Building Resilience in an Urban Police Department

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Objective: The aim of this study is to examine a resilience training intervention that impacts autonomic responses to stress and improves cardiovascular risk, psychological, and physiological outcomes in police. **Methods:** Officers [($n = 38$) 22 to 54 years] modified emotional and physical responses to stress using self-regulation. Measurements include psychological and physiological measures [eg, heart rate variability (HRV), blood pressure, C-reactive protein)] obtained at three time intervals. **Results:** Age was significantly ($P < 0.05$) associated with changes on several measures of psychological stress (eg, critical incident stress, emotional vitality, and depression). Associations were found between coherence and improved HbA1c ($r = -0.66$, $P < 0.001$) and stress due to organizational pressures ($r = -0.44$, $P = 0.03$). Improvements in sympathetic and parasympathetic contributors of HRV were significant ($P < 0.03$). **Conclusion:** A stress-resilience intervention improves certain responses to job stress with greater benefits for younger participants.

Most law enforcement officers (LEOs) begin their careers in good physical condition and health. However, job-related stress disorders cause many to retire early or die prematurely.[1] The law enforcement occupation is considered one of the most stressful occupations because an officer is continually exposed to complex and unpredictable situations.[2] Police officers encounter various amounts of stress from critical incidents such as threats of danger, homicides, death, and accidents[3] to organization pressures of extended work hours, shift work, and a rigid organizational structure that often involves a top-down management approach.[4]

Exposure to acute and chronic stressors potentiates officers' risks for developing adverse health outcomes.[5] Compared with the general population, police officers tend to have a worsened metabolic profile and a higher prevalence of cardiovascular disease (CVD) risk factors.[6–9] Although several conventional risk factors contribute to this increase, the law enforcement profession remains a "risk factor" even after controlling for conventional risk factors.[7,10] Occupational stress appears to contribute to this worsened CVD risk factor profile.[4,9,11–13]

As stress appears to be virtually unavoidable in the law enforcement profession, it is critical that officers develop the ability to recover from recurrent stressors if physiological and psychological health is to be maintained.[14] This capacity to prepare for, recover from, and adapt in the face of stress, adversity, trauma, or challenge is defined as resilience.[15] Developing training tools to sustain resilience and maintain mental and emotional composure was a priority for the 2015 President's Task Force on 21st Century Policing.[16] This notion is supported by an Action Item (6.1.3) of the President's Task Force stating that the Federal Government should support the continuing research into the efficacy of annual resilience training (p. 64). These interventions should equip officers with the tools to maintain composure and self-regulate in challenging situations and should further provide techniques that teach officers to quickly regain psychological and physiological balance afterward.[15]

Current resiliency training programs have focused on various coping strategies such as approach and avoidance, guided imagery, relaxation, and emotion regulation.[5,17–21] Although these methods have demonstrated promise toward enhancing officer resilience, they do not focus on the physiological toll that stress incurs. In addition, some of the aforementioned strategies have only been implemented during acute stressors, such as critical incidents, and have not been examined in response to chronic stressors, such as organizational stress.[19] Recent resiliency training techniques, which focused on modifying officer's physiological and psychological response to stress, have shown marked success in officers' abilities to prepare for, react to, and recover from stress.[15,22,23] Although these results are promising, these studies did not employ a mechanism to make the resilience training accessible and affordable to departments of varying sizes and budgets. In addition, it remains unclear how to build community capacity in order to ensure the longevity of the outcomes and indoctrination of the concepts into the organizational culture.

Given the higher prevalence of CVD risk in police, some studies have measured heart rate variability (HRV), a method that assesses beat-to-beat changes in heart rate. HRV is considered to be a measure of health and fitness and is associated with all-cause mortality.[24,25] It is also a biological marker of aging with low HRV observed in individuals with a range of diseases.[25] Previous works examining HRV in police officers have used it to assess rhythm coherence, HRV pattern, heart rate, and changes in the power spectrum.[15,22,23] However, none of the research to date assessed resilience training in LEOs by measurement of HRV responses to the training. Finally, the effects of stress resiliency training on CVD risk factors in the LEO population are unknown.

Because of the limited understanding of the effectiveness of resiliency training in LEO, the purpose of the present investigation was twofold: to test an available and inexpensive resilience training intervention focused on self-regulating emotional and physiological response to stress in a LEO cohort and to assess the impact of the intervention on both psychological and physiological outcomes, including CVD risk factors, in the LEO cohort.

METHODS

Study Design

The opportunity to participate in this project was announced on all shifts at roll call on three separate days in police departments. An experimental, wait-listed controlled design was employed in which one group of officers received the intervention immediately

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after the baseline data collection while the wait-listed control group received the intervention after a three-month delay. To minimize contamination, the early intervention group and the delayed intervention group were drawn from different police districts.

The intervention was based on methodology successfully employed in the military and elsewhere.[27–32] The intervention consisted of one educational class, taught by a member of the research team and one telementor session, conducted by mental health professionals including licensed psychologists. These sessions were held 2 to 3 weeks apart, followed by 3 months of in-the-field practice of the skills by officers according to what was imparted in the educational class and reiterated in the mentor sessions. The educational and mentor sessions, embraced an interactive format using discussion in a systematic way in that all participants, were encouraged to share their relevant real-life experiences to contextualize topics covered in the sessions. Topics included information about the physiology of stress, triggers of stress, and awareness of changes in the anterior chest area when encountering stressful situations; instruction and practice on how to modify the autonomic response to stress by altering breathing and heart rate with biofeedback (em Wave 2; HeartMath Institute, Boulder Creek, CA); and improved decision-making by focusing on positive rather than negative emotions (eg, anger, frustration normally associated with stress), in order to change the physiologic response to stress.

Officers were instructed to practice the altered breathing and heart rate in the field and at home, with biofeedback, before and after stressful events; these sessions were recorded and downloaded later. The focus of these sessions was to improve *coherence*. Coherence is defined as increased synchronization and resonance in higher-level brain systems and in the activity occurring in the two branches of the autonomic nervous system as well as a shift in autonomic balance toward increased parasympathetic activity.[33]

To assess the latter, inter-beat intervals (IBIs) were detected using a sensor worn on the ear lobe and stored using the em Wave 2 practice device, about the size of a cell phone (em Wave 2). The power spectral density of the most current 64 seconds of IBI data was calculated. The more coherent (sine-wave like pattern), the more concentration in a single peak in the power spectrum output becomes. If coherence is high, then most of the power will be concentrated in or around a single peak within the coherence range of the power spectrum. If it is low, there will be many spectral components spread out across many peaks. The coherence level was recalculated every 5 seconds by comparing the power in the coherence peak to the rest of the spectrum. The coherence score is a log transform of this ratio. The practice device displayed the percentage of coherence using a colored light bar (green for high coherence) so that officers could use the visual feedback to acknowledge when they were achieving greater coherence.

Data Collection Procedures

Data were collected in two separate pilot studies funded by different agencies: Pilot A, funded by the National Institute of Occupational Safety and Health and Pilot B, funded by the US Department of Justice. Each pilot study involved two districts: immediate intervention district and wait-listed district. For all participants, the demographic and health history information was obtained only at baseline. All other data were collected at baseline, 3 months, and 6 months. On a day off, or before or after their shift, officers came to the police district headquarters for an evaluation where they completed the physiological and psychological measurements (described below). In addition, officers wore a portable, single-lead ECG monitor (Bodyguard 2; Firstbeat Technologies, Jyväskylä, Finland) for 24 hours on one workday and on one off day. The monitor was worn three times for 24 hours at work and at home the week before the educational class, at 3 months, and at 6 months. The monitor collected data at 1000 Hz and easily fit under body armor. Officers were asked to record in a pen-and-paper Events Log any activities that may have affected heart rate. The same researcher in both pilot studies conducted the intervention.

Measures

A trained technician made systolic and diastolic blood pressure measurements after 5 minutes of quiet seated rest and *waist girth* was measured at the level of the umbilicus. *HRV* was determined from the aforementioned 24 hours of ECG data recorded on the Firstbeat heart rate monitors worn by the officers beneath their uniforms for 24-hour time periods on a work and off day at 3 months intervals. *Height* was measured using a stadiometer and *weight* was obtained on a calibrated scale. From these data, we estimated overweight by using the calculated body mass index (BMI) defined as weight in kilograms divided by height in meters squared. A nonfasting blood sample was collected to determine other CVD risk factors [ie, low-density lipoprotein-cholesterol (LDL-C), total cholesterol, hemoglobin A1c (HbA1c), and C-reactive protein (CRP)]. A local laboratory processed all specimen samples.

Participants completed one *health and lifestyle questionnaire* at baseline and a comprehensive *self-reported paper-and-pencil measure of stress* (described below) at baseline, 3, and 6 months'

TABLE 1. Psychological Measures of Stress

Type of Stress	Variables	Instrument	Reliability and Validity
Personal	Global Measure of Stress	*Perceived Stress Scale*: 14-item survey answers Likert responses.[34]	Cronbach alpha 0.75 [34]
	Vital Exhaustion	*Maastricht Questionnaire 9-item version of Form B*: including feelings of fatigue, irritability, and demoralization answers Likert responses[35]	Cronbach alpha 0.83[36]
Acute	Critical Incident Stress and Post Traumatic Stress Syndrome	*Impact Events Scale*: 15-item measure response to critical incident stress after a traumatic event.[37]	Cronbach alpha for 0.87 for the total scale.[37]
Organizational	Personal and Organizational Constructs	*Personal and Organizational Quality Assessment-R*: 53-item measures physical stress, resilience, organizational climate, and work performance.[38]	Cronbach alpha for subscales 0.76–0.92[38]
Resilience	Cognitive Flexibility; Meaning Making, Active Coping, Spirituality,	*Response to Stressful Experiences Scale*[39]	Cronbach alpha 0.91–0.93[39]

intervals. These self-reported stress measures, described in Table 1, are designed to assess both personal and work-related stressors.

Statistical Analysis

The ECG data were downloaded and R-R intervals were first manually inspected and corrected appropriately. The corrected R-R intervals were then exported into Kubios HRV software (Biomedical Signal Analysis Group, Department of Applied Physics University of Kuopio, Finland), which was used for HRV analysis. To remove trend components, data were detrended by removal of the first-order linear trend using a method called ‘‘smoothness priors.’’[40] To correct for artifacts, a low level of artifact correction was applied to the entire data set. Detected artifact beats were replaced using cubic spline interpolation using a sample rate of 4 Hz. A Fast Fourier transform (FFT) algorithm was performed using Welch's periodogram method with a window width of 256 seconds and window overlap of 50%. The default values for the frequency bands were used: very low frequency (VLF): 0 to 0.04 Hz, low frequency (LF): 0.04 to 0.15 Hz, and high frequency (HF): 0.15 to 0.4 Hz.

Data from the two studies were combined and SAS 9.4 (SAS Institute, Cary, NC) was used for statistical analysis. Due to a small sample size, instead of comparing the immediate and wait-listed groups on their changes during the first 3 months of the study, we calculated changes in outcomes from pre- to postintervention for all participants and tested the changes using a one-sample two-sided *t* test. We also estimated Cohen's *d*, which is an acceptable measure of effect size when outcomes before and after an intervention are compared. It is calculated as the difference between the means before and after the intervention divided by the pooled standard deviation. Traditionally, effect size is interpreted as small for $d = 0.20$, medium for $d = 0.50$, and large for $d = 0.80$.[41]

We conducted additional analyses to explore whether covariates such as participant characteristics (age, years in law enforcement, hours worked during week, gender, and rank) could have influenced changes in the psychological and physiological outcomes. For this analysis, we first examined bivariate relationships between changes in outcomes and participant's characteristics, using Pearson correlation coefficients for age, years in law enforcement, and hours worked during week, and analysis of variance (ANOVA) for gender and rank. Among the characteristics, we found that only age was related consistently to a number of outcomes. Thus, we developed linear regression models for all psychological and physiological outcomes with the change in outcome as the dependent variable, pre-intervention values as an independent variable, and age as a covariate. Pre-intervention values for each outcome were included in the models because changes in the majority of outcomes depended on their starting values. Significant coefficients ($P < 0.05$) for age in the models indicated that the change depended on age, controlling for pre-intervention value of the outcome.

Pre- to postchange in coherence was tested using a one-sample, two-sided *t* test. To evaluate relationships between changes in coherence and changes in outcomes, Pearson correlation coefficients (*r*) were calculated. For this analysis, the changes in outcomes were calculated to match time points the data on coherence were collected. In both studies, coherence data were collected from the early-intervention group at baseline and 6 months, and from the wait-listed group at 3 and 6 months. Thus, for this analysis, changes in all outcomes were calculated between baseline and 6 months for the early-intervention group, and 3 and 6 months for the wait-listed group. Changes in coherence were not included in the models for changes in psychological and physiological outcomes because coherence was collected at somewhat different time points and also because these data had missing values for participants who did not bring their practice devices to the final data collection where coherence data extrapolation occurred.

RESULTS

Two officers withdrew from the study due to increased workload and personal reasons. Demographic and general characteristics are reported in Table 2, by study (A and B). Averaged across studies ($n = 38$), participants were 41.0 ($SD = 7.6$) years of age, ranging from 22 to 54 years, and were mid-career with an average 14.7 ($SD = 7.0$) years in law enforcement. In addition, 58% of the participants were at the rank of police officer and 42% were Sergeant or higher, 76% were male, and 71% were white.

Most participants (84%) were overweight or obese, by BMI criteria, 87% reported engaging in physical activity (by indicating participation in physical activities or exercises such as running, calisthenics, golf, gardening, or walking, during the past month). On the basis of participants' self-reported metabolic health, 47% had been diagnosed with hypercholesterolemia and 26% with hypertension.

Feasibility and Lessons Learned

The first stated purpose of the study was to test an available and inexpensive resilience training intervention focused on self-regulating emotional and physiological response to stress in LEO population. Retention of subjects proved more efficient in Pilot A study ($n = 20$) wherein participants received monetary compensation for participation. In Pilot B study, due to Department of Justice policies, no incentive was offered and retention of subjects was less robust ($n = 16$ at the end of the study).

The size of the educational classes was small ($n = 10$) allowing for better facilitation of class discussion. To address absences, we recorded the 2-hour *class sessions* on a CD and made that available for check out from a liaison within the department. All officers who were absent availed themselves of these sessions on DVD. Wearing of the heart rate monitors beneath the uniform was uneventful; no issues related to the wearing of the small monitor or using the em Wave practice device at work were reported. The most important departure from expected protocol was the return of the practice device at the end of the study. In Pilot B (where no incentive was offered for participation), only 9 of the 18 officers brought their practice devices to the final data collection session so that coherence data could be extrapolated, despite numerous reminders and explanations about why the device needed to be returned.

At the end of each pilot study, officers were surveyed in a systematic way, and of those returning the surveys, 100% found the intervention valuable. However, the most meaningful feedback was obtained in either the comment box of the survey or at the final data collection during informal interviews with the researcher. For example, in a precursor study, several officers voiced ‘‘I did not realize just how stressed I was’’ postintervention. The majority of the officers completed participation in the study and voiced positive feedback on all aspects of the study. Officers' comments indicated that they were more consciously aware of their stress levels and that the device allowed them the ability to step back mentally and relax. Some officers remarked feeling calmer after using the device and one officer noted more uninterrupted sleep when used before going to bed. Only one officer returned his practice device stating that using this device was ‘‘just not for me.’’

Changes in Psychological and Physiological Measures

Tables 3 and 4 report means, standard deviations, and ranges for pre-intervention values and changes in psychological and physiological outcomes, respectively, as well as corresponding *P* values for the *t* test, along with Cohen's *d*. A statistically significant change ($P < 0.05$) was observed for HbA1c ($M = 0.1$, $SD = 0.3$, $P = 0.02$, $d = 0.42$). In addition, small effects sizes were observed for the Intrusive ($P = 0.14$, $d = 0.26$) and Avoidance ($P = 0.09$, $d = 0.29$)

TABLE 2. Demographic and General Characteristics for Participating Law Enforcement Officers

	Pilot A*		Pilot B†	
Variable	***n***	**Mean ± SD (Range)**	***n***	**Mean ± SD (Range)**
Years in law enforcement	20	13.6 ± 7.7 (1–23)	18	15.9 ± 6.1 (5–22)
Age, yrs	20	39.4 ± 9.1 (22–54)	18	43.0 ± 5.0 (32–50)
BMI	20	30.2 ± 6.2 (20.0–39.9)	18	35.1 ± 7.8 (22.2–54.9)
PSS (0–56)	20	20.7 ± 7.5 (5–33)	18	20.4 ± 6.2 (8–33)
	n	%	*n*	%
Gender				
Male	14	70	15	83
Female	6	30	3	17
Race				
African-American	5	25	2	11
White	13	65	14	78
Latino	2	10	1	6
Other	0	0	1	6
Rank				
Police Officer	11	55	11	61
Detective	0	0	0	0
Sergeant	8	40	6	33
Lieutenant	1	5	1	6
BMI				
Normal	5	25	1	6
Overweight or obese (≥25)	15	75	17	94
Engaged in physical activity				
Yes	16	80	17	94
No	4	20	1	6
Trying to lose weight				
Yes	13	65	11	61
No	7	35	6	33
Do not know/not sure			1	6
Hypertension				
Yes	6	30	4	24
No	14	70	13	76
Hypercholesterolemia				
Yes	7	35	11	61
No	13	65	7	39
CVD				
Yes	0	0	1	6
No	20	100	17	94
Diabetes				
Yes	1	5	1	6
No	19	95	16	94

Percentages may not sum to 100% due to rounding.
BMI, body mass index; CVD, cardiovascular disease; PSS, Perceived Stress Scale.
*Healthier Workforce Center for Excellence study (HWCE).
†Community Orienting Policing Services study (COPS).

subscales of the Impact of Events Scale; Pressures of Life ($P = 0.21$, $d = 0.21$), Relational Tension ($P = 0.22$, $d = 0.21$), and Anger and Resentment ($P = 0.08$, $d = 0.30$) subscales of the Personal and Organizational Quality Assessment, and LDL ($P = 0.14$, $d = 0.27$). However, the direction of change indicated improvement for only two of the outcomes with $d = 0.20$ or greater (Pressures of Life, Anger, and Resentment), while other changes were opposite to improvement.

Some of pre-intervention baseline means reported in Table 4 were outside the normal limits for the general population. The mean level of CRP among officers was 2.1 mg/dL, which is somewhat higher than the general population value of 1.66 mg/dL[42] and is indicative of a moderate risk for CVD.[43] Baseline cholesterol was slightly higher at 198.3 mg/dL than the general population's 196 mg/dL.[44] Triglyceride values were slightly high at 184.7 mg/dL compared with the general population value of 108 mg/dL.[44] The mean BMI (pre intervention) was 33.2 kg/m^2, while normal range is 18.5 to 24.9 kg/m^2 with overweight range defined as 25.0 to 29.9 kg/m^2 and obese category more than 30.0 kg/m^2.[44] This places 94% of Pilot A and 75% of Pilot B participants in the overweight and obese categories, which is greater than the 69% in these categories within the general population.[44] Pre-intervention mean waist circumference was also high at 41.3 inches compared with 38.78 inches for the general population.[45]

Linear regression analysis of changes in the psychological and physiological outcomes, controlling for pre-intervention values of the outcomes, revealed that age was significantly ($P < 0.05$) associated with changes on Avoidance subscale and the total scores of the Impact of Events Scale, Emotional Buoyancy subscale and overall Emotional Vitality Scale scores, Anxiety and Depression subscale and overall Emotional Scale scores, and Fatigue and Health Symptoms subscales and overall Physical Stress Scale scores. In addition, we found weaker associations ($P < 0.10$) of age with changes in Vital Exhaustion, and Intrusive and Intention to Quit

TABLE 3. Pre-to Postintervention Changes in Psychological Measures

Outcome	Preintervention			Change (Post Minus Pre)					Coefficients for Preintervention Outcomes and Age			
	n	M ± SD	Range	n	M ± SD	Range	P^*	$d^\dagger$	b_{Pre} [95% CI]	P	b_{Age} [95% CI]	P
Perceived Stress Scale (0–56)	38	20.6 ± 7.2	5.0–33.0	36	0.5 ± 5.5	−11–11	0.59	0.09	−0.42 [−0.64 to −0.21]	<.001	0.16 [−0.04 to 0.36]	0.11
Vital exhaustion (9–27)	38	16.7 ± 4.4	9.0–26.0	36	0.3 ± 4.4	−12 to 8	0.73	0.06	−0.34 [−0.66 to −0.01]	0.04	0.16 [−0.02 to 0.34]	0.07
Impact of Events Scale												
Intrusive subscale (0–35)	38	8.7 ± 8.6	0.0–31.0	35	1.7 ± 6.5	−10 to 21	0.14	0.26	−0.32 [−0.56 to −0.09]	0.01	0.24 [−0.02, 0.49]	0.07
Avoidance subscale (0–40)	38	11.2 ± 10.3	0.0–34.0	36	2.4 ± 8.0	−13 to 26	0.09	0.29	−0.33 [−0.58 to −0.09]	0.01	0.33 [0.03, 0.64]	0.03
Total Stress Score (0–75)	38	19.9 ± 17.3	0.0–55.0	35	4.3 ± 13.6	−18 to 47	0.07	0.31	−0.31 [−0.55 to −0.07]	0.01	0.57 [0.04, 1.09]	0.03
Response to Stressful Experiences Scale (0–88)	38	62.6 ± 12.8	42–86	36	−0.3 ± 7.9	−19 to 15	0.83	0.04	−0.16 [−0.37 to 0.05]	0.13	−0.25 [−0.60, 0.10]	0.16
Personal and Organizational Quality Assessment												
Emotional Vitality Scale (1–7)	38	4.5 ± 1.0	2.6–6.1	36	−0.1 ± 0.8	−3.1 to 1.5	0.57	0.09	−0.26 [−0.50 to −0.02]	0.03	−0.04 [−0.07 to 0.00]	0.03
Emotional Buoyancy (1–7)	38	4.6 ± 1.2	1.9–6.4	36	−0.2 ± 0.9	−2.9 to 1.3	0.26	0.19	−0.30 [−0.53 to −0.06]	0.01	−0.04 [−0.08 to −0.01]	0.01
Emotional Contentment (1–7)	38	4.3 ± 1.1	2.5–6.0	36	0.1 ± 0.9	−3.3 to 2.2	0.72	0.06	−0.33 [−0.60 to −0.06]	0.02	−0.02 [−0.06 to 0.02]	0.25
Organizational Stress Scale (1–7)	38	4.1 ± 1.2	1.4–6.3	36	0.0 ± 0.7	−1.2 to 1.7	0.85	0.03	−0.26 [−0.44 to −0.08]	0.01	0.02 [−0.01 to 0.04]	0.29
Pressures of life (1–7)	38	3.9 ± 1.5	1.0–6.4	36	−0.2 ± 0.9	−1.8 to 2.0	0.21	0.21	−0.28 [−0.47 to −0.09]	0.01	0.01 [−0.03 to 0.05]	0.55
Relational tension (1–7)	38	4.6 ± 1.4	2.0–7.0	36	0.2 ± 1.1	−3.0 to 2.3	0.22	0.21	−0.37 [−0.61 to −0.12]	0.005	0.01 [−0.03 to 0.06]	0.62
Intention to quit (1–7)	38	2.5 ± 1.9	1.0–7.0	36	0.0 ± 1.3	−2.5 to 3.5	0.85	0.03	−0.38 [−0.58 to −0.18]	<0.001	0.05 [0.00–0.10]	0.06
How stressed have you been (1–15)	37	7.5 ± 3.6	2.0–15.0	33	0.2 ± 3.5	−9.0 to 9.0	0.77	0.05	−0.47 [−0.78 to −0.16]	0.005	0.12 [−0.03 to 0.26]	0.10
Emotional Stress Scale (1–7)	38	2.4 ± 0.9	1.3–5.0	36	−0.1 ± 0.6	−2.1 to 0.8	0.23	0.20	−0.32 [−0.52 to −0.12]	0.003	0.02 [0.00–0.05]	0.05
Anxiety and depression (1–7)	38	2.3 ± 1.0	1.0–4.9	36	0.0 ± 0.6	−2.0 to 0.9	0.77	0.05	−0.29 [−0.47 to −0.11]	0.002	0.03 [0.00–0.05]	0.02
Anger and resentment (1–7)	38	2.6 ± 0.9	1.4–5.1	36	−0.2 ± 0.7	−2.3 to 1.0	0.08	0.30	−0.32 [−0.54 to −0.11]	0.004	0.02 [−0.01 to 0.04]	0.17
Physical Stress Scale (1–6.8)	38	2.8 ± 1.1	1.3–5.2	36	0.0 ± 0.7	−2.3 to 1.3	0.87	0.03	−0.10 [−0.26 to 0.07]	0.24	0.05 [0.03–0.07]	<0.001
Fatigue (1–6.8)	38	3.4 ± 1.6	1.0–6.5	36	−0.1 ± 0.9	−2.5 to 1.5	0.36	0.15	−0.14 [−0.32 to 0.04]	0.13	0.04 [0.01–0.08]	0.02
Health symptoms (1–6.8)	38	2.4 ± 0.9	1.2–5.0	36	0.1 ± 0.7	−2.2 to 1.7	0.60	0.09	−0.18 [−0.40 to 0.03]	0.09	0.05 [0.03–0.08]	<0.001

Lower score is better for Perceived Stress Scale, Vital Exhaustion, and Impact of Events Scale. Higher score is better for Response to Stressful Experiences Scale. On the Personal and Organizational Quality Assessment: higher score is better for the Emotional Vitality Scale; lower score is better for the Organizational Stress Scale, the Emotional Stress Scale, and the Physical Stress Scale.

*P value for one-sample two-sided t test.

†Cohen's d; b_{Pre} and b_{Age} are coefficients for outcomes pre-intervention and age, respectively, as independent variables in the model for change in outcomes, along with corresponding 95% confidence intervals and P values.

TABLE 4. Pre-to Postintervention Changes in Physiological Measures

Outcome	Preintervention			Change (Post Minus Pre)					Coefficients for Preintervention Outcomes and Age			
	n	M ± SD	Range	*n*	M ± SD	Range	*P**	*d*†	b_{Pre} [95% CI]	P_{Pre}	b_{Age} [95% CI]	P_{Age}
Systolic blood pressure	36	120.4 ± 14.5	98–148	32	1.6 ± 13.3	−22 to 28	0.50	0.12	−0.63 [−0.88 to −0.38]	<0.001	0.06 [−0.41 to 0.53]	0.81
Diastolic blood pressure	36	77.9 ± 10.9	60–100	32	−1.7 ± 12.0	−32 to 18	0.44	0.14	−0.65 [−0.98 to −0.31]	<0.001	−0.12 [−0.59 to 0.35]	0.61
LDL	34	108.9 ± 36.4	36–197	31	5.3 ± 19.5	−27 to 58	0.14	0.27	−0.17 [−0.37 to 0.03]	0.09	−0.10 [−1.00 to 0.80]	0.82
CRP	37	2.1 ± 2.3	0.2–11.7	33	0.1 ± 1.5	−5.9 to 3.1	0.64	0.08	−0.39 [−0.57 to −0.20]	<0.001	0.06 [0.01–0.12]	0.02
HbA1C	38	5.5 ± 0.8	4.4–9.1	35	0.1 ± 0.3	−0.5 to 1.1	0.02	0.42	0.14 [−0.07 to 0.34]	0.18	0.00 [−0.02 to 0.01]	0.54
Cholesterol	38	198.3 ± 49.8	123–313	34	2.7 ± 23.0	−63 to 51	0.50	0.12	−0.20 [−0.37 to −0.04]	0.02	−0.27 [−1.25 to 0.71]	0.57
Triglycerides	37	184.7 ± 174.7	47–999	34	−6.8 ± 65.2	−170 to 151	0.55	0.10	−0.36 [−0.53 to −0.19]	<0.001	0.86 [−1.53 to 3.24]	0.47
BMI	38	33.2 ± 7.7	21–55	35	−0.6 ± 4.8	−27.2 to 3.8	0.48	0.12	−0.26 [−0.48 to −0.05]	0.02	−0.03 [−0.24 to 0.18]	0.78
Waist circumference	38	41.3 ± 7.0	27–60	32	0.5 ± 3.2	−11.0 to 9.0	0.38	0.16	−0.16 [−0.31 to 0.00]	0.05	0.01 [−0.14 to 0.15]	0.91

**P* value for one-sample two-sided *t* test.
†Cohen's *d*; b_{Pre} and b_{Age} are linear regression model coefficients for outcomes preintervention and age, respectively, along with corresponding 95% confidence intervals and *P* values.

subscales. For all these outcomes, the coefficients for age in the models indicated that younger participants might benefit more from the intervention than older participants. As an example, while the total stress score on the Impact of Events Scale increased from pre- to postintervention by 4.3 points on average (SD = 13.6, $P = 0.09$), each year of age contributed 0.57 points to this increase. Thus, for a 22-year-old participant with an average pre-intervention total stress score of 19.9, the total stress score was estimated to decrease by approximately 7 points, whereas for a 50-year-old participant with the same average pre-intervention stress score, the stress score was estimated to increase by 9 points. A similar trend was observed for CRP, which increased on average by 0.1 mg/L (SD = 1.5, $P = 0.37$). The coefficient for age in the model for the change in CRP was estimated as 0.06 ($P = 0.02$). Thus, each year of age added 0.06 mg/L to the change in CRP, so that for a 22-year-old participant with an average pre-intervention CRP of 2.1 mg/L, the CRP was estimated to decrease by 1.1 mg/L, whereas for a 50-year-old participant with the same average pre-intervention CRP, the CRP was estimated to increase by 0.7 mg/L.

Results for HRV are reported in Table 5. Statistically significant changes were found for both the sympathetic (LF) and parasympathetic (HF) contributors of HRV. The mean parasympathetic component (HF) increased on both work by 2.5 (SD = 5.5, $P = 0.02$, $d = 0.46$) and off-work days by 2.6 (SD = 5.9, $P = 0.03$, $d = 0.43$), while the sympathetic component (LF) decreased accordingly. Root mean square of normal RR interval difference on off-work day increased by 5.6 (SD = 14.4, $P = 0.04$, $d = 0.39$).

Data on coherence at the end of the studies were collected for 17 (Pilot A) and 9 (Pilot B) participants who brought their practice devices to the final data collection. For these participants ($n = 26$), coherence increased by 38.5% (SD = 21.9, $P < 0.001$). Large increases in coherence were associated with decreases in stress due to organizational pressures ("How stressed have you been" subscale, $r = -0.44$, $P = 0.03$, $n = 24$) and also with decreases in HbA1c ($r = -0.66$, $P < 0.001$, $n = 26$). Figure 1 illustrates the inverse relationship between changes in coherence and changes in HbA1c. For HRV, no correlations with changes in coherence were significant at 0.05 level.

DISCUSSION

The main focus area of this study was to assess the effectiveness of a resilience training intervention on psychological and physiological outcomes, including CVD risk factors, in the LEO population. The demographic and anthropometric results for the officers assessed here suggest that these officers are relatively similar to those assessed elsewhere.[4,6,8] The majority of officers were either overweight or obese despite the fact that they reported being physically active similar to other studies.[6,46]

The variation in the HbA1c, a measurement of blood glucose over time, correlated with increases in coherence: increased synchronization occurring in the two branches of the autonomic nervous system with a shift in autonomic balance toward increased parasympathetic activity (Fig. 1). Although HbA1c increased, on average, by 0.1, *larger increases in coherence were associated with decreases in HbA1c,* as well as with decreases in stress from organizational pressures. Similarly, others found insulin levels were inversely and significantly associated with both HF and LF HRV.[47] Therefore, if increased coherence is associated with decreases in HbA1c (postintervention) and decreases in stress from organizational pressures, then improvement in coherence can clearly be viewed as a positive finding.

Changes in several psychological measures of stress and one physiological measure (CRP) were associated with age. For these outcomes, the coefficients for age in the models for outcome changes indicated that younger participants might benefit more from the intervention. This finding has important implications for

TABLE 5. Pre-to Postintervention Changes in Heart Rate Variability Measures

	Preintervention			Change (Post Minus Pre)				
	n	**M ± SD**	**Range**	***n***	**M ± SD**	**Range**	***P*******	***d***†
SDNN standard deviation of all normal RR intervals								
Off	35	139.0 ± 43.2	64.5–283.0	31	−0.9 ± 37.9	−92.3 to 60.1	0.90	0.02
Work	36	131.3 ± 35.8	66.0–209.3	29	−7.9 ± 27.9	−89.5 to 44.6	0.14	0.29
Heart rate								
Off	35	84.1 ± 10.1	66.7–105.6	31	−1.9 ± 9.5	−24.2 to 12.9	0.27	0.20
Work	36	82.0 ± 10.1	60.7–101.2	28	−0.9 ± 6.0	−17.2 to 10.4	0.43	0.15
RMMSD root mean square of normal RR interval difference								
Off	35	41.9 ± 15.8	15.1–96.2	31	5.6 ± 14.4	−20.3 to 54.2	0.04	0.39
Work	36	43.3 ± 15.8	17.1–93.3	29	−0.2 ± 12.6	−34.4 to 23.6	0.93	0.02
VLF, Very low frequency								
Off	35	12,518 ± 8708	2479–50,545	31	361 ± 8121	−19,414 to 20,872	0.81	0.04
Work	36	11,058 ± 6177	2658–25,754	29	1304 ± 5072	−13,827 to 6870	0.18	0.26
Total power								
Off	35	14,354 ± 9217	2749–53,672	31	595 ± 8442	−18,928 to 21,404	0.70	0.07
Work	36	12,961 ± 6799	3123–27,341	29	−1345 ± 5473	−15,509 to 7650	0.20	0.25
HF, High frequency (nu)								
Off	35	31.4 ± 8.6	8.9–51.2	31	2.5 ± 5.5	−8.3 to 13.7	0.02	0.46
Work	36	31.0 ± 7.7	11.2–47.2	28	2.6 ± 5.9	−9.1 to 16.4	0.03	0.43
LF, Low frequency (nu)								
Off	35	68.5 ± 8.6	48.7–91.0	31	−2.5 ± 5.6	−13.9 to 8.3	0.02	0.46
Work	36	68.9 ± 7.7	52.7–88.7	28	−2.6 ± 5.9	−16.5 to 9.2	0.03	0.43
LF/HF Sympathetic contribution to HR								
Off	35	2.6 ± 1.7	1.0–10.2	31	−0.2 ± 0.7	−1.9 to 1.5	0.08	0.33
Work	36	2.5 ± 1.3	1.1–7.9	29	−0.1 ± 0.8	−1.2 to 2.1	0.67	0.08

**P* value for one-sample two-sided *t* test.
†Cohen's *d*.

future study design and interpretation recognizing that older and younger officers may learn and change differently postintervention. This may also contribute to understanding that although officers enter the profession in good physical health, they retire early or die prematurely[1] and why the profession itself has been shown to be a ''risk factor'' in older officers when controlling for conventional risk factors.[7,10] It is important to note that baseline values for several physiological variables (eg, CRP, cholesterol, triglycerides, BMI) were higher than those in general population. The fact that this sample was less than optimally healthy may complicate the relationships between age and changes in the outcomes discovered in this study. Thus, these relationships need to be investigated in future studies. If this finding is confirmed, it will have implications because it suggests the importance of intervening early in the career path of officers to build resilience.

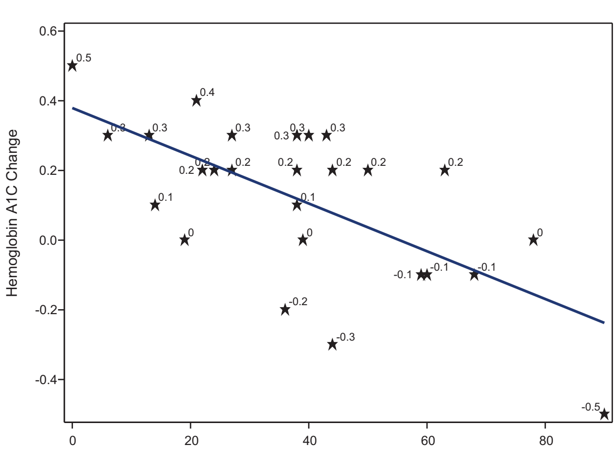

FIGURE 1. The relationship of changes in HbA1c with increases in coherence from before to after intervention.

Overall, two subscales of the *Personal and Organizational Quality Assessment* indicated a possibility of positive change from pre- to postintervention. The Organizational Stress Scale, which is an overall measure of the degree to which employees feel pressured by stressors and conflicts at work and in their personal life, showed a positive change, even though not statistically significant, in Pressures of Life. The primary scale Emotional Stress is an overall measure of the degree to which employees report negative emotions and high scores on the scale indicate employees are likely feeling emotionally stressed. Anger and Resentment scores moved in a positive direction; these findings are consistent with those of other studies where these subscales improved postintervention.[15,23]

However, scores for relational tension, which refers to being stressed by relational disaffection and coworker conflict, increased, on average for the group as a whole. The increase in this score was unanticipated, as it was expected that measures of organizational and critical incident stress would decrease postintervention. The unanticipated increase in relational tension and the two subscales of the Impact of Events Scale may in part have been related to an increased awareness about physical and mental changes in the context of stress, postintervention. Further, although the cause of these unexpected findings cannot specifically be determined, consideration should be given to events within the department at the time of the study. For instance, increases in the homicide rate and budget cuts may impact these measures of organizational and critical incident stress.

An important caveat to consider in the context of this study is that it is possible that results may not achieve statistical significance due to small numbers of participants. Therefore, our team decided to look at variables with mean change scores that minimally reflected change of 0.20 standard deviation.

S*tatistically significant* differences were found among several HRV variables. Specifically, the mean parasympathetic component (HF) increased on both work and off-work days, while the sympathetic component (LF) decreased accordingly; root mean square of normal RR interval difference increased on the off-work day (Table 5). These findings demonstrate an improvement in HRV with a shift in the expected direction of increased parasympathetic activity countered by a decrease in sympathetic activity. As HRV is associated with sudden cardiac death and all-cause mortality, and this population has greater prevalence of CVD and risk factors to begin with, this improvement in HRV variables is noteworthy and appreciated. These findings were similar to those found in other studies within LE that reported officers recalibrating physiologically more quickly after using the HeartMath techniques.[16] However, because our study is the first known to *directly measure ambulatory HRV in police*, other studies thus far have not reported *specific HRV measurements in police for comparison here.*

If an intervention such as this was promoted within police agencies and actively supported by administration and police union representation, participation and retention rates would likely improve; participation here in the context of a research study was completely voluntary. In retrospect, although the present study has some interesting results, quite a bit more is required before we can determine the intervention's utility. One thing missing from this and other pilot studies that address resilience is the *building of community capacity,* that is, individual willingness and organizational support capacity to sustain the intervention after the researcher or education provider exits the institution. Consideration might be given to bundling resiliency monitoring with other efforts to reduce stress and promote general well-being, including education on sleep and nutrition. As stated by the President's Task Force, officer safety and overall well-being is a priority and future research interventions should focus on promoting officer fitness, resilience, and nutrition.

LIMITATIONS

Among the limitations of this pilot study are a small sample and high variability of most of the outcomes. Due to the small sample size, more sophisticated statistical analyses were not appropriate. Responses may have been affected by events within the department at the time the study was conducted. Even though clustering of participants within districts was not accounted for by this approach, its effects on main findings should be limited. Furthermore, testing multiple outcomes could have resulted in false findings; thus, they should be interpreted cautiously and taken as suggestions for future research. Because only 68% of the cohort returned the practice device for data extrapolation, the results of coherence analysis might not reflect the entire participant pool. Finally, in future research, outcomes should be measured several months after the intervention because the effects can take time to develop.

CONCLUSION

Resilience training has the potential to positively affect CVD risk factors, including HRV. Studies need to be conducted with larger groups of officers, and programs should be developed that are cost-effective to deliver this type of intervention to large and small police agencies. Resilience interventions need to be tested in larger groups of police, in particular, with officers early in their career or at the academy. Future studies should continue to evaluate long-term psychological and physiological outcomes of resilience interventions by assessing the effects on CVD risk factors postintervention. Equally important to consider is qualitative evaluation of the officers' perspectives about the training because these perspectives are valuable and likely are not captured in the psychological and physiological data analyses. In addition to validating our approach, future studies and interventions should address stressful situations encountered on the job, considering both organizational and critical incident stressors, and build community capacity within organizations so that the resilience capacity development continues beyond the initial training session.

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