We did try to determine whether stress hormones mediated a pathway through which skin-deep resilience arose using assessments of stress hormones (cortisol, epinephrine, norepinephrine) obtained at age 19 years. These analyses did not support a mediational role for stress hormones. It is likely that the 8 years that separated the stress hormone assessments from the MetS and IR assessments made finding reliable associations difficult. Future research should examine these associations with assessments that are closer in time.

A health behavior pathway could also be operating. Behaving diligently all of the time can leave people feeling exhausted. Worn out, they may increase their risk of developing MetS and IR by neglecting sleep and exercise and by overindulging in comfort foods (Chen, Yu, Miller, & Brody, 2018; Jackson, Knight, & Rafferty, 2010). Accordingly, future research should also examine the contributions of health behaviors to the development of the skin-deep resilience pattern. Finally, missing from the skin-deep resilience literature are studies that address the role of racial discrimination on the pattern's health effects. The normative challenges for African Americans associated with striving for success are compounded by exposure to racial discrimination, which has biological consequences relevant to health (Geronimus, Hicken, Keene, & Bound, 2006; Lewis, Cogburn, & Williams, 2015;

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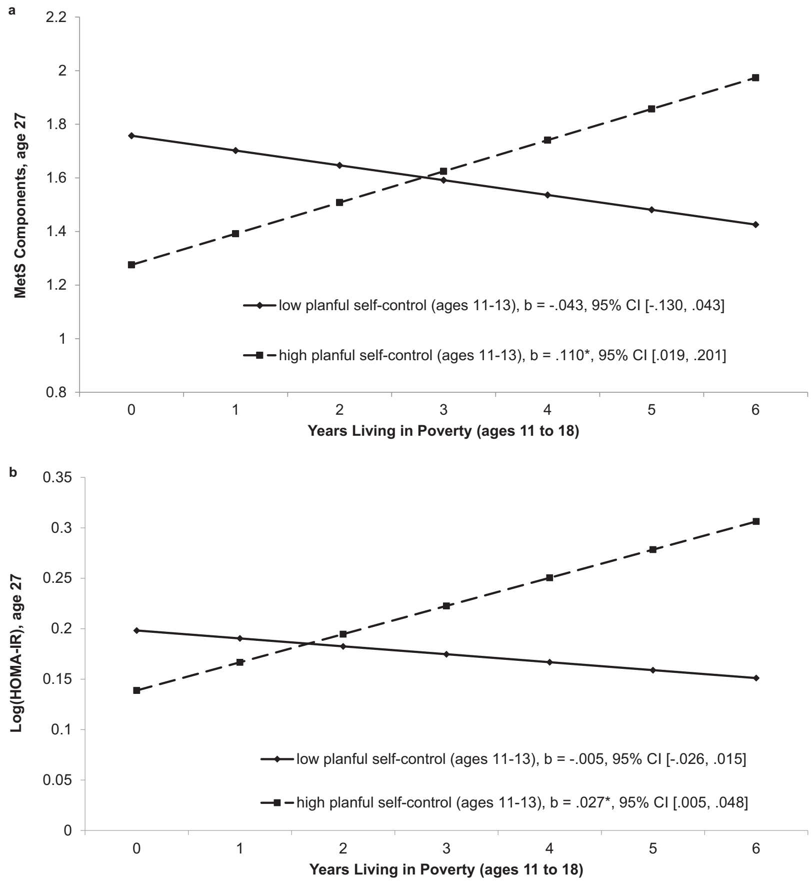

Figure 1. Effects of years living in poverty on youths' metabolic syndrome components (a) and insulin resistance (b) by levels of planful self-control. The lines represent the regression lines for different levels of planful self-control (low: 1 *SD* below the mean; high: 1 *SD* above the mean); b values refer to simple slopes. * $p < .05$.

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Myers, 2009; Williams, 2018). Future studies of skin-deep resilience should focus on the health consequences of exposures to outright and vicarious racial discrimination among minority youths and young adults attempting to maintain high self-control and to persist with efforts to achieve a college education and other markers of upward mobility.

The results should be considered in light of some limitations. First, future research on skin-deep resilience should identify which of the many stressors that covary with poverty contribute to the skin-deep resilience pattern. Identifying these stressors, whether they are at the family or community level, could guide efforts to prevent the pattern in young people striving for upward mobility. Second, although sex, parents' BMI, substance use, and adverse childhood experiences acted as covariates, others should be included in future skin-deep resilience research including indicators of neighborhood disadvantage and school climates. Despite these limitations, the findings show that the skin-deep resilience pattern persists into adulthood for rural African Americans who spend more of their adolescent years living in poverty. These results reinforce the notion that resilience may be a double-edged sword for African Americans from disadvantaged backgrounds. The same characteristics associated with obtaining a college degree and psychological adjustment forecast elevated vulnerability to cardiometabolic health problems.

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