

High Anger Expression Exacerbates the Relationship Between Age and Metabolic Syndrome

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Objective. Building on prior work linking high anger expression to poor health, this cross-sectional study addressed whether anger expression exacerbated age-related risk for metabolic syndrome in a national sample of adults, known as MIDUS (Midlife in the United States).

Method. Respondents reported anger expression via survey assessments and completed an overnight clinic visit.

Results. Unadjusted metabolic syndrome prevalence was 40.6%. Men, less educated individuals, and those who reported not getting regular physical activity were at significantly higher risk for metabolic syndrome. Anger expression did not predict higher risk for metabolic syndrome in main effects models, but it moderated the relationship between age and metabolic syndrome. Age-associated risk for metabolic syndrome was significant only for adults with high anger expression.

Discussion. Among older adults, anger expression predicted higher prevalence of metabolic syndrome. Older adults reporting low anger expression had metabolic syndrome rates comparable to younger adults. Results highlight that failing to show the frequently observed decline in anger expression with age may have pernicious health concomitants.

Key Words: Anger expression—Emotion regulation—Life course or developmental change—Metabolic syndrome.

EMOTIONAL well-being is generally preserved or improved with age. Cross-sectional and longitudinal research shows fewer negative emotions with age, whereas positive emotions are maintained or increased (Carstensen et al., 2011; Stone, Schwartz, Broderick, & Deaton, 2010). Older adults report fewer experiences and expressions of anger and greater anger control compared with younger adults (Phillips, Henry, Hosie, & Milne, 2006; Schieman, 1999, 2010). Between-age-group comparisons do not, however, capture important individual differences in anger among older persons. This study addressed variability among older adults in the link between anger and later life health risks, an important question given that aging is known to increase risk for diabetes and cardiovascular diseases (Berry et al., 2012; Centers for Disease Control and Prevention, 2011). The central question was whether older adults who fail to show the lower levels of anger documented in prior research have greater risk for metabolic syndrome, a known cardiovascular risk factor.

Our formulation draws on the strength and vulnerability integration (SAVI) model, which postulates that the advantages in emotional well-being with age may be attenuated, or eliminated, under conditions of elevated arousal, given that older adults have reduced physiological flexibility (Charles, 2010). The model adds that physiological reactivity from stressors, including emotional stressors, may increase cardiovascular health risks due to frequent arousal accompanied

by a loss of physiological resilience with older age. Anger is understudied in this context, even though it is a prototypical high arousal negative emotion associated with heightened physiological reactivity (Levenson, 1992). As a test of the SAVI model, we hypothesized that older adults who reported greater anger expression, believed to be accompanied by more frequent physiological reactivity, would be at higher risk for metabolic syndrome than older adults who show the more typical pattern of better emotional experience and regulation, defined here in terms of lower anger expression.

Many factors may contribute to heightened anger among older adults. For example, greater susceptibility to poor health, financial strain, role loss, and spousal loss are all chronic stressors faced in middle and old age (Scott, Whitehead, Bergeman, & Pitzer, 2013). Older adults with greater chronic disease burden and lower self-rated health demonstrated less healthy personality profiles, including higher neuroticism and lower conscientiousness, which may also be accompanied by high anger (Sutin, Zonderman, Ferrucci, & Terracciano, 2013; Turiano et al., 2012). A recent study demonstrated that experiencing negative social interactions, defined as interactions causing irritation, frustration, or annoyance, all key components of anger, was more strongly related to negative affect in middle-aged and older adults compared with younger adults (Birditt, 2013). This suggests that when negative interactions occur, older adults are affected more negatively by them. Together, these findings

highlight variability in anger among older adults, and the current study examines the health correlates of such a profile.

Anger expression has well-established ties to cardiovascular and metabolic disease (Chida & Steptoe, 2009; Everson et al., 1999; Schum, Jorgensen, Verhaeghen, Sauro, & Thibodeau, 2003). Long-standing interest in the cardiotoxic effects of expressing anger dates back to a 1896 publication entitled “The Physiologic Effects of the Indulgence in Anger” (JAMA, 1896). Further, prospective and cross-sectional research showing that greater anger expression and related constructs like hostility predict increased risk of metabolic syndrome (Cohen, Panguluri, Na, & Whooley, 2010; Elovainio et al., 2011; Goldbacher & Matthews, 2007), although some studies failed to find an association (Mommersteeg & Pouwer, 2012).

Metabolic syndrome is a constellation of risk factors, including central obesity, hyperglycemia, dyslipidemia, and hypertension, associated with increased risk for coronary heart disease, Type II diabetes, functional limitations, and mortality (Alberti, Zimmet, & Shaw, 2006; Beavers et al., 2013; Cornier et al., 2008; Ford, 2005). Data from the National Health and Nutrition Examination Survey 2003–2006 indicated the unadjusted prevalence of metabolic syndrome was 34.4% and identified age as a key risk factor. The prevalence among adults aged 20–39 was 20.3%, in contrast to 51.5% of adults aged 60 and older (Ervin, 2009; Yang & Kozloski, 2011).

Using data from a national sample of adults known as MIDUS (Midlife in the United States), we first examined cross-sectional age differences in anger expression and metabolic syndrome prevalence, predicting anger expression would be lower and metabolic syndrome prevalence would be greater among older adults. Second, we tested associations between anger expression and metabolic syndrome. The targeted question, however, was whether individual differences in anger expression would moderate the relationship between age and metabolic syndrome, testing the hypothesis that greater anger expression heightens age-related risk for metabolic syndrome.

METHOD

MIDUS began in 1995 with more than 7,000 noninstitutionalized adults recruited through random digit dialing (RDD) from the 48 contiguous states. The sample included siblings from some RDD respondents as well as some twins (Brim, Ryff, & Kessler, 2004; Radler & Ryff, 2010). The second wave (MIDUS II) began in 2004 with a 75% retention rate. Biological data were collected from a subset of respondents ($N = 1,255$) who traveled to one of three General Clinical Research Centers (GCRCs) for an overnight clinic visit. There was a 43% response rate, reflective of the demanding protocol and extensive travel required for many participants (Love, Seeman, Weinstein, & Ryff, 2010). The biological subsample was comparable

with the full MIDUS II sample on most demographic and health characteristics, though was better educated and less likely to smoke than nonparticipants (Love et al., 2010). This study was approved by Institutional Review Boards at Georgetown University, University of California, Los Angeles, and University of Wisconsin–Madison. All participants provided written informed consent.

Anger Expression

Anger expression was assessed using the anger-out subscale from Spielberger’s State-Trait Anger Expression Inventory (Spielberger, 1996). Participants completed the inventory at the clinic, indicating how often (1 = *almost never*; 4 = *almost always*) they expressed their anger outwardly when they felt angry or furious. The scale contained eight items, and internal consistency was 0.77.

Metabolic Syndrome

Metabolic syndrome was defined by the International Diabetes Federation definition (Alberti et al., 2006). Participants were classified as meeting metabolic syndrome criteria when they had central obesity and at least two out of the following risk factors: triglycerides (≥ 150 mg/dL), high-density lipoprotein cholesterol (< 40 mg/dL in men or < 50 mg/dL in women), blood pressure (≥ 130 mm Hg systolic or ≥ 85 mm Hg diastolic), and high fasting plasma glucose (≥ 100 mg/dL or Type II diabetes diagnosis). For the classification of central obesity, waist circumference cutoffs were greater than or equal to 94 cm for men and greater than or equal to 80 cm for women, measured at the narrowest point between the ribs and iliac crest by GCRC staff. Blood pressure was assessed in a seated position 3 times consecutively with a 30-s interval between each measurement. The two most similar readings were averaged. The lipid panel and glucose were assessed from a fasting blood sample taken on the morning of the second day of the GCRC visit (Roche Diagnostics, Indianapolis, IN).

Covariates

Control variables included gender, educational attainment, race (coded to reflect white or black/African American), current smoking status, alcohol consumption over the previous month, regular physical activity (at least 20 min 3 or more times per week), and chronic conditions (sum of those experienced or treated within the previous 12 months, such as diabetes, stroke, and hypertension).

RESULTS

Table 1 provides sample descriptive information as well as bivariate correlations. Unadjusted metabolic syndrome prevalence was 40.6%. Older adults were more likely to be white/Caucasian and less likely to smoke. Age was related to less frequent anger expressions, lower alcohol

consumption, greater waist circumference, higher systolic blood pressure, lower diastolic blood pressure, and greater likelihood of having metabolic syndrome in bivariate analyses. When age was stratified into tertiles, there were significant age differences in anger expression such that each age tertile reported significantly lower anger expression than the younger tertiles, $F(2,1199) = 23.99, p < .001$.

Standardized age and anger expression were entered as predictors of metabolic syndrome diagnostic status in the first step of a logistic regression analysis, controlling

for demographic factors and health covariates. An interaction between age and anger expression was entered in the next step. Results are presented in Table 2. Men (Wald = 32.35, $p < .001$), those with less educational attainment (Wald = 8.06, $p < .01$), more chronic conditions (Wald = 15.34, $p < .001$), and not being physically active (Wald = 6.28, $p = .01$) were at significantly higher risk for metabolic syndrome. Anger expression did not predict metabolic syndrome (Wald = 0.02, $p = .88$). However, the interaction between age and anger expression was significant, Wald = 4.23, $p = .04$. Because men were at higher risk

Table 1. Sample Characteristics and Correlations With Age, Anger Expression, and Metabolic Syndrome ($N = 1,205$)

Variable	<i>M</i> (<i>SD</i>) or %	Range	Metabolic syndrome	Age	Anger expression
			<i>r</i>	<i>r</i>	<i>r</i>
Age (years)	57.5 (11.6)	35–86	.06*	—	—
Gender (% women)	57.0		-.13*	-.05	.02
Race (% black/African American)	18.8		.04	-.15*	.08*
Education (%)			-.09*	-.03	-.001
≤High school	28.0				
Some college	29.7				
≥College degree	42.3				
Anger expression	12.9 (3.3)	8–29	-.001	-.23*	—
Younger adults (35–49 years)	13.8 (3.5)	8–26			
Middle-aged adults (50–65 years)	12.8 (3.3)	8–29			
Older adults (66–86 years)	12.0 (2.8)	8–28			
Waist circumference (cm)	97.5 (16.3)	60–187	.45*	.07*	.06*
Systolic blood pressure (mm Hg)	131.6 (18.1)	83–222	.32*	.27*	-.07*
Diastolic blood pressure (mm Hg)	75.7 (10.7)	48–125	.22*	-.13*	-.002
Triglycerides (mg/dL)	127.6 (78.8)	25–765	.48*	-.03	.05
HDL cholesterol (mg/dL)	55.5 (18.1)	19–121	-.44*	.04	-.02
Fasting glucose (mg/dL)	102.1 (28.2)	56–418	.27*	.03	-.001
Metabolic syndrome (% yes)	40.6		—	—	—
Chronic conditions	2.5 (2.5)	0–29	.12*	.10*	.13*
Current smoking status (%)	14.8		.01	-.18*	.08*
Alcohol (drinks/month)	14.1 (28.3)	0–405	-.02	-.07*	.06*
Regular physical activity (% yes)	76.7		.09*	.03	.02

Notes. HDL = high-density lipoprotein.
* $p < .05$.

Table 2. Logistic Regression Results With Standardized Age, Anger Expression, and Their Interaction Predicting Metabolic Syndrome

Predictor	<i>B</i>	<i>SE</i>	OR	95% CI
Step 1				
Anger expression	-0.01	0.06	0.99	[0.88, 1.12]
Age	0.07	0.06	1.08	[0.95, 1.22]
Gender ^a	-0.73*	0.13	0.48	[0.37, 0.62]
Race ^b	-0.08	0.17	0.92	[0.66, 1.28]
Education	-0.18*	0.06	0.83	[0.73, 0.95]
Current smoking	0.10	0.18	1.11	[0.78, 1.59]
Alcohol	-0.10	0.07	0.91	[0.80, 1.03]
Regular physical activity	-0.36*	0.14	0.70	[0.53, 0.92]
Chronic conditions	-0.26*	0.10	1.30	[1.14, 1.48]
Step 2				
Age × Anger Expression	0.14*	0.07	1.15	[1.01, 1.31]

Notes. CI = confidence interval; OR = odds ratio.

^aGender coded with men as reference group.

^bRace coded with white/Caucasian as reference group. All continuous variables were standardized.

* $p < .05$.

for metabolic syndrome (Yang & Kozloski, 2011), and prior research has shown that the extent to which anger expression predicts cardiovascular outcomes is stronger in men (Chida & Steptoe, 2009), we tested gender by anger and gender by education by anger interactions. Neither interaction was significant, suggesting that the reported findings are not driven by males.

To assess the nature of the obtained interaction, we examined simple slopes reflecting the relationship between age and metabolic syndrome at three levels of anger expression: at 1 *SD* below the mean, at the mean level, and at 1 *SD* above the mean. Adjusting for all covariates, the relationship between age and metabolic syndrome was only significant at high levels of anger expression ($B = 0.23$, Wald = 5.22, $p = .02$). Age and metabolic syndrome were not significantly related at average ($B = 0.09$, Wald = 1.83, $p = .18$) and low levels of anger expression ($B = -0.05$, Wald = 0.31, $p = .58$). These simple slopes are graphed in Figure 1, where the *y*-axis reflects the predicted probabilities of meeting metabolic syndrome criteria for each participant based on the final regression model, which adjusted for covariates (Jaccard, 2001).

Supplemental Analyses

Because the MIDUS includes siblings and twins of the RDD sample, assumptions of independent observations are violated. To address these dependencies, mixed effects models with random intercepts for family clusters were used to rerun analyses. All conclusions drawn from the mixed effects models are unchanged from those reported earlier.

DISCUSSION

Aging involves juxtapositions between gains and losses. On the one hand, physical health tends to decline, but emotional well-being may hold steady or improve. We predicted that older adults who did not show the typical pattern of downregulation in anger expression would be at greater risk for metabolic syndrome. As hypothesized, greater anger expression (i.e., being more likely to express anger outwardly when anger is felt) was associated with an increased probability of having metabolic syndrome among older adults. The pattern of effects was apparent, though weaker, among middle-aged adults, and not apparent at all, among the younger adults. Importantly, older adults reporting low anger expression did not exhibit the expected age-related increase in risk for metabolic syndrome and instead demonstrated comparable risk to their younger counterparts. Nonsignificant interactions with gender suggest that these findings were consistent in both men and women.

The findings support the SAVI model, which suggests that age-related advantages in emotional well-being may be attenuated or even eliminated when physiological vulnerabilities are at play under situations of high arousal (Charles, 2010). Anger is a high arousal negative emotion associated with physiological reactivity (Levenson, 1992); high anger also predicts increased risk for cardiovascular and metabolic disease in prospective research (Chida & Steptoe, 2009; Everson et al., 1999; Goldbacher & Matthews, 2007; Schum et al., 2003). On average, older adults experience and express anger less frequently than younger adults (Schieman, 1999, 2010; Stone et al., 2010), suggesting that some may learn more effective strategies to regulate

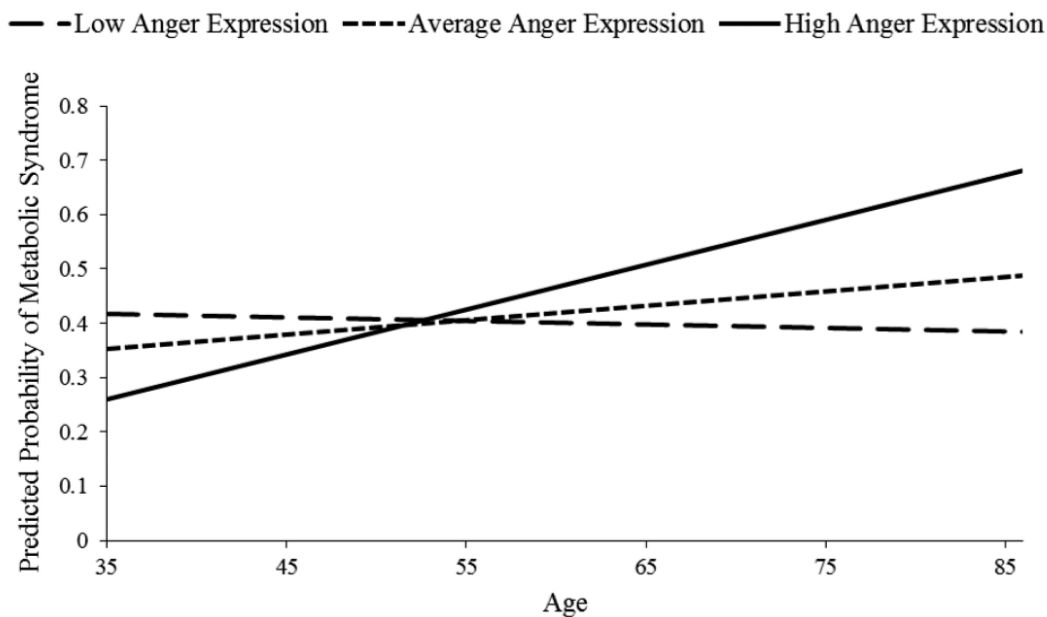


Figure 1. Predicted probability of metabolic syndrome by age and anger expression. The lines represent the simple slopes for age and metabolic syndrome relationship at different levels of anger. Low anger reflects less than 1 *SD* from the mean, and high anger reflects greater than 1 *SD* from the mean. Only the simple slope between age and metabolic syndrome at high anger expression was significant.

their emotions with age and rely less on strategies that have negative consequences (John & Gross, 2004; Scheibe & Carstensen, 2010). Indeed, we found a significant negative relationship between age and anger expression in our sample. As SAVI theorizes, however, our results highlight that older adults who failed to show the typical decline in anger with age are at increased risk for metabolic syndrome compared with same-aged adults reporting fewer expressions of anger.

A key assumption behind this formulation is that more frequent physiological arousal underlies increased rates of metabolic syndrome among older adults with high anger. Due to reduced flexibility in biological systems with age, physical health may be negatively affected by the increased arousal. Although not explicitly measured in our study, research in other domains lends credence to this perspective. Middle-aged adults who reported greater anger in response to a laboratory stressor exhibited greater production of proinflammatory cytokines during a laboratory stressor (Carroll et al., 2011). Adults who displayed more negative behavior during a marital conflict in the laboratory also showed greater endocrine activation and poorer immunological health in response to the conflict (Kiecolt-Glaser et al., 1997). Whether such profiles of high anger and associated exaggerated physiological reactivity in the laboratory prospectively predict disease is an important avenue for future research.

Several caveats should be noted. Limited representation of racial and ethnic minority group members precludes generalizing results to other racial/ethnic groups, where anger may be experienced to a greater extent (Barefoot et al., 1991). The cross-sectional nature of this research does not allow the direction of effects to be resolved; longitudinal data are needed to establish temporal precedence among anger and metabolic syndrome. However, we found that changes in self-rated health over a 10-year time span were unrelated to anger expression (data not shown), which somewhat reduces concern of reverse causation (i.e., that poor health leads to increased anger expression among older adults).

Despite these limitations, a strength of this report was the integration of a well-established risk factor for poor metabolic health (i.e., age) with a core aspect of emotional experience, the tendency to outwardly express anger. We demonstrated that both are important for understanding metabolic risk associated with aging. Specifically, older adults who expressed their anger outwardly had the highest health risks, whereas older adults who reported fewer anger expressions exhibited comparable probabilities of metabolic syndrome to adults several decades younger. An important implication of the findings is whether anger management strategies might be useful for older adults prone to outwardly express their anger, with possible prophylactic implications for metabolic syndrome and subsequent cardiovascular disease.

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