Increased Vulnerability to Health Implications.
Secondary Analysis Exploring the Association of Stress, Chronic Illness, and Absenteeism Among 9-1-1 Telecommunicators

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Abstract

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Introduction: Nationwide, emergency response systems depend on the interrogative and enhanced skills of 9-1-1 telecommunicators. Within minutes, telecommunicators assess complex information, prioritize, triage, and dispatch appropriate help to individuals needing assistance. Telecommunicators (TC) are challenged by acute and chronic workplace stressors, including interactions with callers in crisis and routine exposures to a variety of tense circumstances. Given this exposure, telecommunicators may have elevated levels of emotional or peritraumatic stress to duty-related experiences. While acute stress helps telecommunicators manage critical decision-making, the repeated response can become damaging or negatively impact health. Living in a chronic state of stress may weaken the body and increase vulnerability to chronic illness.
Objective: This paper outlines the literary evidence around the physiological effects and psychological burden of duty-related trauma exposure. The focus of this analysis is to understand

the implications of stress; Specifically, if there is an association between symptoms of stress, chronic illness (CI), and sick leave (absenteeism) in 9-1-1 telecommunicators.

Methods: Secondary data analysis was conducted as a supplement to a study assessing the efficacy of an online mindfulness-based intervention in reducing stress among 9-1-1 telecommunicators. Analysis relied on data collected by the primary study during both the Baseline Assessment (T1) and 3-Month Follow-Up Survey (T3). Participants contributed data by responding to items on validated instruments measuring symptoms of stress (C-SOSI), chronic illness, sick days, and demographic characteristics. Descriptive information on participant demographics was collected during baseline, while information collected during follow-up provided outcome data. Bivariate and multivariate analyses, adjusted for cofounders, provided information on presumed associations between self-reported symptoms of stress, chronic illness, and sick days among 9-1-1 telecommunicators.

Data Findings and Results: A total of 182 Telecommunicators across 29 different call centers provided data during both baseline and 3-month assessment. Results showed that symptoms of stress (C-SOSI) are associated with the number of stress-related self-reported chronic illnesses (CI) in 9-1-1 telecommunicators, though we do not know the causal direction of this association ($r = 0.465$, p-value = <0.001). Symptoms of stress (C-SOSI) did not appear to be associated with greater use of sick days (odds ratio = 1.1, p-value = 0.190) nor did self-report chronic illness (CI) appear to be associated with greater use of sick days among 9-1-1 telecommunicators (odds ratio = 1.1, p-value = 0.378) in this sample.

Interpretation and Conclusion: Consistent with existing research, results found that symptoms of stress and number of chronic illnesses are associated. However, results of the analysis were not conclusive in supporting the model's assumption that reported absenteeism was associated to symptoms of stress and/or chronic illness. While not supported in this sample, previous research and literature provide extensive knowledge on the implication of stress contributing to the

development of chronic physiological, psychological, behavioral, psychosocial, and neurobiochemical conditions. Literature revealed a tremendous gap in research specific to 9-1-1 telecommunicators. This noticeable lack of available data highlights the importance of contributing data for telecommunicators to more extensive research among emergency health personnel occupations as a whole. Findings from these studies offer important data justifying the need for improving occupational and health services to help mitigate the interconnected job-related health consequences telecommunicators face.

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Keywords: stress, chronic illness, absenteeism, 9-1-1 telecommunicators

Introduction

Description of Stress in Telecommunicators

Background (role of telecommunicators within emergency response system). Nationwide, emergency response systems depend on the interrogative and enhanced skills of 9-1-1 telecommunicators. Within minutes, telecommunicators assess complex information, prioritize, triage, and dispatch appropriate help to individuals needing assistance for a variety of emergency needs (Pierce & Lilly, 2012). Emergency medical personnel (EMP) collaborate in making critical decisions in dynamically changing environments of uncertainty.

Telecommunicators are challenged by acute and chronic workplace stressors including tense interactions with callers in crisis and routine exposures to secondary traumatization, ranging from: unexpected accidents or injuries; medical emergencies (i.e., heart attack, stroke, overdose); domestic violence; shootings; death; suicide prevention mitigation; to social needs (i.e. welfare checks for vulnerable populations) (Jonsson, A., & Segesten, 2004; Pierce & Lilly, 2012). The pressure presents as both high emotional stress and temporal narrowing (Elliott, 2005; Pasquale, B., Grohman, Kerry K., Cohen, Harold, & Klein, 2017); defined as an induced stress response based on the perceived consequences over time (Campeau, 2008).

This paper outlines the literary evidence around the physiological effects and psychological burden of duty-related trauma exposure, including exposure that is vicarious in nature (Lilly & Allen, 2015). **The focus of this analysis is to understand the implication of stress – specifically if there is an association between stress, chronic illness (CI), and sick leave in 9-1-1 Telecommunicators.**

Occupational stressors and buffers for emergency response personnel. It is first important to acknowledge that the presumed occupational stressors and health effects for 9-1-1 telecommunicators is limited in comparison to other emergency medical personnel. Studies have indicated 86% of emergency medical personnel reported experiencing critical stress (Fitch & Marshall, 2016). It is plausible stress would be just as high for telecommunicators; Therefore, background will combine available research specific to telecommunicators with more comprehensive data among EMPs. Individuals employed in emergency responder occupations (e.g. ambulance, fire, and police personnel) convey similar levels of stress. Many develop and utilize maladaptive coping skills to handle stress, resulting in reports of burnout (Getrich, M., White, Dale, & Olson, 2012). When considering duty-related distress, Lilly and Allen noted a significant direct effect of stress on psychopathology among telecommunicators. Effects included dissociation, emotion regulation, anger, and even neuroticism (2015). Lilly and Allen further explained that duty-related trauma exposure correlates to psychological inflexibility; defined as being "marked by avoidance of internal, private experiences and ruminative thoughts about the past or future, with interfere with one's ability to act in accordance with values" (2015).

An added component of stress is an incongruency between the characteristics of emergency personnel's' professional identity and self-expectations. For example, the characteristics that help with adaptation ability, attitude, compassion, toughness, sense of vulnerability and sensitivity

experienced within their professional identity may conflict with their personal expectations outside out work, leading to more stress (Avraham, Goldblatt, & Yafe, 2014; L. Miller, 1995). Appendix A outlines additional literature on the stress first responders encounter.

Emergency medical personnel experience both direct or indirect exposures. The type of exposure may have an associated buffering effect, though research is inconclusive. In preliminary literature, Pierce and Lilly note that some researchers believe that physical distance from traumatic scene (i.e., limited risk of physical injury) may serve as a buffer against post-trauma psychopathology, including the risk of developing PTSD (Carlier, Lamberts, & Gersons, 2000; Pierce & Lilly, 2012). However, these same researchers found conflicting results in their own research, noting that there may not be a buffering effect of distance from trauma (Pierce et al., 2012). 9-1-1 telecommunicators may have different trauma and mental impacts than the 1st responders. First responders, such as EMT paramedics and ER staff, have direct exposure to and are able to see the resolution to a trauma, while telecommunicator's involvement is more indirect, with unknown outcomes of an emergency response. As such, it is plausible that that 9-1-1 telecommunicators may have a harder time processing the traumatic event without knowing the resolution. Consequently, they may have ruminating thoughts wondering about the incident's outcome, which could be more stressful or be expressed as secondary traumatization.

A buffering effect may be how emergency response personnel process emotions. Personnel who experienced cognitive, emotional, and functional control of the situation report a positive and empowering experience because of their ability to remain calm during the event (Avraham et al., 2014). Further, EMPs report that these interactions facilitate personal and professional growth (2014); explaining that it helped give meaning and motivation for continuing in the profession despite adverse experiences, associated difficulties and stress (2014). Though understudied for 9-1-1 telecommunicators, it is theorized that these buffering effects help avoid burnout for emergency medical personnel.

Sources of Stress for 9-1-1 Telecommunicators

Exposure to critical incidents. Intervention in crisis situations or witnessing human tragedy may carry a cost for relief workers (Avraham et al., 2014; Eriksson, C. B., Vande Kemp, H., Gorsuch, R., Hoke, S., & Foy, 2001). The Potentially Traumatic Events/Calls measure lists 21 different types of traumatic calls, ranging from domestic interaction to various gun-related events and line of duty death (Troxell, 2008). Using this measure, Troxell assessed that on average 9-1-1 telecommunicators endorsed experiencing 15.32 (*SD* = 3.50) different types of potentially traumatic calls out of 21 (2008). Related, telecommunicators reported an average score of 2.93 on a peritraumatic distress measure, which was associated with the types of calls experienced (Pierce et al., 2012).

When encountering critical incidents, 9-1-1 telecommunicators report experiencing intense fear, helplessness, or horror in reaction to 32% of the different types of calls experienced (Pierce et al., 2012). When endorsing types of traumatic calls experienced, telecommunicators also identified calls they considered "worst" (2012). In reaction to human tragedy, a disproportionate number of 'worst calls' experienced involved exposure to difficult events, such as the: death of a lonely older person; abuse of an innocent child, loss of a family member, or suicide of a despairing victim (Avraham et al., 2014; Regehr, C., Goldberg, G., & Hughes, 2002).

While not specific to 9-1-1 telecommunicators, Avraham and colleagues revealed important information among paramedic's reactions to critical incidents (2014). First, when unable to help the patients, paramedics doubt their professional competence and capabilities, and describe experiencing guilt (2014). Researchers presume a similar reaction among emergency medical personnel in general and believe that finding presents important information when considering stressors 9-1-1 telecommunicators experience. Given this exposure and an uncomfortable lack of

control while on duty, telecommunicators may experience: elevated levels of emotional burden (2014); peritraumatic stress; or development of vicarious trauma (Eriksson et al., 2001), including confronting their own repressed fears and vulnerability around health and illness (2014). Considering the importance of 9-1-1 telecommunicators as the first of the first responders, more research needs to be conducted to assess how stress affects their health and well-being because it is plausible stress would be just as high.

Multitasking as an occupational stressor for telecommunicators. Crucial to the success of the emergency response systems and the health of community members alike, telecommunicators must be skilled at multitasking under high-stakes pressure. They must be able to manage workplace demands, interact with technology and logistical barriers, manage/suppress the emotions of callers, and emotionally detach themselves while making rapid but effective decisions (Avraham et al., 2014; Ramey, Perkhounkova, Hein, Chung, & Anderson, 2016). Researchers note that the human brain is not designed to perform heavy-duty multi-tasking (Wetherell, M.A., Hyland, M.E., & Harris, 2004). There are indications that simultaneously interacting with several sources of stimuli can ultimately produce long-term negative health effects on employees (Nezu, A. M., Nezu, C. M., & D'Zurilla, 2012a; Wetherell et al., 2004).

Adverse outcomes associated with chronic occupational stress, is now being recognized as a public health problem and gaining interdisciplinary stakeholder support (Quick & Henderson, 2016; Sauter, Murphy, & Hurrell, 1990). Recognizing occupational hazards and work stress, the U.S. Centers for Disease Control and Prevention, within the U.S. Department of Health and Human Services, passed The Occupational Safety and Health Act of 1970 ("The National Institute for Occupational Safety and Health (NIOSH)," n.d.). Subsequently, NIOSH was established to promote occupational program interventions that reduce worker illness and advance worker health/wellbeing through safety and health research (NIOSH). With comprehensive literature highlighting how occupational stressors impact our health, workers, employers, businesses, industry leaders, medical professionals, policy makers, and health associations are working to reduce associated health disparities (NIOSH). In sum, telecommunicators are exposed to vicarious trauma in a high demand, low control environment that requires them to multitask under pressure. All of this results in stress, which in turn can negatively affect health and sick days.

What stress is. Before further exploring the impact of stress that telecommunicators face, it is important to gain a better understanding of what stress is, in order to understand its impact on health. First, stress can present itself during various stages of our lives. Individuals may experience stress in the form of: psychosocial; interpersonal; systemic; cognitive; or emotional circumstances. Stress can arise from a combination of objective stressors (e.g. trauma, discrimination, poverty) (B. T. Johnson & Acabchuk, 2018), Stress involves one's perception of the event (i.e., appraisal), subjective distress, and the associated physiological response (Lazarus, R. S., & Folkman, 1984; Mariotti, 2015). Another pathway influencing one's stress response, is based on an individual's "subjective interpretation perceived ability to handle and recover from the stressor" (Johnson et al., 2018). For instance, external factors such as social support influence an individual's ability to cope with stress (Folkman & Lazarus, 1988; 2015).

Stress is an immediate response that by definition, is any uncomfortable "emotional experience accompanied by predictable biochemical, physiological and behavioral changes" (Baum, 1990). The term "stress" is often used interchangeably when describing an individual's response to stress, stress reactivity, and is dependent on several interconnected factors. Stress reactivity is often used to describe an individual's immediate response to a potentially stressful event (Lazarus et al., 1984). Since stress is experienced on an individualized level, responses vary, the outcomes of which can be either good or bad (Folkman et al., 1988). 'Stress and stressor' can refer to the causal agent of the stress response, whereas the term 'distress' refers to the emotional consequences of the process

that the stressor sets in motion (Garrido, Hash-Converse, Leventhal, & Leventhal, 2011). Some degree of stress can be positive (eustress) in that it provides a sense of doing or accomplishing daily tasks. However, if overtaxed, stress can be negative (distress or strain), impacting an individual's health (Pandey, Quick, Rossi, Nelson, & Martin, 2011).

Physiology of Stress

The way that a stressor can affect the brain or body is by inducing various neurobiological changes within the organism; Therefore, the adaptive "physiological stress response is critical for mediating the effects of stress on health" (Dhabhar, 2011). This precipitates a reaction that serves as a defense against immediate threats and to increase one's survival potential in response to a negative or emotional stimulus (Nezu et al., 2012). The physiological mechanism for which stress disrupts various aspects of our body is extensive and far reaching.

When experiencing stress, our body responds by initiating a reaction in the brain (stress perception and processing) and activating the physiological 'fight, flight, or flee' stress response generated by the sympathetic nervous system (SNS) (Dhabhar, Firdaus S ; Mcewen, Bruce S ; Spencer, 1997). Activation of the SNS releases neurotransmitters, hormones (e.g. cortisol), peptides, cytokines and other indicators into circulation within the body (Dhabhar, 2011), thus disrupting the various systems (Altemus, Rao, Dhabhar, Ding, & Granstein, 2001; Pace et al., 2006). When experiencing constant stress, the body is in a chronic state of heighted arousal in which various biomarkers are unable to return to pre- 'fight or flight' levels. Continuous exposure to stressors may lead to the sustained activation of the stress system (Gouin, Glaser, Malarkey, Beversdorf, & Kiecolt-Glaser, 2012), the long-term implication of which may lead to the development of chronic illness (Pandey et al., 2011) or health consequences (Acabchuk, Kamath, Salamone, & Johnson, 2017; Das, 2016). Applying this knowledge, researchers anticipate that 9-1-1 telecommunicators may experience a similar chronic state of heightened arousal so may be at risk for associated adverse health outcomes.

Biological indicators of stress. Stress causes an imbalance at multiple levels of the body's physiological systems, including the: neuroendocrine; genetic and epigenetic; immune; metabolic; nervous (autonomic; parasympathetic; and sympathetic); and metabolic (Schwartz, 2017). Research has shown that the various pathways in which stress interacts with our body alters one's stress sensitivity (Nezu et al., 2012) and leaves a biological mark (Acabchuk et al., 2017; Das, 2016). Combined, cumulative effects may have a detrimental impact on health and the disease process (Gouin et al., 2012). These indicators are being used to assess the long-term impacts of chronic stress (Appendix B expands on the scientific mechanism of this process).

> *"The repeated activation of biological stress mechanisms by psychological challenges and threats is thought to exert an insidious, pervasive, and persistent effect on the body, resulting in "Diseases of Civilization"—hypertension, strokes, heart attacks, diabetes, neck aches, low-back pains, and several skin problems" (American Institute of Stress Website: http://www.stress.org).*

Cytokines are one biological indicator being measured to help understand the stress process (Contrada, 2011). Cytokines have a direct and substantial effects on the central nervous system, including production and enhancement of negative moods, depression, anxiety, physical symptoms, lethargy and fatigue, as well as a range of sickness behaviors (Leventhal H, Patrick-Miller L, Leventhal EA, 1998; Watkins LR, 2000). Additionally, there is plausible evidence of a bi-directional feedback between the immune and endocrine systems as they relate to both depressive and anxiety disorders (Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002; A. H. Miller, 1998). While our endocrine system helps regulate our hormones in response to stressors, continuous exposure may make it more challenging for an individual to return to their neuroendocrine baseline and may increase the overall

burden of physiological and psychiatric disease (Kiecolt-Glaser et al., 2002). An extensive body of evidence supports our hypothesis of an association between stress and, a higher rate of at least one chronic illness, and thus the greater use of sick days for mitigating the psychological and psychological effects of stress. The next section will discuss more on the individual impacts of stress of health and wellbeing.

Consequences of Stress on Health and Well Being

Consequences of stress and trauma. To sum up, responses to trauma can manifest across a variety of complex and interconnected pathways. Research suggests that the accumulation of constant daily stressors over time can have a significant and independent impact long after the experience of a major event (Monroe, Slavich, Torres, & Gotlib, 2007; Nezu, A., & D'Zurilla, 2013). Events that are potentially traumatic, intense, sufficiently threatening, or harmful provoke significant stress reactions and may influence susceptibility to, recovery from, and progression of illness and disease (Dougall & Swanson, 2011). Numerous figures have been developed, illuminating the comorbid impact stress can have on health. Johnson et al. provided one such model, "illustrating the pathways through which chronic stress can contribute to chronic disease" and further emphasizing that pathways involve multiple systems, "are complex, bidirectional, and can be self-reinforcing" (Johnson et al., 2018).

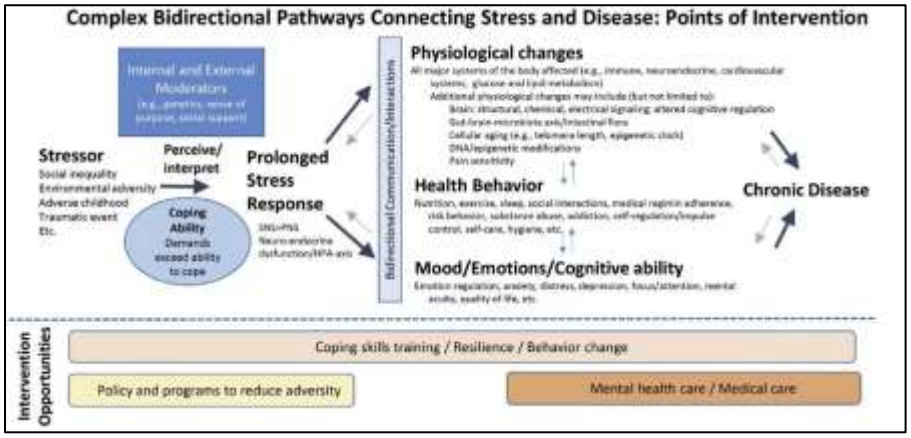


Figure 2: Johnson, & Acabchuk (2018). What are the keys to a longer, happier life? Answers from five decades of health psychology research. *Social Science & Medicine, 196*, 218-226.

With estimates that "50-60% of individuals are likely to be exposed to a traumatic event during their lifetime" (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995), the consequences of stress are far-reaching, especially for 9-1-1 telecommunicators who interact with traumatic events every day. Changes in the physiological, neurobiological, psychological strain, behavioral, cognitive and psychosocial pathways can have a critical impact in individuals experiencing stress (Contrada, Richard J., and Baum, 2011). In summarizing the most prominent pathways in which trauma provokes stress reaction, Dougall et al. believe that (2011):

- *the physiological pathway (e.g., biological activation or dysregulation of our response system) is the most direct route for traumatic stress to affect illness and diseases.*
- *the behavioral pathway may have direct or indirect influences on health, such as increasing vulnerability or interfering with a person's ability to manage a medical condition.*
- *and that that psychosocial pathways can be associated with alterations in physiological response profiles and behavioral patterns; both of which can promote the development, maintenance, or progression of disease.*

Chronic stress and chronic disease. Chronic health conditions are often defined as lasting a year or more, requiring ongoing medical attention and/or limiting activities of living (Anderson & Horvath, 2004; McGonagle & Barnes-Farrell, 2014). Chronic illnesses encompass the entire scope within the biopsychosocial construct, which health psychology uses to refer to a model in which biological factors interact and are affected by psychological and social elements (B. T. Johnson & Acabchuk, 2018). Examples of Chronic Illness (CI) include diagnoses such as: high blood pressure; high cholesterol; cancer; diabetes; asthma; depression; anxiety; and recurring physical pain (McGonagle et al., 2014; Witters, D., & Agrawal, 2011). Stress is known to further increase one's vulnerability by changing both the onset, progression, course, and outcome of chronic disease or illness (Garrido et al., 2011). This is especially applicable to conditions associated with aging, increasing one's susceptibility to: infection; autoimmune and inflammatory disease; exacerbating asthma and allergic reactions; cardiovascular disease; type 2 diabetes; arthritis; Alzheimer's Disease; cancer; and periodontal disease (Dhabhar, 2011; Kiecolt-Glaser et al., 2002).

Psychosocial impacts of stress: The effects of stress expand beyond the direct disease processes. Chronic diseases and added stress often coincide, leading to complex biopsychosocial or environmental influences in an individual's life (Das, 2016; Dougall et al., 2011). Psychosocial constructs may also be interrupted, for instance disrupting: family roles; an in inability to maintain strong relationships; social dynamics; and reductions in quality of life (Charlson, Mary ; Peterson, 2002; Kilian, R., Matschinger, H., & Angermeyer, 2001).

> *"The more negative health outcomes that are engendered by stress, the more likely that such diminished functioning will serve to increase stress (e.g. poor physical or emotional health leads to poorer work performance) … This process is often referred to as the stress generation hypothesis (i.e. poorer health leads to increased stress), which (was then suggested) works in conduction with the stress sensitization process. In other words, continuous daily stress can eventually lead to a lowered threshold that is necessary to trigger negative health outcomes (i.e. less stress is required to produce poor health over time, the stress sensitization hypothesis), whereas poor health can lead to or create additional sources of stress (e.g. increased daily problems and/or more severe chronic illness)."*
>
> (Nezu, A., & D'Zurilla, pg. 24, 2013)

Stress and cardiovascular health system. The previously mentioned "fight or flight" stress response directly and indirectly activates pathways for sympathoadrenal responses (Murburg, 1997). Stress affects cardiovascular regulation through mechanisms such as: high blood pressure; hypertension; cardiac stress; vascular complications (Joint National Committee on Prevention, Detection, Evaluation, National Institutes of Health (U.S.), National Heart, Lung, & National High Blood Pressure Education Program, 1997); alterations in blood flow to the various brain regions ("The American Institute of Stress," n.d.); and increased cortisol suppression (Rauch, S., & Shin, 1997). While cardiovascular responses to stress are "exquisitely coordinated and functional up to a point" (Dimsdale, 2008), the development, progression, and acute clinical manifestation of cardiovascular disease" (Davidson & Baum, 1986)" (including heart attacks and strokes) can be influenced by the body's stress reactions and are a major risk factor (Dougall et al., 2011).

Stress and mental health – depression. Enduring chronic and critical incident stressors for a long period of time can lead to chronic mental health diagnoses, such as anxiety, depression, dissociative disorders, post-traumatic stress disorder (PTSD), or posttraumatic stress symptomatology (PTSS) (Donnelly, Bradford, Davis, Hedges, & Klingel, 2016; Jones, 2016). The associated molecular changes disrupt complex functions, which can impact learning, memory, the ability to process or consolidate information, and emotions (Murburg, 1997). Researchers observed a multilayered association between stress and depression, in which "dysfunction of the

hypothalamic-pituitary-adrenal (HPA) axis can lead to psychiatric disorders, particularly depression" (Gutman, D.A., & Nemeroff, 2011). While genetic and environmental factors may predispose diagnosis, stressful life events (chronic or acute) are associated with the onset of major depression (Kendler, K.S., Karkowshi, L.M., & Prescott, 2009).

Mental disorders appear highly comorbid for public safety personnel. Public safety personnel (PSP) who report high levels of work stress or regular exposure to potentially traumatic experiences, are significantly more likely to screen positive for: major depressive disorder; generalized anxiety disorder; PTSD; social anxiety disorder; chronic pain; and alcohol use disorder (Carleton et al., 2018). In a study looking at the mental health of over 800 9-1-1 telecommunicators, self-reports indicated prevalence of current (probable) PTSD to be between 17.6% to 24.6%, and 23.9% for probable major depression; nearly one quarter of which were moderate-to-severe depressive symptoms (Lilly & Allen, 2015).

Stress and mental health disorders - Post-Traumatic Stress Disorder (PTSD). PTSD is associated with emotional reactions such as increased feelings of anxiety, guilt, shame, irritability, reliving the event, negative imagery, intrusive thoughts, alterations in behavior, drug and alcohol use (Fitch & Marshall, 2016; Jones, 2016; Troxell, 2008). Chronic physiological symptoms of stress or anxiety may run concurrently with PTSD. Clinically, co-morbid symptoms can make diagnosing a challenge but also speaks to the composite effects that individuals under extreme stress, such as 9-1-1 telecommunicators face. Overlapping physiological stress-responses include: being easily startled; having difficulty concentrating; fatigue; headaches; muscle tension; trembling; twitching; sweating; nausea; light headedness; difficulty swallowing; having to go to the bathroom frequently; feeling out of breath; and hot flashes (*American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders*, 2003; Jones, 2016). Experiencing these symptoms can have a cumulative effect, and may lead to development of chromic health conditions.

Chronic illness, depression, and anxiety. Research suggests a likely and complex link between psychiatric disorders and one's increased risk for various medical conditions such as: diabetes; dementia; coronary heart disease; and osteoporosis (Kiecolt-Glaser et al., 2002; Stetler & Miller, 2011). Depression has a bidirectional relationship to serious long-term health risks: 1) there is increased risk of heart attacks, death from cardiovascular disease (CVD) and stroke; 2) CVD increases risk of depression and other behavioral effects such as healthy lifestyle options, accessing healthcare (McCraty, Atkinson, & Tomasino, 2003) and medication adherence (Craig et al., 2016). Additionally, the presence of comorbid anxiety disorder significantly predicted further chronic health conditions such as gastrointestinal problems, genitourinary disorders, and migraines (Harter, M. C., Conway, K. P., & Merikanges, 2003).

Effect of stress on cognition. Activation of the physiological stress response may be associated with damage to the hippocampus in the brain (Williams, Smitsh, Gunn, & Uchino, 2011). Damage to a major component of the brain, has been linked with chronic health conditions such as: decreased cognitive performance; memory loss; deterioration of healthy brain tissue (Launer, Masaki, Petrovitch, Foley, & Havlik, 1995; A. H. Miller, 1998; Swan, G E ; Decarli, C ; Miller, B L ; Reed, T ; Wolf, P A ; Jack, L M ; Carmelli, 1998). Some research suggests that there may be a link between Alzheimer's disease and stress. It is believed that Alzheimer's disease is due to neurofibrillary tangles that are composed of misfolded forms of the protein tau; sequentially effecting the hippocampus, cerebral cortex, and then continues to spread into other brain regions as the brain develops (Jones, 2016). Together, symptoms of stress in telecommunicators can impair decision-making abilities and functioning (Pierce et al., 2012), which could pose significant risk to the general population (Troxell, 2008).

Effect of stress on sleep. Stress-related nightmares may be particularly disrupting to an individual's REM sleep and circadian cycle. The continued sleep disturbance may: contribute to chronic fatigue; interrupt stamina; perpetuate or lead to the development of health condition; and negatively disrupt subjective vigor (Murburg, 1997). Individuals who have difficulty recovering from a stressful event (e.g., who experience prolonged distress and rumination) are prone to high cognitive and somatic pre-sleep arousal, further influencing sleep quality (Williams et al., 2011). Insufficient sleep may be an indicator for too many competing demands, an inability to relax, exhaustion and may be related to chronic stress as it appears to reflect demands such as strenuous environments and job strain (Pandey et al., 2011).

Working, often required, overtime also appears to operate as a stressor for emergency personnel (Ludwig, 2019). Overtime contributes to 9-1-1 telecommunicators' stress by increasing the demands on an employee attempting to maintain performance levels in the face of increasing fatigue and long hours (Pandey et al., 2011). Of further concern, symptoms of tiredness and cognitive overload could further affect the psychological state of individuals in emergency services; as they are associated with poorer levels of concentration, increased rate of error, and have been linked by some investigations for fatal mistakes (Cooper & Weinberg, 2011; Scott, McNaughton, & Polman, 2006). Considering this data, it is feasible to presume that sleep and stress are self-reinforcing where – i) stress effects an individual's sleep ii) the lack of sleep increases symptoms of stress., and iii) the paired stress and un-rejuvenating sleep may lead to the development of chronic illness.

Effect of stress on emotions. Severe or negative emotions can intensify health threats and have been linked to development, morbidity and mortality (Sternberg, 1997) of diseases such as: anxiety, coronary heart disease, birth defects, asthma, ulcers, and ultimately death (Ellsworth & Smith, 1988; Jones, 2016). Emotions can affect health through direct (e.g. alterations in the functioning of the central nervous, immune, endocrine, and cardiovascular systems) pathways (Kiecolt-Glaser et al., 2002) and indirect (e.g. health behaviors). Difficulties in emotional regulation can be a barrier when attempting to cope with stressful problems (Nezu et al., 2012).

High emotional demands and labor have been identified as key determinants of emotional exhaustion in the workplace (Grande, 2003; Pandey et al., 2011). This can be assumed to be applicable for 9-1-1 telecommunicators as well. Under strain, an employee's quality of work may decrease, emotions may be transformed or negatively altered, and there may be a reduced tolerance of challenging situations. To this effect, it can impair an individual's ability to manage interactions, communicate with others clearly, and may lead to increased irritability (Cooper & Weinberg, 2011). Further, if the felt emotions are incongruent with the emotional effort it can in turn promote psychological strain (Cooper et al., 2011). With literature noting the affects emotions can have on health and the high emotional demands that 9-1-1 telecommunicators face, we are hypothesizing an association between symptoms of stress and chronic diseases.

Workplace stress and burnout. Work-related psychosocial stress is often accompanied by symptoms of: mental exhaustion; physical fatigue; headaches; cognitive dysfunction; weariness or difficulty concentrating; emotional affect; low morale; and may present as what is commonly referred to as 'burnout syndrome' (Bäckström, Bixo, Nyberg, & Savic, 2013; Jones, 2016) Burnout is a chronic affective state; its outcome is a depletion of energetic resources resulting from prolonged exposure to work and life stresses (Armon, Melamed, Toker, Berliner, & Shapira, 2014). Maslach and co-workers argue that burnout has three components: 1) 'emotional exhaustion'; 2) 'depersonalization' (felt distance from others); and 3) 'diminished personal accomplishment' (Maslach, 1982). These outcomes are strongly linked to increased turnover and weakened coping (1982; Pandey et al., 2011).

Furthermore, the coexistence of job strain and/or burnout in employees with at least one chronic medical illness (CMI) accelerates the process of developing or intensification of preexisting physiological and psychological symptoms within a relatively short period (Armon et al., 2014). With

underlying risk factors, work-related stress can lead to elevations in: increasing symptom burden or psychopathology; functional impairment; and increased risk of morbidity and mortality (Aboa-Eboulé, C., Brisson, C., Maunsell, E., Masse, B., Bourbonnais, R., Vézina, M., 2007; Armon et al., 2014; Pandey et al., 2011). Individuals experiencing symptoms of burnout may also experience economic loses from days lost at work, a reduced sense of well-being, and increased health services (Kouzis, A., & Eaton, 1997). Appendix C provides additional literature for emerging frameworks on workplace stress and burnout.

Work stress and sick days. Work stressors might contribute longitudinally to the development or affect of somatic and/or psychosomatic symptoms, specifically when mediated by mental health and anxiety (Herr et al., 2017). Weinberg reported that "Stress-related Disorders" rank second to musculoskeletal difficulties as the leading cause of absenteeism (i.e. sick leave) from work (Cooper et al., 2011; Jones, 2016). Psychosomatic symptoms of strain can include headaches (both stress and tension), muscle trembling (such as a twitching eye), excessive perspiration, lack of appetite, indigestion, sickness, shortness of breath, and even a decrease in sexual interest (Cooper et al., 2011).

Mental health days are classified as days spent in bed for all or most of the day (Kouzis et al., 1997). Though studies may have different results in the degree of association there appears to be a relationship where chronic work stress can: 1) amplify the disability associated with psychological and physical conditions and 2) whose onset may be a predictor from absence from work or other usual daily activities (Jones, 2016; Kouzis, et al., 1997). One study notes an odds ratio of between a third to nearly twice as high for workers with either chronic work stress, chronic physical condition, or psychiatric disorder alone reporting a disability day (Dewa, Lin, Kooehoorn, & Goldner, 2007).

A nationwide survey conducted by the New York Business Group on Health revealed that each employee suffering from stress, anxiety, or depression is estimated to lose 16 days of work per year; compared to an average of 4–6 lost workdays for all employees (Goetzel et al., 1998). Further, "the toll of psychological strain related to work was calculated to cause up to 54% of all absenteeism in the United States" (Elkin, A J ; Rosch, 1990). These statistics paired with similarly supportive literature helped formulate the basis of our analysis: believing an association between symptoms of stress (C-SOSI) and use of sick days among 9-1-1 telecommunicators is explained by greater rates of chronic illness (CI) among telecommunicators with high stress levels.

Summary

Previous research and literature provide extensive insight on the implication of stress contributing to the development of chronic physiological, psychological, behavioral, psychosocial, and neurobiochemical disruptions. Additionally, it has been observed that symptoms of stress in the workforce may be associated with the development of chronic illness conditions. The association between occupational burnout and absenteeism has also been studied extensively. However, the association between symptoms of stress, chronic illness, and sick days has not been studied for 9-1-1 telecommunicators. Given this, the analysis will focus on trying to understand if there is an association between stress, chronic illness, and sick leave in telecommunicators.

Methods

Study Setting

This research is being conducted as a secondary analysis of the Next Generation 911 (NG911) Randomized Control Study (RCT): A Multi-Level Intervention Program to Reduce Stress in 9-1-1

telecommunicators. This grant was supported by the National Institute for Occupational Safety and Health (NIOSH), through the Centers for Disease Control and Prevention. The grant was funded to look at the effectiveness of an online 7-week mindfulness training toolkit in reducing the various physical, psychological, and neurological symptoms of stress, as measured by self-report on the 56-item Calgary Symptoms of Stress Inventory (C-SOSI) (Carlson & Thomas, 2007). Participants in the first stage of recruitment included 323 active duty 9-1-1 telecommunicators working in 31 call centers across the United States and Canada; with the majority residing in the states of Washington, Kansas, and Missouri (Meischke et al., 2018).

Selection of Study Subjects

Original study data was collected using a randomized controlled trial study design. For recruitment, call center managers sent an email to employees within enrolled call centers describing the research and providing contact information for the research team. Individuals interested in participating contacted the research team directly. Eligibility criteria required that participants be currently employed as a 9-1-1 telecommunicators (call-receivers, dispatchers, or both) at one of the enrolled call centers. If interested and eligible, informed consent was provided electronically prior to any additional data being collected. Once consented, researchers provided participants an electronic link to the baseline questionnaire. **Table 1** shows respondent characteristics. The majority of participants in this sample were middle age, female, white and employed as both call receiver and dispatcher. Most reported being in their job for an extended period of time. More detail is provided in the results section.

Two of the collaborators from the original study provided committee support for this thesis. Dr. Hendrika Meischke, is affiliated with the Northwest Center for Public Health Practice in Seattle, at the University of Washington. Dr. Meischke PhD served as a committee chair. Additionally, Dr. Ian Painter collaborated on the thesis committee as a biostatical consultant. The full study NG911 protocol was approved by the Institutional Review Board (IRB) at the University of Washington. Because participant identifiers were excluded, the secondary analysis was classified as IRB exempt.

Description of Intervention

This secondary analysis is a cross-sectional observational study of data collected after the intervention was received by the intervention group. Both control and intervention groups were included in the analysis (Meischke et al., 2018). Training for the intervention was adapted from Mindfulness-Based Stress Reduction (MBSR), which is an evidence-based program originally implemented as in-person training (Kabat-Zinn, 1990; Kabat-Zinn, Lipworth, & Burney, 1985).

Briefly, the online mindfulness training (Destress 9-1-1) was comprised of seven modules each completed on a weekly basis. Completion times for each of these modules ranged from 20 to 30 minutes and included the following: a short video introducing the theme for the week; a brief text describing the theme and activities for the week; an audio-guided meditation exercise; suggestions for brief mindfulness activities that can be performed during the day and at work; a brief check-in form that participants could use to communicate with study staff regarding the intervention; and a moderated discussion board on which participants could post questions or comments (Meischke et al., 2018). Mindfulness-based interventions have been shown to reduce stress (including perceived) and burnout, improve mental emotional functioning and physical health, reduce sleep disturbance and fatigue, and enhance resiliency in numerous worker populations, including among 9-1-1 Telecommunicators (2018).

Data collection

Telecommunicators across 29 different call centers participated in the study. Data for this analysis was generated from two separate timepoints. During the baseline assessment (T1), respondents were asked to report on: demographic characteristics; symptoms of stress, occupational stressors, and buffers. Outcome data was collected during a follow-up survey three months post enrollment (T3). In the follow-up survey (T3), participants repeated assessment items from the baseline survey, but in addition were also asked to self-report on chronic illness (CI) and sick days (absenteeism). Data during both the Baseline Assessment (T1; demographic data) and 3-Month Follow-Up Survey (T3; all other data) was used in this study.

Definition of key analysis variables.

Participants contributed data by responding to online surveys in RedCap. Descriptive information collected during baseline, summarized data on the categorical distribution of independent/covariate factors used for preliminary analysis. In addition to basic demographic information providing data on predictors (i.e. age, gender, race, education), surveyors collected categorical information based on job-related (moderating) factors (i.e. position title, number of years working, job shift). Primary measures collected data on stress (The Calgary Symptoms of Stress Inventory (C-SOSI; (Carlson & Thomas, 2007), self-reported chronic illness and sick days.

Measures

Demographic: Participants were asked to self-report on standard demographics. Survey data collected information such as gender, age, race, relationship status, and highest education level. Participants were also asked to provide information on job position, job shift and number of years working as a telecommunicator.

Symptoms of Stress: The Calgary Symptoms of Stress Inventory (C-SOSI) was used to record symptoms of stress, measuring physiological and physical indications. An overall score on the C-SOSI will be used to assess overall symptoms of stress. The C-SOSI is a self-report survey consisting of 56 items with 8 subscales: cardiovascular; muscle tension; neurological/GI, depression; anger; sympathetic arousal; upper respiratory; and cognitive disorganization. This measure has demonstrated acceptable internal consistency both within sub-scores, and in correlation between individuals sub-scores and an overall score. Both predictive and concurrent validity of the tool have been established in that captured effect of stress management therapies and correlation with levels of exposure to sources of occupational and illness related stress (Murphy, S., Beaton, R., Pike, K., & Johnson, 1999).

Chronic disease or illness (CI): Reports of chronic disease were collected from participants self-report from 13 pre-selected diseases from the question “Has a healthcare provider ever told you that you had any of the following? Check all that apply”. Diseases were selected for being commonly associate with symptoms of stress, and include: Anxiety; Chronic Pain; Depression; Fatigue; GERD; Heart Disease; Hypertension; Irritable Bowel Syndrome (IBS); Insomnia; Migraine; Respiratory; Skin; and Stomach Ulcers. Additional information on incidence and rate for each disease and a composite scale will be reported (i.e. “Never diagnosed (dx) with CI listed”; “Dx with one CI listed”; “dx with two or more CI listed”). Reported items will be used to generate individual frequencies and an overall chronic disease count (CDC).

Absenteeism, or sick leave: Absenteeism was recorded as a dependent binary variable based on response when asked to self-report on days taken off work due to sickness. Absenteeism will be assessed based on self- reporting 'yes' or 'no' based on the question "In the past month, have you taken any sick days?" If reporting 'yes', participants will also be asked to provide data on the count and durations of work days missed. Potential covariates for this objective are overcommitment (OC) and Overtime (OT).

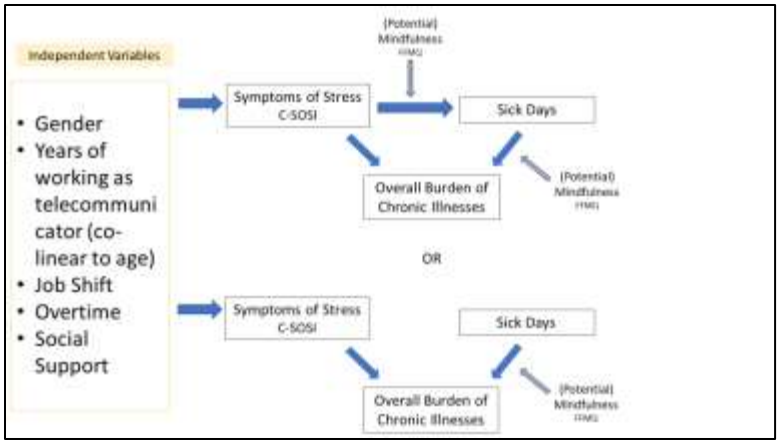
Overtime (OT): To assess Overtime, Telecommunicators will be asked i) if they have worked overtime, ii) if it was voluntary or mandatory, and iii) the number of required hours. Paired together, researchers believe that absenteeism, OC, and OT could be a proxy of burnout.

Social Support (DCSQ-SS): Original study data collected measures of social support both on the Swedish Demand-Control-Support Questionnaire (DCSQ) and the visual analog scale (VAS). For the secondary analysis, we focused on the Swedish Demand-Control-Support Questionnaire (DCSQ). Modified from the initial 17-item measure, the shorted version asked 6 questions specifically assessing for social support in the workplace. The subscale has been evaluated and found to have satisfactory internal consistency (α=0.83) of support, demands, latitude and decision authority (Sanne, B., Torp, S., Mykletun, A., & Dahl, 2005). The same researcher also reported ease of use across various settings (2005). Questions on the subscale assess the overall workplace atmosphere by asking participants to report on the overall environment and interactions with colleagues, including both from peers and their supervisors. Participants were asked to self-report on the degree to which they agreed with statements on a 4-point Likert scale. Responses ranged from 0 (strongly disagree) to 3 (strongly agree), with higher scored indicating higher perceived social support.

Analysis Plan

Hypothesis testing/generation. Following an extensive literature review, researchers generated a conceptual model to visually represent hypothesized associations among study outcomes. This model presents independent variables that have a presumed association to how symptoms of stress, chronic illness, and absenteeism. Analysis aims to explore if there is an association between i) symptoms of stress (C-SOSI) and sick days; ii) between chronic illness (CI) and sick days, and iii) if the association between CI and sick days explains the association between SOSI and sick days. While there are underlying processes involved, this model displays the primary constructs that analysis will explore.

Figure 1: *Conceptual Model for Increased Vulnerability to Health Implications. Secondary Analysis Exploring the Association of Stress, Chronic Illness, and Absenteeism among 9-1-1 Telecommunicators.*



Paired with the conceptual model, researchers propose the following research questions:

I. *Hypothesis I:* Symptoms of stress (C-SOSI) are associated with greater use of sick days among 9-1-1 telecommunicators.
II. *Hypothesis II:* Symptoms of stress (C-SOSI) are associated with a higher number of stress-related self-reported chronic illness (CI) in 9-1-1 telecommunicators.
III. *Hypothesis III:* Self-report chronic illness (CI) is associated with greater use of sick days among 9-1-1 telecommunicators.
IV. *Hypothesis IV:* The association between symptoms of stress (C-SOSI) and use of sick days among 9-1-1 telecommunicators is explained by greater rates of CI among telecommunicators with high stress levels.

Sample size/power considerations.

Power considerations were based on detecting an association between any use of sick leave and C-SOSI score. An unpublished analysis of data collected from a previous study (Meischke H, Painter I, Lilly M, Beaton R, Revere D, Calhoun B, 2015) found a statistically significant association between C-SOSI score and use of sick leave; with every 10-point increase in C-SOSI score associated with a 20% increase in odds of using sick leave. Using an effect size based on the lower 80% bound for this estimate (corresponding to an 11% increase in odds), we determined that to detect an association between C-SOSI and use of sick leave with 80% power would require approximately 200 participants (Meischke H, Painter I, Lilly M, Beaton R, Revere D, Calhoun B, 2015).

Statistical methods

All statistical analyses were conducted using R statistical package Version 3.4.1 (Team R Core, 2017). Descriptive statistics for participant demographic characteristics, use of overtime, social support and primary hypothesis variables were calculated. Bivariate analyses were conducted to examine associations between demographic characteristics, use of overtime, social support and the hypothesis variables (use of sick leave, C-SOSI and chronic disease count), using Fisher's exact test, Pearson's product moment correlation test, and logistic regression.

Multivariable analyses were conducted to examine the potential role of demographic and primary outcome variables as confounding factors in the association between outcome variables. Variables which showed a statistically significant association in the bivariate analyses and other

variables identified in the literature as potentially having an association were included in the multivariable analyses.

Data Findings and Results

A total of 182 Telecommunicators across 29 different call centers provided data during both Baseline (T1) and 3-Month Assessment (T3).

Table 1 provides a summary of respondent characteristics for this sample. The majority of the participants identified as White females under the age of 46. The majority of participants reported that their job position was as both a call taker and dispatcher and had served as telecommunicators for at least two years Participants reported an average of 1.7 Chronic Illnesses, with most frequently reported conditions consisting of: migraine (24.7%); anxiety (22.5%); hypertension (22.0%); GERD (22.0%); and depression (20.3%). 9-1-1 telecommunicators reported an average score of 51.1 for symptoms of stress on the C-SOSI (scores ranging from 0 - 224). Fifty-one respondents (28%) reported taking sick days, averaging 0.6 sick days in the last month, and also reporting 7.4 hours of required overtime. Scores averaged 17.4 when reporting measures of social support both at home and work.

Hypothesis I results: Symptoms of stress (C-SOSI) was not associated with greater use of sick days among 9-1-1 telecommunicators (odds ratio = 1.1, p-value = 0.190) (**Table 2**). Secondary analyses examined the association between C-SOSI and use of sick days after adjusting for the following potential confounding variables: gender, age, job position, and chronic illness (table 2). No change was observed in the association after controlling for these variables (**Table 3**).

Hypothesis II results: Symptoms of stress (C-SOSI) was associated with a higher number of stress-related self-reported chronic illness (CI) in 9-1-1 telecommunicators (r = 0.465, p-value <0.001) (table 2). Secondary analyses examined the association between C-SOSI and CI count after adjusting for the following potential confounding variables: gender, age, number of years working, job position, and job shift (table 2). No change was observed in the association after controlling for these variables (table 3).

Hypothesis III results: Self-report chronic illness (CI) was not associated with greater use of sick days among 9-1-1 telecommunicators (p-value = 0.378) (table 2). Secondary analyses examined the association between CI count and sick days after adjusting for the following potential confounding variables: gender, age, number of years working, and job shift (table 2). No change was observed in the association after controlling for these variables (table 3).

Hypothesis IV results: Hypothesis 4 was reliant on finding statistical significance for Hypotheses I-III. Because we did not see an association between the three primary outcomes, we were unable to test the if the association between symptoms of stress (C-SOSI) and use of sick days among 9-1-1 Telecommunicators is explained by greater rates of CI among telecommunicators with high stress levels.

Table 4 illustrates the proposed hypothesis and associate results following analysis.

Hypothesis	Results
Hypothesis I: Symptoms of stress (C-SOSI) are associated with greater use of sick days among 9-1-1 telecommunicators.	Not Supported in this sample
Hypothesis II: Symptoms of stress (C-SOSI) are associated with higher number of stress-related self-reported chronic illness (CI) in 9-1-1 telecommunicators.	Supported in this sample
Hypothesis III: Self-report chronic illness (CI) is associated with greater use of sick days among 9-1-1 telecommunicators.	Not Supported in this sample
Hypothesis IV: The association between symptoms of stress (C-SOSI) and use of sick days among 9-1-1 telecommunicators is explained by greater rates of CI among telecommunicators with high stress levels	Irrelevant and not able to run since did not see an association with other hypotheses.

Discussion

Interpretation of Study Findings

Hypothesis II –Symptoms of stress (C-SOSI) had a statistically significant association with a higher number of stress-related self-reported chronic illness (CI) in 9-1-1 telecommunicators. This finding contributes to the breadth of literature on the negative health toll stress can take on individuals. 9-1-1 telecommunicators in our sample self-reported, many of the chronic illnesses noted to have an association to stress, including migraines; anxiety; GERD; and depression. These illnesses have the potential to effect individuals daily functioning and, as the name suggests, lead to long-term or serious complications. With respondents indicating an average of 1.7 of the listed conditions, it can be assumed that individuals have at least some limitation for optimal health. From an occupational perspective, this also suggests a degree of being unable to perform their job fully.

Secondary data analyses revealed that women, older participants and participants who had been telecommunicators for a longer time period, were more likely to report chronic illness (Section 2 of Table 2). It's plausible that cumulative exposure to stress (as indicated by age and time in job) can significantly increase stress. This could be useful for focusing future research and making modifications to the work environment for to first ensure the ongoing health of 9-1-1 telecommunicators and to ensure the optimal outcomes for the community they play a vital role in serving.

How key findings compare or contrast with previous work

For Hypothesis I: Symptoms of stress (C-SOSI) do not appear to be associated with greater use of sick days among 9-1-1 Telecommunicators (r = 1.078, p-value = 0.190). This finding was not consistent with research showing that chronic work stress may be a predictor of absence from work (Jones, 2016; Kouzis, et al., 1997). Noteworthy – in baseline data, there is an association between C-SOSI score and using any sick days; however, there is not an association when looking at follow-up data. While not significant in our analysis, outside literature indicates that further exploration could indicate an association.

For Hypothesis III: Self-report chronic illness (CI) is not associated with greater use of sick days among 9-1-1 Telecommunicators (p-value = 0.378). In looking at the Chronic Disease Count

(Section 2 of Table 2), use of sick days does not appear to be a statistically significant association (p-value = 0.378). While our study sample reported taking less than a day of sick leave despite having a chronic illness, this appears inconsistent with reports from outside researchers noting that employees suffering from stress, chronic physical condition, or mental health diagnoses have at least some degree of association with an increased number of sick days taken from work (Dewa et al., 2007; Goetzel et al., 1998)

The results of this study are consistent with previous work, suggesting that 9-1-1 Telecommunicators face interconnected stressors. A combination of co-occurring symptoms speaks to the physical and psychological effects that stress may have on the body. With several of the CI's overlapping, clinical implications for diagnosing and best managing symptoms can be complicated, and should be considered, including or future analyses and research. As we gain more understanding of how chronic illness and stress are connected may help avoid further stigmatization (e.g., perceptions of devaluation) of individuals based on chronic illness. One explanation for insignificant results in this sample, may be fear of disclosing physical or mental health symptoms and associated reproductions. Exposure to stress can increase risk for developing mental disorders and chronic pain, which both involve substantial personal and social costs. (Carleton et al., 2018).

The limited use of sick days could be associated to worries of stigmatization or factor of the job. Analytical results support literature, indicating that 9-1-1 telecommunicators are often required to work mandatory overtime. Mandatory OT may create a burden for telecommunicators to take sick days, especially if the call center is already short staffed as is. There are also financial considerations for why an employee may opt to not take sick leave when needed.

Psychosocial Consequences: Beyond direct effects on disease processes, chronic diseases and added stress may lead to complex biopsychosocial or environmental influences in an individual's life. Psychosocial constructs may also be interrupted, for instance disrupting: family roles; an in inability to maintain strong relationships; social dynamics; and reductions in quality of life (Charlson, Mary ; Peterson, 2002; Kilian, R., Matschinger, H., & Angermeyer, 2001). In our study sample, participants noted an average score of 17.4 for social support, validating that there could be an association between stress and psychosocial implications for 9-1-1 telecommunicators.

Implications of findings

For public health practitioners or clinicians. Growing evidence of the adverse physical and psychological outcomes associated with chronic occupational stress is being recognized as a public health problem and gaining stakeholder support. Interdisciplinary stakeholders are dedicated to learning how to produce clinically significant reductions in negative health outcomes, premature mortality, and financial burden of preventable chronic illnesses related to the risk factors of stress. In one study, depression and unmanaged stress emerged as the top two most costly risk factors in terms of medical expenditures (Goetzel et al., 1998) — increasing health care costs by 2–7 times as much as physical risk factors such as smoking, obesity, and poor exercise habits (McCraty et al., 2003). Treatments for chronic illnesses account for a significant portion of total health care dollars, with estimates of in-hospital costs exceeding $25 billion (Kahn et al., 2015), and upwards of $35 million or 1.4% of all healthcare spending in the United States per year (OECD: Organization for Economic Cooperation and Development: Health at a glance: OECD Indicators., 2011).

Given the health concerns, several interventions are often implemented to help ameliorated the long-term implications of stress on the body (Appendix D). Many of these interventions are at the individual level (both primary and secondary preventive strategies and health behavior changes). Programs may help individuals build a protective buffer against the negative health burden of stress (Das, 2016) by: recognizing their symptoms; enhancing coping skills; learning effective cognitive and emotion regulation (Bonanno, 2004); building self-efficacy (Herr et al., 2017); and increasing

resilience to thrive despite exposure to difficult situation (Acabchuk et al., 2017; Mariotti, 2015); Appendix E expands on literature around several of these buffers to stress. From a health systems perspective, these interventions may be imperative in reducing the immense public health burden of chronic disease at the population level (B. T. Johnson & Acabchuk, 2018). These interventions may also serve a cost-benefit in increasing the quality of work, reduce losses to the organization, and decreasing turnover for employees at the frontline of our community's health, safety, and security (McCraty et al., 2003).

Study strengths and limitations.

Strengths. Data were collected as part of a randomized control trial from 9-1-1 call centers nationwide. Having collected data across multiple sites across various geographic regions and sites, providing the opportunity to asses organizational-level factors and makes the data more generalizable. Generalizability was also verified, as study data was consistent with the homogeneity of the 9-1-1 telecommunicators workforce: mostly female, white, and under the age of 45. Having collected data on demographic, physiological, psychosocial and work-related factors provides support to further evaluation to mitigate the multiple stressors 9-1-1 Telecommunicators face. Extensive literature supporting primary outcome measures further validates the need for future research.

Limitations. Conducting secondary analysis, presents several limitations. First, analysis was limited to the data collected in the original study. This limits what factors could be assessed, which may not align within the initially proposed study design. Because the sample size among participants was small (n = 186) and variable among regions and professions, there may be variation if a study on stress and chronic illness would be conducted in different call centers and communities. Sample size may have contributed to a low statistical power, making analysis may be unable to detect a change in order to see if outcome variables are unassociated.

Potential threats to internal validity may exist within the pretest - posttest study design itself. Specifically, external influences may impact longitudinal studies, for example: reporting bias, history/recall bias; changes over time; and social desirability bias (Grembowski, 2016). As a primary outcome, sick leave was self-reported; therefore, may be subject to recall bias and would need to be considered at it may be variable and inaccurate. While original data was collected to assess if sick leave was work related, it was not able to be parsed out within secondary analysis given the small sample size. Additionally, this variable was not included in the initial hypothesis so goes beyond the scope of this analysis. There may also bias to being able to participate given work time constraints. Additionally, there may be selection bias from the emergency responders that chose to participate in the initial study surveys, including the emergency call centers that elected to participate in the NG911 study. Finally, it is also possible that the individuals who self-selected to participate may represent levels of resilience or other personal psychological characteristics that differ from the general 9-1-1 TC workers (Meischke et al., 2018).

For future research. First, we used a number of self-reported chronic illnesses to build a 9-item scale to see if there is a relationship between stress and the number of CIs, thus assessing the overall burden. In further considering the co-morbidity of many chronic illnesses reported in research, it is presumable that diseases become hard to clinically distinguish. Future research should address the bias in self-report by investigating the comparison of self-reported items to diagnosis by medical providers. Researchers hoped to use a composite score on the C-SOSI to create a supplemental table using the sub-scales to show a difference between reported symptoms associate with stress and physician-diagnoses. This comparison could be helpful in seeing if self-reported

symptoms align with medical diagnoses, if any bias in reporting exists, and provide accurate data on both symptoms of stress and diagnoses 9-1-1 telecommunicators have.

The parent study showed that engaging in the mindfulness training reduced self-reported stress. The mindfulness component within the parent study is important, given that it may potentially ameliorate health impacts that stress can have. For instance, stress can contribute to individual's: making mistakes; being unaware of surroundings; doing things on autopilot; forgetfulness; perceptions; being preoccupied with future or past; cognitive awareness; or being able to detect and describe thoughts, emotions, feelings, and sensations. Contributing to existing literature, it could be valuable to further assess the cognitive impacts stress has on telecommunicators. Given that engaging in mindfulness reduced stress, supplemental research could assess if implementing mindfulness practices, such as NG911, mitigates the cognitive disruptions that telecommunicators are at risk of. The mindfulness training from the parent study has been disseminated and made available. Call centers could promote utilization of these free resources for telecommunicators. From a strength-based and health promotion approach, encouraging 9-1-1 telecommunicators to practice mindfulness not only helps raise awareness of the effect of stress but is important for autonomy. Additionally, I feel that these skills could tie into and individual's resiliency and the coping factors.

Though unable to assess in this paper, future studies could tie in personality assessments as literature considers potential associations between the two. Personality is important factor to consider in relation to stress, as the characteristic ways of thinking, feeling, and behaving influence how an individual respond to stress (Smith, C.A., Kirby, 2011). The processes for how a 9-1-1 Telecommunicator responds to stress — exposure, reactivity, recovery, and restoration — is a potential pathway to poor health (Williams et al., 2011). Appendices G provides literature in considering theories of personality in relation to stress.

Technological advances are now allowing for biological tests to evaluate a various dimensions of stress levels. Collecting biomarkers may contribute invaluable data. While this would be a more complicated study to implement, it has the potential to support vast research on the long-term implication of stress in a specific population. The researcher hypothesizes a grouping of several diagnoses related to stress having an association to an overall diagnosis of "Adrenal Fatigue". Here, CI burden would be a proxy for 'Adrenal Fatigue'; however, because there is not a validated measure for this, it cannot be statistically tested for. Future research could utilize many of the scientific advances that allow for detection of biomarkers to measure symptoms of stress.

Conclusion:

The objective of this study was to explore complex associations between symptoms of stress, chronic illness, and use of sick days among 9-1-1 Telecommunicators. Study results showed a significant relationship between self-reported stress and number of chronic illness, even though this did not result in greater use of sick days. Study intentions include further examination of the long-term health implications telecommunicators face, contributing additional data to research on outcomes emergency medical personnel in high-stress occupation.

Findings from this study indicate multilevel public health enquiry. First, there is a need for continued research on 9-1-1 telecommunicators. Next, it underlines the importance of improving health services. It emphasizes establishing health-promotion interventions and toolkits, serving to support the health of emergency personnel. Hopefully, utilizing stress-reduction toolkits and self-care regimens can improve negative health outcomes. These resources may help mitigate burnout symptoms by helping individuals recognize symptoms of stress and effectively engaging in healthy coping strategies. Accordingly, effectively applying these skills has the potential to also prevent the development of the various illnesses that have been discussed throughout the paper. Finally, this paper stresses working with occupational agencies to implement programs to prevent undesirable

outcomes. Perhaps a two-prong approach is best. As NIOSH works to improve the safety, health, and wellbeing of workers, workplaces could implement strategies of mitigate many of the occupational stressors. For instance, researchers in the primary study have since disseminated strategies for how call centers can better support telecommunicators, including suggestions for modifying the way call centers operate to reduce stress. 9-1-1 telecommunicators serve an integral role in our emergency response system. By better understanding ways to support them, we are able to improve health outcomes for individuals needing emergency assistance in our community.

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Appendices: Tables

Table 1:
Respondent Characteristics

Respondent Characteristics	Frequency (n)	Percent (%)
Total Participants	**182**	**100.0**
Gender		
Male	34	18.9
Female	148	81.3
NA	0	0.0
Race		
American Indian/Alaskan Native (AIAN)	5	2.7
Asian	3	1.6
Black	5	2.7
Native Hawaiian/Pacific Islander (NHPI)	0	0.0
Other	8	4.4
White	170	93.4
Multi-Race	7	3.8
Age		
below 26	14	7.7
26 - 35 years	58	31.9
36 - 45 years	63	34.6
46 - 55 years	37	20.3
56 - 64 years	10	5.5
65 years or above	0	0.0
NA	0	0.0
Job Position		
Call taker only	9	4.9
Dispatcher only	0	0.0
Both call taker and dispatcher	145	79.7
Other	28	15.4
NA	0	0.0
Number of Years Working with Job		
Less than 2 years	18	9.9
2 - 5 years	42	23.1
6 - 10 years	40	22.0
11 - 20 years	60	33.0
21 - 30 years	16	8.8
Over 30 years	6	3.3
NA	0	0.0

Table 1 (continued)

Respondent Characteristics	Frequency (n)	Percent (%)
Total Participants	**182**	**100.0**
Job Shift		
Day	40	22.0
Day and Night	54	29.7
Night	32	17.6
Rotates	92	50.5
Weekend	44	24.2
Education		
High school/GED	21	11.5
Some college	86	47.3
Associates degree	16	8.8
Bachelor's degree	50	27.5
Post-graduate study or degree	8	4.4
NA	1	0.5
Chronic Illness		
Anxiety	41	22.5
Chronic Pain	6	3.3
Depression	37	20.3
Fatigue	8	4.4
GERD	40	22.0
Heart Disease	5	2.7
Hypertension	40	22.0
IBS	19	10.4
Insomnia	17	9.3
Migraine	45	24.7
Respiratory	20	11.0
Skin	29	15.9
Stomach Ulcers	7	3.8
Number of Chronic Illnesses		
CI Disease Count	1.7	1.9
Symptoms of Stress Score (SOSI)		
SOSI	51.1	29.2
Social Support		
Social Support Score	17.4	3.1

Table 1 (continued)

Respondent Characteristics	Frequency (n)	Percent (%)
Total Participants	**182**	**100.0**
Required Overtime (OT)		
Yes	81	44.5
No	95	52.2
NA	6	3.3
Number of required OT hours		
OT Hours Required	7.4	12.1
Any Sick Days Taken		
Yes	51	28.0
No	125	68.7
NA	6	3.3
Number of Sick Days Taken		
Number of Sick Days	0.6	1.2

Table 2:
Bivariate Analysis

For table 2 what we are trying to present is the bivariate association between each variable and the three primary variables of interest (C-SOSI, CI and sick day used).

Total Participants = 182
(*Note: Some Participant Information missing according to the variable, specified below)

	Sick Days (Section 1)			
	N =	Number who used at least 1 Sick Day in month (essentially the Proportion)	Percent used at least one sick day in previous month (%)	p-value
Gender	182			
Male	32	6	18.8	0.198
Female	144	46	31.2	
Missing	6			
Race				
White	165	47	28.5	0.732
non-White	11	4	36.4	
Missing	6			
Age				
below 26	14	5	35.7	0.689
26 - 35 years	57	20	35.1	
36 - 45 years	60	15	25.0	
46 - 55 years	35	9	25.7	
56 - 64 years	10	2	20.0	
Missing	6			
Job Position				
Call taker only	9	6	66.7	0.049
Both call taker and dispatcher	140	38	27.1	
Other	27	7	25.9	
Missing	6			
Number of Years Working with Job				
Less than 2 years	18	8	44.4	0.513
2 - 5 years	41	13	31.7	
6 - 10 years	37	8	21.6	
11 - 20 years	58	18	31.0	
21 - 30 years	16	3	18.8	
Over 30 years	6	1	16.7	
Missing	6			

* Some frequencies do no sum to column total due to missing responses.

Table 2 (continued)

Sick Days (continued)				
	N =	Number who used at least 1 Sick Day in month (essentially the Proportion)	Percent used at least one sick day in previous month (%)	p-value
Job Shift				
Day				
Day (Yes)	39	9	23.1	0.427
Day (No)	137	42	30.7	
Day and Night				
Day and Night (Yes)	49	14	28.6	1.000
Day and Night (No)	127	37	29.1	
Night				
Night (Yes)	31	8	25.8	0.828
Night (No)	145	43	29.7	
Rotates				
Rotates (Yes)	89	29	32.6	0.321
Rotates (No)	87	22	25.3	
Weekend				
Weekend (Yes)	42	13	31.0	0.846
Weekend (No)	134	38	28.4	
Missing	6			
Education				
High school/GED	21	5	23.8	0.811
Some college	83	22	26.5	
Associates degree	16	4	25.0	
Bachelor's degree	48	17	35.4	
Post-graduate study or degree	7	2	28.6	
Missing	6			
Overtime Required				
Yes	80	26	32.5	0.406
No	95	25	26.3	
Missing	7			
Chronic Disease Count				
Odds Ratio (OR)			1.1	0.408
Missing	6			
Social Support (DCSQ_SS)	_	_	_	_
Odds Ratio (OR)	_	_	0.9	0.177
Missing	7	_	_	_
Symptoms of Stress (C-SOSI) (when making a 10-point change)				
Odds Ratio (OR)			1.1	0.190
Missing	6			

Table 2 (continued)

Chronic Disease Count (Section 2)				
	N =	Mean (if applicable)	SD (if applicable)	p-value
Gender				
Male	34	1.1	1.6	0.031
Female	148	1.9	2.0	
Missing	0			
Race				
White	170	1.7	1.9	0.121
non-White	12	2.2	1.2	
Missing	0			
Age				
below 26	14	0.9	1.4	0.001
26 - 35 years	58	1.2	1.6	
36 - 45 years	63	2.0	2.1	
46 - 55 years	37	2.3	2.0	
56 - 64 years	10	1.9	1.5	
Missing	0			
Job Position				
Call taker only	9	1.9	2.1	0.586
Both call taker and dispatcher	145	1.8	2.0	
Other	28	1.3	1.4	
Missing	0			
Number of Years Working with Job				
Less than 2 years	18	0.9	1.3	<0.001
2 - 5 years	42	1.1	1.4	
6 - 10 years	40	1.5	1.9	
11 - 20 years	60	2.2	2.1	
21 - 30 years	16	2.7	2.2	
Over 30 years	6	3.0	1.8	
Missing	0			

* Some frequencies do no sum to column total due to missing responses.

Table 2 (continued)

Chronic Disease Count (continued)				
	N =	Mean (if applicable)	SD (if applicable)	p-value
Job Shift				
Day				
Day (Yes)	40	2.2	2.2	0.092
Day (No)	142	1.6	1.8	
Day and Night				
Day and Night (Yes)	54	2.0	2.1	0.407
Day and Night (No)	128	1.6	1.8	
Night				
Night (Yes)	32	1.3	1.5	0.271
Night (No)	150	1.8	2.0	
Rotates				
Rotates (Yes)	92	1.5	1.7	0.279
Rotates (No)	90	1.9	2.1	
Weekend				
Weekend (Yes)	44	1.8	1.9	0.592
Weekend (No)	138	1.7	1.9	
Missing	0			
Education				
High school/GED	21	1.3	1.4	0.478
Some college	86	1.8	2.0	
Associates degree	16	2.5	2.3	
Bachelor's degree	50	1.5	1.8	
Post-graduate study or degree	8	1.4	1.8	
Missing	1			
Overtime Required				
Yes	81	1.9	1.8	0.105
No	95	1.7	2.0	
Missing	6			
Sick Days				
Yes	51	2.0	2.0	0.378
No	125	1.7	1.9	
Missing	6			
Social Support (DCSQ_SS)	-	Correlation		p-value
	-	-0.107		0.152
Missing	NA			
Symptoms of Stress (C-SOSI) (when making a 10-point change)		Correlation		p-value
	-	0.465		<0.001
Missing	NA			

* Some frequencies do no sum to column total due to missing responses.

Table 2 (continued)

Symptoms of Stress (C-SOSI) (Section 3)				
	N =	Mean (if applicable)	SD (if applicable)	p-value
Gender				
Male	34	42.4	26.1	0.056
Female	148	53.0	29.6	
Missing	0			
Race				
White	170	51.5	29.7	0.429
non-White	12	44.6	21.0	
Missing	0			
Age				
below 26	14	52.5	37.6	0.950
26 - 35 years	58	48.6	28.3	
36 - 45 years	63	51.4	29.7	
46 - 55 years	37	53.0	28.6	
56 - 64 years	10	53.9	25.3	
Missing	0			
Job Position				
Call taker only	9	63.4	35.2	0.420
Both call taker and dispatcher	145	50.2	29.0	
Other	28	51.7	28.5	
Missing	0			
Number of Years Working with Job				
Less than 2 years	18	45.2	35.3	0.206
2 - 5 years	42	48.8	24.6	
6 - 10 years	40	47.0	29.7	
11 - 20 years	60	51.8	28.4	
21 - 30 years	16	64.8	31.8	
Over 30 years	6	67.2	32.7	
Missing	0			

* Some frequencies do no sum to column total due to missing responses.

Table 2 (continued)

Symptoms of Stress (continued)				
	N =	Mean (if applicable)	SD (if applicable)	p-value
Job Shift				
Day				
Day (Yes)	40	57.9	33.7	0.950
Day (No)	142	49.1	27.6	
Day and Night				
Day and Night (Yes)	54	51.8	31.2	0.816
Day and Night (No)	128	50.7	28.5	
Night				
Night (Yes)	32	45.1	30.5	0.207
Night (No)	150	52.3	28.9	
Rotates				
Rotates (Yes)	92	49.9	26.6	0.587
Rotates (No)	90	52.2	31.8	
Weekend				
Weekend (Yes)	44	53.6	34.4	0.512
Weekend (No)	138	50.2	27.5	
Missing	0			
Education				
High school/GED	21	44.3	26.3	0.419
Some college	86	53.9	28.8	
Associates degree	16	56.5	37.5	
Bachelor's degree	50	46.2	28.6	
Post-graduate study or degree	8	53.6	25.5	
Missing	1			
Sick Days				
Yes	51	55.40	30.4	0.189
No	125	49.00	28.2	
Missing	6			
Overtime Required				
Yes	81	52.0	30.3	0.720
No	95	50.4	27.9	
Missing	6			
Chronic Disease Count		Correlation		p-value
Correlation		0.465		0.00
Missing	NA			
Social Support (DCSQ_SS)	-	-		-
Correlation		-0.244		0.00
Missing	-	-		-

* Some frequencies do no sum to column total due to missing responses.

Table 3:
Multivariate Analysis

For Table 3 We are doing *Logistical and **Linear Regression			
Total Participants = 182 (*Note: Some Participant Information missing according to the variable, specified below)			
*			
If Sick Days Is Outcome	Estimate	Std.Error	p-value
SOSI + Gender	-0.0064	0.0058	0.264
SOSI + Age	-0.0078	0.0057	0.171
SOSI + Job Position	-0.0063	0.0058	0.276
SOSI + Chronic Disease Count	-0.0068	0.0065	0.298
If Sick Days Is Outcome	Estimate	Std.Error	p-value
Chronic Disease Count + Gender	-0.0532	0.0864	0.538
Chronic Disease Count + Age	-0.1115	0.0892	0.211
Chronic Disease Count + Job Position	-0.0700	0.0871	0.422
**			
If Chronic Disease Count Is Outcome	Estimate	Std.Error	p-value
SOSI + Gender	0.0295	0.0043	0.000
SOSI + Age	0.0297	0.0042	0.000
SOSI + Number of Years Working	0.0279	0.0043	0.000
SOSI + Job Shift (Day)	0.0296	0.0043	0.000

Appendices

Appendix A:
Stress in first responders (not Telecommunicators)

Mental Health, Cognition, and Emotion in Emergency Workers:

Mental disorders appear highly comorbid for public safety personnel and can be mutually maintaining. As mentioned above, emergency workers, are frequently in high-risk and stressful environments. Public safety personnel (PSP) who report high levels of work stress are significantly more likely to screen positive for major depressive disorder, generalized anxiety disorder, posttraumatic stress disorder (PTSD), social anxiety disorder, chronic pain, and alcohol use disorder (Carleton et al., 2018). Commonly associated with stress, anxiety affects about 40 million American adults age 18 and older (about 18%)(Jones, 2016).

It would be important to study if there is a job-specific moderator between depression as it relates to a risk-factor for suicide. This is important to consider, given the higher rate of suicide in emergency personnel. In interviewing more than 4,000 EMS and fire professionals in 2015, Fitch and associates reported that 37% reported contemplating suicide - nearly 10 times the overall rate among American adults (Fitch & Marshall, 2016).

Cognition in Emergency Workers:

In an effort to better understand lived experiences during the management of critical 9-1-1 emergency calls, Pasquale and associates used phenomenological inquiry to explore veteran paramedic field experiences (Pasquale, B., Grohman, Kerry K., Cohen, Harold, & Klein, 2017). Based on testimonies of ten volunteers, researchers reported findings on six core themes around situational assessment and decision-making: situational awareness; workspace control; experience; temporal awareness; patient acuity; and resource management (Pasquale et al., 2017). This is important as researchers have not focused on cognitive performance under stress, particularly as it pertains to assessing the scenario and providing patient care at the scene of an emergency. Rapid decision-making is dependent on their situational assessment of prior successful experiences (Kahneman, D., & Klein, 2009; LeBlanc, V. R., MacDonald, R. D., McArthur, B., King, K., & Lepine, 2005; Norri-Sederholm, T., Paakkonen, H., Kurola, J., & Saranto, 2015). Situation awareness (SA) has not been definitively defined in emergency medical services research; however, it has been generally accepted in fire science, military, and industrial decision-making research as a general cognitive understanding of the current environment and being able to accurately anticipate future problems to enable effective future action (Dow, M., Garis, L., & Thomas, 2013; Pasquale, B., Grohman, Kerry K., Cohen, Harold, & Klein, 2017).

In a study looking at Israeli paramedics' experiences and coping strategies when encountering critical incidents, Avraham and associates revealed two main themes: 1) between connection and detachment and 2) between control and lack of control of the situation. Paramedics, who connected with their feelings regarding the patient and/or the family in different critical incidents (CIs), as well as those who sensed a lack of control, experienced difficult and negative emotions; for instance, severe frustration and helplessness, powerlessness, and even self-blame. The emotion of hopelessness was especially present for emergencies involving infants or when chances of survival were minimal, despite exhausting all possible treat treatments acquired through their training (Avraham et al., 2014).

Appendix B:
Physiology of Stress

Biological Indicators of Stress

Internal factors, such as genetics and biological measures, are being used to assess impacts of chronic stress. Repeated activation and prolonged stress can biologically dysregulate or modify various systems. Stress can cause an imbalance in the neuroendocrine, genetic and epigenetic, immune and autonomic nervous systems, and impair other components of the body's physiological system responses at multiple levels (M. S. Schwartz, 1995). Research has shown that the various pathways in which stress interacts with our body alters one's stress sensitivity and leaves a biological mark that can contribute to the development of disease or long-term health consequences (Acabchuk et al., 2017; Das, 2016; Mariotti, 2015; Nezu et al., 2012). A crucial aspect of an acute and chronic environmental stressor is thought to be its disruptive impact in the context of specific life circumstances of the individual ("contextual threat"), rather than the amount of change it required (Anderson et al., 2011). Additionally, stress can alter our metabolic system. Metabolism allows our bodies to produce and use energy, but also assists in controlling/helping our: breathing; blood circulation; body temperature; muscles contract; operates the brain and nerves; eliminate waste; and helps regulate various other activities associated with living (Jones, 2016).

Specific reactions that are part of the physiological stress response include the supportive adaptive physical responses (e.g. "fight or flight") as a defense against immediate threats. Immediate responses include: elevations in heart rate and blood pressure; alterations in the blood flow - shunting blood flow away from non-essential organs necessary for successful defense to threats (e.g., digestive and reproductive systems); and increased blood flow to large skeletal muscles and brain (Pandey et al., 2011; "The American Institute of Stress," n.d., http://www.stress.org). There are also elevations in blood sugar levels (produced by the breakdown of glycogen, fat, and protein stores), which adds to the amount of fuel that is available for effortful mental (e.g. decision making) and physical responses (Pandey et al., 2011; "The American Institute of Stress," n.d.). The long-term implication of these responses to stress may be associated with development of chronic illness.

> *"The repeated activation of biological stress mechanisms by psychological challenges and threats is thought to exert an insidious, pervasive, and persistent effect on the body, resulting in "Diseases of Civilization"— hypertension, strokes, heart attacks, diabetes, neck aches, low-back pains, and several skin problems" (American Institute of Stress Website: http://www.stress.org).*

One of the predominant biomarkers is cortisol. Studies linking stressful life conditions to later morbidity and mortality show that stress can have direct and measurable effects on the body through allostatic load (AL) (J. A. Schwartz, 2017; Solís, C.B., Fantin, R., Castagné, R., Lang, T., Delpierre, C., Kelly-Irving, 2016); Figure 3 (Johnson et al., 2018) notes additional biomarkers for AL. "Allostatic load" is an index that has been proposed as a way to assess the cumulative effect of the overall stress-induced "psychophysiological wear and tear" that takes place while different biological systems work to stay within a range of equilibrium (allostasis) in response to demands placed by internal or external chronic stressors (Dhabhar, 2011; McEwen, 1998, 2002; Sun, J., Wang, S., Zhang, J., & Li, 2007). Studies often further divide common measurements of allostatic load into categories representing the underlying physiological systems, such as: neuroendocrine; immune and inflammatory; metabolic; cardiovascular and respiratory; and nervous systems (Johnson et al., 2018; J. A. Schwartz, 2017; Solís et al., 2016). One additional finding that is important to note is that research has suggested that it is the stress response, not damage to DNA and proteins, that may be related to deterioration as we age (Jones, 2016).

Lazarus & Folkman added that the onset or progression of disease may be influenced through repeated activation of the sympathetic adrenomedullary (SAM) system and the hypothalamic–pituitary–adrenocortical (HPA) axis, which are central to the body's characteristic responses to stress (1984). In response to elevation of both SAM and HPA, psychological reactivity to stress is also associated to negative affect and can be expressed as anger, hostility, or depression (Smith & Ruiz, 2002). It has been suggested that the negative emotions that lead to distress-related immune dysregulation may disrupt the regulatory feedback mechanism central to stress recovery. This has the potential to not only make individuals more susceptible to illness and contribute to prolonged pain, infection, delayed wound healing or recovery time, but may be a core mechanism behind a large and diverse set of health risks and the overall burden of disease associated with negative emotions (Kiecolt-Glaser et al., 2002; Turk DC, 1992; Williams et al., 2011).

Cytokines have a direct and substantial effects on the central nervous system, including production and enhancement of negative moods, depression, anxiety, physical symptoms, lethargy and fatigue, and a range of sickness behaviors (Kiecolt-Glaser et al., 2002; Leventhal H, Patrick-Miller L, Leventhal EA, 1998; Watkins LR, 2000). The cumulative effects of chronic daily stressors and emotional experiences have been found to promote a state of chronic low-grade elevation in circulating inflammatory response markers (e.g. interleukin-6 (IL-6) and C-reactive protein (CRP), proinflammatory cytokines), and have the capacity to permanently alter neuroendocrine and autonomic responses (Gouin et al., 2012). Further, this elevation suggests that continuous exposure stressors may lead to repeated and sustained activation of the psychological stress system. Combined, cumulative effects may have a detrimental impact on health and the disease process (Gouin et al., 2012; Kiecolt-Glaser et al., 2002; Leventhal H, Patrick-Miller L, Leventhal EA, 1998). Gouin and associates also suggested the possibility that the cumulative impact of several stressors may overshadow the increased reactivity associated with chronic stress; exposure to multiple stressors may lead to physiological changes that are larger than the increased reactivity associated with each stressor (Gouin et al., 2012).

There is plausible evidence of a bi-directional feedback between the immune and endocrine systems as they relate to both depressive and anxiety disorders (Kiecolt-Glaser et al., 2002; A. H. Miller, 1998); Figure 2 (B. T. Johnson & Acabchuk, 2018). These complex pathways can also be self-reinforcing. For instance, studies have suggested they can activate a variety of emotion-responsive hormones including: the sympathetic-pituitary-adrenal medullary axis; hypothalamic-pituitary-adrenocortical (HPA) axis; catecholamines (norepinephrine and epinephrine); adrenocorticotropin hormone; cortisol; growth hormone; and prolactin (Gutman, D.A., & Nemeroff, 2011; Kiecolt-Glaser et al., 2002; A. H. Miller, 1998; Rabin, 1999). Summarizing his research, Dhabhar explains that the critical elements for determining whether the effects of stress on immune function are: 1) the type (immunoprotective, immunoregulatory/inhibitory, or immunopathological) of immune response that is affected; 2) the direction (enhancing versus suppressive) that the stress or stress hormones have on immune functions; 3) the timing of the stress hormone exposure to stressor-induced physiological activation (neurotransmitters, hormones, and their molecular, cellular, organ-level, and systemic effects); 4) the duration, intensity/concentration of stress; and 5) whether it was acute or chronic. (Dhabhar, 2011).

Research suggests that dysregulation of the HPA axis is a likely link between psychiatric disorders such as depression and one's increased risk for various medical conditions, such as diabetes, dementia, coronary heart disease, and osteoporosis (Gutman et al., 2011; Stetler & Miller, 2011). While our endocrine system helps to regulate our hormones in response to these stressors, continuous exposure may make it more challenging for an individual to return to their

neuroendocrine baseline and may increase the overall burden of physiological and psychiatric disease. For instance, once cortisol levels rise, they can initiate, perpetuate, or aggravate the symptoms or behaviors associated with depression, such as anxiety, insomnia, and poor memory (Dhabhar, 2011; Kiecolt-Glaser et al., 2002; Nezu, A. M., Nezu, C. M., & D'Zurilla, 2012; Wolkowitz OM, 1999). Dhabhar provides additional figures that illustrate the effect of stress on immune function (Figures 5) and complex stress spectrum model highlighting the effects of both acute and chronic stress (Figure 6) (Dhabhar, 2011). Because the hippocampus is responsible for regulating the release of cortisol, the major chemical responsible for increasing one's risk of depression, the dysregulation of it appears to coincide with the deleterious effects of chronic stress.

Finally, recent research looking at the influence of microbiome in the gut, have shown that changes in the microbiome can affect signaling in the brain, alter mood and emotion regulation, may influence cognition and behavior, increase pain sensitivity and may even be related to increased risk of disease (e.g., vascular issues that can lead to stroke or cognitive decline) (Tang, A.T., Choi, J.P., Kotzin, J.J., Yang, Y., Hong, C.C., Hobson, N., 2017). Scientific advances in understanding the influence of gut microbiota on emotion, cognition and behavior may propel social scientists to ask new questions about the associations between nutrition and stress, mental health and disease. Based on the extensive literature of various biological alterations support the development of our hypothesis of an association between symptoms of stress (C-SOSI), a higher rate of at least one physician-reported chronic illness, and thus the greater use of sick days for mitigating the psychological and psychological effects of stress.

Appendix C:
Workplace Stress and Burnout

Work-related psychosocial stress is often accompanied by symptoms of: mental exhaustion, physical fatigue, headaches, cognitive dysfunction, weariness or difficulty concentrating, emotional affect, low morale, and may present as what is commonly referred to as 'burnout syndrome' (Bäckström et al., 2013; Jones, 2016). Burnout is a chronic affective state; its outcome is a depletion of energetic resources resulting from prolonged exposure to work and life stresses (Armon et al., 2014). Maslach argues that burnout has three components: 'emotional exhaustion', 'depersonalization' (felt distance from others), and 'diminished personal accomplishment'; the outcomes of which are strongly linked to increased turnover and weakened coping (Lee, R., Ashforth, B., & Bobko, 1996; Maslach, 1982; Pandey et al., 2011). Frameworks have emerged considering challenge stressors being associated with personal growth, achievement and job satisfaction, whereas hindrance stressors thwart task accomplishment, personal growth, and are associated with withdrawal behavior and work strain (Cavanaugh, M. A., Boswell, W. R., Roehlin, M. V., & Boudreau, 2000; Pandey et al., 2011; Podsakoff, N. P., Lepine, J. A., & Lepine, 2007).

Siegrist also proposed an 'effort-reward imbalance model' suggesting that it is the mismatch of high effort expended at work with consequent low rewards that leads to distress and negative health outcomes (Pandey et al., 2011; Siegrist, 1996). This can be summarized by stating that low control, high overall demands, an imbalance of efforts and rewards, and stressors viewed as hindrances, all have detrimental consequences in the workplace for individuals and organizations (Cavanaugh et al., 2000; LePine, J. A., Podsakoff, N. P., & LePine, 2005; Pandey et al., 2011). Working overtime appears to operate as a stressor for emergency personnel because it increases the demands on an employee attempting to maintain performance levels in the face of increasing fatigue and long hours (Rau & Williams, 2006).

With chronic work stress or high distress, workers with mental illness experience more intense 'disability (or mental health) days' classified as days spent in bed for all or most of the day; with an odds ratio of between a third to nearly twice as high for workers with either chronic work stress, chronic physical condition, or psychiatric disorder alone (Dewa et al., 2007; Kouzis, A., & Eaton, 1997). Work stress also appears to precipitate diagnosable depression and anxiety in previously healthy young workers or otherwise apparently healthy individuals, when they are exposed to high psychological job demands (e.g. excessive workload, extreme time pressures) (Melchior, M., Caspi, A., Milne, B.J., Danese, A., Poulton, R., & Moffitt, 2007). Stressors also lead to elevated blood pressure which is seen as an underlying risk factor through which work-related stress can lead to elevations in cardiovascular diseases (Aboa-Eboulé, C., Brisson, C., Maunsell, E., Masse, B., Bourbonnais, R., Vézina, M., 2007; Jones, 2016; Pandey et al., 2011). Adding to the theory of high psychological demands and low decision latitude, combining job strain increases the risk of a first coronary heart disease event (Aboa-Eboulé et al., 2007; Pandey et al., 2011).

Furthermore, the coexistence of burnout in employees with at least one chronic medical illness (CMI) accelerates the process of developing or intensification of preexisting depressive symptoms within a relatively short period; increasing symptom burden, functional impairment, and increased risk of morbidity and mortality (Ahola, K., & Hakanen, 2007; Armon et al., 2014). The results of two other studies indicated the superiority of burnout over job strain as a predictor of future onset of depression; however, job demands can also predict burnout, which then predicted future depression (Ahola et al., 2007; Hakanen, Schaufeli, & Ahola, 2008). Suls & Bunde noted that burnout does not conceptually overlap with depression because it is contextualized to occur at work

and is determined by the social environment, whereas depression is a global state pervading all spheres of an individual's life (Suls, J., & Bunde, 2005). Additionally, in a study of women reporting work-related psychosocial stress and burnout syndrome showed a different response to GABA-A receptor, affecting depression, as will be discussed later (Bäckström et al., 2013).

A nationwide survey conducted by the New York Business Group on Health revealed that each employee suffering from stress, anxiety, or depression is estimated to lose 16 days of work per year compared to an average of 4–6 lost workdays for all employees (Goetzel et al., 1998). In the U.K., the Department of Social Security reported that overall sickness absence and absence due to illness related to psychological and emotional strain accounted for nearly 80 million working days lost (Weinberg, A. & Cooper, 2011). Further, absenteeism rates in the U.K. were an average of 8.5 days per year while the toll of psychological strain related to work was calculated to cause up to 54% of all absenteeism in the United States (Elkin, A J ; Rosch, 1990; Weinberg et al., 2011).

Though studies may have different results in the degree of association there appears to be a relationship between conditions where chronic work stress can amplify the disability associated with these psychological and physical conditions and whose onset may be a predictor from absence from work or other usual daily activities (Jones, 2016; Kouzis, et al., 1997). Individuals experiencing symptoms of burnout may have an increased psychopathology in addition to economic loses from days lost at work, a reduced sense of well-being, and increased health services (Kouzis et al., 1997). Findings from these studies support the importance of improving health services, healthcare professionals utilizing toolkits and self-care regimens that not only help mitigate burnout symptoms but also prevent the development of the various illnesses that have been discussed throughout the paper.

Appendix D:
Commonly Used/Effective Therapies to Treat Stress

Given the health concerns, several interventions are often implemented to help ameliorated the long-term implications of stress on the body. Outside of pharmacological treatments, some of the more traditional methods involve deep breathing and mindfulness. However, some interventions may involve an even simpler approach, such as laugh therapy. Laughing stimulates the brain to block the production of immunity suppressors such as cortisol and has been shown to have a positive effect on the body and on health (Pandey et al., 2011; Robinson, 1991). Early interventions of effective behavioral techniques/toolkits activate the body's relaxation response via the parasympathetic nervous system (e.g. mindfulness, deep-breathing, stress-reduction, biofeedback, physiological monitoring of sleepiness; and heart rate variability) and can help individuals modify their reactions to stress. Programs such as these hope that increasing body-awareness, can help individuals recognize the physical and psychological symptoms of stress (including self-reported) and then more actively and effectively manage the negative health effects of it (Landsman-Dijkstra, Van Wijck, & Groothoff, 2006).

Intense emotions, such as anxiety and anger, alter the breathing rhythm, which becomes shallow and fast (Fried, R., & Grimaldi, 1993; Pandey et al., 2011). Deep (abdominal) breathing is fundamental to most forms of relaxation and works by methodically allowing an individual to fill his/her lungs with oxygen, releasing carbon dioxide, altering the metabolic levels, and downregulating the sympathetic nervous system (including decreased brain activity and lowering blood pressure) which then allows the body a greater ability to cope with stress by conserving energy and controlling chronic health problems (Freeman, 2001). This practice, also helps the individual learn how to better concentrate on what is happening in the here and now, also known as mindfulness or meditation, which is a widely recognized stress-management tool (Pandey et al., 2011). Meditation is a state of consciousness characterized by inward attention, nonevaluative awareness of the ongoing situation, and deep relaxation to "empty the mind" of thoughts while a state of homeostasis is experienced; this profound state of relaxation is also called hypometabolism (Murata, T., Takahashi, T., Hamada, T., Omori, M., Kosaka, H., Yoshida, H., 2004; Pandey et al., 2011; Shapiro, S. L., Astin, J. A., Bishop, S. R., & Cordova, 2005).

Coping interventions emphasize strategies such as emotion regulation, impulse control, and cognitive restructuring to improve mental health and health behavior (Barker, 2014; Ferguson, K.M., Bender, K., Thompson, 2015; Folkman & Lazarus, 1988; Giles-Corti, B., Donovan, 2002; Loucks, E.B., Schuman-Olivier, Z., Britton, W.B., Fresco, D.M., Desbordes, G., Brewer, J.A., Fulwiler, 2015). In addition, the results of the Mindfulness generated in the primary study, it is important for researchers to understand various treatment modalities are being implemented within clinical practices for individuals who are experiencing and frequently exposed to stress, as stress-related psychiatric disorders remain poorly treated. Interventions include but are not limited to Cognitive-Behavioral Therapy (CBT), Cognitive Processing, Problem-Solving Therapy, Prolonged Exposure Therapy, Mindfulness-Based and goal-setting strategies.

Beyond mechanisms of pharmacotherapies understanding more about the mechanisms of behavioral therapy could better inform and improve treatments. For instance, understanding how integrating an exercise program to mindfulness, therapy, or medical care can also help to reduce symptom burden. As once source of comparison, Veterans are often considered to have a high rate of stressful exposures. In a small study of Veterans, a therapeutic horseback riding program, a treatment similar to mindfulness, not only reduced PTSD symptoms but also showed improvement

in self-efficacy and emotion regulation (R. A. Johnson et al., 2018). Researchers found that soldiers with a stronger sense of self-efficacy are associated with higher levels of performance and had lesser amounts of strain in response to long work hours and work overload (Jex, S.M., & Bliese, 199AD; McGonagle & Barnes-Farrell, 2014; Stajkovic, A.D., & Luthans, 1998).

Researchers are also working to identify a biological explanation for how psychotherapies improve stress-related psychiatric illness. Cognitive behavioral therapies have been shown to improve symptoms in PTSD and depression. One study showed that chronic stress decreased the prefrontal cortex region of the brain's response to stimulation, which may underlie the benefits of cognitive behavioral therapy. The results support the idea that controlling activity in the prefrontal cortex, such as by using a medication, could boost the effectiveness of cognitive behavioral therapies for PTSD and other mental disorders (Fucich, Paredes, Saunders, & Morilak, 2018).

> "Teaching individuals to better cope with stress can serve as an effective means of both attenuating extant pathology, increasing one's resilience to stress, and possibly preventing future health and mental health difficulties. Learning to more effectively cope with stress can serve to decrease the experience of major negative life events and chronic daily problems as well as potentially attenuating the impact that such stress can have on one's immune functioning, physiology, and neurobiology"
> (Nezu et al., pg.28, 2012).

One study looking at the effectiveness of cognitive processing therapy and prolonged exposure in conditions reflective of current clinical practice within the Veterans Health Administration (Rutt BT, Oehlert ME, Krieshok TS, 2018), found that completing cognitive processing therapy and prolonged exposure were equally effective at reducing total PTSD Checklist scores in Veterans. In addition to these therapies, evidence-based therapies such as exposure therapy, eye movement desensitization and reprocessing (EMDR), and stress inoculation therapy (SIT) are often used to bring tremendous relief to individuals experiencing the various symptoms of PTSD (Fitch & Marshall, 2016).

Biofeedback:

Biofeedback can be used to regulate and control the physiological process and emotional states by reducing the effects that stress has on both the mind and body (Brown, 1978; Pandey et al., 2011). Through electronic sensory devices, biofeedback provides immediate return of information about physiological processes (heart rate, blood pressure, muscle tension, brain activity, peripheral temperature, electrodermal activity). It enables individuals to regulate their reactions to stress voluntarily by showing when physiological processes are altered (2011). Biofeedback is an appropriate tool, as it can be used independently or in combination with other methods of relaxation to help control reactivity to a specific source of stress (Lehrer, P. M., Carr, R., Sargunaraj, D., & Woolfolk, 1994; 2011; M. S. Schwartz, 1995).

Appendix E:
Buffers to Stress

Effects of Coping:

The conscious and unconscious way the brain reacts to stress, may lead to poor health and psychological outcomes (Nezu et al., 2012). Unremitting daily stress or environmental and internal emotions (e.g. negative ruminating thinking, practicing avoidance, suppressing/minimalizing feeling) leads to continuous activation of the amygdala; Thereby, impacting one's ability to engage in more high-road processing or implement coping strategies which can either diminish the amplification of negative affective states or prolong stress exposure health outcomes (2012; Uchino, B.N., Birmingham, 2011; Williams et al., 2011).

In one study, ambulance personnel prepared themselves for the unknown situation by holding an "inner dialogue." It was reported that while imagining the type of coping that awaited them, this dialogue helped them to remain alert and to deal with anticipatory stress (Jonsson, A., & Segesten, 2004). During the event, ambulance personnel made a conscious effort to use tactics (cognitive empathy strategy) to block their emotional reactions/emotional distancing/emotional detachment toward patients and the stress associated with it. They understood the patients' situation and suffering, but maintained emotional distance to preserve their ability to provide the technical means for treatment (Regehr, C., Goldberg, G., & Hughes, 2002). Paired, Alexander and Klein underlined the importance of: 1) providing recovery time between events to prevent the cumulative effect of emotional burden; and 2) the importance of having a space to converse and process their experience with someone about the event. This assisted in internalizing the traumatic experience in coping with difficult memories, calming down, releasing tension, neutralizing negative emotions, reframing their actions, and granted a renewed sense of control of the situation to help renew their professional confidence (Alexander, D. A., & Klein, 2001; Avraham et al., 2014; Halpern, J., Gurevich, M., Schwartz, B., & Brazeau, 2009; Jonsson, A., & Segesten, 2004; Regehr et al., 2002). This was supported by Nezu who also suggested that one way to try and overcome the barrier when addressing complex and/or emotionally laden problems, individuals should use the strategies of: externalization, visualization, and simplification" (Nezu et al., 2012).

Social Networks and Stress:

External networks are another factor to be considered, and there are a few models that Uchino and associates used to describe the relationship. Sometimes referred to as the buffering model, suggests that relationships are beneficial because they can decrease the negative effect of stress on both mental and physical health (Cohen, S., & Herbert, 1996; Uchino, B.N., Birmingham, 2011). Individuals with diminished social support were 75% or 80% more likely to develop a mood or anxiety disorder, even in the absence of previous mental illness history (Carleton et al., 2018; Melchior et al., 2007). Positive social networks may help improve physical health, healthy behavior, immune function, disease recovery, and may contribute to positive mental health by building resiliency, giving a sense of purpose and increasing overall quality of life (B. T. Johnson & Acabchuk, 2018). One factor to note is that researchers found that a decrease in self-esteem may in turn offset any benefits of received support and/or operate as a source of stress on its own (Uchino et al., 2011). Finch and associates found that receiving tangible and informational support predicted increased depressive symptoms, whereas received emotional support did not predict depressive symptoms (Finch, J. F., Barrera, Jr., M., Okun, M. A., Bryant, W. H. M., Pool, G. J. & Snow-Turek, 1997). However, received positive interactions (belonging support) predicted lower levels of depression. Other

research in chronic disease populations suggests a detrimental influence of received tangible support on depression but a beneficial influence of received emotional support (Penninx, B. W. J. H., van Tilburg, T., Boeke, P., Boeke, A. J., Deeg, D. J.H., Kriegsman, D. M. W., 1998; Uchino, B.N., Birmingham, 2011). Overall, Uchino and associates stated that there is nothing about received emotional support per se that precludes it having a stress-buffering influence (2011). A conceptual model (Figure 4) by Berkman illustrates that by decreasing social isolation or expanding connections to various networks, individuals can improve, maintain, or protect their health (Berkman, Glass, Brissette, & Seeman, 2000).

Finally, the matching hypothesis predicts that stress-buffering is most effective when the type of support matches the needs or challenges of the stressful event and predicts that informational and tangible support should be most effective for controllable events (e.g., preparing for a job interview), whereas emotional and belonging support should be most effective for uncontrollable events (e.g., job layoff) (Cutrona, C. E., & Russell, 1990; Uchino et al., 2011); Figure 7. The stress prevention model suggests that social support is beneficial because network members may provide individuals with the resources to avoid or reduce exposure to some negative life events (Gore, 1981; Uchino et al., 2011). Some studies examining stress reduction as a mediator of support influences may be relevant, because general perceptions of stress likely reflect both stress exposure and stress reactivity (Bonds, D. D., Gondoli, D. M., Struge-Apple, M. L., & Salem, 2002).

Appendix F:
Stress Scales/Measures Used to Evaluate Stress

While not focused on for this thesis, nor comprehensive, I think it is helpful to note the various scales that researchers and clinicians use to evaluate stress. Past tools have relied on self-reported measures, scales, checklists, and interview assessments to report an individual's stress, which may have been more subjective or ambiguous to report on. As discussed, technological advances now allow biological tests to evaluate a various dimensions of stress levels. These tests reveal the explicit implications that may contribute to disease outcomes or underlie the relationship that stress has on our bodies. Stress research is credited to a) Adolf Meyer's research on external life stresses and health outcomes in humans and b) Hans Selye's seminal work on the identification and study of changes in an organism evoked in response to the physical and physiological stressors in animal models (Anderson, B., Wethington, E., and Karmarck, 2011; Selye, 1936, 1956).

Along with the study of environmental stressors and illness came the development of the Schedule of Recent Experience (SRE) (Anderson et al., 2011; Hawkins, N. G., Davies, R., & Holmes, 1957). Researchers assumed that an individual's level of stress can be defined by the cumulative amount of change or adaptation, weather positive or negative, brought about by events. Stress, in combination with neurobiological systems, can negatively impact later behavioral and emotional reactivity to negative life events and daily problems increasing one's stress sensitivity (Nezu et al., 2012). A crucial aspect of an acute and chronic environmental stressor is thought to be its disruptive impact in the context of specific life circumstances of the individual ("contextual threat") rather than the amount of change it required (Anderson et al., 2011).

Perceived Stress Scale (PSS): (Cohen, S., Kamarck, T., & Mermelstein, 1983, 1993). Designed to measure the degree to which situations in one's life are appraised as stressful. The PSS is suggested for examining the role of nonspecific appraised stress in the etiology of disease and behavioral disorders and as an outcome measure of experienced levels of stress.

The Traumatic Life Events Questionnaire (TLEQ): (Kubany, 2004). TLEQ Assesses lifetime exposure to 23 different traumatic events with response options ranging from 0 = never experienced to 6 = more than 5 times.

The Peritraumatic Distress Inventory (PDI): (Brunet, A., Weiss, D. S., Metzler, T. J., Best, S. R., Neylan, T. C., Rogers, C., . . . Marmar, 2001). The Peritraumatic Distress Inventory is a 12-item measure assesses participants' retrospective reports of distress surrounding their worst duty-related incident. Response options range from 0 = not at all to 4 = extremely true.

The Peritraumatic Dissociative Experiences Questionnaire: (Marmar, C. R., Metzler, T. J., & Otte, 2004). The Peritraumatic Dissociative Experiences Questionnaire is a 10-item measure to assesses retrospective reports of dissociative experiences. This can include with psychological trauma and PTSD, and has been used to report on of dissociative experiences during participants' worst duty-related incidents.

A self-administered 18-item questionnaire, the job content questionnaire (JCQ), was developed to measure psychological demands (the quantity of work, the intellectual requirements and the time constraint of the job) and job decision latitude (opportunities to make decisions, to be creative, and to use and develop one's abilities at work). Early research using this measure suggested that the health problems associated with job strain resulted in a combination of high psychological

demands and low decision latitude at work (Karasek, R., Brisson, C., Kawakami, N., Houtman, I., Bongers, P., & Amick, 1998; Karasek, R and Theorell, 1992).

van Straten et al. also measures work-related stress using a Dutch version of the Maslach Burnout Inventory (MBI), which contains three subscales: (1) emotional exhaustion (MBI-EE), 5 items; (2) depersonalization (MBI-DP), 4 items; and (3) personal accomplishment (MBI-PA), 6 items. Each item is scored on a scale from 0 to 6. For MBI-EE and MBI-DP, a higher score indicates more work-related stress, while a high MBI-PA score indicates less work-related stress. Individuals can be considered burnt out when they report high MBI-EE (≥ 2.2) in combination with high MBI-DP (≥ 2.0) or low MBI-PA (Van Straten, Cuijpers, & Smits, 2008).

Appendix G:
Personality

Personality is important factor to consider in relation to stress, as the characteristic ways of thinking, feeling, and behaving influence how an individual responds to stress (Smith, C.A., Kirby, 2011). In addition to interpersonal social–environmental factors that may make people more vulnerable to health impacts, individuals vary greatly in the way they interact with experiences (Rothbart, 2007). Included is the extent to which they are exposed to stress, the magnitude and patterning of their physiological and emotional response. Additionally the cognitive processing and circumstances around a potentially stressful life events should be considered, for instance: the anticipation of a stressor (which may present as worry); the length of time it takes to recover from stress; and the extent to which there is adequate restoration during or following times of stress (for instance rumination from reimaging the stressors) (Smith et al., 2011; Uchino et al., 2011; Williams et al., 2011). Each of these stress processes — exposure, reactivity, recovery, and restoration — is a potential pathway to poor health (Uchino, B.N., Birmingham, 2011; Williams et al., 2011)

Though not descriptive of every individual, theories of personality can be used when discussing stress. "Type A" personality is often used to delineate a high-stress personality. Believed to have an overactive sympathetic nervous system, individuals are described as someone who tends to be driven, impatient, competitive, or even have increased anger or hostility (Jones, 2016; Teague, Mackenzie, & Rosenthal, 2017). The increased secretions and continuous circulation of emergency stress hormones in the blood elevate heart and respiratory rates, increases blood pressure, triggers the release of cholesterol and triglycerides, and may contribute to elevated risk or vulnerability of hypertension, heart disease, or stroke for individuals (Jones, 2016; Teague et al., 2017). On the other hand, individuals with "Type B" personalities, tend to be calm, steady, relaxed, and less vulnerable to stress (Jones, 2016).

Neuroimaging techniques have been used to examine how connections with the limbic system, amygdala, and prefrontal cortex that influence our personality are associated with our stress responses. Explored in more detail below, individuals with 5-HTTLPR S allele exhibit increased activity in the amygdala and cerebral cortex while processing emotional information. Suggesting that anxiety and fearfulness associated with the short allele may reflect hyperresponsiveness of the amygdala to relevant environmental stimuli, thereby exasperating or amplifying the stress-related response (Berntson, G. G., Sarter, M., & Cacioppo, 2003; Hariri, A. R., Mattay, V. S., Tessigore, A., Kolachana, B., Fera, F., Goldman, D., 2002; Rothbart, 2007; Williams et al., 2011). These regions are involved in "top-down" processing of emotion and are important in executive functioning as we respond to our environment.

Executive functioning constitutes a multifaceted construct comprising a number of basic neurocognitive processes, including: conceptual reasoning; working memory; cognitive flexibility; response selection, inhibition, initiation; set formation; and set maintenance (Suchy, 2009; Williams et al., 2011). Studies have suggested that a serotonergic neurotransmitter system underpinning executive functioning or self-regulation is a common contributing factor in depressive vulnerability (Carver, C. S., Johnson, S. C., & Joorman, 2008; Suchy, 2009); which is illustrated in Figure 8 (Williams et al., 2011). Individuals who are able to override dominant emotional tendencies or impulses, stay on task, stay organized, and meet goals will reduce the probability of experiencing stressful circumstances; an important skill for emergency personnel (2011).

Appendices: Tables

Table 1:
Respondent Characteristics

Respondent Characteristics	Frequency (n)	Percent (%)
Total Participants	**182**	**100.0**
Gender		
Male	34	18.9
Female	148	81.3
NA	0	0.0
Race		
American Indian/Alaskan Native (AIAN)	5	2.7
Asian	3	1.6
Black	5	2.7
Native Hawaiian/Pacific Islander (NHPI)	0	0.0
Other	8	4.4
White	170	93.4
Multi-Race	7	3.8
Age		
below 26	14	7.7
26 - 35 years	58	31.9
36 - 45 years	63	34.6
46 - 55 years	37	20.3
56 - 64 years	10	5.5
65 years or above	0	0.0
NA	0	0.0
Job Position		
Call taker only	9	4.9
Dispatcher only	0	0.0
Both call taker and dispatcher	145	79.7
Other	28	15.4
NA	0	0.0
Number of Years Working with Job		
Less than 2 years	18	9.9
2 - 5 years	42	23.1
6 - 10 years	40	22.0
11 - 20 years	60	33.0
21 - 30 years	16	8.8
Over 30 years	6	3.3
NA	0	0.0

Table 1 (continued)

Respondent Characteristics	Frequency (n)	Percent (%)
Total Participants	**182**	**100.0**
Job Shift		
Day	40	22.0
Day and Night	54	29.7
Night	32	17.6
Rotates	92	50.5
Weekend	44	24.2
Education		
High school/GED	21	11.5
Some college	86	47.3
Associates degree	16	8.8
Bachelor's degree	50	27.5
Post-graduate study or degree	8	4.4
NA	1	0.5
Chronic Illness		
Anxiety	41	22.5
Chronic Pain	6	3.3
Depression	37	20.3
Fatigue	8	4.4
GERD	40	22.0
Heart Disease	5	2.7
Hypertension	40	22.0
IBS	19	10.4
Insomnia	17	9.3
Migraine	45	24.7
Respiratory	20	11.0
Skin	29	15.9
Stomach Ulcers	7	3.8
Number of Chronic Illnesses		
CI Disease Count	1.7	1.9
Symptoms of Stress Score (SOSI)		
SOSI	51.1	29.2
Social Support		
Social Support Score	17.4	3.1

Table 1 (continued)

Respondent Characteristics	Frequency (n)	Percent (%)
Total Participants	**182**	**100.0**
Required Overtime (OT)		
Yes	81	44.5
No	95	52.2
NA	6	3.3
Number of required OT hours		
OT Hours Required	7.4	12.1
Any Sick Days Taken		
Yes	51	28.0
No	125	68.7
NA	6	3.3
Number of Sick Days Taken		
Number of Sick Days	0.6	1.2

Table 2:
Bivariate Analysis

For table 2 what we are trying to present is the bivariate association between each variable and the three primary variables of interest (C-SOSI, CI and sick day used).
Total Participants = 182
(*Note: Some Participant Information missing according to the variable, specified below)

Sick Days (Section 1)				
	N =	Number who used at least 1 Sick Day in month (essentially the Proportion)	Percent used at least one sick day in previous month (%)	p-value
Gender	182			
Male	32	6	18.8	0.198
Female	144	46	31.2	
Missing	6			
Race				
White	165	47	28.5	
non-White	11	4	36.4	0.732
Missing	6			
Age				
below 26	14	5	35.7	
26 - 35 years	57	20	35.1	
36 - 45 years	60	15	25.0	0.689
46 - 55 years	35	9	25.7	
56 - 64 years	10	2	20.0	
Missing	6			
Job Position				
Call taker only	9	6	66.7	
Both call taker and dispatcher	140	38	27.1	0.049
Other	27	7	25.9	
Missing	6			
Number of Years Working with Job				
Less than 2 years	18	8	44.4	
2 - 5 years	41	13	31.7	
6 - 10 years	37	8	21.6	
11 - 20 years	58	18	31.0	0.513
21 - 30 years	16	3	18.8	
Over 30 years	6	1	16.7	
Missing	6			

* Some frequencies do no sum to column total due to missing responses.

Table 2 (continued)

Sick Days (continued)				
	N =	Number who used at least 1 Sick Day in month (essentially the Proportion)	Percent used at least one sick day in previous month (%)	p-value
Job Shift				
Day				
Day (Yes)	39	9	23.1	0.427
Day (No)	137	42	30.7	
Day and Night				
Day and Night (Yes)	49	14	28.6	1.000
Day and Night (No)	127	37	29.1	
Night				
Night (Yes)	31	8	25.8	0.828
Night (No)	145	43	29.7	
Rotates				
Rotates (Yes)	89	29	32.6	0.321
Rotates (No)	87	22	25.3	
Weekend				
Weekend (Yes)	42	13	31.0	0.846
Weekend (No)	134	38	28.4	
Missing	6			
Education				
High school/GED	21	5	23.8	0.811
Some college	83	22	26.5	
Associates degree	16	4	25.0	
Bachelor's degree	48	17	35.4	
Post-graduate study or degree	7	2	28.6	
Missing	6			
Overtime Required				
Yes	80	26	32.5	0.406
No	95	25	26.3	
Missing	7			
Chronic Disease Count				
Odds Ratio (OR)			1.1	0.408
Missing	6			
Social Support (DCSQ_SS)	-	-	-	-
Odds Ratio (OR)	-	-	0.9	0.177
Missing	7	-	-	-
Symptoms of Stress (C-SOSI) (when making a 10-point change)				
Odds Ratio (OR)			1.1	0.190
Missing	6			

Table 2 (continued)

Chronic Disease Count (Section 2)				
	N =	Mean (if applicable)	SD (if applicable)	p-value
Gender				
Male	34	1.1	1.6	0.031
Female	148	1.9	2.0	
Missing	0			
Race				
White	170	1.7	1.9	0.121
non-White	12	2.2	1.2	
Missing	0			
Age				
below 26	14	0.9	1.4	0.001
26 - 35 years	58	1.2	1.6	
36 - 45 years	63	2.0	2.1	
46 - 55 years	37	2.3	2.0	
56 - 64 years	10	1.9	1.5	
Missing	0			
Job Position				
Call taker only	9	1.9	2.1	0.586
Both call taker and dispatcher	145	1.8	2.0	
Other	28	1.3	1.4	
Missing	0			
Number of Years Working with Job				
Less than 2 years	18	0.9	1.3	<0.001
2 - 5 years	42	1.1	1.4	
6 - 10 years	40	1.5	1.9	
11 - 20 years	60	2.2	2.1	
21 - 30 years	16	2.7	2.2	
Over 30 years	6	3.0	1.8	
Missing	0			

* Some frequencies do no sum to column total due to missing responses.

Table 2 (continued)

Chronic Disease Count (continued)				
	N =	Mean (if applicable)	SD (if applicable)	p-value
Job Shift				
Day				
Day (Yes)	40	2.2	2.2	0.092
Day (No)	142	1.6	1.8	
Day and Night				
Day and Night (Yes)	54	2.0	2.1	0.407
Day and Night (No)	128	1.6	1.8	
Night				
Night (Yes)	32	1.3	1.5	0.271
Night (No)	150	1.8	2.0	
Rotates				
Rotates (Yes)	92	1.5	1.7	0.279
Rotates (No)	90	1.9	2.1	
Weekend				
Weekend (Yes)	44	1.8	1.9	0.592
Weekend (No)	138	1.7	1.9	
Missing	0			
Education				
High school/GED	21	1.3	1.4	0.478
Some college	86	1.8	2.0	
Associates degree	16	2.5	2.3	
Bachelor's degree	50	1.5	1.8	
Post-graduate study or degree	8	1.4	1.8	
Missing	1			
Overtime Required				
Yes	81	1.9	1.8	0.105
No	95	1.7	2.0	
Missing	6			
Sick Days				
Yes	51	2.0	2.0	0.378
No	125	1.7	1.9	
Missing	6			
Social Support (DCSQ_SS)	-	Correlation		p-value
	-	-0.107		0.152
Missing	NA			
Symptoms of Stress (C-SOSI) (when making a 10-point change)		Correlation		p-value
	-	0.465		<0.001
Missing	NA			

* Some frequencies do no sum to column total due to missing responses.

Table 2 (continued)

Symptoms of Stress (C-SOSI) (Section 3)				
	N =	Mean (if applicable)	SD (if applicable)	p-value
Gender				
Male	34	42.4	26.1	0.056
Female	148	53.0	29.6	
Missing	0			
Race				
White	170	51.5	29.7	0.429
non-White	12	44.6	21.0	
Missing	0			
Age				
below 26	14	52.5	37.6	0.950
26 - 35 years	58	48.6	28.3	
36 - 45 years	63	51.4	29.7	
46 - 55 years	37	53.0	28.6	
56 - 64 years	10	53.9	25.3	
Missing	0			
Job Position				
Call taker only	9	63.4	35.2	0.420
Both call taker and dispatcher	145	50.2	29.0	
Other	28	51.7	28.5	
Missing	0			
Number of Years Working with Job				
Less than 2 years	18	45.2	35.3	0.206
2 - 5 years	42	48.8	24.6	
6 - 10 years	40	47.0	29.7	
11 - 20 years	60	51.8	28.4	
21 - 30 years	16	64.8	31.8	
Over 30 years	6	67.2	32.7	
Missing	0			

* Some frequencies do no sum to column total due to missing responses.

Table 2 (continued)

Symptoms of Stress (continued)				
	N =	Mean (if applicable)	SD (if applicable)	p-value
Job Shift				
Day				
Day (Yes)	40	57.9	33.7	0.950
Day (No)	142	49.1	27.6	
Day and Night				
Day and Night (Yes)	54	51.8	31.2	0.816
Day and Night (No)	128	50.7	28.5	
Night				
Night (Yes)	32	45.1	30.5	0.207
Night (No)	150	52.3	28.9	
Rotates				
Rotates (Yes)	92	49.9	26.6	0.587
Rotates (No)	90	52.2	31.8	
Weekend				
Weekend (Yes)	44	53.6	34.4	0.512
Weekend (No)	138	50.2	27.5	
Missing	0			
Education				
High school/GED	21	44.3	26.3	0.419
Some college	86	53.9	28.8	
Associates degree	16	56.5	37.5	
Bachelors degree	50	46.2	28.6	
Post-graduate study or degree	8	53.6	25.5	
Missing	1			
Sick Days				
Yes	51	55.40	30.4	0.189
No	125	49.00	28.2	
Missing	6			
Overtime Required				
Yes	81	52.0	30.3	0.720
No	95	50.4	27.9	
Missing	6			
Chronic Disease Count		Correlation		p-value
Correlation		0.465		0.00
Missing	NA			
Social Support (DCSQ_SS)	-	-		-
Correlation		-0.244		0.00
Missing	-	-		-

* Some frequencies do no sum to column total due to missing responses.

Table 3:
Multivariate Analysis

For Table 3 We are doing *Logistical and **Linear Regression			
Total Participants = 182 (*Note: Some Participant Information missing according to the variable, specified below)			
*			
If Sick Days Is Outcome	Estimate	Std.Error	p-value
SOSI + Gender	-0.0064	0.0058	0.264
SOSI + Age	-0.0078	0.0057	0.171
SOSI + Job Position	-0.0063	0.0058	0.276
SOSI + Chronic Disease Count	-0.0068	0.0065	0.298
If Sick Days Is Outcome	Estimate	Std.Error	p-value
Chronic Disease Count + Gender	-0.0532	0.0864	0.538
Chronic Disease Count + Age	-0.1115	0.0892	0.211
Chronic Disease Count + Job Position	-0.0700	0.0871	0.422
**			
If Chronic Disease Count Is Outcome	Estimate	Std.Error	p-value
SOSI + Gender	0.0295	0.0043	0.000
SOSI + Age	0.0297	0.0042	0.000
SOSI + Number of Years Working	0.0279	0.0043	0.000
SOSI + Job Shift (Day)	0.0296	0.0043	0.000

Table 4:
Hypotheses

Hypothesis	Results
Hypothesis I: Symptoms of stress (C-SOSI) are associated with greater use of sick days among 9-1-1 telecommunicators.	Not Supported in this sample
Hypothesis II: Symptoms of stress (C-SOSI) are associated with higher number of stress-related self-reported chronic illness (CI) in 9-1-1 telecommunicators.	Supported in this sample
Hypothesis III: Self-report chronic illness (CI) is associated with greater use of sick days among 9-1-1 telecommunicators.	Not Supported in this sample
Hypothesis IV: The association between symptoms of stress (C-SOSI) and use of sick days among 9-1-1 telecommunicators is explained by greater rates of CI among telecommunicators with high stress levels	Irrelevant and not able to run since did not see an association with other hypotheses.

Appendices: Figures

Figure 1:
R.Leitner_Conceptual Model for Thesis

Figure 1: Conceptual Model for *Increased Vulnerability to Health Implications. Secondary Analysis Exploring the Association of Stress, Chronic Illness, and Absenteeism among 9-1-1 Telecommunicators.*

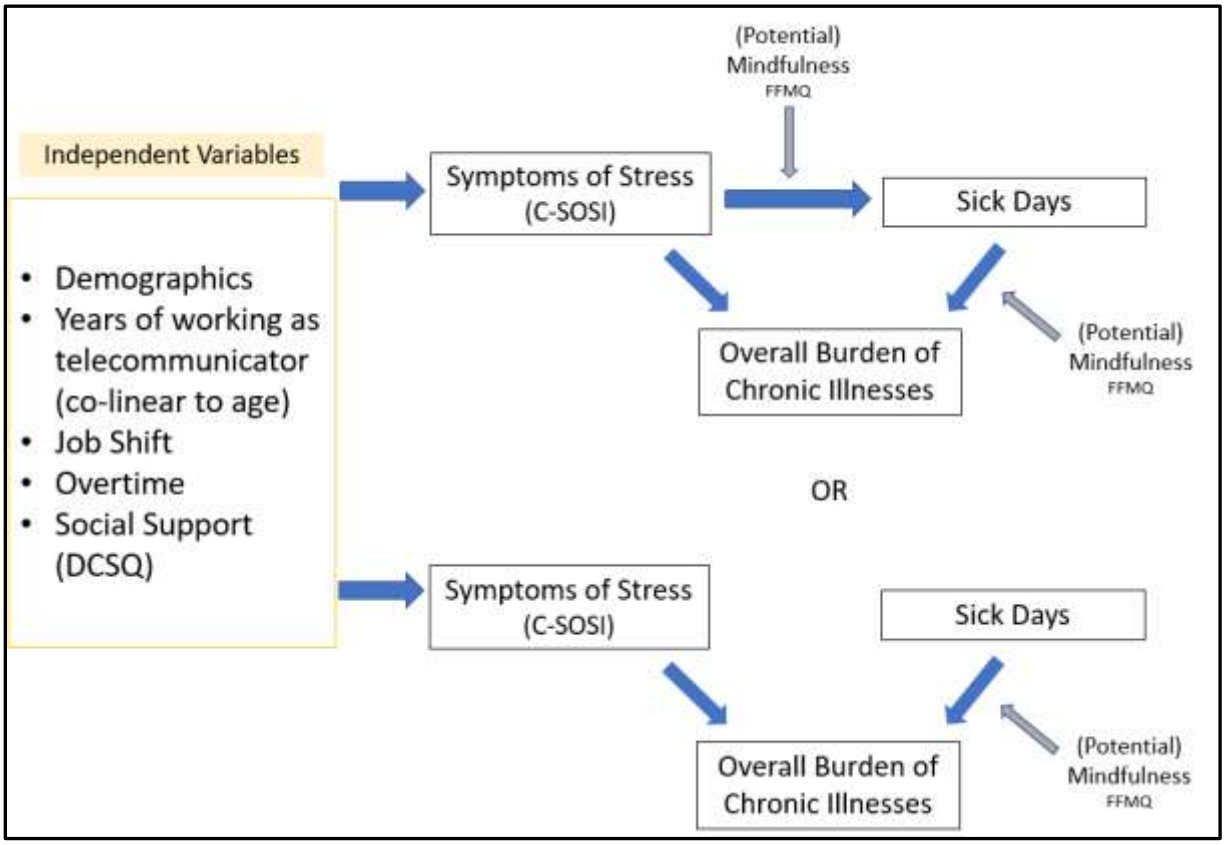

Figure 2:
Complex Bidirectional Pathways Connecting Stress and Disease

Johnson, & Acabchuk. (2018). What are the keys to a longer, happier life? Answers from five decades of health psychology research. *Social Science & Medicine, 196*, 218-226.

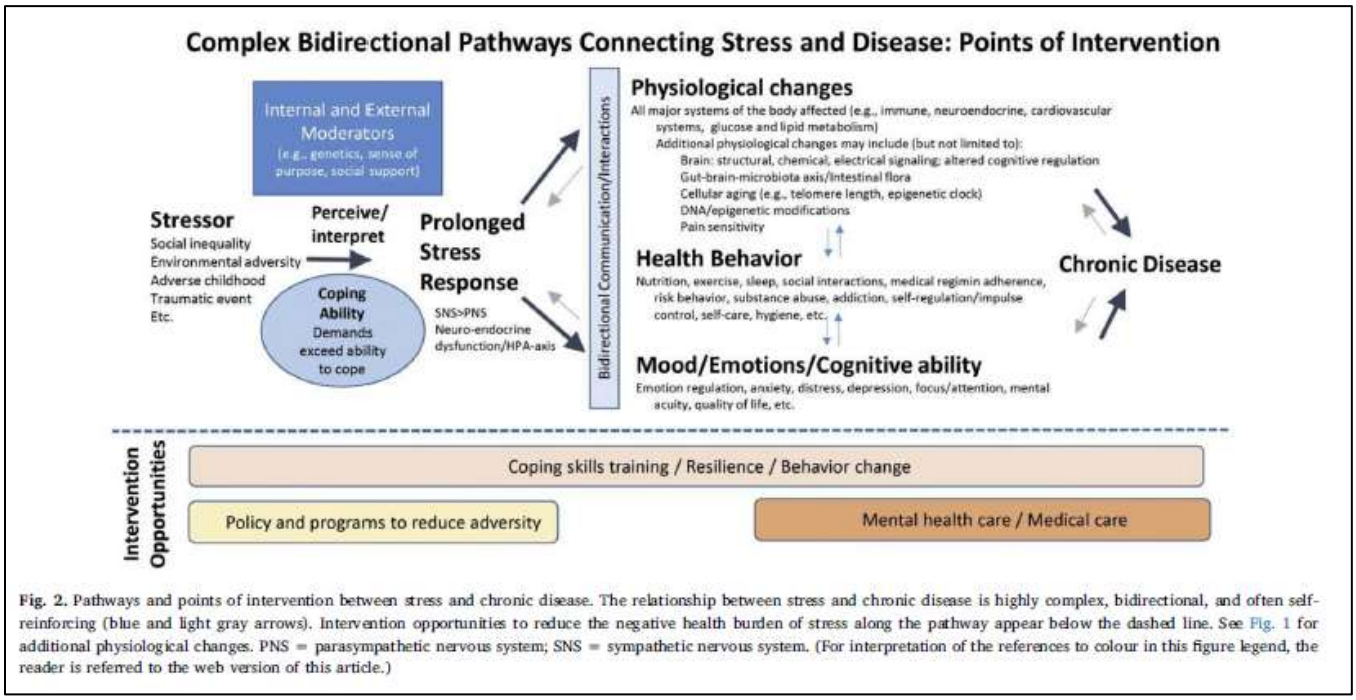

Fig. 2. Pathways and points of intervention between stress and chronic disease. The relationship between stress and chronic disease is highly complex, bidirectional, and often self-reinforcing (blue and light gray arrows). Intervention opportunities to reduce the negative health burden of stress along the pathway appear below the dashed line. See Fig. 1 for additional physiological changes. PNS = parasympathetic nervous system; SNS = sympathetic nervous system. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Note: This model appeared in Johnson, & Acabchuk. (2018). However, citations for the model's development included: (Folkman, S., Lazarus, R.S., 1988; Mariotti, A., 2015)

Figure 3:
Biological Pathways of Stress: Biomarkers for Allostatic Load

Johnson, & Acabchuk. (2018). What are the keys to a longer, happier life? Answers from five decades of health psychology research. *Social Science & Medicine, 196*, 218-226.

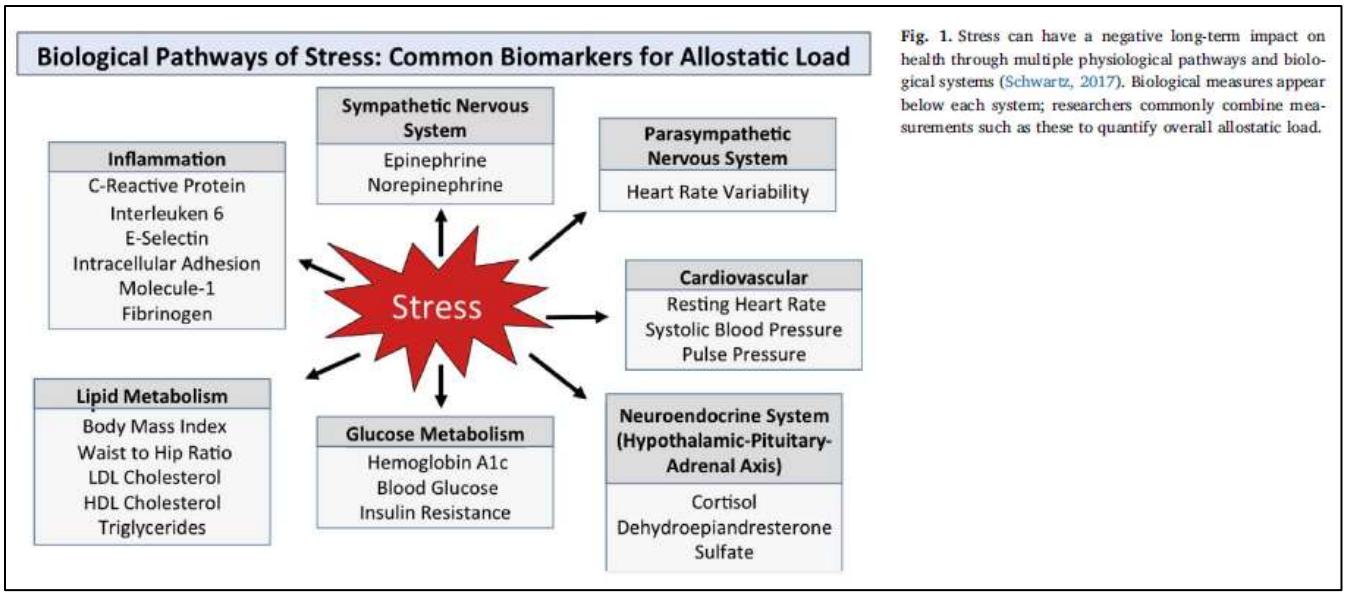

Fig. 1. Stress can have a negative long-term impact on health through multiple physiological pathways and biological systems (Schwartz, 2017). Biological measures appear below each system; researchers commonly combine measurements such as these to quantify overall allostatic load.

Note: author of this thesis initially found this figure in Johnson, & Acabchuk. (2018). However, the article cited Schwartz, J.A., 2017 for the development of the model.

Figure 4:
Conceptual Model of How Social Networks Impact Health

Berkman, L.F., Glass, T., Brissette, I., Seeman, T.E., 2000. From social integration to health: durkheim in the new millennium. Soc. Sci. Med. 51 (6), 843–857.

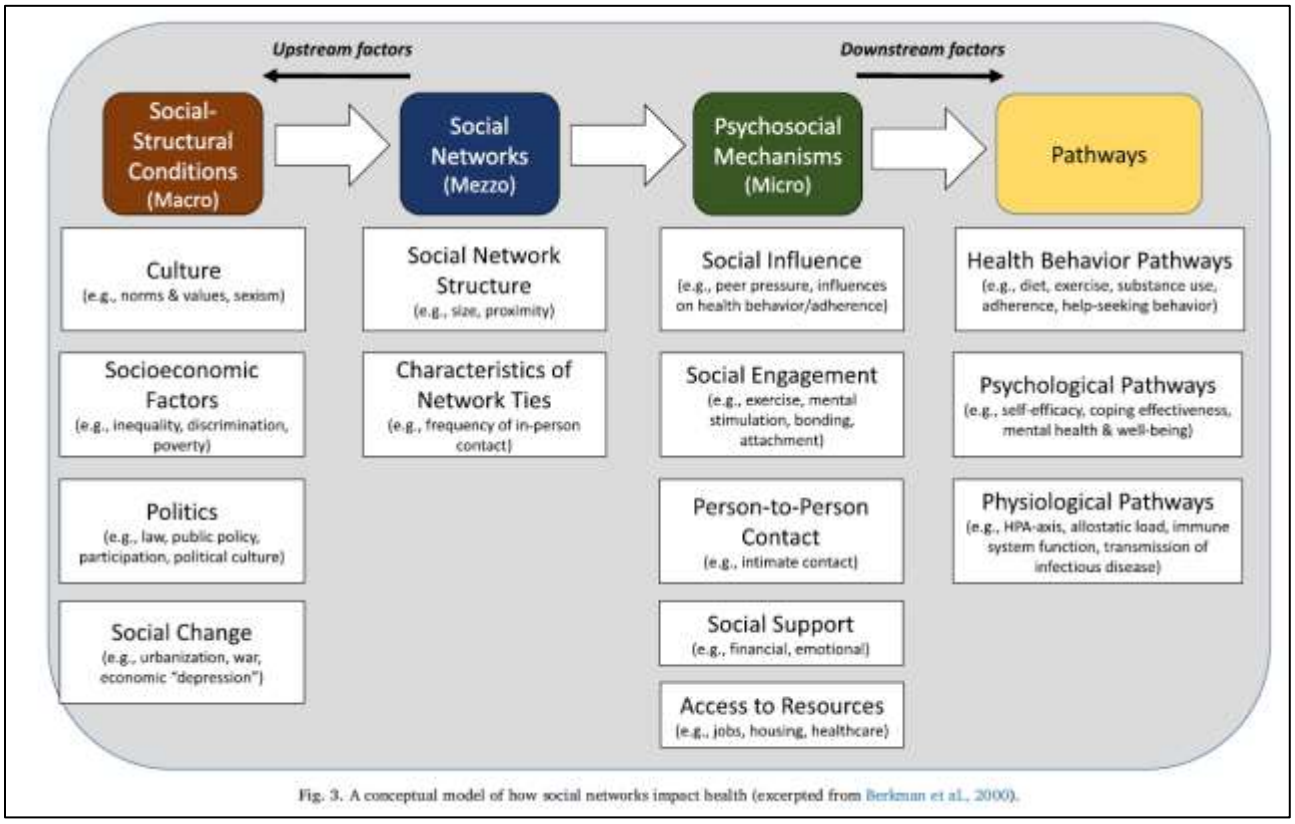

Fig. 3. A conceptual model of how social networks impact health (excerpted from Berkman et al., 2000).

Note: author of this thesis initially found this figure in Johnson, & Acabchuk. (2018). What are the keys to a longer, happier life? Answers from five decades of health psychology research. *Social Science & Medicine, 196*, 218-226.

Figure 5:
Effects of Stress on Immune Function

Dhabhar, F.S. (2011). Effects of stress on immune function: Implications for immune protections and immunopathology. In R.J. Contrada & A. Aaum (Eds.). The handbook of stress science: Biology, psychology, and health (pp. 47-63). New York, NY: Springer Publishing.

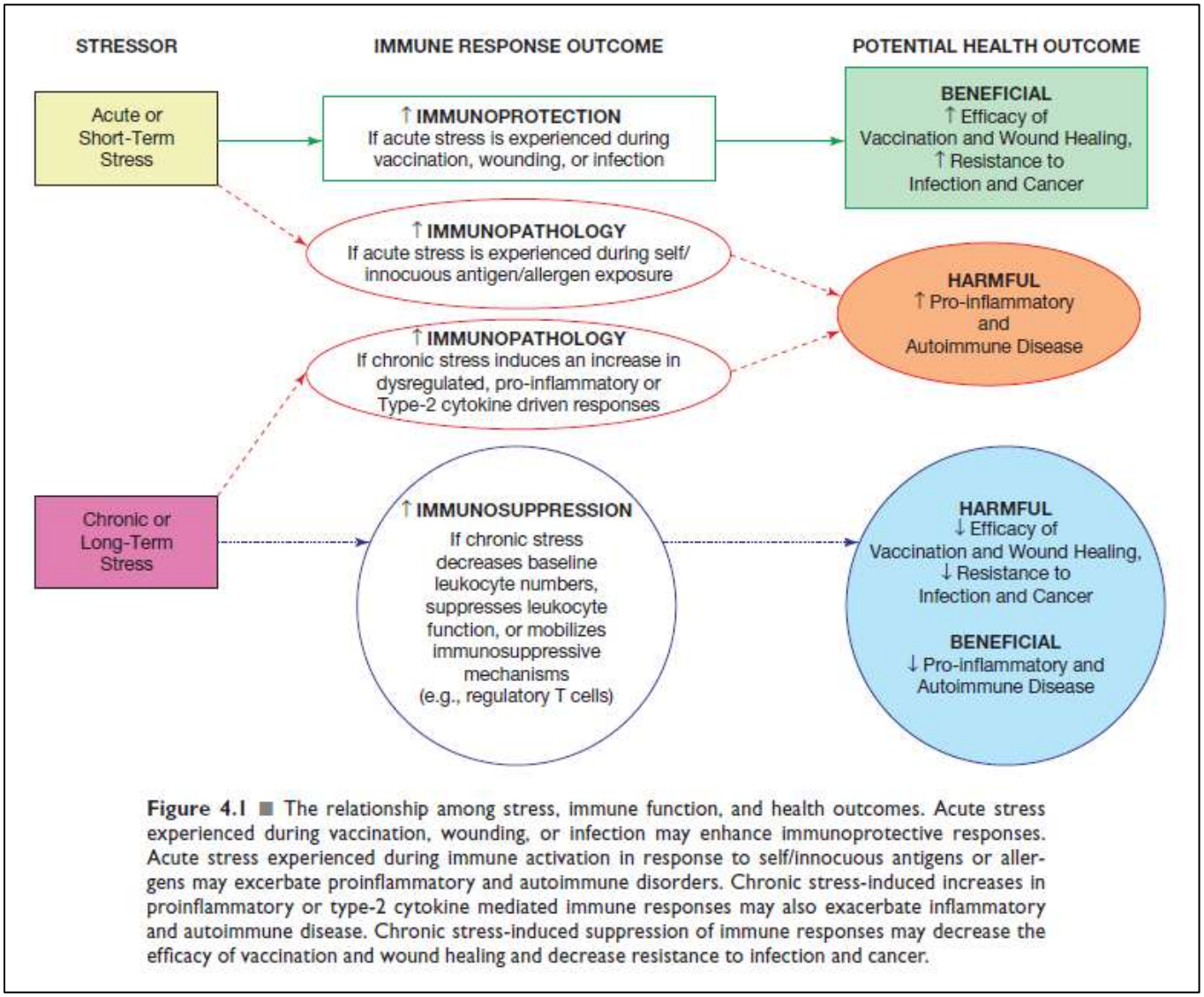

Figure 4.1 ■ The relationship among stress, immune function, and health outcomes. Acute stress experienced during vaccination, wounding, or infection may enhance immunoprotective responses. Acute stress experienced during immune activation in response to self/innocuous antigens or allergens may excerbate proinflammatory and autoimmune disorders. Chronic stress-induced increases in proinflammatory or type-2 cytokine mediated immune responses may also exacerbate inflammatory and autoimmune disease. Chronic stress-induced suppression of immune responses may decrease the efficacy of vaccination and wound healing and decrease resistance to infection and cancer.

Figure 6:
Stress Spectrum Model

Dhabhar, F.S. (2011). Effects of stress on immune function: Implications for immune protections and immunopathology. In R.J. Contrada & A. Aaum (Eds.). The handbook of stress science: Biology, psychology, and health (pp. 47-63). New York, NY: Springer Publishing

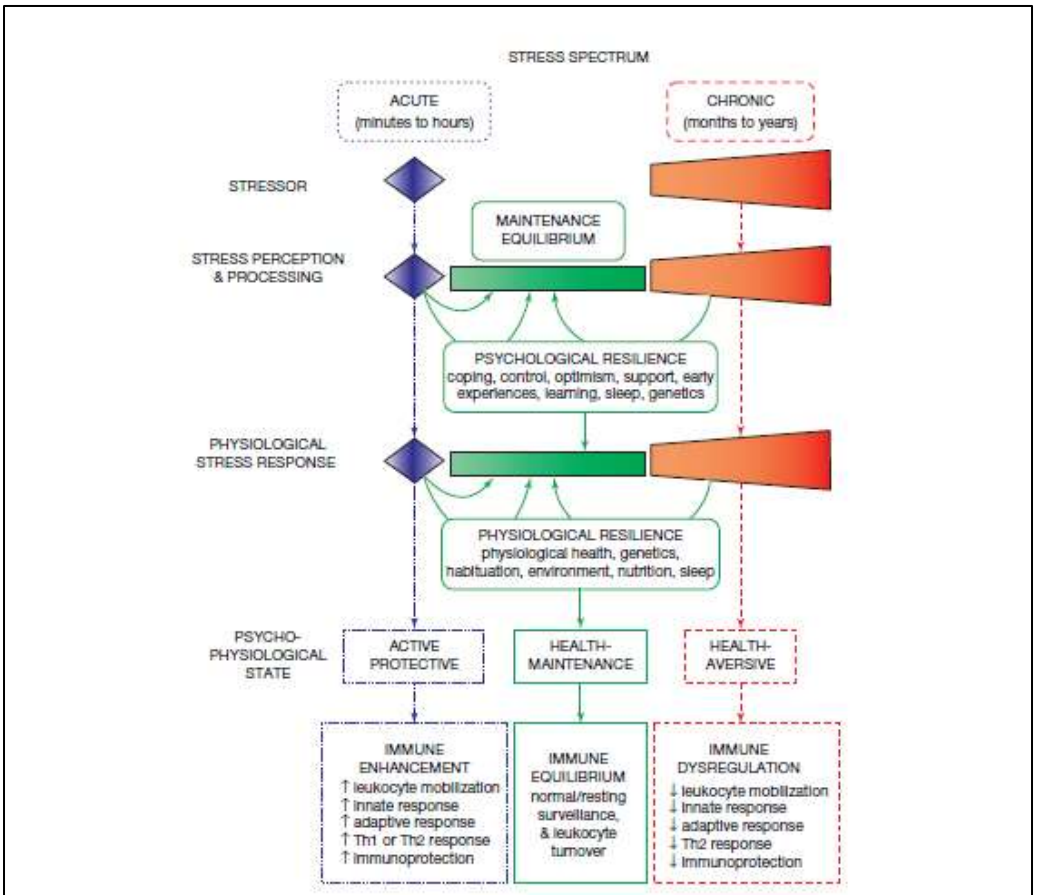

Figure 4.2 ■ The stress spectrum model. We have proposed a definition of stress as a constellation of events, consisting of a stimulus (stressor), that precipitates a reaction in the brain (stress perception & processing), that activates physiologic fight or flight systems in the body (physiological stress response) (Dhabhar & McEwen, 1997). The duration of a physiological stress response is the critical determinant of its effects on immune function and health. The stressor itself may be acute (e.g., narrowly missing being hit by a car) or chronic (e.g., caring for a chronically ill child, spouse, or parent). Stress perception and processing by the brain are critical for determining the duration and magnitude of the physiological stress response stimulated by any given stressor. Acute or chronic stress is generally superimposed on a psychophysiological health maintenance steady state. The extent and efficiency with which an organism returns to its health maintenance steady state after stress depends on resilience, which we define as the *capacity of psychological and interacting physiological systems to recover from challenging conditions*. Factors such as coping mechanisms, sense of control, optimism, social support, early life experiences, learning, genetics, and sleep are important mediators of psychological resilience. Factors such as neuroendocrine reactivity, genetics, environment, nutrition, and sleep are important mediators of physiological resilience. Psychological resilience mechanisms are especially important in humans because they can limit the duration and magnitude of chronic stress responses. By the same token, psychogenic stressors can be particularly detrimental in human subjects because they may generate stress responses long after stressor exposure or even in the absence of physical stressors or salient threats. The physiological stress response is the ultimate effector arm of the stress spectrum. It may consist of acute or chronic physiological activation (neurotransmitters, hormones, and their molecular, cellular, organ-level, and systemic effects) that results in psychophysiological states that have different effects on health. Acute stress generally results in activation of mechanisms that include enhancement of immune function while chronic stress results in health-aversive conditions that result in dysregulation or suppression of immune function. The molecular mechanisms mediating conversion from positive to negative effects of stress on immune function and health are slowly beginning to emerge, and merit further investigation. Reprinted from Dhabhar, F. S., & McEwen, B. S. (2006). Bidirectional effects of stress on immune function: Possible explanations for salubrious as well as harmful effects. In R. Ader (Ed.), *Psychoneuroimmunology IV*. San Diego: Elsevier.

Note: author of this thesis initially found this figure in Dhabhar, F.S. (2011). However, the article also cited (Dhabhar & McEwen, 1997; Dhabhar, F. S., & McEwen, B. S., 2006

Figure 7:
Existing Models Linking Support to Stress and Coping Processes

Uchino, B.N., Birmingham, W. (2011). Stress and Support Processes. In R.J. Contrada & A. Baum (Eds.). The handbook of stress science: Biology, psychology, and health (pp. 111-121). New York, NY: Springer Publishing.

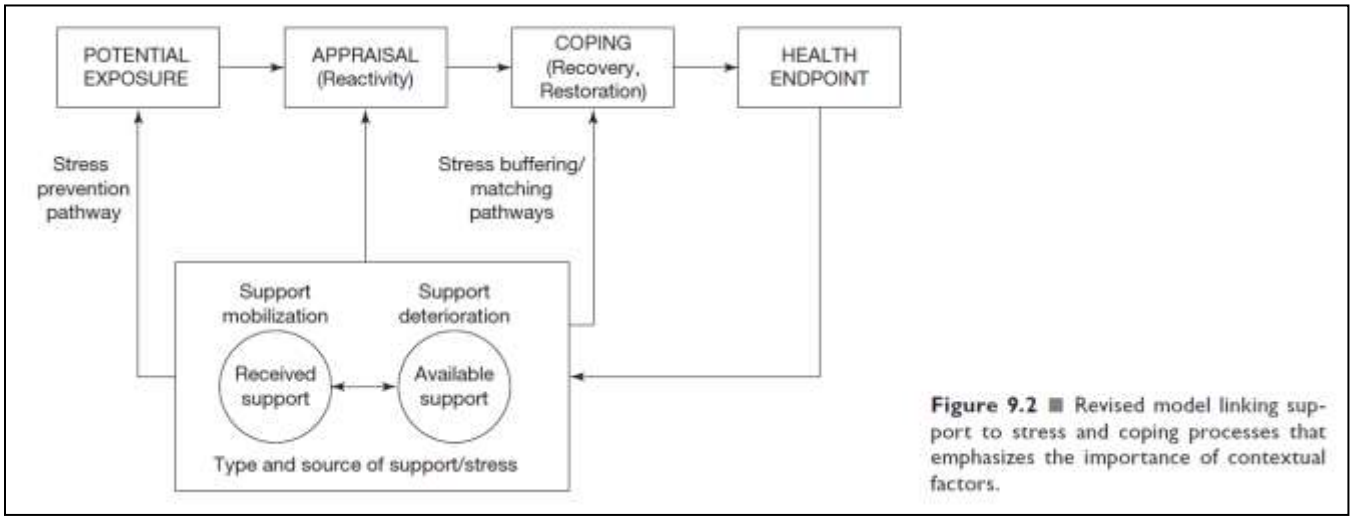

Figure 9.2 ■ Revised model linking support to stress and coping processes that emphasizes the importance of contextual factors.

This model appeared in Uchino, B.N., Birmingham, W. (2011). However, citations for the model's development included: (Barrera, 1986; Barrera, 2000; Cohen & Hebert, 1996; Cohen & McKay, 1984; Cohen & Willis, 1985; Cutrona & Russell, 1990; Gore, 1981; Lin, 1986)

Figure 8:
Schematic of Individual Differences in Stress Processes

Williams, P.G., Smith, T.W., Gunn, H.E., Uchino, B.N., (2011). Personality and Stress: Individual differences in exposure, reactivity, recovery, and restoration. The handbook of stress science: Biology, psychology, and health (pp. 231-245). New York, NY: Springer Publishing.

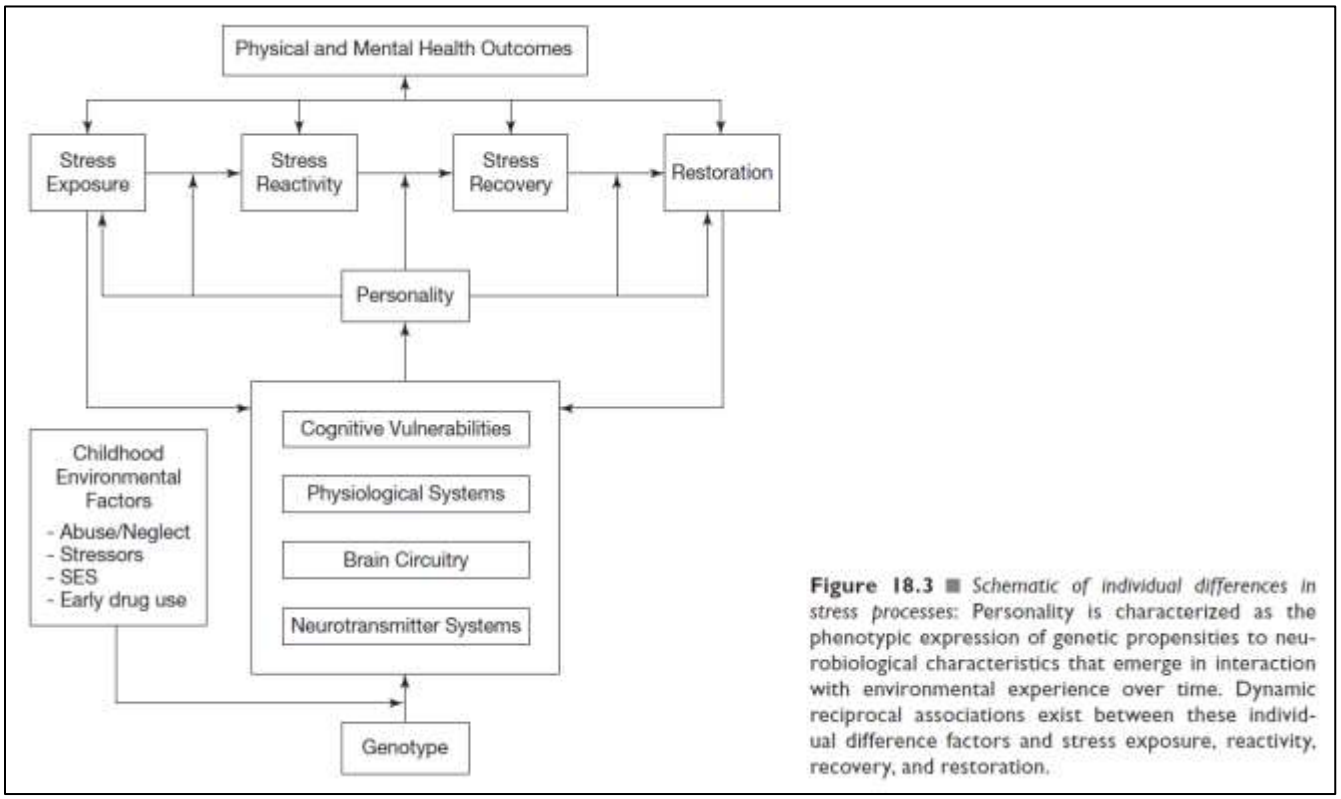

Figure 18.3 ■ *Schematic of individual differences in stress processes*: Personality is characterized as the phenotypic expression of genetic propensities to neurobiological characteristics that emerge in interaction with environmental experience over time. Dynamic reciprocal associations exist between these individual difference factors and stress exposure, reactivity, recovery, and restoration.