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Obese But Fit: The Relationship of Fitness to Metabolically Healthy But Obese Status among Sexual Minority Women

Jane A. McElroy, PhD [a,*], Tess Gilbert, MHS [b], Elizabeth C. Hair, PhD [c], Katherine J. Mathews, MD [d], Sarah Davis Redman, PhD, MPAff [e], Amy Williams, MD [a]

[a] *Department of Family & Community Medicine, University of Missouri, Columbia, Missouri*
[b] *NORC at the University of Chicago, Bethesda, Maryland*
[c] *Evaluation Science and Research, Truth Initiative, Washington, DC*
[d] *Department of Obstetrics, Gynecology, and Women's Health, Saint Louis University, St. Louis, Missouri*
[e] *NORC at the University of Chicago, Atlanta, Georgia*

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ABSTRACT

Purpose: The purpose of this study was to describe fitness characteristics of metabolically healthy sexual minority women who are obese.
Methods: As part of the Healthy Weight in Lesbian and Bisexual Women Initiative funded by the U.S. Office on Women's Health, one site enrolled self-identified lesbian or bisexual women age 40 and older in a randomized controlled trial that evaluated interventions to improve health. Women with waist-to-height ratio of 0.5 or greater were classified as obese. Women without diabetes or cardiovascular disease and with normal range fasting blood level measurements of glucose, triglycerides, high-density cholesterol, and blood pressure were classified as metabolically healthy but obese (MHO). Otherwise, women were classified as metabolically unhealthy obese (MUHO). Fitness measurements included predicted VO_2 maximum, 1-minute heart rate recovery, and strength (single maximal leg lift and chest press). Self-reported demographic and physical activity level data were obtained by standardized questionnaires.
Results: Of the 53 participants who completed the eligibility screener in Columbia, Missouri, 47 were enrolled in the study (89% participation proportion) with 45 categorized as obese. Approximately one-third (38%) were MHO. The majority of MHO and MUHO participants ranked poor or very poor on a composite fitness score that included measures of strength, flexibility, and aerobic fitness (75.0% and 77.8%, respectively). In the logistic regression models, better 1-minute heart rate recovery after peak exercise performance was significantly associated with MHO individuals (odds ratio, 2.92; 95% CI, 1.13–9.10) compared with MUHO. No other fitness measure was significantly different between the two groups.
Conclusion: Consistent with other studies, we identified more than one-third of our obese sexual minority women as MHO. Fitness measures may be potential predictors of MHO status because one measure, heart rate recovery, was significantly associated with MHO status. With the population prevalence of obesity high and even higher among lesbian or bisexual women, sexual minority women are an ideal population for a longitudinal study to better understand MHO characteristics.

Conventional medical wisdom along with convincing epidemiologic evidence suggests that individuals who are obese (typically defined as having a body mass index [BMI] of ≥30 kg/m^2) are unhealthy because of the conditions commonly found in this population: elevated blood pressure (BP), elevated triglycerides, low levels of high-density lipoprotein cholesterol, elevated fasting glucose levels, or decreased insulin resistance. Further, because these conditions are risk factors for numerous sequelae including cardiovascular disease (CVD) and type 2

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* Correspondence to: Jane A. McElroy, PhD, Department of Family and Community Medicine, University of Missouri, MA306 Medical Science Building, 7 Hospital Drive, Columbia, MO, 65212. Phone: 573-882-4993; fax: 573-884-6172.
E-mail address: mcelroyja@missouri.edu (J.A. McElroy).

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diabetes mellitus (Reilly & Kelly, 2011), physicians routinely recommend that obese patients lose weight to prevent or manage associated chronic conditions (Case, Jones, Nelson, O'Brian, & Ballantyne, 2002).

The MHO literature suggests that fat distribution (visceral vs. peripheral) provides a more meaningful predictor of metabolic risk and morbidity than BMI. Women with increased visceral adipose tissue (VAT; android or apple body shape) are more prone to metabolic abnormalities and the associated macrovascular diseases, including type 2 diabetes, hypertension, and coronary artery disease, than women with increased subcutaneous adipose tissue (gynoid or pear-shaped). It is believed that VAT causes increased insulin resistance through release of free fatty acids and cytokines (Hamdy, Porramatikul, & Al-Ozairi, 2006; Lebovitz, 2003; Rimm, Hartz, & Fischer, 1988). VAT distribution is more common in African American, Asian, Latina, Indian, and Japanese women (Hamdy et al., 2006; Man et al., 2009). Using indexes that account for body fat distribution such as waist-to-hip (or waist-to-height [WHtR]) ratio, intra-abdominal fat depot volume, or waist-to-height ratio may provide a more accurate means of risk stratifying obese women (Kahn, 1993; Rimm et al., 1988).

This emerging field of potentially metabolically healthy but obese (MHO) individuals is particularly relevant to sexual minority women for several reasons (Plourde & Karelis, 2014). First, National Health Interview Survey data suggest that obesity rates for lesbian or gay women (36.7%) and for bisexual women (40.9%) are much higher than that of heterosexual women (28.3%). A recent systematic review on the relationship between sexual orientation and weight supported the finding from the National Health Interview Survey (Eliason et al., 2015). Second, evidence supports obesity as a risk factor for the metabolic syndrome (Gami et al., 2007; Hu, 2003). As a minority group that is known to have higher obesity rates, determining the obesity-related sequelae in lesbian or bisexual women (defined as lesbian, bisexual, gay, queer, other nonheterosexual sexual orientations) and their propensity for developing metabolic diseases is useful. Third, cultural beauty ideals or aesthetic norms that promote thin women may not stereotypically resonate with lesbian or bisexual women, because lesbian or bisexual communities are more accepting of various body weights (Eliason & Fogel, 2015). Similarly, lesbian or bisexual women are less likely than heterosexual women to report weight as an important characteristic of attraction (Cohen & Tannenbaum, 2001; Legenbauer et al., 2009).

This concept of MHO is also relevant to older lesbian or bisexual women because advanced age has been reported as a risk factor for metabolically unhealthy obese (MUHO) or converting to MUHO (Appleton et al., 2013; Schroder et al., 2014; van Vliet-Ostaptchouk et al., 2014; Wildman et al., 2008). In a review of physical activity, fitness levels, and health outcomes, Blair, Cheng, and Holder (2001) concluded that cardiorespiratory fitness was consistently and strongly related to an inverse dose–response gradient for many health outcomes, including diabetes and CVD. Higher fitness level is associated with less visceral and intrahepatic fat accumulation, preserved insulin sensitivity, and normal adipose tissue function (Bluher, 2014; Stefan et al., 2008). In assessing MHO status, most (Bell et al., 2015; Farrell, Cheng, & Blair, 2004; Kanagasabai, Thakkar, Kuk, Churilla, & Ardern, 2015; Katzmarzyk, Church, Janssen, Ross, & Blair, 2005; Ortega et al., 2013; Poelkens et al., 2014; Schroder et al., 2014; Sung et al., 2015), but not all studies (Appleton et al., 2013; Brochu et al., 2001; Hankinson et al., 2013) have reported better fitness levels to be predictive of MHO status. The purpose of this study is to describe MHO characteristics for a cohort of older lesbian or bisexual women enrolled in a randomized control trial on health and fitness.

Methods

The Living Out, Living Actively (LOLA) project is a randomized controlled trial of lesbian or bisexual woman aged 40 or over funded by an Office of Women's Health initiative. Before randomization into groups (i.e., the run-in period), participants received medical clearance from a health care provider to participate in a 16-week intervention on health and fitness. As described more fully in Fogel and colleagues (pages S7–S17 in this issue), during the run-in period, participants completed questionnaires on relevant medical history, including diagnosis of diabetes and CVD made by a physician as well as self-reported questions including demographics, physical activity level using the International Physical Activity Questionnaire-Short Version (Craig et al., 2003), and standardized psychosocial measures (Fogel et al., pages S7–S17 in this issue). Participants also provided a fasting blood sample and completed a fitness assessment at a local fitness center. This study was approved by the University of Chicago (for NORC) and University of Missouri Institutional Review Board for the Protection of Human Subjects. All participants completed written informed consent.

Biometrics including measurements of weight, height, waist circumference, and BP and were collected by trained program staff. Jackson-Pollock generalized equations were used with skinfold measurements to calculate percent of fat-free and fat mass (Jackson, Pollock, & Ward, 1980). Resting systolic and diastolic BP was measured using standard clinical protocol. A fasting 10-mL blood sample was used to measure glucose and lipids.

Participants also completed a standardized fitness assessment using the Balke-Ware treadmill test or recumbent bicycle ergometer test using modified American College of Sports Medicine (ACSM) guidelines (Borgida & Campbell, 1982) to obtain aerobic fitness measure. A single maximal repetition lift was used to determine leg and chest strength following the ACSM guidelines with results stratified by age and gender (Borgida & Campbell, 1982). One-minute heart rate recovery was calculated by maximum heart rate at the end of the treadmill (or bicycle) test minus resting heart rate divided by 10 (5 categories: poor, <2; fair, 2–2.9; good, 3.0–3.9; excellent, 4–5.9; and outstanding, ≥ 6.0; Borgida & Campbell, 1982). An overall fitness composite score was calculated using ACSM guidelines of fitness that stratifies by age groups and gender (Borgida & Campbell, 1982).

The results for four tests (leg and chest maximal lift, predicted VO_2 max, and 1-minute heart rate recovery) were ranked as very poor, poor, average, above average, excellent, and/or outstanding using ACSM age- and gender-stratified recommendations on a 6-point scale with a maximum score of 24. Scores for the four tests were summed and participants were assigned to one of three fitness levels (<12, 12–19, or ≥ 20 points). The validated IPAQ scoring protocol was used to dichotomize participants (yes/no) into meeting the recommended physical activity guidelines (150 minutes per week of moderate physical activity or 75 minutes per week of vigorous physical activity; Centers for Disease Control and Prevention [CDC], 2014). See the IPAQ website for specifics on the scoring protocol for the short version of IPAQ (Sjostrom et al., 2005).

A modified version of Rey-Lopaz's (2014) recommendation was used to classify participants as metabolically healthy or metabolically unhealthy. Specifically, individuals were identified as metabolically healthy if they had not been diagnosed with diabetes or CVD and also had none of the following: 1) BP $\geq$ 130/85 mm Hg, 2) fasting plasma glucose $\geq$ 110 mg/dL, 3) fasting triglyceridemia >150 mg/dL, and 4) high-density lipoprotein cholesterol < 40 mg/dL. Participants were defined as obese based on a WHtR of equal to or greater than 0.5. In the original Rey-Lopaz recommendation, waist circumference was an additional criterion to classify metabolic health and obesity was defined using BMI ($\geq$30 kg/m^{2}; Rey-Lopez, de Rezende, Pastor-Valero, & Tess, 2014). We used WHtR to define obesity because VAT measures excessive weight in the abdominal region and is known as a predictor of CVD risk and metabolic abnormalities (Kissebah et al., 1982).

Descriptive statistics (frequencies, mean values, and standard deviation) described items measuring demographic characteristics, the metabolic syndrome, and CVD risk factors (Table 1). Spearman's rank correlation coefficient was used to compare fitness measures and self-reported physical activity data. A series of analysis of variance analyses more completely examined associations with MHO and fitness measures noted in Table 1. Exact logistic regression models described predictors of MHO. Variables placed in the models included age (continuous), fitness measures (predictive VO_2 max, single maximal leg or chest lift, 1-minute heart rate recovery, overall fitness level categories), or self-reported physical activity (three categories: low, moderate, high; or meeting physical activity guidelines). Significance was measured at $p < .05$. SAS/STAT software. Version 9.3 was used for these analyses (Cary, NC).

Results

Of the 53 participants from Columbia, Missouri, who completed the eligibility screener, 47 participants completed components used in this analysis: blood draw, medical examination with medical questionnaire, and fitness assessment. Of these 47 participants, 45 were classified as obese using the criterion of WHtR of 0.5 or greater (92% participation proportion; Table 1).

The majority of participants in this analysis were White (88%), highly educated (4-year college degree or higher: 70%), postmenopausal (58%), and self-identified as lesbian (79%). Approximately half were in a committed relationship and earned $50,000 or more in annual income. The mean age was 53 years (range, 40–69). Slightly more than one-third (37.8%) were MHO (Table 1). Using the definition criteria for metabolically healthy, MUHO had a mean number of 2.25 conditions (range, 1–4; Table 2). MUHO participants were more likely to be heavier (34 kg/m^{2}) compared with MHO participants (Table 3).

Table 1
Characteristics of Metabolically Healthy Obese (MHO) and Metabolically Unhealthy Obese (MUHO) Participants Using Weight to Height Ratio of $\geq$0.5 to Define Obesity

Characteristic	MUHO $n = 28$, Mean (SD)		MHO $n = 17$, Mean (SD)		Total $n = 45$, Mean (SD)	
Age (y)	51.8 (12.5)		51.4 (8.6)		53.0 (7.9)	
	n	%	*n*	%	*n*	%
Age groups (y)						
40–49	8	30	6	35	14	31
50–59	10	35	7	41	17	38
$\geq$60	10	35	4	14	14	31
Menopausal status						
Premenopausal	10	36	5	29	15	33
Postmenopausal	16	57	10	59	26	58
Missing	2	7	2	12	4	9
Race						
White	25	89	15	88	40	89
Non-White	3	11	2	12	5	11
Educational attainment						
High school to some college	7	25	6	40	13	30
4-Year college degree	5	18	5	33	10	23
Postgraduate work or degree	16	57	4	27	20	47
Employment status						
Working full or part time	23	82	11	73	34	79
Retired	2	7	4	27	6	14
Disabled	2	7	0	0	2	5
In school full time, not working	1	4	0	0	1	2
Sexual orientation						
Lesbian	23	82	11	73	34	79
Bisexual	5	18	4	27	9	21
Annual household income						
$\leq$$30,000	5	18	4	27	9	21
$30,001–$50,000	9	32	2	13	11	25
$50,001–$100,000	12	43	6	40	18	42
>$100,000	2	7	3	20	5	12
Have some kind of health care coverage						
Yes	26	93	14	93	40	93
Relationship status						
In a committed relationship with a woman	12	43	9	60	21	49
Single and not involved with a woman, man, or both	4	14	3	20	7	16
Single and not involved with anyone	12	43	3	20	15	35

Table 2
Metabolic Indicators of Metabolically Healthy Obese (MHO) and Metabolically Unhealthy Obese (MUHO) Participants Using Weight to Height Ratio of ≥0.5 to Define Obesity

Indicator	MUHO $n = 28$		MHO $n = 17$		Total $n = 45$	
	n	%	*n*	%	*n*	%
Fasting triglyceridemia (mg/dL)						
>150 (at risk)	14	50	0	0	14	31
≤150	14	50	17	100	31	69
High-density lipoprotein cholesterol (mg/dL)						
<40 (at risk)	4	14	0	0	4	9
≥40	24	86	17	100	41	91
Fasting plasma glucose (mg/dL)						
≥110 (at risk)	3	11	0	0	3	7
<110	25	89	17	100	42	93
Blood pressure (mm Hg)						
≥130/85 (at risk)	14	50	1	6	15	33
<130/85	14	50	16	94	30	67
Meeting physical activity guidelines						
Yes	6	79	5	71	11	24
No	22	21	12	29	34	76

The majority of MHO and MUHO participants ranked in the least fit category (<12 points) on the composite fitness score (76.5% and 78.6%, respectively). As seen in Table 4, the 1-minute heart rate recovery was the only fitness measure that showed a significant difference between MHO and MUHO participants (odds ratio [OR], 2.92; 95% CI, 1.13–9.10; $p = .02$), with MHO participants having a faster heart rate recovery after exercise. The logistic regression exact model suggested that younger age was more likely to be MHO (OR, 0.96; 95% CI, 0.88–1.04). Although the ORs were not significant for any of the fitness measures except 1-minute heart rate recovery, the odds ratios were in the hypothesized direction; in other words, MHO participants were more likely to lift more weight or meet the physical activity guidelines compared with MUHO participants (Table 4). Significant differences in mean self-reported physical activity level (either as categories of physical activity levels or meeting the recommended CDC guidelines) between MHO and MUHO participants were not observed (CDC, 2014). The correlation between fitness levels using testing protocol by trained personnel (predicted VO_2 maximum) and self-reported physical activity was weak ($r^2 = 0.18$).We also examined the predictors for being MHO for the cutoff of a WHtR of 0.6 or greater, which reduced our sample size by approximately 25%, with slightly more women being categorized as MUHO ($n = 35$; MHO = 14, MUHO = 21). The logistic regression exact model suggested that 1-minute heart rate recovery was no longer a significant predictor of MHO, but rather a higher predicted VO_2 maximum was significantly associated with being MHO (OR, 0.46; 95% CI, 0.21–0.90; $p < .05$).

Discussion

Two important and related findings are worth highlighting. First, a measure of fitness (1-minute heart rate recovery for women at or above 0.5 WHtR or for heavier women, higher predicted VO_2 max) was significantly associated with metabolic health status. This is consistent with several recently published studies about the importance of fitness and metabolic health (Bell et al., 2015; Farrell et al., 2004; Kanagasabai et al., 2015; Katzmarzyk et al., 2005; Ortega et al., 2013; Poelkens et al., 2014; Schroder et al., 2014; Sung et al., 2015). Second, participant's self-report of physical activity was correlated weakly with their composite fitness level ($r^2 = 0.18$), potentially indicating that participants misclassified their physical activity levels as moderate or rigorous, or simply exaggerated duration of moderate or rigorous activity (reporting bias). Because we used certified fitness trainers and well-established protocols for the assessment, we are confident in the measurement of fitness in this study. Taken together, these findings suggest that future studies may want to use the 1-minute heart rate recovery or a more labor-intensive aerobic fitness measure such as predicted VO_2 max as a measure of fitness, rather than self-reported physical activity.

Although using a standardized physical activity questionnaire may be thought to be a proxy of fitness level, it is worth noting that a physical activity questionnaire determines a behavior that is defined as bodily movement that increases energy expenditure. In contrast, fitness assessments are a physiologic attribute often determined by a standardized aerobic test, such as a treadmill test. Consequently, fitness measures are typically reported to be more accurate and may be a stronger predictor of health outcomes, because fitness assessments are less prone to misclassification error (Blair et al., 2001). Because we found that the 1-minute heart rate recovery was significantly associated with metabolic health, it is possible that heart rate recovery could be used as a proxy for fitness measures and in place of self-report to predict metabolic health. Increasing the heart rate (e.g., by doing jumping jacks or step-ups) and subsequently measuring the 1-minute heart rate recovery can be easily

Table 3
Fitness Indicators of Metabolically Healthy Obese (MHO) and Metabolically Unhealthy Obese (MUHO) Participants Using Weight to Height Ratio of ≥0.5 to Define Obesity

Indicator	MUHO ($n = 28$)		MHO ($n = 17$)		Total ($n = 45$)	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Total minutes*						
Vigorous physical activity	30.7	55.7	14.1	21.6	24.4	46.3
Moderate physical activity	35.9	52.1	19.7	31.7	29.8	45.8
Walking	37.5	41.2	30.6	43.6	34.9	41.7
Body mass index	34.0	5.9	31.5	6.9	33.0	6.3
Waist circumference	39.3	5.2	36.7	5.3	38.3	5.3
Predicted VO_2 max	24.1	5.5	25.8	5.2	24.7	5.4
1minute heart rate recovery	17.9	7.0	23.0	7.5	19.8	7.5
Single maximum leg lift/weight ratio	1.1	0.4	0.9	0.4	1.0	0.4
Single maximum chest lift/weight ratio	0.4	0.2	0.4	0.2	0.4	0.2

* On days that >10 minutes of activity is performed.

Table 4
Exact Logistic Model Comparing Fitness Characteristics of Metabolically Healthy Obese to Metabolically Unhealthy Obese Participants

Characteristic	Odds Ratio	95% CI	*p* Value
Age (continuous)	0.96	0.88–1.04	.32
Lower VO_2 max	0.72	0.43–1.17	.20
One-minute heart rate recovery	2.92	1.13–9.10	.02
Single maximal leg lift	1.22	0.80–1.93	.39
Single maximal chest press	1.14	0.74–1.87	.63
Meeting physical activity guidelines	1.51	0.30–7.46	.80
Cumulative fitness score	1.39	0.33–5.89	.81

performed in a physician's office. Our finding is also useful for educational purposes in a clinical setting. Physicians could advise patients that if they feel winded after climbing stairs and their recovery is slow, then they could be at risk for poor metabolic health.

Another patient-centered component to MHO phenomena rests in the cultural aspects of a more accepting view of body sizes and broader definitions of beauty in the lesbian or bisexual population (Eliason & Fogel, 2015). Lesbian or bisexual women contribute to a nuanced, culturally relevant understanding of weight and health and may highlight specific biases within medical and public health practice. This understanding can also help health care professionals to provide practical and suitable advice to their obese lesbian or bisexual patients (Hainer & Aldhoon-Hainerova, 2013; Kwan, 2009; Lainscak, von Haehling, Doehner, & Anker, 2012; Plourde & Karelis, 2014; Rey-Lopez et al., 2014; Samocha-Bonet et al., 2014).

In a systematic review comparing BMI, waist circumference, and WHtR measurements to VAT measurement, waist circumference and WHtR were better predictors of VAT than BMI (Browning, Hsieh, & Ashwell, 2010). VAT measures excessive weight in the abdominal region and is known as a predictor of CVD risk and metabolic abnormalities (Kissebah et al., 1982). Although we did not use imaging to determine the distribution of adipose tissue, most of our participants ($n = 32$) were 'apple' shaped (WHtR ≥ 0.8), which is associated with higher VAT compared with a pear shape (WHtR ≤ 0.8; Fredriks, van Buuren, Fekkes, Verloove-Vanhorick, & Wit, 2005). Similar to testing 1-minute heart rate recovery, determining WHtR may be a quick and more accurate alternative to BMI in future studies of MHO.

Conclusion

As the prevalence of obesity continues to grow, identifying better ways to help prevent CVD and metabolic diseases among populations that are more likely to be obese, such as lesbian or bisexual women, becomes increasingly important (Bowen, Balsam, & Ender, 2008). In our study, we identified a cohort of obese participants using WHtR who were metabolically healthy. In other words, these participants' blood panel results for metabolic risk factors (e.g., cholesterol, triglycerides, glucose, and BP) were within healthy ranges and there was no history of CVD or diabetes. With our exploratory study, we found that fitness measures were suggestive as potential predictors of MHO status. Poor correlation between self-reported measures of physical activity and direct measures of fitness suggest caution in using a standardized short physical activity instrument to classify physical fitness of individuals. As almost 90% of the participants were ranked below average for aerobic fitness, the limited variability of this measure reduced our ability to fully assess the association with MHO status. With more than one-third of our participants classified as MHO, our result was on the higher end of reported MHO prevalence compared with other studies (Plourde & Karelis, 2014), suggesting that lesbian or bisexual women would be an ideal population to enroll in a longitudinal study to determine whether or not MHO is a transitory or stable condition.

Implications for Practice and/or Policy

We found that the 1-minute heart rate recovery was significantly associated with metabolic health in a cohort of women age 40 to 69 years. It is possible, with additional confirmatory studies that also include men, that heart rate recovery could be used as a proxy for fitness measures and in place of self-reported physical activity levels to predict metabolic health for middle aged adults. Elevating the heart rate (e.g., by doing jumping jacks or step-ups) and subsequently measuring one minute heart rate recovery can be accomplished at a health care visit. Our finding is also useful for educational purposes in a clinical setting. Physicians could advise 'healthy' obese patients that if they feel winded after climbing stairs and their recovery is slow, then they could be at risk for poor metabolic health. Similar to testing 1-minute heart rate recovery, determining WHtR may be a quick and more salient measure of precursors of metabolic health than the standard use of BMI. Continued study of metabolically MHO phenomena will advance our nuanced understanding of health risks associated with obesity and provide evidence to support best practices in clinical settings.

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Author Descriptions

Jane A. McElroy, PhD, is Associate Professor of the University of Missouri, Department of Family & Community Medicine. She is an epidemiologist with two research tracks focusing on health disparity (including sexual and gender minority research) and environmental exposure and health risks.

Tess Gilbert, MHS, is a Senior Research Analyst at NORC at the University of Chicago. Ms. Gilbert is an epidemiologist who focuses on program evaluation, rural health, and the impact of disparities on health outcomes.

Elizabeth C. Hair, PhD, is Vice President for Evaluation Science and Research, Truth Initiative. She is a developmental psychologist with expertise in quantitative methods and evaluation. Her current work focuses on tobacco control.

Katherine J. Mathews, MD, is an OB-GYN attending physician, Department of Obstetrics, Gynecology, and Women's Health, Saint Louis University. She has special interests in health care for uninsured and minority medical populations, as well as in public health and health care policy.

Sarah Davis Redman, PhD, MPAff, is a Research Scientist at NORC at the University of Chicago. She has over a decade of experience designing and conducting evaluations on a range of public health topics.

Amy Williams, MD, is a practicing family physician and assistant professor, Department of Family and Community Medicine, University of Missouri, where she teaches residents and medical students. Her research emphasis on community-based physical activity projects, childhood obesity, and LGBT health.