Mindfulness, Cortisol, and Sexual Minorities: Investigation of the effects of Mindfulness on Diurnal Cortisol Patterns in Sexual Minorities

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Honors Thesis
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Acknowledgments

I would first like to thank Andrew Manigault for all of his time, patience, and guidance in helping me write this. He helped to expand my knowledge and skills in research and academic writing, and helped to make this a truly positive learning experience. I would also like to thank Dr. Peggy Zoccola for giving me the opportunity to further develop my research interests, as well as her encouragement and guidance in preparing me for the rest of my academic career. Finally, I would like to thank James Emerson for always pushing me to move forward.
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Abstract

Previous research suggests that mindfulness is able to buffer against the effects of stress on health. The Mindfulness Stress Buffering Account (MBSA) posits that mindfulness can reduce stress reactivity (i.e. the magnitude of stress responses), most evidently in high stress populations. Of interest, sexual minority young adults (i.e., LGBTQ individuals) experience unique stressors in addition to general stressors, and the stress buffering effect of mindfulness has yet to be tested in an LGBT population. Additionally, Monitor and Acceptance Theory (MAT) posits that the benefits of mindfulness are dependent upon the interactive effect of both mindfulness subcomponents (i.e., attention monitoring and acceptance). Thus, the present study examined the effects of day-to-day stress and trait mindfulness on diurnal cortisol patterns in a population of sexual minority young adults. All participants (N = 121) self-reported trait mindfulness at the start of the study and daily stressors nightly over a seven-day period. A randomly selected subsample (N = 58) provided four saliva samples each day to assess diurnal cortisol. Greater trait mindfulness was expected to buffer against (i.e., moderate) the relationship between daily stressful events and diurnal cortisol output/slope, and the combination of high awareness and acceptance was expected to show the strongest stress buffering effect. Results indicated that daily stressful events and cortisol output/slope were unrelated, and mindfulness did not moderate (or buffer against) the effect of day-to-day stress on either cortisol slope or output. Finally, there was no indication that high awareness and acceptance more strongly moderated the effect of stress and cortisol. Nevertheless, acceptance scores were negatively associated with total stress scores. Implications for the mindfulness stress buffering account and monitor and acceptance theory are discussed.
Introduction

With over 3,000 scientific publications (Black, 2015), mindfulness, as well as mindfulness training interventions, have become increasingly popular subjects of research. Mindfulness can be described as the practice of monitoring experiences in the present moment, while adopting a position of acceptance (Lindsay, & Creswell, 2015). Mindfulness interventions are widely used in clinical populations to improve functioning, and reduce psychological distress (Veehof, ten Klooster, Taal, Westerhof, & Bohlmeijer, 2011). Mindfulness interventions are effective in improving cardiovascular function and efficiency via decreasing vascular resistance and ventricular overload (May et al., 2016), treating chronic insomnia (Ong et al., 2014), drug and alcohol use, (Alterman, Koppenhaver, Mulholland, Ladden, & Baime, 2004), improving quality of life in cancer patients (Carlson, Speca, Patel, Goodey, 2004), and reducing average levels of blood glucose in individuals with type 2 diabetes (Rosenzweig et al., 2007).

Some have proposed that mindfulness can result in a variety of positive health outcomes by buffering against the effects of stress on health (Creswell, and Lindsay, 2014). More specifically, the Mindfulness Stress Buffering Account (MSBA) suggests that the effects of mindfulness on health are limited to outcomes known to be initiated or exacerbated by stress, and that the effects of mindfulness on health will be most pronounced in individuals with high stress burden (e.g., unemployed adults). Stress experienced by sexual minorities (i.e., lesbian, gay, bisexual, and transgender individuals) goes beyond general stressors that apply to the majority of the population. This population experiences unique stressors characterized by emotional distress, discrimination, isolation, and rejection (Balsam, Beadnell, & Molina, 2013), which in turn increases susceptibility to negative health outcomes (e.g., stress-related diseases). As such, sexual minorities may benefit from mindfulness because they experience high stress burden.
According to the MBSA, the effects of mindfulness on health will be most evident in populations experiencing a high amount of stress, in which stress is likely to trigger or intensify disease pathogenic processes.

A new account suggests that the acceptance and monitoring (i.e., awareness) components of mindfulness may differentially influence stress responses (Lindsay and Creswell, 2017). That is, Monitor and Acceptance Theory (MAT) posits that present moment monitoring alone may increase affective reactivity while the synergy of both present moment monitoring and acceptance will show the greatest buffering effect. Some research supports the MAT in relation to depressive symptoms (Barnes & Lynn, 2010), tobacco and alcohol use (Eisenlohr-Moul, Walsh, Charnigo, Lynam, & Baer, 2012), and adaptive cognitive processing tendencies such as reappraisal (Desrosiers et al., 2014). However, no study to date has investigated predictions of the MAT in relation to Hypothalamic Pituitary Adrenocortical (HPA) axis functioning in daily life. As such, the purpose of this project was to address this gap in the literature by investigating predictions of the MAT on the relationship between daily stress and diurnal cortisol exposure in sexual minority young adults. Based on the MSBA, it was hypothesized that dispositional, or trait, mindfulness would moderate the relationship between daily stress and cortisol exposure, such that greater mindfulness would reduce the strength of the stress-cortisol exposure relationship. Additionally, based on the MAT, it was predicted that both high degrees of present moment awareness and acceptance would be associated with stress buffering effects, while high present moment awareness alone would not.

**Stress and Health**

Research involving stress has become increasingly important to the field of health psychology, as stress can have deleterious effects to our overall health. A “stressor” is a
perceived or actual threat experienced by an individual, and the reaction to the stressor is the “stress response”. The way an event is appraised is determinant of whether a stress response will be triggered. A threat to one individual is not necessarily a threat to another. Thus, perception plays an important role in the stress response (Folkman & Lazarus, 1985). Acute stressors can be exhilarating (i.e., increased energy) as well as exhausting. An acute stress response typically arises and subsides rapidly, following a reaction to an immediate perceived threat or situation via effective feedback mechanisms. Conversely, a chronic stress response is a sustained or dysregulated response that becomes increasingly destructive to the body. Chronic stress typically manifests itself in individuals who face unrelenting pressures and demands for extended periods of time, like those in dysfunctional families or of low socioeconomic status (Miller, & Rothstein, 1994).

While having an influence on our behavior, mood, and well-being, acute stress also brings about changes in the physiological systems of the body (i.e., increased blood pressure/heart rate, altered immune function). Similarly, various functions of the body can become adversely affected by chronic stressors (e.g., the immune system, gastrointestinal function, growth development, sleep, memory, cardiovascular, reproductive, and metabolic systems). For example, chronic stress is associated with increased rates of viral replication in HIV patients (Cole, Korin, Fahey, & Zack, 1998). In regard to immune function, high levels of chronic stress have been found to be associated with lower secondary antibody responses to immunization (Sheldon Cohen, Miller, & Rabin, 2001), as well as suppression of both cell-mediated and humoral immunity (Segerstrom & Miller, 2004). Susceptibility to viruses, such as the rhinovirus, is also increased as amount of stressful life events and perceived stress increase (Schneiderman, Ironson, & Siegel, 2005). In sum, the effects of stress on health are extensive.
**Stress and Allostasis**

The body copes with environmental, psychosocial, and physical stressors by producing certain neurotransmitter and hormonal mediators (e.g., cortisol, catecholamines) in an effort to initiate coordinated physiological responses to deal with the stressor (McEwen, & Seeman, 2009). It is hypothesized that under certain circumstances, physiological responses to acute stress which are normally adaptive can become dysregulated and contribute to negative health outcomes – a theory known as the Allostatic Load Model (McEwen, 1998). The model encompasses four key features, the first being that the brain coordinates neuroendocrine and behavioral responses to situations, to which some are perceived as stressful. Second, based on developmental and biological factors, individuals differ greatly in their ability to cope with stressors. For example, early life stress, such as abuse, may predispose an individual to increased physiological responses to challenges throughout life. Third is the ability to turn on and off stress responses efficiently. Finally, that type of dysregulated stress response (e.g., chronic over activity) is associated with wear and tear on the body when it is forced to adapt to adverse challenges and environments. In sum, the Allostatic Load Model outlines a mechanism by which stressors, both acute and chronic, can have a wide range of negative effects on health.

More specifically, the Allostatic Load Model suggests that physiological systems (e.g., cardiovascular, immune, hormonal), adjust to stressful challenges through allostasis (McEwen, & Seeman, 2009). Allostasis, or “stability through change”, is a process in which an organism maintains balance and regulation in physiological functions (i.e., homeostasis) as changes in environmental demands occur (Sterling, Eyer, 1988). For example, as physical and emotional demands during the day change, the cardiovascular system responds with an increase in blood pressure to provide adequate blood flow. Blood pressure is returned to baseline when there is no
longer a physical or emotional demand. Since allostasis is thought to develop over a long period of time, the result may be modifiable set points of various physiological systems (i.e., repeated alterations in physiology may increase resting blood pressure). Thus, duration of the stress response is an important predictor of the effects it will have on health (Stults-Kolehmainen, Tuit, & Sinha, 2014). Allostatic load is the wear and tear experienced by the body following repeated allostatic responses, as well as inefficient turning on and off of these responses (McEwen, & Seeman, 2009). Incessant activation of the systems, failure of the systems to shut off following the stressor, and deficient system responses that cause increased activity of counter-regulated allostatic systems following stress, are all situations thought to lead to allostatic load (McEwen, 1998). For example, individuals of low socioeconomic status experience financial burden, which can manifest itself in repeated novel stressors and activate the stress response too frequently. When activation of allostatic systems become too frequent, elevated blood pressure and glucocorticoids exposure in response to stress can accelerate negative health outcomes (e.g., Type II diabetes, and obesity). Deficiency of systems, such as chronically low HPA activity, can also be associated with elevated activity of counter-regulated systems, such as inflammatory cytokines (McEwen, 1998). For example, Sternberg et al. (1989) found that development of arthritis in Lewis rats is related to inadequate levels of cortisol resulting from defective HPA axis responsiveness to inflammatory and other stress mediators. In conclusion, the Allostatic Load Model provides a mechanism by which stress can affect various health outcomes—via dysregulation of allostatic systems and overexposure of stress mediators like cortisol.

**The Hypothalamic Pituitary Adrenocortical (HPA) Axis**

The Allostatic Load Model identifies cortisol as a primary stress mediator due to its significant effect on the body, and its role in promoting allostasis. Cortisol, a glucocorticoid
hormone, is the eventual result of the Hypothalamus-Pituitary-Adrenal (HPA) axis activation (Stalder et al., 2015). Cortisol is secreted as a result of stressful situations (e.g., trauma, pain, surgery, infections, and apprehension). When one experiences a stressor, the hypothalamus first releases Corticotropin-Releasing Hormone (CRH), which in turn stimulates the release of Adrenocorticotropic Hormone (ACTH) from the anterior pituitary gland. The key target for circulating ACTH through the bloodstream is the adrenal cortex, which subsequently stimulates the release of cortisol (Smith, Vale, 2006). ACTH and cortisol are necessary for survival functions in that the body is able to survive the immediate crisis of stressors by releasing adrenocortical hormones as well as adrenaline to deal with a perceived threat and danger (e.g., a physical threat). Cortisol prepares the body for a response by mobilizing energy. It also augments cardiovascular activity, and enhances memory in the short term. While these “stress mediators” are adaptive and protective, they may also result in damaging effects to the body when exposure to them are prolonged (McEwen, & Seeman, 2009). A response is generally considered to be adaptive when it facilitates the mobilization of energy, the organism is able to respond, and then the reaction subsides once the perceived threat is over. However, if cortisol is secreted too frequently, or fails to return to baseline levels following a threat, the increased exposure will enable cortisol to affect the body in a different way. For example, cortisol exerts anti-immune and anti-reproductive effects. Such effects are minimized when exposure is low, but may negatively impact health when exposure increases. Thus, inefficient HPA axis activation may lead to increased cortisol exposure thereby promoting allostatic load, and ultimately negative health outcomes. As such, cortisol provided the present study with an ideal dependent measure because cortisol is a primary stress mediator, which widely impacts health.
**Diurnal Cortisol**

Relevant to the present investigation, cortisol secretion does not only occur as a result of acute stress. In healthy individuals, cortisol secretion follows a diurnal rhythm throughout the day, meaning that there is a rapid increase before awakening, a peak shortly following awakening, and subsequently shows a steady decline throughout the rest of the day (Jobin, Wrosch, Scheier, 2014). A change in cortisol concentration typically takes place during the first hour after waking, with the most concentrated peak happening between 20-45 minutes (Chida, Steptoe, 2008). Subsequently, cortisol levels typically decline throughout the remainder of the day.

Diurnal slopes as well as cortisol output are of particular interest to the present research as they have been shown to be associated with perceived stress (Lovell, Moss, & Wetherell, 2011) and a number of important health and well being outcomes. For example, a flattened slope can be characterized by elevated evening cortisol levels and may be indicative of HPA axis dysfunction (R. Ryan, Booth, Spathis, Mollart, & Clow, 2016). Both chronic as well as acute stress are associated with flattened diurnal cortisol slopes. For example, flattened diurnal cortisol slopes have been linked to higher levels of perceived stress, poor performance on explicit memory tasks, larger waist circumference, and lower perceived social support (Abercrombie et al., 2004). Goodwin et al. (1987) found that chronic stress due to loss of marital support was associated with flattened diurnal profiles, which subsequently was linked to poorer cancer outcomes. Similarly, Jobin et al. (2014) found that pessimists, who typically have higher baseline stress levels, showed elevated afternoon/evening cortisol levels on days that they had higher perceived levels of daily stress. It is worth noting that this effect was not found in the CAR measurement among their participants. In regard to cortisol output, Stawskit et al. (2013)
conducted a study looking at the association between daily stressors and salivary cortisol. A large sample of adults (N = 1694) completed telephone interviews assessing daily stressors, as well as emotions for an 8-day period. Saliva samples were also taken at 4 time points: upon waking, 30 minutes after waking, before lunch, and before bed. They found increased cortisol AUC to be associated with stressor days relative to days participants were stressor-free. This suggests that increased cortisol output is associated with daily stressors. Due to the present focus on daily stressors, evening cortisol (in the form of total exposure) as well as diurnal slope was used as primary outcomes because they both provides a valid operationalization of stress-induced HPA axis activation in daily life.

**Sexual Minority Stress**

Compared to heterosexuals, sexual minority individuals (e.g., lesbian, gay, and bisexual men and women) report poorer mental and physical health (Institute of Medicine, 2011). For example, Mays and Cochran (2001) found that lesbians, compared to heterosexual women, were 3.9 times more likely to suffer from generalized anxiety disorder, and 2.9 times more likely to experience comorbid mental disorders. Similarly, they also found that gay men, compared to heterosexual men, were 5 times more likely to suffer from panic disorders, 3.6 times more likely to suffer from major depression, and 3.9 times more likely to experience comorbidity of mental disorders. Previous research has also revealed that lesbian and bisexual women may be at greater risk for heart disease compared to heterosexual women (Diamant, Wold, Spritzer, & Gelberg, 2000). Taken together, these statistics indicate that sexual minority individuals are subject to numerous health disparities relative to their heterosexual counterparts.

Meyer (2003) offers a model (see Figure 1) depicting the impact of stress and coping on mental health outcomes. The model describes circumstances within an individual’s environment
that may lead to stressor exposure (e.g., general stressors, and minority stressors). An individual’s minority identity (i.e., gay, lesbian, bisexual) leads to additional stressors. These stressors are related to perception and appraisals of oneself as a stigmatized minority.

Unique stressors experienced among sexual minority individuals may contribute to disparities in health. Stress experienced by sexual minorities is unique in that this population experiences minority specific stressors (i.e., minority stress) as well as stressors that are non-minority specific. Minority stress refers to stressors experienced by individuals that are associated with the minority group to which they belong, such as racial, ethnic, or sexual minorities (Wong, Schrager, Holloway, Meyer, & Kipke, 2014). Minority stress theory posits that disparities in mental and physical health among sexual minority populations can be attributed to stressors relating to stigma, prejudice, and discrimination toward this population (LeBlanc, Frost, & Wight, 2015). Stigmatization results in increased exposure to acute stress, which overtime can lead to negative physical and psychological health outcomes. Stigma refers to a co-occurrence of stereotyping, separation, labeling, status loss, and discrimination in the context of power being exercised (Hatzenbuehler, Phelan, & Link, 2013). Further, meta-analytic, as well as experimental studies, have showed that stressors associated with uncontrollable social evaluations are powerful elicitors of HPA-axis activation (Dickerson & Kemeny, 2004; Dickerson, Mycek, & Zaldivar, 2008). Thus, cortisol is a relevant measure associated with stigma and stress. Minority stressors fall on a continuum related to proximity to the self (i.e., some stressors are distal while others are proximal). Stressors distal to the self are primarily based on environment, and do not typically depend on the individual’s appraisal of the event (e.g., prevailing stereotypes, and explicit actions of prejudice). Stressors proximal to the self include internalizations of negative social attitudes toward the minority group to which one
belongs. For example, internalized homophobia is the expectation of negative social attitudes from members of the majority (LeBlanc et al., 2015).

Along with prejudice events (e.g., discrimination, violence), minority stress also encompasses components of social stress such as expectations of rejection, and stress associated with concealment of sexual identity (Balsam et al., 2013). Individuals who identify as lesbian, gay, or bisexual are more likely than heterosexuals to report day-to-day as well as lifetime discrimination, and are twice as likely to experience a life event related to prejudice, such as being fired from a job due to their sexual minority status (Mays & Cochran, 2001). Sexual minority individuals who experience rejection, such as that from family, show increased chances of suicide, depression, risky sexual behavior, and illegal drug use compared to sexual minority individuals who do not experience rejection (C. Ryan, Huebner, Diaz, & Sanchez, 2009). Concealment of sexual identity may present a difference in the type of stressors experienced. Those who choose to conceal their sexual orientation may be subject to more internal stressors, while those who disclose their sexual orientation may experience more external stressors, such as anti-LGBT behaviors from others (Balsam et al., 2013). Resulting from unique stressors caused by stigmatization, research has revealed various mental health burdens among sexual minorities, such as increased risk of depression and anxiety (King et al., 2008). However, this effect is not limited to negative mental health outcomes, but negative physical health outcomes as well. Stigma can adversely affect health directly by restricting access to healthcare or activating stress responses, and indirectly by weakening positive health behaviors (Major, Mendes, & Dovidio, 2013).

In sum, sexual minorities experience minority specific stressors in varied forms, and such stressors are thought to burden LGBT individuals beyond non-minority specific stressors.
Ultimately, the additive effect of minority specific stressors and non-minority specific stressors is thought to contribute to the disparities in health observed among sexual minority individuals and their heterosexual counterparts. This population therefore stands to gain from interventions that buffer against the effects of stress on health. Additionally, given that the present project aimed to examine the stress buffering effects of mindfulness on health, the LGBT population provided an ideal study population. Some have proposed that the stress buffering effects of mindfulness will be most pronounced in populations suffering from high stress burden (Creswell, & Lindsay, 2014). Thus, given that the LGBT population has multiple sources of stress, this population stands to benefit from such interventions, and the effects of mindfulness may therefore be more salient in this population.

**Mindfulness**

While stigmatization of sexual minorities can bring about unique stressors that in turn increase susceptibility to negative health outcomes, certain interventions can help to buffer against the effects of stress on health. One such intervention is the development of mindfulness. Mindfulness is commonly defined as the practice of bringing a certain quality of attention to the present moment, while adopting a position of acceptance (Lindsay, & Creswell, 2015; Kabat-Zinn, 1990). Development of mindfulness is thought to be achieved through the practice of meditation. One such example, concentrative meditation, involves sustained attention to a simple stimulus (e.g., breathing) for extended periods of time. In the event that the mind wanders off during meditation, practitioners are instructed to redirect their attention toward the meditative target. Generally, mindfulness is considered to be a state, and the ability to transition into a mindful state is thought to develop through meditation practice. Finally, once developed,
mindfulness is thought to influence various aspects of daily life (e.g., emotion regulation; Bishop et al., 2004).

Many conceptualizations of mindfulness have been proposed, and a consensus regarding an absolute definition of mindfulness has yet to be achieved. However, two components seem to remain consistent across varied mindfulness definitions—present moment awareness and acceptance. Based on this observation, Bishop et al. (2004) suggest that mindfulness follows a two-factor structure involving “self-regulation of attention” (i.e., maintenance of attention on immediate experience), and “attitudinal orientation” or mindful acceptance (i.e., acceptance, curiosity, and openness). According to Bishop et al.’s model, orientation to one’s present moment experience begins with a commitment to an attitude of curiosity to the wandering of the mind, as well as observation and acceptance of various thoughts, feelings, and sensations that arise. Self-regulation of attention supports a non-elaborative awareness of one’s experiences, as opposed to a ruminative stream of thoughts about the experience. They propose that mindfulness is not thought suppression, but that thoughts, feelings, and sensations are objects of observation, and not distractions. Such observations require a certain awareness of the present moment, which further allows a position of acceptance to be adopted. Thus, the components of awareness and acceptance must both be considered specifically to understand the buffering effects of mindfulness on stress and health.

Awareness

Mindful awareness is initiated by bringing an awareness to a present moment experience by “observing and attending to the changing field of thoughts, feelings, and sensations from moment to moment” (Bishop et al., 2004, p. 232). As various thoughts, feelings, and sensations arise in a current experience, keeping sustained attention to the breath keeps the mind in the
present moment. Further, if the mind starts to wander, redirecting attention to the breath brings awareness back to the present moment as opposed to focusing on worries, or ruminations. Self-regulation of attention also emphasizes a non-elaborative awareness to inhibit secondary elaborative processing. This suggests that rather than centering in on elaborations of an experience (e.g., associations, origins, or implications), one acknowledges the various thoughts and directs awareness back to the present moment (Bishop et al., 2004).

Of interest, the awareness component of mindfulness seems to find empirical support beyond a theoretical conception. For example, previous research illustrating awareness as a component of mindfulness deals with emotional awareness. Brown and Ryan (2003) assessed emotional states of participants both implicitly (Implicit Association Test) and explicitly (self-report), and found that people high in mindfulness, measured using the Mindful Attention Awareness Scale (MAAS), showed positive correlations between self-reported and implicitly measured emotional states. Conversely, those low in mindfulness showed no correlation between the two. This suggests that people high in mindfulness are more aware or attuned to their emotions, thus having a greater awareness of those emotions. More specifically, those high in mindfulness may practice self-regulation of attention directed towards present moment experiences (which includes emotional states) more habitually than those who are low in mindfulness, and thus report explicit and implicit emotional states, which are more consistent with one another. Another study done by Hodgins and Adair (2010) compared visual attentional processing between adult meditators and non-meditators through various cognitive tasks. These tasks included measures of perspective-shifting, concentration, change blindness, selective attention, and sustained inattentional blindness. They found that experienced meditators were able to notice a greater number of changes more quickly in flickering scenes, identify more
alternative perspectives in various images, had more accurate counting in a concentration task, and showed fewer interferences due to invalid cues in a visual selective attention task. Thus, these findings provided some preliminary evidence for sustained attention onto present experiences (i.e., mindful awareness) being an essential component of mindfulness.

**Acceptance**

Along with awareness arises the second component of mindfulness—acceptance. When practicing mindfulness, individuals incorporate a certain openness and acceptance to internal as well as external stimuli in their moment to moment experiences (Keng, Smoski, & Robins, 2011). Along with being open to experiences, acceptance in this case is also non-judgmental. In other words, acceptance of the present moment is “allowing” current sensations, thoughts, and feelings to happen, and to disregard expectations of having a particular or differing experience (S. C. Hayes, Strosahl, & Wilson, 1999). Finally, some suggest that this component of mindfulness involves maintaining curiosity about the wandering of the mind from the breath to various thoughts and objects of one’s current experience. In sum, this account suggests that mindful acceptance incorporates curiosity, non-judgment, and openness directed towards present experiences.

Interventions aimed at manipulating mindfulness, like Mindfulness-Based Stress Reduction (MBSR), and Mindfulness-Based Cognitive Therapy (MBCT), focus on teaching mindful meditation in order to facilitate a non-judgmental acceptance of the stimuli being observed (Kabat-Zinn, 1982). For example, individuals in MBSR and MBCT interventions are instructed to let go of judgment, elaboration, and interpretation of the present moment experience, as opposed to trying to change or avoid the situation. Rather than being preoccupied and avoidant to an experience, one is actively attending to internal and external stimuli (Breslin,
Furthermore, some empirical research supports the role of acceptance in mindfulness. Baer et al. (2006) conducted a study in order to examine the relationship between openness to experience and trait mindfulness. Various descriptions of mindfulness include receptivity and attentiveness to feelings and observation of internal and external stimuli. Thus, individuals shown to be higher in openness to experiences would intuitively be more accepting of experiences in the present moment. In this study, 613 undergraduate students completed five mindfulness questionnaires: the Mindful Attention Awareness Scale (Brown & Ryan, 2003), the Freiburg Mindfulness Inventory (Buchheld, Grossman, & Walach, 2001), the Kentucky Inventory of Mindfulness Skills (Ruth A. Baer, Smith, & Allen, 2004), the Cognitive and Affective Mindfulness Scale (A. M. Hayes & Feldman, 2004), and the Mindfulness Questionnaire (Chadwick et al., 2008). They found a positive correlation between openness to experience and mindfulness across all scales tested. Thus, there is some preliminary evidence suggesting that acceptance is a core component of mindfulness.

**Operationalization of Mindfulness**

Typically, mindfulness is operationalized using behavioral measures, intervention programs, and self-report scales. Behavioral assessments, such as a self-prompted mindfulness task, are suggested to be useful in measuring mind wandering (i.e., task-unrelated thoughts). Mind wandering is thought by some to be antithetical to mindfulness, however assessment of mindfulness behaviorally may require more than just measures of mind wandering due to its subjective nature (Quaglia et al., 2014). Intervention programs are also used as a way to operationalize mindfulness. For example, the Mindfulness Based Stress Reduction Program (MBSR) is a systematic approach to teaching mindfulness meditation in order to enhance moment-to-moment awareness of experiences (Grossman, Niemann, Schmidt, & Walach, 2003).
In the program, individuals spend 8-10 weeks learning meditation practices, discussing mindfulness techniques, and receiving daily mediation/yoga assignments to do on their own. Lastly, self-reported scales are also used to measure mindfulness. Scales can either measure dispositional (i.e., experiencing mindfulness over time and situations), or state mindfulness (i.e., experiencing mindfulness at a specific time or situation).

Self-report scales can differ in intended use as well as in conception. The intended use of a scale generally pertains to a certain targeted population. For example, the MAAS was developed to be used in assessing variations in mindfulness in the general population. Conceptually, scales may differ in the processes, aside from attention and awareness, which may be included in measurement. More specifically, there is overlap regarding the acceptance component of mindfulness. Some scales also consider it to be a form of emotional regulation (Aldao, Nolen-Hoeksema, & Schweizer, 2010), or a coping strategy (Carver, Scheier, & Weintraub, 1989).

While differences in conception can occur, such as overlap in a certain component, other self-report scales can be useful in assessing both essential components of mindfulness—mindful awareness and acceptance. For example, the Five Facet Mindfulness Questionnaire (FFMQ) is a scale that encompasses five component skills including describing, observing, acting with awareness, nonreactivity, and nonjudgment of inner experiences. Previous research has indicated a possible relationship between psychological adjustment (i.e., symptoms, and well-being) and the five facets, which varies with mediation experience (Baer et al., 2008). Researchers have used the subscales Observe and Nonreactivity within the FFMQ previously in order to measure the mindful awareness and acceptance components of mindfulness, respectively (Lindsay & Creswell, 2017). These findings suggest that conceptualization of mindfulness as a two-factor
construct is useful in helping to explain its relation to other variables (e.g., stress). Given the interest of the present study, the FFMQ is a fitting operationalization of mindfulness in that it is likely to capture aspects of mindfulness relevant to the present Hypotheses (e.g., mindful acceptance and awareness), while also measuring other constructs thought to change as mindfulness develops.

The Mindfulness Stress Buffering Account

Previous research suggests that mindfulness may have an impact on physical as well as mental health (Kabat-Zinn et al., 1998; Teasdale et al., 2000). Creswell and Lindsay (2014) offer a model to explain the link between health and mindfulness—the mindfulness stress-buffering account. This model postulates that mindfulness affects a wide range of health outcomes by diminishing the effect of stress on health (e.g., decreases stress reactivity responses, and mitigates stress appraisals). They predict that the effects of mindfulness on health will be most evident in high stress populations (e.g., unemployed adults) and/or when stress is likely to trigger or intensify disease pathogenic processes.

Previous studies have shown results consistent with the predictions of the mindfulness stress-buffering account. For example, stress has been shown to contribute to some of the negative outcomes associated with cardiovascular disease, HIV/AIDS, and cancer (Sheldon Cohen, Janicki-Deverts, & Miller, 2007). Stress tends to exacerbate disease pathogenesis. For example, stress is associated with greater metastasis and cancerous tumor growth, as well as more rapid HIV infection. Stress is also hypothesized to trigger the onset of major depression, as well as post-traumatic stress disorder. Conversely, mindfulness seems to gear the progression of such diseases in the opposite direction. More specifically, mindfulness training interventions have been shown to buffer CD4+ T lymphocyte declines in adults with HIV (Creswell, Myers,
Cole, & Irwin, 2009), reduce post-stress inflammation (Rosenkranz et al., 2013), increase psoriatic lesion resolution (Kabat-Zinn et al., 1998), and reduce risk relapse/recurrence in patients recovering from major depression (Teasdale et al., 2000). The evidence presented is consistent with the mindfulness stress-buffering account in that it suggests the negative effects of stress on health can be reduced by mindfulness.

With initial evidence suggesting an effect of mindfulness on health via stress, it is important to take note of the biological pathways thought to be associated with this process. Mindfulness is suggested to alter the way in which stress is processed in the brain, which in turn affects peripheral stress-responses and potential risks for disease. Mindfulness has been shown to influence two pathways in the brain, a “top-down” regulatory pathway (i.e., inhibited activity in region of stress-processing) and a “bottom-up” reduced stress-reactivity pathway (i.e., modulation of the reactivity of those stress-processing regions; Creswell & Lindsay, 2014). Creswell and Lindsay’s model further postulates that if stress-processing in the brain can be modified by mindfulness, then physiological stress responses cascade, like the HPA axis as well as the sympathetic-adrenal-medullary (SAM) axis should also be influenced.

Some experimental studies suggest that mindfulness influences HPA axis activation during stress. For example, Brown et al. (2012) conducted a study in which undergraduates were assessed in trait mindfulness, anxiety, perceived stress, and fear of negative evaluation. Participants were then exposed to situations of high or low stress. The high stress situation was the Trier Social Stress Test (TSST), which included speech-based and math tasks in front of evaluators. In the low stress or control situation, participants performed the task alone and into a recorder. Their results revealed that in the high stress situation, those higher in trait mindfulness showed less cortisol reactivity compared to those lower in trait mindfulness, as well as lower
anxiety and negative affect. In the low stress situation there was no relationship between cortisol reactivity and mindfulness. Another study done by Carlson et al. (2004) looked at the relationship between early stage prostate and breast cancer, and a Mindfulness-Based Stress Reduction (MBSR) program. They assessed quality of life, perceived stress, mood, and cortisol levels in fifty-nine patients with breast cancer, and ten patients with prostate cancer. Participants were enrolled into an eight-week long MBSR program that included meditation, yoga, relaxation, as well as home practices. They found improvements in quality of life, sleep quality, and perceived stress. Improvements in quality of life were also found to be significantly related to decreases in afternoon cortisol levels, but not morning or evening levels. Their preliminary findings suggest that MBSR may be able to reduce symptoms of stress in breast and prostate cancer patients, and further, may possibly present beneficial changes in HPA-axis functioning. Similarly, a short-term meditation training method implemented by Tang et al. (2007) was shown to decrease stress-related cortisol in 40 undergraduate students when compared to a control group that received relaxation therapy. Further, they found that participation in the meditation training was associated with an increase in sIgA antibody production (i.e., a measure of immunoreactivity), scores on the vigor on the Profile of Mood States scale, as well as a decrease in anxiety, anger, fatigue, and depression, relative to control training. These findings provide evidence of the influence mindfulness may have on perceived stress, and HPA axis functioning.

In sum, the mindfulness stress-buffering account offers a description of mindfulness and its direct effects on health. The model describes biological pathways in which stress processing is altered and thus reduces SAM and HPA-axis reactivity. The model allows for further investigation of the impact stress has on health, and the possible buffering effects of mindfulness.
Relevant to the present study, possible health benefits that follow from mindfulness are useful for populations experiencing high amounts of or unique stressors, such as sexual minorities. The present study sought to expand on the findings of previous research in an attempt to further understand the buffering effects mindfulness has on stress and cortisol in daily life. To do this, it tested if trait mindfulness buffers against the effects of daily stress on diurnal cortisol in a population of sexual minority young adults over the course of a week.

**Monitor and Acceptance Theory**

While there is growing evidence of the positive effects mindfulness training has on health, speculation still remains about the mechanisms underlying mindfulness interventions. Lindsay and Creswell (Lindsay & Creswell, 2017) offer a theoretical account of some of those mechanisms called the Monitor and Acceptance Theory (MAT). They propose that the basic mechanisms underlying the benefits of mindfulness are dependent upon the interactive effect of attention monitoring and acceptance. Specifically, MAT posits that attention monitoring along with acceptance produces harmonious effects in mindfulness training. According to MAT, attention monitoring training enhances present moment awareness. Alone, attention monitoring is ample enough to improve various cognitive effects such as working memory, task switching, and sustained attention. However, through development of attention monitoring skills, attention toward noticeably positive and negative stimuli is enhanced. Thus, mindful awareness alone may not be sufficient to improve performance on tasks that require emotion regulation (e.g., stressor tasks). For example, monitoring body sensations (e.g., heart rate) during a panic attack could lead to symptom exacerbation (Ehlers & Breuer, 1996). However, with the addition of acceptance skills, improvements in stress and physical health may be seen. It is important to note the nature of the acceptance mechanism in mindfulness training. Rather than acceptance being
taught as an isolated skill, it is synergistically combined with attention monitoring. Attention monitoring provides a basis for noticing moment-to-moment experiences, and those experiences are viewed with an attitude of acceptance.

MAT’s first main tenet is that attention monitoring enhances awareness (Lindsay & Cresswell, 2017). While there is limited experimental work directly testing MAT, various self-report mindfulness questionnaires with subscales representative of attention monitoring and acceptance have been used in previous research. For example, the FFMQ and its subscales Observe and Nonreactivity have been used in various studies to assess these two mechanisms. MAT proposes that attention monitoring can improve cognitive functioning outcomes that are affectively neutral. Evidence for this can be seen in a study done by Moore and Malinowski (2009). They found monitoring skills to be related to performance on a focused attention task in a mixed sample of non-meditators and meditators. Along with improving cognitive outcomes, MAT also predicts that increased attention monitoring will worsen negative reactivity, and further, enhance positive reactivity. Without acceptance, negative thoughts and feelings can be exacerbated. Conversely, monitoring positive cues can intensify positive experiences. Studies have found psychological distress (e.g., depressive, and stress symptoms) to be associated with monitoring (Barnes & Lynn, 2010; Hamill, Pickett, Amsbaugh, & Aho, 2015). Along with focus on negative cues, MAT further suggests that through affective reactivity, monitoring skills may have an effect on stress-related health outcomes. For example, monitoring has been shown to predict higher anorexic symptoms (e.g. focus on weight and food; Adams et al., 2012). Monitoring has also been found to be associated with increased physician visits, and poorer subjective health (Consedine & Butler, 2014).
MAT’s second main tenet is that when paired with acceptance, monitoring mitigates affective reactivity. More specifically, the MAT predicts that the combination of acceptance and monitoring leads to improvements in affective-cognitive tasks. While acceptance has been found to be associated with improved performance on the Stroop task (Moore & Malinowski, 2009), studies testing the combined effects of acceptance and attention monitoring are lacking. Another MAT prediction is that attention monitoring, and high levels of acceptance are associated with stress reduction, and improved affective outcomes. Barnes and Lynn (2009) found that among students with low levels of acceptance, monitoring was associated with increased depressive symptoms. However, attention monitoring was not associated with depressive symptoms at high levels of acceptance. Their findings help to illustrate that acceptance can moderate the relationship between outcomes of psychological distress (e.g., depression), and monitoring. The last prediction the MAT makes is that the synergistic effects of monitoring and acceptance describe the mechanism for which stress-related health outcomes are improved by mindfulness interventions (Creswell & Lindsay, 2014). A study done by Tomfohr et al. (2014) looked at the effects mindfulness had on markers of inflammation, specifically through the combined effects of acceptance and monitoring. They found that monitoring alone was not associated with IL-6 levels (i.e., a marker of inflammation), however, those higher in both monitoring and acceptance had low IL-6 levels.

In sum, MAT posits that attention monitoring can improve moment-to-moment awareness. Alone, monitoring can improve cognitive function in a neutral affective situation. Further, monitoring intensifies affective reactivity by worsening negative experiences, and augment positive experiences. Acceptance changes the relation one has to a present moment experience, thus regulating affective reactivity. Acceptance improves emotionally regulated
tasks, reduces negative reactivity, and helps stress-related outcomes. While the findings presented provide preliminary evidence for the underlying mechanisms of mindfulness training, more research is needed in order to draw definitive conclusions about these mechanisms. The present study therefore sought to expand on previous research by testing predictions of the MAT.

**Research Goals**

Mindfulness has been proposed to positively affect health by buffering against stress (Creswell & Lindsay, 2014). Nevertheless, support for this theory has been primarily anecdotal, or focused on acute stress responses. As such, the present project aimed to extend previous work by investigating the effects of trait mindfulness on the relationship between day-to-day self-reported stress, and diurnal cortisol secretion. Additionally, the stress buffering effects of mindfulness was tested using a sample of sexual minority young adults. As reviewed, the effects of mindfulness are more pronounced in high stress burden population, and sexual minority young adults are affected by minority specific stress in addition to general stress. Therefore, the buffering effects of mindfulness should be particularly salient in this population. Finally, the present project aimed to test predictions of the Monitor and Acceptance Theory. More specifically, the present project investigated the degree to which both components of mindfulness (i.e., awareness and acceptance) were necessary for the stress buffering effects of mindfulness to occur.

**Hypotheses**

The following Hypotheses were tested in the present study: (1) Higher self-reports of day to day stressful events would be associated with greater diurnal cortisol output and flattened slope; (2) Trait mindfulness would moderate the relationship between daily stressful events and diurnal cortisol output as well as slope such that the positive relationship between daily stressful
events and diurnal cortisol output/slopes would be smaller for participants who scored high in trait mindfulness relative to low mindfulness; (3) The moderating effect of mindfulness on the relationship between day to day stressful events and diurnal cortisol output/slope would be strongest for participants who scored high in both mindful awareness and acceptance; (4) High total trait mindfulness would be associated with lower daily stress; (5) Daily stress would be negatively associated with mindful awareness and acceptance.

Method

Participants

The present sample enrolled into the Daily Activities, Stress, and Health (DASH) Study at Ohio University between April 2015 and June 2016. The sample consisted of 121 (66 biologically female; 55 biologically male) U.S. participants between the ages of 18 and 35 ($M = 25.35, SD = 4.544$). Participants were sexual and gender minority adults with 66.1% identifying as gay, lesbian, or homosexual, 19.8% identifying as bisexual, and 14.8% other. This sample was predominantly white (80.2%) with 12.4% identifying as multi-racial, 3.3% Hispanic, 2.5% as Black or African-American, 0.8% Asian, and 0.8% American Indian or Alaskan native. A randomly selected subset (N = 58) also provided four saliva samples daily during the week of daily diary surveys, and is the focus of this report. Among the 58 participants assigned to provide saliva samples, 5 did not return saliva samples (88.6% completion rate), and 4 deviated from cortisol sampling procedures. The remaining 49 participants with valid cortisol data (30 biologically female; 19 biologically male; age $M = 24, SD = 4.1$) were 79% White, 14% multi-racial, 2.0% Hispanic, 2.0% as Black or African-American, 2.0% Asian, and self-identified as 61% homosexual, 21% bisexual, and 18% other sexual orientation. Participants who provided cortisol data did not differ from those who did not with respect to sexual orientation $\chi^2(4, N =$
Recruitment methods included contact via email with LGBTQ organizations, social media, and listservs in Ohio as well as surrounding areas. Those contacted were encouraged to reach out to friends who may be eligible to participate. Figure 2 shows enrollment, dropout, and randomization information. There were 512 individuals who completed the eligibility screening. Among these individuals, 324 dropped out due to ineligibility (N = 241) or opted to not continue with enrollment (N = 83). The remaining 188 individuals completed the baseline survey, and following that 54 were excluded due to an incomplete survey (N = 44), ineligibility (N = 8), or non-US (N = 2). The remaining 134 participants were randomized into a survey only condition (N = 68), or a survey and cortisol condition (N = 66). Of those in the survey only condition, 5 ended up declining to participate further or did not respond. Of those in the survey and cortisol condition, 8 individuals declined to participate, or did not respond. Further, 5 participants who were enrolled either did not collect, or did not return cortisol samples. Thus, the final sample for testing cortisol-related hypotheses was 49 participants.

Procedures

Individuals were emailed a link for the screening instrument to determine eligibility via an online survey. Those who were found to be eligible were then linked to an online consent form for the baseline survey. Recruitment materials contained a link for a 5-minute screening survey online to determine their eligibility. Individuals were eligible if they indicated they (a) had reliable Internet access in the evening, (b) identified as a sexual or gender minority (i.e., lesbian, gay, bisexual, transgender, or “other”), (c) were between the ages of 18-35, (d) reported
having no major psychological or endocrine disorders, (e) were not pregnant, and (f) did not report taking any steroid-based medications.

Participants completed a baseline survey assessing the following: demographics, perceived stress (over the last month), LGBT-specific stressors, rumination, worry, dispositional hardiness, perceived social support, and social connectedness to the LGBT community. In addition, the following were also examined: medication use, frequency of nicotine use, caffeine, and alcohol use, typical exercise patterns, diet, height, weight, mood, and sleep problems.

Participants who successfully completed the baseline survey (> 90% item completion) were then randomly assigned to either the survey-only component of the study, or the survey-plus-cortisol component. A block randomization list was created using a randomization list generator online (www.randomizer.org). Participants were selected into each component based on the order in which they completed the initial survey. A second consent was then obtained for each participant via phone call. Participants in the survey-only condition completed a seven-day daily survey assessing daily LGBT-specific and general stressors, positive/negative emotions and events, rumination, social support, and perceived stress. Following the last evening survey, several items were included with regard to satisfaction and usability were presented to participants.

Those in the survey-plus-cortisol condition also completed the seven-day daily surveys, as well as were mailed Saliva Collection Kits containing labeled storage containers, instructions, and logs for sample times. Email, phone, and text-based communications were used to contact participants to remind and encourage them to complete their daily surveys and to give cortisol samples. Upon completing the saliva samples on the seventh day, participants received an email and were encouraged to mail back the samples to the lab at their earliest convenience.
In total, participants were eligible to receive $95 for full participation in the study. For completing the baseline survey, participants were compensated $15 via an electronic store gift card. For each daily evening survey, participants were compensated $5, and an additional $5 for each day the successfully completed all four saliva samples. Further, a bonus of $5 was given for completing all evening surveys, as well as an additional $5 bonus for completing all saliva samples.

**Primary Measures**

**Demographics.** Using a combination of two items from the 2012 Massachusetts Behavioral Risk Factor Surveillance System Survey, transgender status and sexual orientation were assessed. Additional demographics assessed included: sex, age, income, employment status and satisfaction, education, relationship status, race/ethnicity, food security, and degree of sexual and/or gender identity disclosure (Outness Inventory; alpha = .84; Mohr & Fassinger, 2000).

**Salivary Cortisol.** A subset of randomly chosen participants provided saliva samples at four time points each day including: (1) upon waking, (2) 45 minutes post-waking, (3) 12 hours post-waking, and (4) at bedtime. Collecting the four samples at these times is crucial in order to ensure a reliable estimate of mean basal levels and diurnal slope is obtained (Luecken & Gallo, 2007). Saliva Collection Kits that contained four time labeled saliva storage containers for each of the seven days, instructions about how to give sample, as well as logs to record times of samples. Participants were instructed to keep samples in their freezer until the time came to mail them back. Once returned to the lab, samples were kept in a freezer at -80°C until they were assayed. All saliva samples were centrifuged and assayed at Ohio University. Duplicate concentrations of each cortisol sample were then determined by using a standard enzyme-linked
immunoassay. The sensitivity of the assay is < 0.012 µg/dL. Coefficients of variance for inter-assay and intra-assay are less than 8%.

**Cortisol Output.** Cortisol output was computed using the trapezoidal method (Pruessner 2003). Daily AUC₈ scores were averaged across the week for each participant. Given the aims of the proposed project, AUC with respect to ground (AUC₉) was used to quantify cortisol because AUC₉ represents the total area under the curve for all measurements, and is related to total hormonal output.

**Diurnal Cortisol Slope.** For each day, diurnal cortisol slopes were calculated by computing the difference between bedtime and wake time cortisol levels (in nmols/L), divided by the number of hours between the two samples. These scores were also averaged across the week for each participant.

**Total Stress.** Daily self-reports of stress were measured using an events checklist of daily non-LGBT specific stressful events, as well as daily LGBT specific events derived from the Heterosexist Harassment and Discrimination Scale (S. Cohen, Kamarck, & Mermelstein, 1983; alphas > .80). Participants were asked to indicate how often the event occurred in the past day. Event examples include: “Dissatisfaction with work”, and “Hiding your relationship from other people”. Answers for occurrence of event were on a 5-point scale ranging from 0 = did not occur today, to 4 = occurred often (more than 5-6 times). Average scores for each subscale—non-LGBT events (α = .93) and LGBT-specific events (α = .95)—were computed for each day and averaged over the week. Total Stress scores were computed as follows: Total Stress = (weekly average # of daily non-LGBT events) + (weekly average # of daily LGBT-specific events) / 2.

**Mindfulness.** Trait mindfulness was assessed using the Five Facet Mindfulness Questionnaire-short form. The five subscales of the FFMQ include: observing, describing, acting
with awareness, non-judging of inner experience, and non-reactivity to inner experience. The questionnaire was 24 items containing statements about everyday experience. For example, participants were asked to rate: “I find it difficult to stay focused on what’s happening in the present moment”. Answers were on a 5-point scale (e.g., 1= never or very rarely true, 5= very often or always true). All items were averaged to obtain total mindfulness scores ($\alpha = .85$), while items indicative of the observing ($\alpha = .65$), describing ($\alpha = .86$), acting with awareness ($\alpha = .79$), non-judging ($\alpha = .76$), and non-reactivity ($\alpha = .82$) were averaged separately for each subscale. The FFMQ short form has good convergent, and discriminant validity, and internal consistency (Bohlmeijer, ten Klooster, Fledderus, Veehof, & Baer, 2011).

**Covariates**

**Sex.** Biological sex was assessed as a self-report item included in the demographics questionnaire. Sex is well known to effect HPA axis activation (Bailey & Silver, 2014), and thus was considered as a covariate.

**Body Mass Index.** Using self-reported height and weight, Body Mass Index (BMI) was calculated by the following: $\text{BMI} = (\text{weight in pounds}) \times 703 / (\text{height in inches})^2$. BMI will be considered as a covariate, because previous research suggests it is related to diurnal cortisol. For example, Champaneri et al. (2013) conducted a study in which they collected 18 salivary cortisol samples over a period of three days. They found that BMI was negatively associated with awakening cortisol, as well as early decline of cortisol levels. Thus, BMI will be considered as a covariate.

**Analytic Plan**

Hypotheses 1-2 examined the relationship between self-reports of stress, mindfulness, and either cortisol output or slope. To test these Hypotheses, two separate hierarchical linear
regressions were conducted on cortisol output scores (i.e., AUC\(_g\)) and diurnal cortisol slopes. In either case (i.e., analyses of output or slope), biological sex and BMI (i.e., biological cortisol covariates) were entered into the first step. Next, total stress was entered into the second step; thus, providing a test of Hypothesis 1. Finally, the third step consisted of trait mindfulness while the fourth step consisted of the interaction of trait mindfulness and total stress (providing a test of Hypothesis 2).

Hypothesis 3 examined the relationship between self-reports of stress, mindful awareness, mindful acceptance, and either cortisol output or slope. Thus, analysis of this Hypothesis was redundant with tests of Hypothesis 1-2 up to step 2. However, for the test of Hypothesis 3, step 3 included both mindful awareness and acceptance. Step 4 included all two-way interactions of total stress, mindful awareness and mindful acceptance while step 5 included the 3-way interaction of mindful awareness, acceptance and total stress (providing a test of Hypothesis 3).

In analyses testing Hypotheses 1-3, participants were included in final analyses if they had valid cortisol data (N = 49) and were not missing data on any of the variables included in final models (i.e., cortisol AUC\(_g\), diurnal cortisol slopes, biological sex, BMI, total stress scores, total mindfulness scores, as well as mindful acceptance and mindful awareness scores) such that sample size (N = 48) remained constant across models. Within this sample, one subject had outlying scores on the diurnal cortisol slope variable (-3.62 SDs) while another participant had outlying scores on the total stress variable (+4.07 SDs). Excluding these outliers form analyses did not alter the results; outlying values were therefore included in final analyses.

All predictor variables were mean centered prior to use in regression analyses so as to minimize multicollinearity inherent in nested models. Hypotheses 4 and 5 examined the
relationship between self-reported stress and total mindfulness (Hypothesis 4) or between self-reported stress, mindful acceptance, and mindful awareness (Hypothesis 5). Given that these analyses did not include cortisol measures, participants who were/were not randomized to provide daily salivary samples were included (N = 121). Hypothesis 4 and 5 were tested using bivariate Pearson correlations which included all participants who had no missing data on the total stress, total mindfulness, mindful awareness, and mindful acceptance variables (N = 117). Among these participants, one participants had an outlying score on the total mindfulness variable (+ 3.00 SDs) while two others had outlying scores on the total stress variable (+ 3.29 SDs and + 5.86 SDs). Excluding these outliers form analyses did not alter the results; outlying values were therefore included in final analyses.

Two sets of correlational analyses were conducted on the present data. In the first analysis, correlations between AUC$_{G}$, diurnal slopes, sex, bmi, total stress, non-LGBT stress, LGBT-specific events, total mindfulness scores, awareness scores, and acceptance scores were calculated using Pearson correlation analyses (see Table 2) for individuals included in analyses of cortisol data (N = 48). In the second analysis, correlations between total stress, non-LGBT (non-LGBT specific) events, LGBT events, total mindfulness, awareness and acceptance were calculated using Pearson correlation analyses (see Table 3) for the full sample (N = 117).

**Exploratory Analysis.** It is possible that there is a difference between LGBT stress events and non-LGBT (i.e., general) stress event in relation to stress, cortisol, and mindfulness. To test this, Hypotheses 1-3 were tested again (i.e., using the same hierarchical linear regression model) while replacing the total stress variable first with either average of LGBT-specific events over the week or average non-LGBT events over the week.

**Results**
Descriptives

Descriptive statistics for study measures can be found in Table 1.

Correlations

As shown in Table 2, non-LGBT stress events were unrelated to AUC_{G}, diurnal slope, and BMI. Also, there was no association between non-LGBT events, and whether a participant was biologically male or female. Also shown in Table 2, LGBT related stress events were positively associated with non-LGBT stress events, and was unrelated to AUC_{G}, diurnal slope, sex, and BMI. Further, total mindfulness was negatively associated with LGBT stress events, and it was unrelated to non-LGBT stress events, awareness, BMI, and sex. Also, awareness was positively associated with total mindfulness, and was unrelated to LGBT events, non-LGBT events, total stress, BMI, sex, slope, and AUC_{G}. Finally, acceptance was positively associated with total mindfulness, and was unrelated to awareness, LGBT events, non-LGBT stress events, total stress, BMI, sex, slope, and AUC_{G}.

As shown in Table 3, acceptance was negatively related to non-LGBT specific stress events, and LGBT events.

Test of Hypotheses 1-2

Cortisol Output. A hierarchical linear regression was conducted to test whether self-reports of stress and mindfulness were predictive of cortisol output scores (i.e., cortisol AUC_{G}). As shown on Table 4, biological sex and BMI were entered simultaneously in the first step of the model, and were jointly unrelated to cortisol output. In step 2, total stress was entered into the model and did not account for a significant amount of variance in cortisol output (see Table 4). Hypothesis 1 was therefore not supported with respect to cortisol output. In step 3, total mindfulness scores were entered and were unrelated to cortisol output. Finally, in step 4, the
interaction of total stress and total mindfulness did not account for a significant amount of variance in cortisol output. Hypothesis 2 was therefore not supported with respect to cortisol output.

**Cortisol Slope.** A hierarchical linear regression was conducted to test whether self-reports of stress and mindfulness were predictive of diurnal cortisol slopes. As shown in Table 5, biological sex and BMI were entered simultaneously in the first step of the model, and were jointly unrelated to diurnal cortisol slopes. In step 2, total stress was entered into the model and did not account for a significant amount of variance in diurnal cortisol slopes (see Table 5). Hypothesis 1 was therefore not supported with respect to diurnal cortisol slopes. In step 3, total mindfulness scores were entered and were unrelated to diurnal cortisol slopes. Finally, in step 4, the interaction of total stress and total mindfulness did not account for a significant amount of variance in diurnal cortisol slopes. Hypothesis 2 was therefore not supported with respect to diurnal cortisol slopes.

For both cortisol output and slope, the above analyses were conducted again using either average daily non-LGBT events or daily LGBT-specific events instead of total stress. In either case, using daily non-LGBT events or daily LGBT-specific instead of total stress did not influence the present results.

**Test of Hypothesis 3**

**Cortisol Output.** A hierarchical linear regression was conducted to test whether the awareness and acceptance subscales of mindfulness interacted with daily reports of stress to predict cortisol output scores (i.e., cortisol AUC$_g$). As shown on Table 6, biological sex and BMI were entered simultaneously in the first step of the model, and were jointly unrelated to cortisol output. In step 2, total stress was entered into the model and did not account for a
significant amount of variance in cortisol output (see Table 6). In step 3, mindful awareness and acceptance were entered into the model and were jointly unrelated to cortisol output. All two-way interactions of total stress, mindful awareness, and mindful acceptance were entered in step 4. Jointly these two-way interactions did not account for a significant amount of variance in cortisol output. Finally, the three-way interaction of mindful awareness, mindful acceptance, and total stress was entered in step 5. As shown in Table 6, the three-way interaction of mindful awareness, mindful acceptance, and total stress was not significantly related to cortisol output. Thus Hypothesis 3 was not supported with respect to cortisol output.

**Cortisol Slope.** A hierarchical linear regression was conducted to test whether the awareness and acceptance subscales of mindfulness interacted with daily reports of stress to predict diurnal cortisol slopes. As shown in Table 7, biological sex and BMI were entered simultaneously in the first step of the model, and were jointly unrelated to diurnal cortisol slopes. In step 2, total stress was entered into the model and did not account for a significant amount of variance in diurnal cortisol slopes (see Table 7). In step 3, mindful awareness and acceptance were entered into the model and were jointly unrelated to diurnal cortisol slopes. All two-way interactions of total stress, mindful awareness, and mindful acceptance were entered in step 4. Jointly these two-way interactions did not account for a significant amount of variance in diurnal cortisol slopes. Finally, the three-way interaction of mindful awareness, mindful acceptance, and total stress was entered in step 5. As shown on Table 7, the three-way interaction of mindful awareness, mindful acceptance, and total stress did not account for a significant amount of variance in diurnal cortisol slopes.

For both cortisol output and slope, the above analyses were conducted again using either average daily non-LGBT events or daily LGBT-specific negative events instead of total stress.
In either case, using daily non-LGBT events or daily LGBT-specific instead of total stress did not influence the present results.

**Test of Hypothesis 4**

It was hypothesized that high total trait mindfulness will be associated with lower daily total stress. As shown in Table 3, total mindfulness scores were unrelated to total stress scores, daily non-LGBT events or daily LGBT-specific negative events.

**Test of Hypothesis 5**

It was hypothesized that daily perceived stress would be negatively associated with mindful awareness and acceptance. As shown in Table 3, mindful acceptance scores were negatively related to total stress scores, daily negative events and daily LGBT-specific negative events while mindful awareness scores were unrelated were unrelated to total stress scores, daily non-LGBT events or daily LGBT-specific negative events.

**Discussion**

The aim of the present project was to test the stress buffering effect of mindfulness in sexual minority young adults. Additionally, in an effort to test predictions of Monitor and Acceptance theory (Lindsay, and Creswell, 2017), the present project investigated the degree to which the two components of mindfulness (i.e., awareness and acceptance) must be present for the effects of mindfulness on stress related outcomes to be observed. It was expected that higher self-reports of day-to-day stressful events would be associated with greater diurnal cortisol output and flattened slope. Previous research suggests that perceived stress is positively associated with cortisol output (Stawski, Cichy, Piazza, & Almeida, 2013) as well as a flattened slope (Abercrombie et al., 2004). It was also expected that trait mindfulness would moderate the relationship between daily stressful events and diurnal cortisol output as well as slope, such that
the relationship between stress and cortisol output/slope would be weaker as mindfulness increases. Previous work (Brown, Weinstein, & Creswell, 2012) suggest that trait mindfulness moderates the effect of stress on cortisol secretion to acute stress such that, as mindfulness increases, the magnitude of acute cortisol secretion to a laboratory stressor decreased under conditions of high stress. Furthermore, in this study, mindfulness did not moderate the magnitude of cortisol secretion to acute stress under conditions of low stress (Brown et al., 2012). Additionally, it was expected that the moderating effect of mindfulness on the relationship between day to day stressful events and diurnal cortisol output/slope would be expected to be strongest for participants who score high in both mindful awareness and acceptance. Monitor and Acceptance Theory predicts that the protective effect of mindfulness on stress-related outcomes is dependent upon the presence of both its awareness and acceptance components. Finally, trait mindfulness as well as both of its subcomponents were expected to be negatively associated with total stress.

To test the moderating role of mindfulness (and its subcomponents) on the relationship between day-to-day stress and diurnal cortisol, it was important for the present research to first find a positive relationship between daily stress and cortisol output/diurnal slope. However, total stress was presently unrelated to either cortisol output or diurnal cortisol slope (i.e., Hypothesis 1 was not supported). This finding is generally inconsistent with the literature. Previous research often finds that increased stress is associated with increased cortisol output and flattened diurnal cortisol slope. For example, Jobin et al. (2014) found increased self-reported stress to be associated with elevated levels of cortisol output. In this study, the day to day stress measure was averaged over multiple days much like the present study. Nevertheless, Jobin et al. (2014) used an older population ($M_{age} = 71.61$). As such, it is possible that sample differences like age may
account the presently inconsistent results. Further, Lovell et al. (2011) found self-reported perceived stress to be associated with flatter cortisol slopes and HPA axis hyperactivity, in young females ($M_{age} = 19.22$). Thus, while this study also used a younger population, the sex ratio differed and may possibly account for the present lack of a relationship between cortisol slope and self-reported stress.

Beyond sample characteristics, a few methodological factors are worth acknowledging while interpreting the present test of the relationship between stress and cortisol. The present approach to computing and analyzing daily self-reportS of stress may have contributed to the lack of a relationship between stress and diurnal cortisol slope/output. In the present study, stress was computed as an average across the week. Unfortunately, this method does not allow to test how day to day variations in stress may influence cortisol. For example, it is possible that between individual differences in weekly self-reports of stress are unrelated to diurnal cortisol slope or output, yet on days that individuals undergo more stressors (than their weekly average), the cortisol slope (of that day) may be flattened and the cortisol output (of that day) may be larger. Supporting this view, previous research has found that self-reports of stress on a given day positively predicts diurnal cortisol slope/output. For example, Stawski et al. (2013) assessed stress on a day-to-day basis and found that compared to stress free days, daily reported stress was associated with significantly greater cortisol AUC. Further, Adam et al. (2006) also used a day-to-day self-reported stress measure, and found it to be associated with flatter diurnal cortisol slope. They computed cortisol parameters separately for each of the three days samples were collected, in an effort to examine variations in cortisol day to day. Thus, future analyses would benefit from exploring the relationship between daily stressors and cortisol using more advanced analyses that can directly test for day-to-day fluctuation in cortisol levels.
Stress can be measured using perceptions of stress, day-to-day event checklists, or major life event checklists (Cohen et al., 2007). In the current study, stress was only measured using the measures of day-to-day event checklists. Thus, it may be possible that, although day-to-day stressful events did not predict cortisol output or slope, other stress measure may still capture how stress is related to cortisol. For example, major life events (i.e., job loss, divorce, etc.) have been proposed to be linked with chronic diseases such as cardiovascular disease (Kershaw et al., 2014), as well as a suppressed immune response (Segerstrom & Miller, 2004). Given major life events tend to predict important health-related outcomes, future research may therefore benefit from revisiting the relationship between stress and diurnal cortisol slope/output using major life event checklists. Further, perhaps the measure of daily events did not account for additional LGBT-specific stressors this population experiences on a daily basis. For example, perhaps microaggressions were not well represented on the measure. Given this possibility, the sample might have been experiencing additional stressors that they were unable to indicate of the measure that was provided.

Another factor to consider is whether there were other types of stress buffering at play with this population. For example, social support has been associated with positive effects on health, (e.g., the immune system), and has been proposed to act as a buffer against stress (Ditzen & Heinrichs, 2014). It is possible that this population is experiencing a high amount of social support due to the type of sampling procedure used. Snowball sampling was used in an effort to reach more potential participants. Individuals were instructed to pass along recruitment information to friends, co-workers, etc. they think might be eligible to participate. It is possible that individuals in this sample have a fairly stable network of people also in the LGBT
community they receive social support from. If so, this could account for the present projects inability to detect a significant relationship between cortisol secretion and stress.

The present study also aimed to test the interactive effect of mindfulness and self-reports of stress on diurnal cortisol slopes and output. Multiple linear regressions were unable to detect a significant interaction of mindfulness and stress on cortisol output or diurnal cortisol slope. While this finding is not inconsistent with the mindfulness stress buffering account (Creswell and Lindsay, 2014), the present non-significant relationship between stress and cortisol output/slope rendered this study a poor test of the mindfulness stress buffering account. As proposed by the MSBA, the stress buffering effect of mindfulness will be most salient in situations where stress is present in large quantities. Alternatively, when stress is absent, mindfulness is not expected to improve health or limit HPA axis activation. Evidence for this claim exists in the context of laboratory stressors. Brown and Ryan (2012) found that greater trait mindfulness predicted a smaller cortisol increase under high stress conditions. Furthermore, trait mindfulness was unrelated to the magnitude of cortisol increase to acute stress, under low stress conditions. It is possible that other stress-buffering agents, like social support for example, buffered against the effects of daily stressors on cortisol output. If that is the case, this could be an explanation as to why stress was unrelated to cortisol secretion in this sample.

The present study also attempted to test predictions of Monitor and Acceptance Theory (MAT). It was expected that the moderating effect of mindfulness on the stress-cortisol relationship would be strongest among individuals who reported high levels of awareness and acceptance relative to other combinations of awareness and acceptance. The results do not indicate that high awareness and acceptance more strongly moderated the effect of stress on cortisol output or diurnal cortisol slopes, relative to other combinations of these subcomponents.
(i.e., Hypothesis 3 was not supported). Given that mindfulness did not significantly interact with self-reported stress to predict cortisol output and diurnal cortisol slopes, mindful awareness and acceptance were unlikely to do so.

Finally, the present project investigated how total mindfulness (Hypothesis 4), and its subcomponents (Hypothesis 5) related to daily self-reports of stress. It was found that total trait mindfulness was unrelated to total amounts of daily stress, daily self-reports of non-LGBT stressful events, or daily self-reports of LGBT-specific stressful events (i.e., Hypothesis 4 was not supported). However, mindful acceptance scores were negatively related to total stress scores, daily self-reports of non-LGBT stressful events, and daily self-reports of LGBT-specific stressful events while mindful awareness scores were unrelated to total stress scores, daily non-LGBT events or daily LGBT-specific events (i.e., Hypothesis 5 was partially supported). According to MAT (Lindsay & Creswell, 2017), mindful acceptance may benefit health by reducing negative affect. In the present study, we found that individuals who report greater acceptance also tend to report fewer daily stressors overall. Unfortunately, the present study design does not allow for causal inference. As such, it is equally possible 1) that individuals who face fewer stressors in daily life tend to be more accepting than individuals who face more stressors, or 2) that individuals who are more accepting are less likely to perceive events as stressful. Either way, the present study provides some support for predictions of the MAT in that mindful acceptance related to stress in a way that was not observable with awareness or total mindfulness. Thus, at the very least, the present findings suggest that future research should take into account how both mindfulness subcomponents may independently relate to outcomes of interest.
Limitations and Future Directions

Limitations of the present study are worth noting. First, the relationship between stress and cortisol should be revisited to test for day to day variations in stress and diurnal cortisol slopes and cortisol output. The present use of multiple regressions and weekly measures of stress and cortisol reduced the present test of the stress-cortisol relationship to between-individual variation while past research (Stawski, 2013) suggests that stress and cortisol secretion are also likely to vary from day to day. Second, the present stress measure was limited to day to day stressful events. Future research could therefore revisit the relationship between stress and cortisol using other measures of stress like major life event checklists, and general perceptions of stress. Finally, the present study was observational and thus does not allow for causal inference. Future studies could test directional hypothesis regarding the relationship between acceptance and self-report of stress. For example, participants could be randomly assigned to complete a high or low stress task and asked to report acceptance of the stress task before, during and after completion. The presently found relationship between acceptance and stress should be replicated in other populations. Moreover, participants were recruited largely from college student organization, and may not have accurately represented those who are not college-educated. This lack of representativeness may be attributed to the non-probability sampling method that was used to find participants. While this sampling has strengths, given that nature of the study (e.g., targeting LGBTQ organizations, random sampling would have been difficult), it is possible this method led to a less representative sample. Further, future research should consider other populations, more specifically other types of minority populations (e.g., racial and ethnic minorities).
Conclusion

In conclusion, stress was presently unrelated to diurnal cortisol secretions when compared across individuals. Nevertheless, tests of this relationship could be improved by using more complex analyses (e.g., mixed linear models), and using other measures of stress. Additionally, neither total mindfulness nor the interaction of its subcomponents were found to buffer against the effects of stress on cortisol secretions. Given that levels of day to day stress were low in the present sample, a lack of a stress buffering effect is consistent with mindfulness theories tested. Finally, it was found that acceptance predicted lower self-reports of stress. Given that this relationship was not found using total trait mindfulness or awareness measures, the present findings suggest that a distinction between mindful awareness and acceptance is advisable when testing the relationship between mindfulness and stress-related health outcomes (as suggested by monitor and acceptance theory). Future studies could replicate this finding in other populations and experimentally manipulate stress or acceptance to determine the directionality of this relationship.
References


https://doi.org/10.1037/a0032736

https://doi.org/10.1016/0163-8343(82)90026-3


https://doi.org/10.1007/s10067-011-1690-9

Table 1.
Descriptives of Key Variables (N = 121)

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<th>Survey Only (n = 68)</th>
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<td>LGBT Stress</td>
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<td>Total Mindfulness</td>
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<td>Awareness</td>
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<td>Diurnal Slope</td>
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Table 2.
Zero-Order Correlations among variables used in analyses of cortisol data (N =48).

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<td>.087</td>
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<td>.501**</td>
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<td>-.252</td>
<td>-.152</td>
<td>.718**</td>
<td>-.044</td>
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</table>

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
aSex was coded as 0 = male, 1 = female.
Table 3.
*Zero-Order Correlations among variables used in analyses of self-reported stress (N =117)*

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<th>5</th>
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<td>2. Non-LGBT Events</td>
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<td>3. LGBT Events</td>
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</table>

**. Correlation is significant at the 0.01 level (2-tailed).
* . Correlation is significant at the 0.05 level (2-tailed).
Table 4.

Summary of Hierarchical Regression Analysis Predicting Cortisol AUCG Scores (N = 48)

<table>
<thead>
<tr>
<th>Variable</th>
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<th>F</th>
<th>ΔF</th>
<th>ΔR²</th>
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<td></td>
<td></td>
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<tr>
<td>Sex&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.079</td>
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<td>.323</td>
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<td>BMI</td>
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<td>.010</td>
<td>.844</td>
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<tr>
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<td>.012</td>
<td>.008</td>
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<tr>
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<td>.039</td>
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* p < 0.05 level (2-tailed).
** p < 0.01 level (2-tailed).

<sup>a</sup>Sex was coded as 0 = male, 1 = female.
Table 5.
Summary of Hierarchical Regression Analysis Predicting Diurnal Cortisol Slopes (N = 48)

<table>
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<td>0.658</td>
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* p < 0.05 level (2-tailed).
** p < 0.01 level (2-tailed).

*a Sex was coded as 0 = male, 1 = female.
Table 6.

Summary of Hierarchical Regression Analysis Predicting Cortisol AUCG Scores (N = 48)

<table>
<thead>
<tr>
<th>Variable</th>
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<th>ΔF</th>
<th>ΔR²</th>
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<td>Sex</td>
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<td>.323</td>
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<td>.026</td>
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<td>BMI</td>
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<td>.010</td>
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<tr>
<td>Step 2</td>
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<td>Total Stress</td>
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<td>.012</td>
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<tr>
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<td>.008</td>
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* p < 0.05 level (2-tailed).
** p < 0.01 level (2-tailed).

Sex was coded as 0 = male, 1 = female.
Table 7.  
Summary of Hierarchical Regression Analysis Predicting Diurnal Cortisol Slopes (N = 48)

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<th>ΔF</th>
<th>ΔR²</th>
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*.  p < 0.05 level (2-tailed).
**. p < 0.01 level (2-tailed).

*aSex was coded as 0 = male, 1 = female.
Figure 1.
Meyer’s Minority Stress Model of stress processes in lesbian, gay, and bisexual populations. (Meyer, 2003).
Figure 2.
DASH Study Flow Diagram indicating enrollment, dropout, and randomization information.