The physical and emotional benefits of participating in an exercise-based cardiac rehabilitation (CR) program are well-documented. However, not all patients achieve gains in CR due, in part, to poor treatment adherence, which may be affected by cardiac symptoms, older age, and transportation limitations. Studies also have suggested that psychosocial functioning, including emotional distress, negative disposition (personality), and ineffective coping strategies, may have a negative influence on patient adherence and outcomes of CR.

Although symptoms of depression and anxiety improve following the completion of CR, elevated emotional distress also is associated with CR dropout and poor adherence. In addition, anxiety among patients in CR is associated with contrasting outcomes,

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Author Affiliations:
Departments of Psychology (Drs Jackson and Emery) and Internal Medicine (Dr Jackson), Ohio State University, Columbus.

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Correspondence: Charles F. Emery, PhD, Department of Psychology, Ohio State University, 1835 Neil Ave, 149, Psychology Bldg, Columbus, OH 43210 (emery.33@osu.edu).

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including poor health behaviors (ie, smoking\textsuperscript{20} and inactivity\textsuperscript{21}) as well as, paradoxically, closer monitoring of one's own physiology, resulting in more immediate and frequent health care utilization.\textsuperscript{22} Consistent with the latter paradoxical observation, Whitmarsh et al\textsuperscript{8} found that the individuals who completed CR were higher in emotional distress than those who prematurely discontinued or had poor attendance. These conflicting results suggest that additional factors such as personality traits may interact with symptoms of distress to influence adherence and/or dropout from CR.

Prior research suggests that personality may play a role in how one copes with the stress of cardiac disease.\textsuperscript{23} Alexithymia (ie, difficulty describing or processing emotion) has been associated with anxiety and somatization,\textsuperscript{24} poor health behaviors,\textsuperscript{13} and higher body mass index.\textsuperscript{14} One prior study found that alexithymia was not associated with CR attendance.\textsuperscript{25} However, the influence of alexithymia on other CR outcomes has not been examined.

Research on coping strategies among individuals with heart disease has revealed that “approach coping,” which includes planning the next course of action, thinking rationally about the situation, and seeking advice, is associated with positive personality traits, such as optimism.\textsuperscript{25} Conversely, “avoidance coping,” or distancing oneself from the stressor, is associated with depressive symptoms\textsuperscript{26,27} and alexithymia.\textsuperscript{28} Prior research indicates a negative association between maladaptive coping and self-reported physical functioning among patients in CR, but no relationship between active coping and physical functioning.\textsuperscript{15} Furthermore, lower maladaptive coping in combination with higher optimism was associated with better physical functioning.\textsuperscript{15} No prior studies have examined coping strategies as predictors of change in physiological outcomes of CR.

The purpose of this pilot study was to examine emotional distress (depressive and anxiety symptoms), alexithymia, and coping strategies (approach and avoidance coping) as predictors of CR outcomes and attendance. It was hypothesized that more symptoms of depression and anxiety, higher alexithymia, and more avoidance coping would be associated with less improvement in CR outcomes and poor attendance. Conversely, more approach coping was expected to be associated with positive changes in CR outcomes and better attendance. Four interaction effects also were hypothesized: (1) higher emotional distress in conjunction with avoidance coping or alexithymia was expected to predict poorer CR outcomes and attendance; (2) alexithymia in conjunction with avoidance coping was expected to predict poorer CR outcomes and attendance; (3) emotional distress in conjunction with approach coping was expected to predict better CR outcomes and attendance; and (4) alexithymia in conjunction with approach coping was expected to predict better outcomes and attendance.

**METHODS**

Fifty-six participants were recruited from an outpatient CR program during the initial CR session. Criteria for participation included ability to read English and physician diagnosis of a cardiac condition leading to a CR referral. Ten participants dropped out of the study after completing baseline measures for the following reasons: time constraints (n = 2), impairment due to comorbid conditions (n = 2), lack of insurance coverage for continued participation in CR (n = 2), no longer interested (n = 2), returned to work (n = 1), and death (n = 1).

As shown in Table 1, the sample was mostly middle-aged and older adults (61.1 ± 12.6 years of age), white (59%), and men (65%). Primary cardiac diagnoses included myocardial infarction (35%), cardiac surgery (ie, coronary artery bypass graft surgery, stent placement, and percutaneous transluminal coronary angioplasty; 36%), and other cardiac diagnoses (eg, angina, valvular disorder, and heart failure; 29%).

The CR program was 12 weeks in duration and included 36 one-hour exercise sessions (3 per week) and 10 weekly educational classes. Each educational class lasted approximately 30 to 45 minutes, covering a topic relevant to cardiac disease management. Classes were taught by specialists in each topic, including dietitians, exercise physiologists, pharmacists, and master’s-level health psychology trainees.

**Measures**

The following health information was obtained from patient medical records: cardiac diagnosis, the number of comorbid conditions, and left ventricular ejection fraction. In addition, the following outcomes were recorded at baseline and followup (after the CR program was completed): (1) blood cholesterol (high-density lipoprotein, low-density lipoprotein, and total cholesterol) and (2) oxygen uptake ($\dot{W}_{O2\text{max}}$). $\dot{W}_{O2\text{max}}$ was recorded following maximal exercise on a treadmill, stationary bicycle, or recumbent stepper. The test was conducted by a clinical exercise physiologist, supervised by a cardiologist. Starting speed was based on pre-CR level of physical functioning, and speed and grade were increased every 2 minutes. The concentration of expired oxygen and carbon dioxide was assessed in breath-by-breath analysis with 7-second averages to calculate $O_2$ and carbon dioxide production. $\dot{W}_{O2\text{max}}$ was calculated and expressed in mL·kg\textsuperscript{-1}·min\textsuperscript{-1}. The test was terminated when maximum exercise...
The total number of sessions attended was recorded after participants completed CR. In addition, the following self-report measures were completed by participants at baseline and followup.

Lipid consumption was evaluated using the Northwest Lipid Research Clinic Fat Intake Scale, a 12-item measure of dietary fat intake. Lower scores indicated less consumption of fats. The test-retest reliability of the scale has ranged from 0.76 to 0.78 when collected 6 to 8 weeks apart, and the measure is associated with other known measures of fat intake that predict plasma total cholesterol. The internal reliability in this study was good ($\alpha = 0.80$).

The Cardiac Rehabilitation Quiz is a 25-item measure created for this study to evaluate multiple domains of cardiac disease knowledge, including diet, exercise, and risk factors for disease progression. Items were developed with input from exercise physiologists, dietitians, health psychologists, and nurses. Scores are reflected as percentage of items answered correctly. In this study, internal consistency was good ($\alpha = 0.78$).

The following self-report measures were completed only at baseline to evaluate hypothesized predictors and moderators of CR outcomes.

- **The Beck Depression Inventory** is a 21-item measure of depressive symptoms used widely in research and clinical settings. It has demonstrated high internal consistency and adequate discriminant and content validity in both clinical and nonclinical populations. Its use in cardiac populations is also well-documented.

- **The State scale in this study was excellent reliability ($\alpha = 0.89$).**

- **Anxiety symptoms were measured with the State Scale of the State-Trait Anxiety Inventory. It is a well-documented.** Reliability was high ($\alpha = 0.79$), and reliability in this study was excellent ($\alpha = 0.78$).

- **The Toronto Alexithymia Scale is a 20-item questionnaire evaluating expression and interpretation of emotions. Higher total scores suggest greater difficulty expressing and identifying emotions. The Toronto Alexithymia Scale has demonstrated adequate internal consistency among cardiac patient populations ($\alpha = 0.79$), and reliability in this study was excellent ($\alpha = 0.87$).**

- **The Coping Orientation to Problems Experienced–Short Form** is a 28-item questionnaire measuring multiple methods of coping, including approach and avoidance coping. The Coping Orientation to Problems Experienced has demonstrated moderately high test-retest reliability and adequate internal consistency for the entire measure (median value of Cronbach $\alpha$ was 0.71). The denial, behavioral disengagement, and

(continued...)

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**Table 1** - Demographic, Predictor, and Outcome Variables for Study Participants

<table>
<thead>
<tr>
<th>Demographic/Predictor</th>
<th>Baseline Means (SD)</th>
<th>Followup Means (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>61.1 (12.6)</td>
<td></td>
</tr>
<tr>
<td>Sex, % male</td>
<td></td>
<td>65</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White, %</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>African American, %</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Other (e.g., Hispanic, Asian, and Pacific Islander), %</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Education, y</td>
<td>14.4 (3.1)</td>
<td></td>
</tr>
<tr>
<td>Marital status, married, %</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Myocardial infarction, %</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Cardiac surgery (i.e., CABG, stent, PCTA), %</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Other diagnoses (i.e., angina, valvular disorders, CHF), %</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Left ventricular ejection fraction, %</td>
<td>52.8 (11.8)</td>
<td></td>
</tr>
<tr>
<td>Comorbid conditions, n</td>
<td>4.0 (2.4)</td>
<td></td>
</tr>
<tr>
<td>Depressive symptoms, BDI score</td>
<td>9.7 (7.9)</td>
<td></td>
</tr>
<tr>
<td>Anxiety symptoms, STAXI score</td>
<td>36.4 (13.2)</td>
<td></td>
</tr>
<tr>
<td>Alexithymia, TAS-20 score</td>
<td>49.6 (12.6)</td>
<td></td>
</tr>
<tr>
<td>Approach coping, COPE score</td>
<td>14.9 (4.1)</td>
<td></td>
</tr>
<tr>
<td>Avoidance coping, COPE score</td>
<td>10.0 (3.7)</td>
<td></td>
</tr>
<tr>
<td>Total number of sessions attended</td>
<td>27.1 (11.4)</td>
<td>(max = 36)</td>
</tr>
<tr>
<td>$V_{O_{2\max}}$, mL·kg$^{-1}$·min$^{-1}$</td>
<td>16.5 (5.6)</td>
<td>21.95 (8.9)$^a$</td>
</tr>
<tr>
<td>High-density lipoprotein</td>
<td>37.2 (13.4)</td>
<td>40.3 (13.4)$^a$</td>
</tr>
<tr>
<td>Low-density lipoprotein</td>
<td>95.6 (44.2)</td>
<td>78.0 (31.6)</td>
</tr>
<tr>
<td>Total cholesterol</td>
<td>165.6 (48.5)</td>
<td>135.8 (34.1)</td>
</tr>
<tr>
<td>Knowledge of cardiac disease</td>
<td>69.6 (13.7)</td>
<td>79.1 (15.2)$^a$</td>
</tr>
<tr>
<td>Self-report of lipid consumption, FIS score</td>
<td>27.9 (6.3)</td>
<td>25.7 (6.3)$^a$</td>
</tr>
</tbody>
</table>

Abbreviations: BDI, Beck Depression Inventory; CABG, coronary artery bypass graft; CHF, congestive heart failure; COPE, Coping Orientation to Problems Experienced; FIS, Fat Intake Scale; PCTA, percutaneous transluminal coronary angioplasty; STAXI, State Scale of the State-Trait Anxiety Inventory; TAS-20, Toronto Alexithymia Scale; $V_{O_{2\max}}$, maximal oxygen uptake.

$^a P < .01$. Threshold was reached by patient report of extreme fatigue or the technician observed abnormal heart rhythm, significant ischemic changes, or other limiting symptoms. The full stress test required 45 minutes to complete.

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self-distraction subscales have been used to represent the broader concept of avoidance coping among cardiac patients.\textsuperscript{36} For this study, approach coping was composed of the following subscales: active coping, use of instrumental support, and planning. Internal consistency for the avoidance and approach coping scales were 0.79 and 0.77, respectively.

### Statistical Analyses

To evaluate the representativeness of participants who completed CR, $\chi^2$ and independent-samples $t$ tests were conducted, comparing study completers with study dropouts. Pearson correlations also were employed to determine associations between demographic variables and study predictors. Ethnic differences were explored using $t$ tests.

Change in CR outcomes over time was assessed using repeated-measures general linear models. Hierarchical linear modeling was then used to test interactions of emotional distress (ie, depression and anxiety), alexithymia, and coping style (ie, approach and avoidance) in predicting change in CR outcomes. Change scores were created for all outcome variables and avoided coping (African Americans: $M = 11.6 \pm 5.0$; whites: $M = 9.0 \pm 2.4$; $t = -2.44$, $P = .019$).

Analysis of variance was used to evaluate change in Demands over time associated with CR. Results indicated significant increases in $V_{\text{O}2\max}$ ($F_{1,24} = 32.27$, $P < .001$), high-density lipoprotein ($F_{1,25} = 8.30$, $P = .008$), cardiac disease knowledge ($F_{1,20} = 12.59$, $P = .002$), and reduced self-reported lipid intake ($F_{1,20} = 13.22$, $P = .001$) following CR, as shown in Table 1.

Correlations of emotional distress, alexithymia, and coping strategies with CR outcomes revealed that alexithymia was associated with increased low-density lipoprotein ($r = -0.60$, $P = .015$), and baseline levels of anxiety were associated with poorer attendance ($r = -0.40$, $P = .011$). No other significant associations were found between CR outcomes and emotional distress or coping strategies. Regression analyses of interaction effects indicated that alexithymia predicted increased self-reported lipid consumption in the context of higher approach coping (1 SD above the mean; $\beta = .07$, SE = 0.03, $P = .008$) as shown in the Figure. No other interactions of distress or coping were found.

### RESULTS

The $\chi^2$ and $t$ tests indicated that the study participants did not differ from those who dropped from the study and/or CR on any demographic variables, health factors, or alexithymia. However, those who dropped reported higher levels of anxiety at baseline ($M = 43.9$, SD = 13.1) than those who completed the study ($M = 34.5$, SD = 12.7, $t_{20} = 2.08$, $P = .043$).

Baseline correlations of demographic variables with psychological variables indicated that older age was associated with fewer symptoms of emotional distress and less avoidance coping, as shown in Table 1. In addition, higher education was associated with less emotional distress, lower alexithymia, and more approach coping. Student $t$ tests revealed that African American participants reported higher levels of depressive symptoms ($M = 14.0 \pm 9.8$) than whites ($M = 7.3 \pm 5.3$, $t = -3.09$, $P = .003$), as well as greater avoidance coping (African Americans: $M = 11.6 \pm 5.0$; whites: $M = 9.0 \pm 2.4$; $t = -2.44$, $P = .019$).

### Table 2 • Pearson Correlations Between Demographics and Predictor Variables

<table>
<thead>
<tr>
<th></th>
<th>Depressive Symptoms (BDI)</th>
<th>Anxiety (STAIX1)</th>
<th>Alexithymia (TAS-20)</th>
<th>Approach Coping (COPE)</th>
<th>Avoidance Coping (COPE)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>$-0.33^a$</td>
<td>$-0.50^b$</td>
<td>$-0.16$</td>
<td>$-0.11$</td>
<td>$-0.44^b$</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td>$-0.31^a$</td>
<td>$-0.36^b$</td>
<td>$-0.55^b$</td>
<td>$0.31^*$</td>
<td>$-0.18$</td>
</tr>
</tbody>
</table>

Abbreviations: BDI, Beck Depression Inventory; COPE, Coping Orientation to Problems Experenced; STAIX1, State Scale of the State-Trait Anxiety Inventory; TAS-20, Toronto Alexithymia Scale.

\textsuperscript{a}$P \leq .05$.

\textsuperscript{b}$P \leq .01$.
The purpose of this study was to examine predictors of CR outcomes and attendance. Results indicated that participants who completed CR experienced increases in exercise capacity and high-density lipoprotein levels as well as reported reduced dietary consumption of lipids and more knowledge about cardiac disease management. This replicates prior studies showing improvements in exercise capacity and lipid profiles following CR and extends the benefits of CR to include improvement in disease knowledge.

As hypothesized, alexithymia was associated with increased low-density lipoprotein levels. Alexithymia has been linked to poor nutrition, sedentary lifestyle, and a higher BMI, suggesting that individuals higher in alexithymia may consume more saturated fats and not engage in regular exercise. In the context of CR, individuals higher in alexithymia may be less likely to change their diet and fully participate during exercise sessions. However, results also suggested that alexithymia was associated with decreased self-reported lipid consumption, but only in the context of low approach coping. One possible explanation for this result is that individuals higher in both approach coping and alexithymia may attempt to “fix” a situation on their own, thereby mistakenly disregarding advice from others, including CR staff. In contrast, those lower in approach coping and higher in alexithymia may be more malleable and receptive to input from others. Past studies have reported negative consequences of approach coping for adherence, which may be especially true when patients want to maintain control over their situation and not change their behaviors.

Emotional distress was not associated with change in the outcome measures, which is in contrast to several studies showing an association of depression and anxiety with change in exercise capacity. While the severity of depressive symptoms in this investigation does not differ from previous studies, the small sample size of this pilot study limited power and may contribute to the null findings.

The data confirm that anxiety symptoms predicted poorer adherence to CR among study completers, and anxiety was higher among those who dropped from CR. This partially supports findings from previous research. However, in contrast to prior studies, no association was found between depressive symptoms and attendance. Furthermore, no association was found between attendance and alexithymia or coping strategies, which is consistent with prior data on alexithymia and CR attendance.

Older age and more education were associated with positive outcomes, but African Americans reported higher levels of depressive symptoms and avoidance coping, which is consistent with previous studies. Post hoc analyses revealed that higher education was associated with better attendance (r = 0.34, P = .005), while age and race were not. Higher education also was associated with less emotional distress, lower levels of alexithymia, and lower levels of approach coping, which likely play a role in the relationship between education and attendance.

This pilot study makes several contributions. First, a breadth of physiological and self-report measures was included, several of which have not been used in prior CR studies (ie, self-reported lipid consumption and disease knowledge). Second, the sample had sizeable minority representation, which is important for generalizability of findings. Third, interactions were examined between emotional distress, negative disposition, and coping style, which have traditionally been explored independently from one another in the context of CR.

One primary limitation of this study was the small sample size, resulting in reduced statistical power, which likely prohibited detection of some effects. Furthermore, small sample size reduces generalizability to a wider population of individuals in CR programs. Despite the small sample size, the results provide promising pilot data for future studies with larger samples.

Overall, these results offer an expanded view of the relationship between psychosocial functioning and CR outcomes. The interaction of alexithymia with approach coping in predicting change in lipid consumption suggests possible areas for intervention. Personality dimensions are not easily modified, but coping strategies are readily modifiable and are suitable targets for cognitive-behavioral interventions. Because these data suggest that approach coping may not always be beneficial, training should focus on situation-appropriate coping responses. In addition,
because of the association of higher anxiety and lower education with poorer CR attendance, patients exhibiting higher anxiety or lower educational resources may benefit from early identification and additional support to facilitate participation in CR.

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