

Reducing Robust Health-Relevant Cardiovascular Stress Responses Among Active-Duty Special Forces Police

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Abstract

Policing presents a complex set of risk factors for occupational health and safety among officers, including environmental, psychosocial, and health risks. Environmental risks include facing critical incidents such as violent offenders, hostage negotiations, intense crime scenes, and irate civilians. Critical incidents are high pressure situations that are typically time sensitive, and elicit substantial physiological threat responses. When facing a threat, the body normally responds by going into a “fight-or-flight” mode, in which a host of physiological and psychological processes are invoked to help the body cope successfully with the threat [1]. For example, heart rate increases, digestion stops, blood flow to the brain moves from prefrontal cortex (logical thought) to the hindbrain (instinctual drives), and a person becomes less cognitively aware of their surroundings and more focused on fighting or fleeing from the threat. The natural and instinctual physiological response to threat may place police officers at a greater risk of injury or death, by reducing their situational awareness (i.e., ability to notice important environmental stimuli and other threats in their environment), and split-second decision making skills (e.g. shoot/don't shoot).

Advanced police teams called Special Weapons and Tactics (SWAT) officers, are called to the highest risk encounters [2]. The current research is the first to observe robust cardiovascular reactivity among SWAT officers during multiple, active duty shifts. Significant cardiovascular reactivity may pose a health risk to SWAT officers over time. Accordingly, this research documents the case examples from one team of SWAT officers who applied a simple cardiovascular and respiratory control technique during daily activities. Results suggest that this micro-intervention may have significant positive impact on daily cardiovascular health among SWAT officers.

Keywords: Special forces police; Police stress; Scenario based training; Cardiovascular stress response; Resilience

Police work and stress

Policing presents a complex set of risk factors for occupational health and safety among officers including environmental, psychosocial, and health risks. Environmental risks include facing critical incidents such as violent offenders, hostage negotiations, intense crime scenes, and irate civilians [3,4]. These critical incidents are often high pressure situations that are typically time sensitive and elicit substantial physiological threat responses [5]. When facing a threat, the body normally responds by going into a “fight-or-flight” mode, in which a host of physiological and psychological processes are invoked to help the body cope successfully with the threat [1]. For example, heart rate increases, digestion stops, blood flow to the brain moves from prefrontal cortex (logical thought) to the hindbrain (instinctual drives) [6,7,8]. Thus, and a person becomes less cognitively aware of their surroundings and more focused on fighting or fleeing from the threat [9,10]. This natural and instinctual physiological response to threat can place officers at greater risk of injury and death by reducing their situational awareness (i.e., ability to notice important environmental stimuli and other threats in their environment) and cognitive, split-second decision making skills (e.g., shoot/don't shoot) [11,12,13].

Advanced police teams called Special Weapons and Tactics (SWAT) officers, are highly trained officers with specialized equipment that is not available to other front-line officers (i.e., patrol officers) [14]. In most police organizations, SWAT officers are mandated to first have served as front-line officers who are then required to engage in intensive, specialized training to maintain advanced skills [14,15]. Given the fact that SWAT officers are required to maintain good health and engage in many hours of specialized training, it may be the case that these officers do not display the same robust physiological arousal and subsequent health problems that front-line officers often demonstrate [16,17,18].

The problem is that no current research is available that documents the active-duty cardiovascular reactivity profiles of SWAT officers.

The current study

To address the lack of knowledge regarding cardiovascular reactivity risk among SWAT officers, the current study is the first to monitor cardiovascular profiles over both training and active-duty operational assignments among SWAT officers. Further, based on the observation of cardiovascular profiles, a micro intervention was applied. The micro intervention specifically addressed the physiological risk factors (maladaptive heart rate and respiratory arousal to highly threatening emergency calls). The micro-intervention focused on psychophysiological control techniques that are hypothesized to improve cardiovascular regulation during daily activities and reactivity to high stress encounters in the line of duty.

Methods

Participants

A team of SWAT officers (n = 8) from a large metropolitan city in

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Canada were monitored during their entire shift for 16 days (5 training days and 11 active duty days). Participants were male, ages ranged from 36-50 years (Mean = 42) with similar years of experience (Mean = 7.92).

Procedure and Measures

During all training and active duty hours, all participants were fitted with a chest band (i.e., Zephyr Bioharness) that recorded ambulatory physiological data. This cutting edge device is one of the first fully ambulatory systems that reliably records physiological threat responses with accuracy comparable to medical grade and lab-based physiological equipment (<http://www.zephyranywhere.com/>). The bioharness was developed for the US Military for precise biological monitoring during high activity field experiences and is well suited for measurements during police work. This lightweight band worn around the chest, next to the skin, and collects heart rate (HR), respiration (BR), body movement, ECG, heart rate variability (HRV) and core temperature and has a GPS feature for measuring activity. Blood pressure measurements, recorded on the Omron ambulatory wrist cuff, were taken at the beginning and end of each SWAT officer's shift.

During the five training days, officers engaged in a number of reality-based scenarios (e.g. school shooting, domestic violence, apartment search). All scenarios were conducted under the guidance of expert SWAT trainers, who provided the officers the opportunity to practice advanced skills and techniques. During the training days, all scenarios were observed by the researchers in order to record and match specific activities the officer engaged in (i.e., when they were handcuffing a criminal) to the officers' physiological profiles in order to pinpoint cardiovascular reactivity to high stress encounters. On all active-duty days, officers wore the bioharness chest bands during time on-base and emergency call-outs. Officers recorded their daily activities in their police notes. Researchers did not accompany officers into the field, rather they later used the SWAT officers' notes to associate the occupational events with their physiological profiles.

Prior to engaging in the research study, all officers signed a consent form detailing the requirements of the study. This research study was approved by the University of Toronto, Research Ethics Board.

Micro-Intervention

Following the scenario-based training days, officers were taught a simple physiological control technique shown to reduce maladaptive cardiovascular reactivity [19]. Specifically, the micro intervention is to gain enhanced control over the fight or flight response when a person is anticipating, or experiencing a stressful event [9,10]. An empirically-tested method of controlled breathing (i.e., tactical breathing) (5 second inhale and 5 second exhale) [11,20] and mental focus (concentration on the task at hand in a positive, active, emotional state) [21,22] are techniques that place the body in a balanced state of sympathetic and parasympathetic control, in which a panic or highly stress reactive state physiologically not possible [9,20]. We contend that remaining in physiological control allows the officer to avoid instinctual fight or flight actions that include a narrowing of vision and situational awareness; thus, enhancing their cognitive capacities to apply their high

level tactical skills and diffuse extremely stressful and risky situations successfully [23].

Results

None of the participants reported any chronic diseases. No officers reported cardiovascular diseases or symptoms specifically relevant to this project, including irregularities or palpitations. Further, all general health-related variables were similar across participants. Specifically, body mass index (BMI) ranged from 26.8 to 32.3 (Mean=29.12). None of the officers reported medication use, cigarette smoking, or any other substance-related use. Daily (beginning and end of the SWAT platoon shift) blood pressure measurements are presented in (Table 1). None of the blood pressure measurements were significantly different from age appropriate norms, or of medical significance. Further, although blood pressure values were somewhat elevated following the police actions, at no time during the study did any officer report cardiovascular irregularities, including palpitations, arrhythmia or chest pain.

As a visual representation of our findings, we present a number of case examples in the figures below (Figures 1a-2e). A blue line is placed on each figure at a heart rate (BPM) of 100, the value at which the stress response is engaged. The figures are examples of typical cardiovascular profiles gathered from members of one team of SWAT officers. Observation of cardiovascular profiles indicated that during training scenarios (Figures 1a-1e), heart rate regulation (beats per minute, BPM) showed high daily arousal during the hours of active occupational requirements (i.e., above a stress response level of 100 BPM on average). Following the inception of the micro-intervention, daily cardiovascular arousal was reduced during overall shift hours (Figures 2a -2e). Of note, despite periods of rapid cardiovascular reactivity to active-duty emergency calls, heart rate returned to the normal range of resting heart rate (i.e., between 60 and 85 BPM) between the majority of calls (Figures 2a-2c), suggesting overall healthier cardiovascular regulation.

A second observation in this study was that highly realistic training scenarios mimicked the heart rate reactivity observed during real life active-duty calls (contrast training Figures 1a-1e and active-duty Figures 2a-2e). Maximum heart rate reactivity during high intensity training scenarios ranged from (HR_MAX 122 to HR_MAX 182) which are similar to the reactivity demonstrated in real life emergency calls (HR_MAX 107 to HR_MAX 182).

Discussion

This study is the first to present multiple day cardiovascular profiles of SWAT officers during training and active-duty hours. The case examples presented here demonstrate a number of important, novel findings. *First*, that highly realistic training scenarios mimic real life physiological profiles during emergency active-duty calls. There has been substantial public interest in understanding if current police training is sufficient in preparing officers for high stress emergency encounters with civilians ("The Atlantic" - Stoughton, 2014; "The New York Times" - Thureau, 2015; "The Huffington Post" - [24]). It appears that utilizing active scenarios, modeled after real police calls that have happened in the region, does provide an opportunity to learn and apply specialized

	Shift Start Systolic Mean (SD)	Shift Start Diastolic Mean (SD)	Shift Start Pulse Mean (SD)	Shift End Systolic Mean (SD)	Shift End Diastolic Mean (SD)	Shift End Pulse Mean (SD)
5 Training Days	127.48 (17.35)	77.67 (11.65)	68.79(15.36)	128.17 (18.59)	79.20 (11.87)	108.30 (25.37)
11 Active Duty Days	118.43 (20.30)	75.86 (14.52)	63.53(11.72)	122.47 (11.61)	74.95 (8.58)	66.27 (12.56)

Table 1: Daily Blood Pressure Measurements.

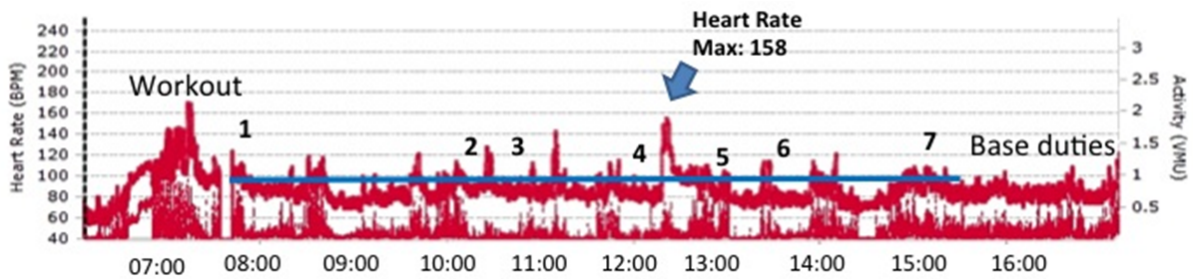


Figure 1a: Training day, active-shooter school scenarios.

Description of activities:

- 1-2: Officer checks weapons. He lines up and prepares for scenario involving criminal with gun.
- 2-3: Officer enters scenario with teammate. Officer cuffs and removes criminal.
- 3-4: Officer prepares and enters scenario involving three possibly armed individuals.
- 4-5: Officer prepares and enters the school shooting scenario, encounters 3 active shooters holding students hostage. Helps learn capture criminals.
- 5-6: Trainer provides feedback. Officer is debriefed with team.
- 6-7: Officer loads equipment into truck and travels to base. Officer unloads truck at base.

Note I: The blue line indicates that during active training hours cardiovascular reactivity reached over 130130M several times and peaked at 158.

Note II: Activity level is a measure of physical activity 0.2 to 0.5 is equivalent to slow movement or walking, 1.0 is equivalent to a light jog, 2.0 is equivalent to running, and 3.0 is maximum possible effort. Activity level is a useful metric to help interpret if the peaks in heart rate reactivity are due to physical exercise or due to the psychological 'threat' associated with the activity. In this graph, physical movement is associated with heart rate during the workout period. However, during the school shooting scenario, max HR 158 /30M is occurring even in the absence of physical exercise, demonstrating the perceived stressfulness of the situation.

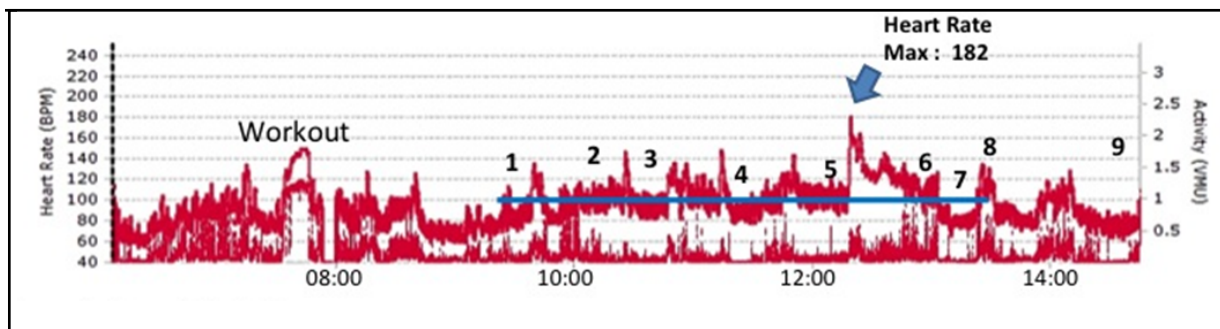


Figure 1b: Training day, active-shooter school scenarios.

Description of activities:

- 1-2: Officer prepares for scenario.
- 2-3: Male student with gun in backpack in a school. Officer engages suspects, cuffing, and searching them.
- 3-4: Three possibly armed students in a school. Team engages and cuffs three suspects. Officer uses laser simulation on suspect.
- 4-5: Team is debriefed.
- 5-6: Active school shooter scenario. Team enters building and shoots at suspects, apprehend gunman.
- 6-7: Team is debriefed.
- 8-9: Toad Truck Return to Base.

Note I: During active training hours cardiovascular reactivity reached over 140 8PM several times during training scenarios, with a max of HR 182 BPM.

Note II: Activity level is a measure of physical activity. 0.2 to 0.5 is equivalent to slow movement of walking. 1.0 is equivalent to a light jog, 2.0 is equivalent to running, and 3.0 is maximum possible effort. Activity level is a useful metric to help interpret if the peaks in heart rate reactivity are due to physical exercise or due to the psychological 'threat' associated with the activity. In this graph, physical movement is associated with heart rate during the workout period. However, during the school shooting scenario, max HR 182 8PM is occurring even in the absence of physical exercise, demonstrating the perceived stressfulness of the situation.

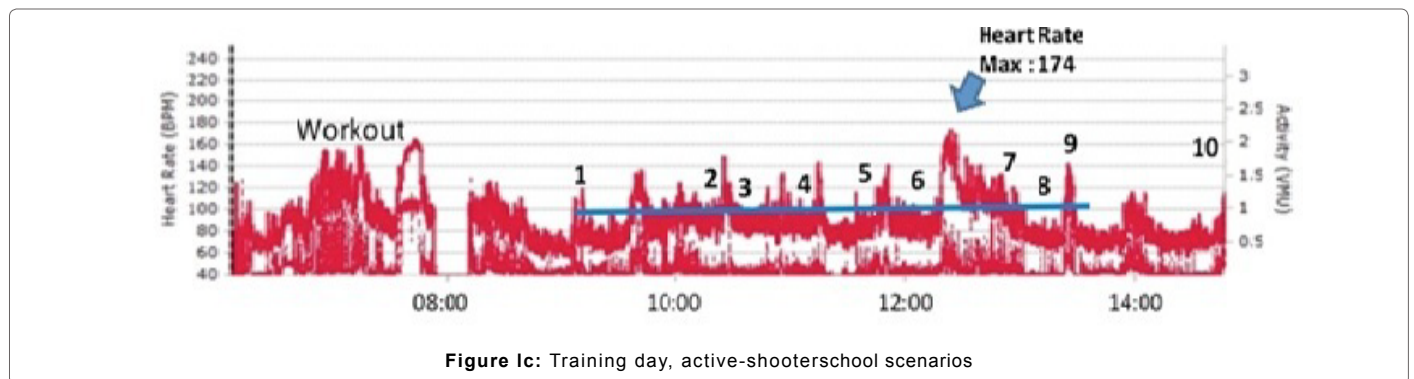


Figure 1c: Training day, active-shooterschool scenarios

Description of activities:

- 1-2: Officer checks his weapons and prepares for scenario.
- 2-3: Officer enters scenario with gun aimed.
- 3-4: Officer questions and instructs individuals and then searches their possessions.
- 4-5: Officer is debriefed.
- 5-4: Officer waits outside during scenario.
- 6-7: Officer shoots and hits criminal, runs after criminal.
- 7-8: Officer is debriefed.
- 9-10: loading truck return to base

Note I: During active training hours, cardiovascular reactivity reached over 140 BPM several times during scenarios and at max, 174 BOM. **Note II:** Activity level is a measure of physical activity. 0.2 to 0.5 is equivalent to slow movement or walking, 1.0 is equivalent to a light jog, 2.0 is equivalent to running, and 3.0 is maximum possible effort. Activity level is a useful metric to help interpret if the peaks in heart rate reactivity are due to physical exercise or due to the psychological 'threat' associated with the activity. In this graph, physical movement is associated with heart rate during the workout period. However, during the school shooting scenario, max HR 174 BPM is during mild physical exertion, demonstrating the perceived stressfulness of the situation.

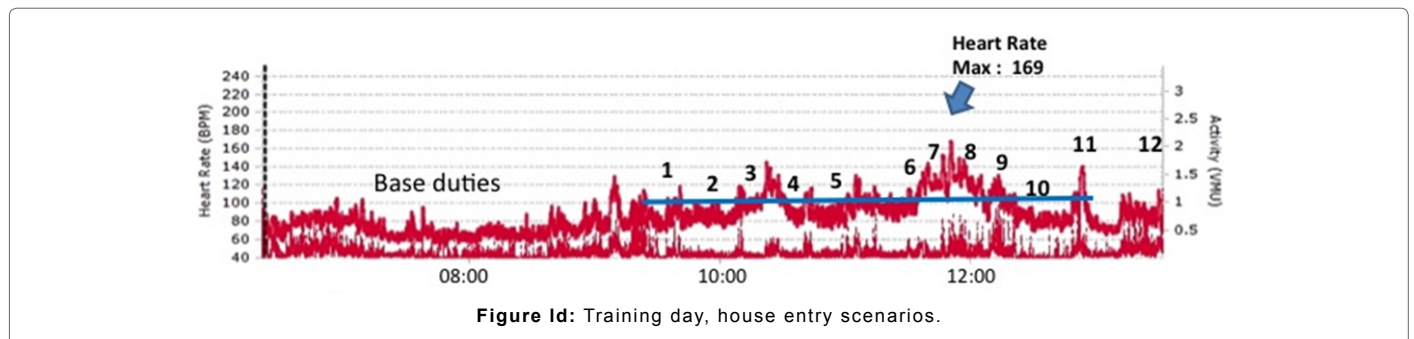


Figure 1d: Training day, house entry scenarios.

Description of Activities:

- 1-2: Team is briefed. Two suspects carrying weapons, hiding inside a kitchen.
- 2-3: Team arrives on the scene. The suspects exit the house, the other officers' move into the house.
- 3-4: Team searches the basement.
- 4-5: Scenario ends. Team receives feedback.
- 5-6: Team is briefed. Two suspects inside house, domestic violence, female is going to shoot her boyfriend.
- 6-7: Team enters budding.
- 7-8: The habitant steps out of house, screams at the female suspect who then shoots her boyfriend. Officer arrests the shooter.
- 8-9: Team holds one of the habitants on the floor of the second level before searching the basement.
- 9-10: Scenario ends, officers are debriefed.
- 11-12: Loading truck return to base.

Note I: Cardiovascular reactivity reached over 140 BPM several times during the training scenarios, with a max at HR 169 BPM. **Note II:** Activity level is a measure of physical activity. 0.2 to 0.5 is equivalent to slow movement or walking, 1.0 is equivalent to a light jog, 2.0 is equivalent to running, and 3.0 is maximum possible effort. Activity level is a useful metric to help interpret if the peaks in heart rate reactivity are due to physical exercise or due to the psychological 'threat' associated with the activity. In this graph, physical movement is associated with heart rate during truck loading. However, during house entry scenario, max HR 169 BPM is during mild physical exertion, demonstrating the perceived stressfulness of the situation.

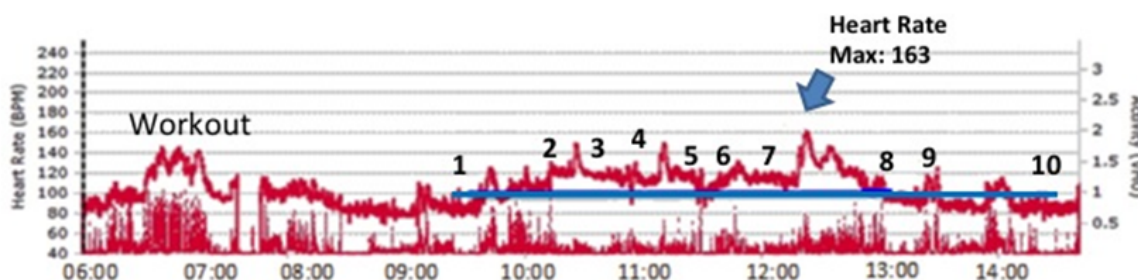


Figure 1e: Training day, active-shooter school scenarios.

Description of Activities:

- 1:2: Officer checks weapons and prepares for scenario involving armed criminal.
- 2:3: Officer enters first scenario with teammates. Officer aims his gun and gives instructions to suspect.
- 3:4: Officer is debriefed.
- 4:5: Officer prepares for and then enters second scenario, involving three individuals, one of whom is non-compliant.
- 5:6: Officer receives feedback from trainer.
- 4:7: Officer prepares to enter third scenario.
- 7:8: Officer climbs stairs and shoots at suspect before calling for medical help.
- 8:9: Officer receives feedback from trainer and is debriefed.
- 9:10: Officer loads equipment into truck and travels to base.

Note I: During active training hours, cardiovascular reactivity reached over 140 fPM several times during training scenarios, with a max HR of 163 BPM.

Note II: Activity level is a measure of physical activity. 0.2 to 0.5 is equivalent to slow movement or walking, 1.0 is equivalent to a light jog, 2.0 is equivalent to running, and 3.0 is maximum possible effort. Activity level is a useful metric to help interpret if the peaks in heart rate reactivity are due to physical exercise or due to the psychological 'threat' associated with the activity. In this graph, physical movement is associated with heart rate during the workout period. However, during school shooting scenario, max HR 163 BP61 is during mild physical exertion, demonstrating the perceived stressfulness of the situation.

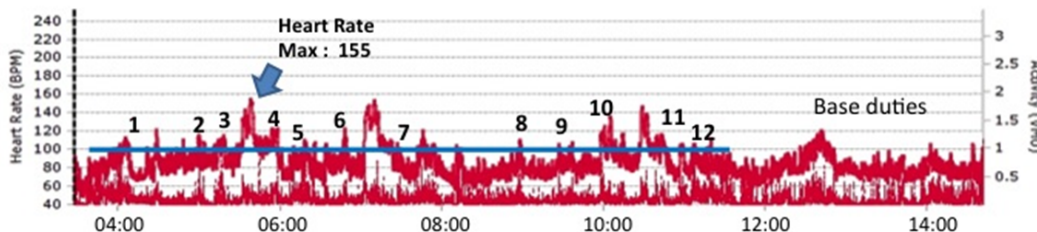


Figure 2a: Active-duty calls with micro-intervention.

Description of Activities:

- 1:2: Officer is briefed on first search warrant.
- 2:4: Officer travels to target address.
- 3:4: Officer executes search warrant, drawing his weapon on a target. 4:5: Officer returns to the station for a briefing on the second search warrant.
- 5:4: Officer travels to target address while performing breathing exercises.
- 6:7: Officer executes search warrant, drawing his weapon on an initially noncompliant target.
- 7:8: Officer returns to the station for a briefing on the third search warrant.
- 8:9: Officer performs a drive by reconnaissance of the target address.
- 9:10: Officer arrives at and approaches the target address.
- 10:11: Officer executes search warrant. Officer secures two floors, drawing his weapon on multiple targets.
- 11:12: Officer returns to the station.

Note I: During real world emergency calls, average cardiovascular regulation was below 100 BPM. Cardiovascular reactivity reached over 140 BPM several times during active duty shift, with a max MR of 155 8PM.

Note II: Activity level is a measure of physical activity over time. 0.2 to 0.5 is equivalent to slow movement or walking, 1.0 is equivalent to a light jog, 2.0 is equivalent to running, and 3.0 is maximum possible effort.

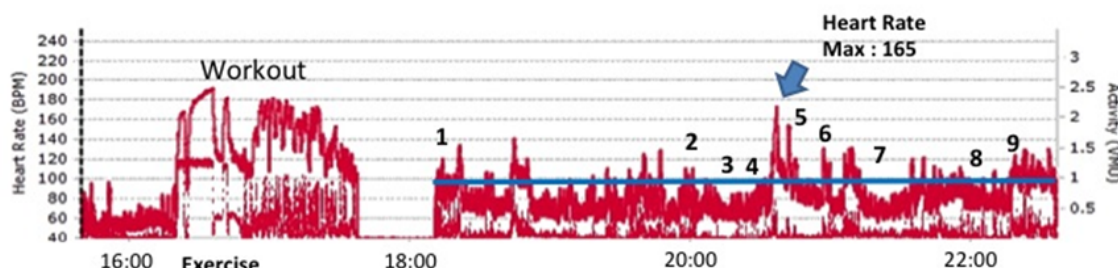


Figure 2b: Active-duty calls with micro-intervention.

Description of activities:

- 1-2: Officer gears up and drives to the station.
- 2-3: Officer is briefed at station.
- 3-4: Officer arrives at target address.
- 4-5: Officer issues warrant. Officer runs to the rear of the premise. Moving inside.
- 5-6: Officer returns to the station.
- 6-7: Officer removes gear.
- 7-8: Officer returns to base.
- 8-9: Officer removes equipment from truck.

Note I: During real world emergency calk, average cardiovascular regulation was below 100 RPM. Cardiovascular reactivity reached over 130 8PM several times during active duty shift, with a max MR of 165 8PM.

Note II: Activity level is a measure of physical activity over time. 0.2 to 0.515 equivalent to slow movement or walking, 1.0 is equivalent to a light Jog, 2.0 is equivalent to running, and 3.0 is maximum possible effort.

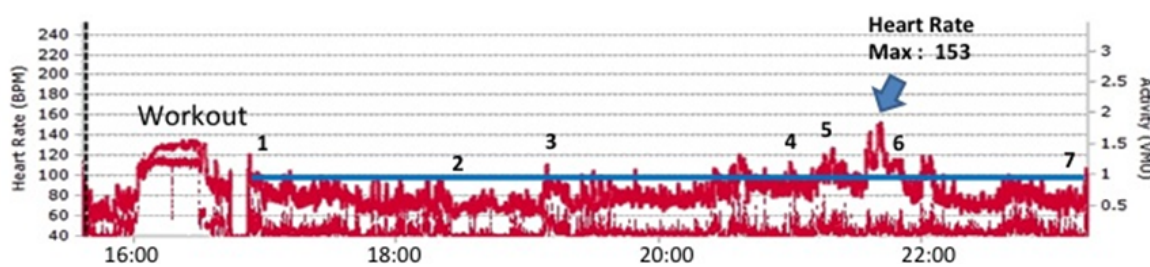


Figure 2c: Active-duty calls with micro-intervention.

Description of Activities

- 1-2: Officer is debriefed.
- 2-3: Officer takes notes.
- 3-4: Officer receives a tactical briefing.
- 4-5: Officer travels to target address, engages micro-intervention breathing.
- 5-6: Officer enters target address.
- 6-7: Officer returns to station.
- 7-8: Officer reports off duty.

Note I: During real world emergency calls, average cardiovascular regulation was below 100 PPM. Cardiovascular reactivity reached over 12011PM several times during active duty shift, with a max HR of 153.

Note II: Activity level is a measure of physical activity over time. 0.2 to 0.5 is equivalent to slow movement or walking, 1.0 is equivalent to a light jog, 2.0 is equivalent to running, and 3.0 is maximum possible effort.

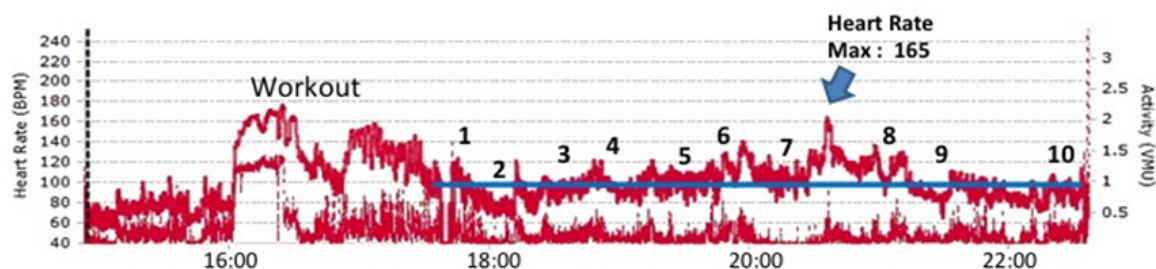


Figure 2d: Active-duty calls with micro-intervention.

Description of Activities:

- 1-2: Officer participates in team meeting.
- 2-3: Officer participates in team training on dynamic entry.
- 3-4: Officer travels to the station.
- 4-5: Officer receives an investigative briefing.
- 5-6: Officer receives a tactical breathing
- 6-7: Officer travels to target address while performing breathing exercise.
- 7-8: Officer arrives at target address. He draws his weapon on two non-compliant males, engaging in a verbal confrontation with non-compliant female.
- 8-9: Officer returns to the station.
- 9-10: Officer completes paperwork.

Note I: During real world emergency calls, average cardiovascular regulation was on average 100 BPM. Cardiovascular reactivity reached over 135 RPM several times during active duty shift.

Note II: Activity level is a measure of physical activity over time. 0.2 to 0.5 is equivalent to slow movement or walking, 1.0 is equivalent to a light jog, 2.0 is equivalent to running, and 3.0 is maximum possible effort.

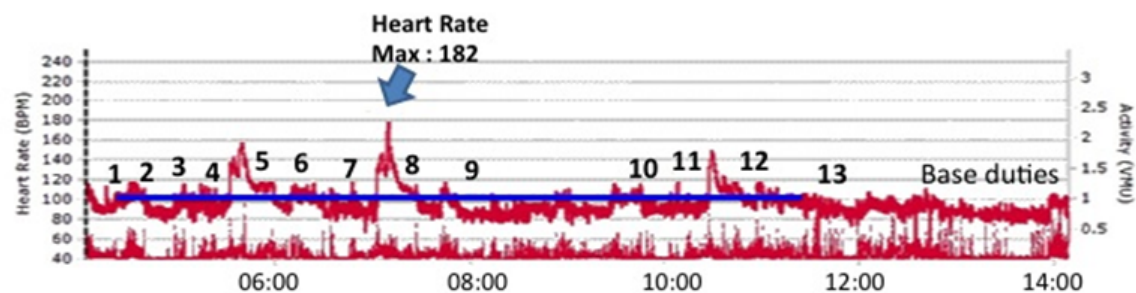


Figure 2e: Active-duty calls with micro-intervention.

Description of Activities:

- 1-2: Officers briefed for a search warrant.
- 2-3: Officer travels to target address, engaging in breathing exercises.
- 3-4: Officer arrives at the target address, drawing rifle and approaching.
- 4-5: Officer breaches door and clears rooms. Officer engages and cuffs compliant suspects. 5.6: Officer returns to truck, to receive second briefing. Officer engages in breathing exercises. 6-7: Officer travels to and arrives at the second warrant address.
- 7-8: Officer breaches door and enters building, verbally engaging suspects.
- 8-9: Officer returns to truck to receive third briefing. Officer engages in breathing exercises. 9.10: Officer performs general patrol.
- 10-11: Officer arrives at third warrant address, drawing his rifle on approach.
- 11-12: Officer verbally engages and cuffs multiple suspects.
- 12-13: Officer returns to station after being relieved by detectives.

Note I: During real world emergency calls, average cardiovascular regulation was below 100 BPM. Cardiovascular reactivity reached over 140 RPM several times during active duty shift.

Note II: Activity level is a measure of physical activity over time. 0.2 to 0.5 is equivalent to slow movement or walking. 1.0 is equivalent to a light jog, 2.0 is equivalent to running, and 3.0 is maximum possible effort.

skills during periods of realistic high-stress arousal. Considering that police organizations may need to decide to invest in additional training hours for officers in the upcoming years, our data suggests that realistic training scenarios are of more benefit than stationary or classroom guided training. *Second*, the data reveal that officers also experience robust cardiovascular reactivity to real-world emergency calls. Heart rate reactivity above 150 BPM has been shown to be associated with performance detriments because sensory distortions, such as tunnel vision and auditory exclusion, are likely to occur [25,26]. It is yet to be known if SWAT officers, given regular advanced training, can maintain high performance even in the face of elevated heart rate reactivity. Future research studies should examine performance during a variety of heart rate reactivity levels. *Third*, the application of a micro-intervention, focused on specific cardiovascular regulation and reactivity risk factors, does appear to aid in the control of maladaptive patterns among these officers. Future research monitoring a micro-intervention over the long term would present evidence if maladaptive cardiovascular regulation could be avoided over time by regular application of intervention techniques. *Fourth*, there is a significant body of research indicating that police officers are at elevated risk of contracting cardiovascular disease related to robust, recurrent cardiovascular stress responses [27,28,29,30]. Replacing maladaptive cardiovascular physiological responses with resilient responses may have a two-pronged benefit, a). improve cardiovascular health and reduce the risk of disease, b). encourage optimal police performance by maximizing the benefit of a controlled and efficient physiological response to critical incidents. A further benefit of the micro-intervention applied here is that it is brief, free, and contains high face validity for officers, as they experience the immediate benefits of engaging in the intervention. Officers were interviewed upon completion of the study and all reported value in the micro-intervention and recommended this technique for all levels of police officers, from recruits to Special Forces.

Limitations

This observational study consists of one small team of SWAT officers. The present research study is not meant to generalize to all SWAT team officers or front-line officers at this stage. However, given the high degree of difficulty in attaining permission to observe tactical teams in the multi-day, intensive physiological profiling manner as conducted in this study, we believe the case examples provide valuable information for police training and resilience promotion discourse. The profiles (Figures 1a-2e) indicate that future research among this population is warranted.

Recommendations

Significant cardiovascular reactivity may pose a health risk to SWAT officers over time. As previous research from front-line officers indicated, individuals who are routinely exposed to high stress, threatening encounters are two and three times the risk of chronic medical conditions, including cardiovascular disease [16,17,27]. Results suggest that a tactical breathing micro-intervention may have significant positive impact on daily cardiovascular health and stress reactivity among SWAT officers. Given the positive results of the cases examined, it is recommended that a similar intervention be applied to a large sample of SWAT and front line officers in the future. The impact of police officers on civilians is exponential. Police actions can entail life or death decisions for all people involved in a critical incident (e.g., civilians, officers, suspects). Consequently, the health and performance of police in the field is paramount to public safety and, in turn, social welfare.

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