A Daily Diary Study of Lifestyle Behaviors, Psychological Distress, and Well-Being

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A DAILY DIARY STUDY OF LIFESTYLE BEHAVIORS, PSYCHOLOGICAL DISTRESS, AND WELL-BEING

By

Austen Rex Anderson

A DISSERTATION

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of the University of Miami
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August 2019
A DAILY DIARY STUDY OF LIFESTYLE BEHAVIORS, PSYCHOLOGICAL DISTRESS, AND WELL-BEING

Austen Rex Anderson

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A Daily Diary Study of Lifestyle Behaviors, Psychological Distress, and Well-Being (August 2019)

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Many lifestyle behaviors such as diet, exercise, and sleep are related to physical and mental health. However, very little research has been done on the day-to-day influence of these activities on both psychological distress (PD) and more holistic conceptions of overall well-being. This study seeks to investigate the patterns of common lifestyle behaviors and their relationships with daily PD and well-being. The central research questions are 1) what lifestyle behaviors are associated with PD and well-being, and 2) do the seven lifestyle behaviors predict the three outcome variables at different degrees of strength? Seventy-six adult participants were recruited online and completed daily diary surveys about their participation in a variety of lifestyle behaviors, PD symptoms, and well-being for up to 14 days. The data were analyzed using multilevel modeling to illuminate the day-to-day fluctuations in variables that cannot be explored in cross-sectional or large-interval longitudinal research. Examining multiple lifestyle behaviors simultaneously in these exploratory analyses allowed for a comparison of their relative impact on distress and well-being, thus revealing those behaviors that have the greatest average association with PD and well-being. At the within-person level, time spent in social interaction was the most consistent predictor of PD and well-being. Consumption of fruits and vegetables and exercise also generally positively predicted well-being. Depending on the model, time spent outside, meditation and alcohol intake
were also occasionally associated with the dependent variables. T-tests revealed some differences in the strengths of the associations and with social interaction being a stronger positive predictor of well-being relative to other lifestyle behaviors. This project built on other early investigations into daily activities and well-being and the results may inform the development of future lifestyle interventions.
To Ali,

With all my love.
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Ali as my great source of love, conversation, compassion, forgiveness, and fun. Calvin for his wonderful spirit, warmth, and sense of humor. My parents Rick and Allison for their ever-present support, interest, and kindness. Justin and Lauryn, who I count as both close siblings and true friends. My ward family at church. My Tuesday night brothers. And my God.
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CHAPTER ONE

INTRODUCTION

Lifestyle behaviors including diet, exercise, and substance use are important contributors to physical and mental health. Unhealthy lifestyle behaviors contribute to noncommunicable diseases, which kill about 40 million people globally each year; the leading cause of death and roughly 70% of all cases (World Health Organization, 2017). Noncommunicable diseases can also involve disability, often quantified in terms of healthy years lost (Richards et al., 2015), and depression is the largest contributor to global disability, with more than 300 million individuals currently living with a depressive disorder (Friedrich, 2017). Anxiety disorders and substance use are also both among the top 20 causes of worldwide disability. Importantly, reviews have suggested that lifestyle factors should be considered as important contributors to overall psychological distress (PD; Lopresti, Hood & Drummond, 2013; Walsh, 2011) and to depression specifically (Sarris et al., 2014).

Unlike an individual’s genotype, lifestyle behaviors are important to study because they can be modified through what Walsh (2011) described as therapeutic lifestyle change. The field of lifestyle medicine focuses on applying “environmental, behavioural, and psychological principles to enhance physical and mental wellbeing [sic]” (Sarris et al., 2014). This approach to healthcare may be particularly helpful to combat a bias that Marcia Angell, former editor of the New England Journal of Medicine, found troubling, wherein “even when changes in lifestyle would be more effective, doctors and their patients often believe that for every ailment and discontent there is a drug” (Angell, 2009).
Scholars have produced significant work by investigating the ways lifestyle behaviors contribute to physical disease and how to design medical care around changing lifestyle behaviors to improve physical health and to reduce PD. Scholars are interested in the role of lifestyle behaviors as predictors of PD, including behaviors such as exercise, nutrition, substance use, social relations, time outside, and meditation or relaxation. The strength of the evidence base for each of these behaviors varies, but all have been linked to PD in multiple studies. Scholars have identified a dose-response in cross-sectional research, such that the number of healthy lifestyle behaviors one reports engaging in on average is negatively associated with one’s likelihood of having a mental health disorder at that time (Loprinzi & Mahoney, 2014). No direction of causation can be attributed in this research, but scientists have used randomized trials to demonstrate causal effects of some lifestyle variables on PD. Despite the evidence linking lifestyle behaviors with PD, we do not know enough about the daily impact of these behaviors, knowledge which may help individuals change their behaviors to improve their health. The research on lifestyle behaviors has been limited in four main ways as described below.

**Psychological Distress and Well-Being**

First, most studies do not thoroughly consider both PD (mental health symptoms) and forms of well-being. Many medical and mental health providers have changed their conceptualizations of health and mental health over time. Historically, their focus was on symptom reduction or reduction of PD, but over the past half-century scholars have moved toward incorporating positive functioning (well-being) in conceptions of health (Huppert & Whittington, 2003). Ryff and Singer (1998) argued that certain “goods,” such as meaning, intimacy, and coherence, contribute to a life lived well and are essential
components to overall health and well-being. Ryff’s (1989) Psychological Well-Being measure aims to assess the core components of human well-being (e.g., purpose in life, positive relations, and personal growth).

Ryff’s approach (1989) is often classified as eudaimonic well-being (EWB), which emphasizes functioning well in life (c.f., Waterman et al., 2010). EWB is often contrasted to hedonic well-being (HWB), or subjective well-being, which is based on satisfaction with life (Diener, Emmons, Larsen, & Griffin, 1985), positive emotions, and low levels of negative emotions (e.g., Watson, Clark, & Tellegen, 1988). Both forms of well-being are considered by many to be important outcomes in research. In most cases, these conceptions of overall well-being have also been associated with the same lifestyle behaviors that predict physical health and PD. Thus, the lifestyle behaviors considered essential for physical health, such as exercise, nutrition, substance use, and other less-studied lifestyle behaviors, may also be important contributors to both PD and WB.

**Multiple Time-Point Measurement**

Second, studies often rely on measurements at single time points to quantify complex constructs. The research on the associations between lifestyle behaviors and PD and WB mostly consists of cross-sectional surveys that demonstrate correlations between one or a few lifestyle behaviors and some conception of PD or WB, although large-interval longitudinal survey studies and randomized trials incorporate follow-up assessments. A strength of many of these studies is that they often include (sometimes impressively) large and/or representative samples, but they are limited in that they require individuals to summarize complex, dynamic constructs, at a single time point or at a few distant time points. For example, a person’s depression symptoms or substance use,
which presumably vary across days, are often condensed into single averaged values. One specific problem with this approach is that the individual’s responses may be biased by weaknesses in human memory or cognitive tendencies such as the recency effect, wherein people tend to remember recent information over older information (Murdock, 1962). Thus, research in this area would be benefitted by a daily diary survey that assesses the lifestyle and PD and WB constructs at the daily level, reducing the impact of recall biases and hopefully improving measurement accuracy.

**Within-Person Associations**

Third, studies that do measure the constructs at multiple time points often do not assess relationships among constructs within persons. Cross-sectional and large-interval longitudinal research tends to focus on analyzing aggregated between-person associations. The implication of these findings is that a behavior is associated with a certain conception of PD or WB within the given sample. For example, the participant’s self-reported estimate of hours of exercise per week may correlate with the self-reported typical degree of depression symptoms or satisfaction with life. The weakness of this type of research is that it says nothing about the within-person fluctuations in certain behaviors and PD and WB.

Although cross-sectional research is essential in understanding population-level associations between lifestyle behaviors and PD and WB, alternative approaches to researching these relations are needed. When researchers collect data multiple times (5+) per person, it has been labeled as intensive longitudinal research (Bolger & Laurenceau, 2013). Beneficially, these data can be analyzed with multilevel modeling, which can separate out the between-person and within-person associations. Findings related to the
between- and within-person associations between exercise and heart attacks are helpful in demonstrating this. At the between-person level, individuals who exercise tend to have fewer heart attacks (negative association), however, at the within-person level, heart attacks tend to occur soon after a specific bout of exercise (positive association; Mittleman et al., 1993). This research indicates that exercise can be both positively and negatively related to heart attacks, depending on the level of analysis. These types of discrepancies may apply for lifestyle behaviors and PD and WB. For example, although exercising may be strongly linked to mental health at the between-person level, it may be less strongly linked to mental health at the day-to-day level, or vice versa. In other words, exercising regularly may lead to lower chances of depressive symptoms on average, but it is possible that hard physical exercise may be painful or draining, resulting in a more modest increase (or even a decrease) in mood or satisfaction for that day.

I investigated the daily association between lifestyle behaviors and well-being to help clarify the kind of associations at the within- and between-persons levels. Assessing the daily presence of, and when appropriate, amount or duration of various lifestyle behaviors along with self-reported ratings of PD and WB resulted in nested data with two levels: data at the person level (for between-person analysis) and data at the daily level (for within-person analysis). The associations between the average of a given lifestyle behavior and average PD and WB were separated from the association between past 24-hour lifestyle behaviors and past day PD and WB.

These basic research findings may be important for their own sake, but they may be especially important in designing relevant lifestyle interventions (e.g., Jakicic et al., 2016; Kelders, Kok, Ossebaard, & Gemert-Pijnen, 2012). By focusing on the most
influential lifestyle behaviors, individuals’ PD and WB may more quickly improve, thus encouraging continued pursuit of positive lifestyle changes and increased well-being (Frederickson, 2004).

**Multiple Lifestyle Behaviors**

Fourth, previous research has involved one or a few lifestyle behaviors, not allowing for a comparison of the relative influence of the various behaviors on PD and WB. Both cross-sectional and longitudinal research only include one or a small number of lifestyle behaviors to investigate as predictors of PD and WB. Although this research is important, it would be helpful to gain insight into the relative strength of many lifestyle-PD and WB associations simultaneously to better understand which behaviors tend to have the strongest daily relationship with PD and WB. For example, although evidence has shown that diet is linked to mental health, it is unclear how strong the influence of diet is when it is examined alongside other lifestyle behaviors. The current study took an exploratory approach by including a variety of lifestyle behaviors that were measured at the daily level to investigate which behaviors have the strongest association with daily fluctuations in PD, HWB, and EWB.

Thus, this project built on previous research in four main ways by: 1) examining both PD and WB, 2) making use of repeated measurements for relevant constructs, 3) focusing on the within-person associations of lifestyle behaviors with PD and WB more than between-person correlations, and 4) exploring the association of a relatively large number of lifestyle behaviors with PD and WB. The research questions are:

1) Will lifestyle behaviors and PD and WB be significantly associated in this sample?
2) Will the associations between the seven lifestyle behaviors and PD and WB differ?

I expect that at the daily, within-person level, specific lifestyle behaviors will predict end-of-day self-reported PD and WB. I also expect that exercise, fruit and vegetable consumption, heavy alcohol use, tobacco use, and social interaction will be the strongest predictors of PD and WB. Overall, this timely study would provide added insight into the role of important lifestyle behaviors as contributors to health and well-being.
CHAPTER 2
REVIEW OF THE LITERATURE

Individuals in Western societies are increasingly eating lower quality diets and becoming more sedentary relative to earlier generations (Hidaka, 2012; Walsh, 2011). These and other lifestyle behaviors are associated with PD and WB as demonstrated by multiple recent reviews and meta-analyses (Cairns, Yap, Pilkington, & Jorm, 2014; Sarris, Coulson, & Jacka, 2013; Sarris et al., 2014; Walsh, 2011). The strength of the research demonstrating these associations varies by behavior, with some (diet and exercise) having more support than others (time outside and meditation). I describe the relevant research linking each of these behaviors to PD and WB below.

A general framework has been developed that describes the biological mechanisms of action for many of these lifestyle behaviors on mental health. Sarris et al. (2014) summarized this model by arguing that poor lifestyle behaviors tend to increase baseline cortisol, increase low-grade systemic inflammation and oxidative stress, and disrupt the hypothalamic pituitary adrenal (HPA) axis, all of which are implicated in PD. Further, changes in endocrine functioning and inflammation are predictive of depression, by way of neurodegeneration and reduced neurogenesis (Maes et al., 2012; Raison, Capuron, Miller, 2006). On the other hand, proper exercise and nutrition have also both been implicated in improved brain plasticity (Molteni, Barnard, Ying, Roberts, & Gomez-Pinilla, 2002; Pinilla, 2006), which may help individuals better adapt to stressors (DeCarolis & Eisch, 2010). Through these various biological mechanisms, lifestyle behaviors appear to play important roles in PD. Importantly though, some
research in this area has moved beyond symptoms of PD as the only outcome of interest
and has included conceptions of well-being.

**Well-Being**

A biomedical model that focuses on “returning the body from states of negative
functioning back to neutral,” has been deemed by some scholars as an inadequate
conception of health (Ryff & Singer, 1998, p. 3). They have argued for more holistic
conceptions of well-being that focus on positive subjective states and functioning well. In
the social sciences, well-being has traditionally been categorized as either HWB or EWB
(Ryan & Deci, 2001). HWB emphasizes high levels of positive emotions relative to
negative emotions (e.g., Watson, Clark, & Tellegen, 1988) and satisfaction with life
(Diener, Emmons, Larsen, & Griffin, 1985). Alternatively, EWB stems from Aristotle’s
ethics (1999) and emphasizes functioning well through experiencing meaning, purpose,
and growth (Fowers, 2012; Ryff, 1989).

Research indicates that both forms of well-being can be measured and are
statistically correlated to a substantial degree (Compton, Smith, Cornish, & Qualls, 1996;
Linley, Maltby, Wood, Osborne, & Hurling, 2009), leading some to deny any benefit in
attempting to distinguish the two (Kashdan, Biswas-Diener, & King, 2008). Others argue
that EWB’s focus on functioning well is related to HWB, but still independent (Fowers,
2012; Keyes & Annas, 2009; Ryff, 2013). Advanced analyses using exploratory
structural equation modeling has further clarified the distinction between the two forms
of well-being (Joshanloo, 2016), and genetic research has demonstrated that the two
forms of well-being differentially correlate with immune functioning (Fredrickson et al.,
2013). To move beyond symptom-based PD, this study also included measures of HWB
and EWB. As described below, some evidence links several lifestyle behaviors with these forms of well-being.

Well-Being and Mental Health

PD and WB are also related, but distinct constructs. For example, research investigating the association between psychological well-being and depression found that they were modestly negatively correlated (Ryff & Keyes, 1995). Measurement models have demonstrated unique and shared variance between mental health and mental illness, leading Keyes (2005) to claim that “the absence of mental illness does not equal the presence of mental health” (p. 546). In a review of the literature linking positive well-being with physical health, Boehm and Kubzansky (2012) argued that positive well-being may lead one to be more psychologically adaptable, reduce negative feelings, and buffer from the effects of stress, which in turn might act on the same inflammatory and neuroendocrine mechanisms that predict mental illness. I investigated PD and WB in this study to assess any differential association of lifestyle behaviors with PD symptoms and positive functioning.

Much of the research linking lifestyle behaviors with PD and the two forms of well-being has been performed in cross-sectional surveys, longitudinal surveys, and in randomized trials with follow-up periods. These forms of research have strengths and contribute to our understanding of the important role of lifestyle behaviors in contributing to PD and WB, but they also have limitations. A common limitation across these methods includes limited access into these associations as they occur in daily life, due to infrequent measurement and/or highly controlled experimental protocols. The analyses
tend to result in associations that are aggregated across people (e.g., Does self-reported average vegetable consumption correlate with PD across people?).

**Within-Person Analysis**

An increasingly used research approach, called intensive longitudinal modeling, offers additional insight into day-to-day and moment-by-moment associations that cannot be obtained in the other forms of measurement. Collecting data by administering many (at least 5, but often more) surveys to each participant across time allows for what has been described as intensive longitudinal methods (ILM; Bolger & Laurenceau, 2013; Iida, Shrout, Laurenceau, & Bolger, 2012). The purpose of this form of research is to measure the variation or fluctuation of variables over time for individuals. Using these analyses, one can still investigate the between-person effects by creating an average of the variables measured within persons over time, but the unique contribution of this research is the ability to explore within-person differences. Within-person differences explain how changes in a variable over time can be linked to changes in another variable. As an example, cross-sectional research may ask “how often do you exercise” along with questions about self-reported average ratings of well-being (“how satisfied with your life are you”) and PD (“rate your level of anxiety”). In contrast, ILM research might once a day over a period of one or more weeks ask participants to report on their exercise in the last 24 hours (“How many minutes did you engage in moderate to vigorous exercise today?”) and to rate one’s well-being (“How satisfied with your life were you today?”).

Interestingly, the associations between lifestyle behavior and PD and WB can differ according to the different levels of analysis. Along with the previous example discussing heart attacks and exercise, Tennen, Affleck, Armeli, and Carney (2000) found...
that the direction of association (i.e., positive or negative) at the between- and within-person levels can be different. They found at the between-person level that drinking to cope with stress is positively associated with anxiety, whereas at the within-person (or daily level) drinking to cope with stress was negatively associated with anxiety. Because within-person findings clarify associations between relevant constructs, this study investigated both the between- and within-person associations between lifestyle behaviors and PD and WB.

A number of previous ILM studies investigated lifestyle behaviors and PD and WB (e.g., Chan, Yen, Fu, & Hwang, 2015; Flueckiger, Lieb, Meyer, Withhauer, & Mata, 2017; Flueckiger, Lieb, Meyer, & Mata, 2014; Hyde, Conroy, Pincus, & Ram, 2011; Sonnentag, Binnewies, & Mojza, 2008), but these studies have often failed to assess both PD and WB (in two commonly assessed forms of the latter). This study combined the within-person analysis approach with multiple outcome variables. Previous ILM studies have also been limited in the breadth of lifestyle behaviors they include.

**Lifestyle Behaviors**

A recent systematic review described the research support for the daily (within-person) association between exercise, sleep, and social interactions with depressive symptoms (Pemberton & Tyszkiewicz, 2016). One of the authors’ conclusions was that scholars should conduct more research that assesses multiple lifestyle behaviors simultaneously, which provides the opportunity to explore the relative impact of the behaviors on mental health. With that in mind, I review the research covering the associations between lifestyle behaviors and PD and WB. The behaviors I review are
exercise, diet, social interaction, tobacco use, heavy alcohol use, meditation, and time outside.

In this section, I review the evidence linking various lifestyle behaviors with mental health and well-being, cross-sectionally, longitudinally, and in quasi-experimental or randomized trials. I also discuss some specific potential mechanisms of action where available. The review of evidence makes it clear that individual lifestyle behaviors are associated with PD and WB. The innovative aspect of this study is that it takes an exploratory approach in investigating the concurrent association of multiple lifestyle approaches with PD and WB. Because no overarching theory explains how these behaviors might influence PD and WB, this form of descriptive research may provide empirical guidance on creating new theory, which can be tested with subsequent confirmatory research.

**Exercise**

Most U.S. adults do not engage in the recommended amount of daily exercise that has proven to reduce the risk of developing many medical conditions (Sapkota et al. 2005), including cancer (Friedenreich, Neilson, & Lynch 2010), obesity, diabetes, and cardiovascular disease (Gleeson et al., 2011). Taking an evolutionary perspective, physical exertion was built into the daily activities of our ancestors such as walking to and from gathering places, building shelter, fishing, hunting, foraging, and carrying heavy loads (Eaton & Eaton, 2003). In fact, research has shown that studies of groups that live similarly to our ancestors have an average of 50% better aerobic abilities than modern Westerners (Coradain, Gotshall, Eaton, & Eaton, 1998). Reduced physical activity also has important implications for PD and WB.
**Exercise and psychological distress.** Walsh (2011) indicated that exercise is related to a variety of psychological benefits including protection from PD, reductions in PD, and improved cognitive performance. A review by Strohle (2009) concluded that depression and some anxiety disorders were negatively associated with exercise cross-sectionally. For example, daily exercise has been linked to symptoms of PD in a sample of 19,842 Scottish individuals, where exercise intensity was correlated with fewer symptoms (Hamer, Stamatakis, & Steptoe, 2008). In another sample, adults who scored higher on physical fitness tests and who self-reported greater rates of exercise reported fewer depressive symptoms (Galper, Trivedi, Barlow, Dunn, & Kampert, 2006).

Prospectively, physical activity reduced the risk of having a mental disorder two years later in a sample of Swedish healthcare workers and social insurance officers (Jonsdottir, Rödjer, Hadzibajramovic, Börjesson, & Ahlborg, 2010). Another prospective study found that depression and overall PD were predicted by previous or current levels of exercise, controlling for pre-existing mental and physical health problems (Brown, Ford, Burton, Marshall, & Dobson, 2005).

Along with studies of the naturalistic association between exercise and mental health, exercise interventions are often used to reduce PD. A recent Cochrane review of randomized controlled trials indicates that exercise interventions have a moderate impact (.62 standardized mean difference [SMD]) relative to placebo, controls, and active controls (Cooney, Dwan, & Mead, 2014). It is important to note that the authors reported that due to bias in the studies, the effect of exercise is likely smaller than what was published, and they found no differences between exercise and psychotherapy interventions. Another meta-analysis revealed a large effect (SMD = .80) of exercise
interventions on mental health diagnoses, although the effect was lower (.34) when the authors analyzed only more rigorous trials (Rosenbaum, Tiedemann, Sherrington, Curtis & Ward, 2014). In contrast, a subsequent meta-analysis that aimed to adjust for publication bias resulted in a large treatment effect favoring exercise interventions over controls (SMD = 1.11; Schuch et al., 2016). In non-clinical samples, a meta-meta-analysis of randomized trials revealed a significant moderate sized effect on depression (SMD = .50) and anxiety (SMD = .38) without significant heterogeneity across meta-analyses (Rebaret al., 2015). The research indicates that exercise interventions were effective, but the exact size of the impact has not been determined and the authors expected that effect sizes would likely differ depending on many study characteristics.

Exercise is theorized to impact overall health through a variety of anti-inflammatory mechanisms by reducing visceral fat, releasing interleukin-6 followed by anti-inflammatory cytokines, and secreting anti-inflammatory cortisol and adrenaline through activation of the HPA axis and the sympathetic nervous system (Eyre, Papps, & Baune, 2013; Gleeson et al., 2011). Exercise also affects the release of neurotransmitters such as dopamine, serotonin, and norepinephrine, which have been negatively associated with the symptoms of major depression (Lopresti et al., 2013; Nutt, 2008). Lastly, exercise may promote the production of brain-derived neurotrophic factor, which plays a role in neurogenesis (Deslandes et al., 2009), and neurotrophic factor has also been negatively linked to clinical depression.

**Exercise and well-being.** Boehm and Kubzansky (2012) reviewed the well-being literature and found a consistent link between HWB and physical activity. They found mixed associations between EWB and exercise. In a cross-sectional analysis of 6,728
adults, physical fitness and self-reported physical activity were correlated with HWB (Galper, Trivedi, Barlow, Dunn & Kampert, 2006). Cotter and Lachman (2010) found that physical activity was cross-sectionally associated with a form of EWB based on a sense of self-control. Another study found change in EWB over time was associated with physical activity (Williams, Gagne, Mushlin, & Deci, 2005). Another survey of Australian adults indicated that physical activity, especially strenuous activity, was associated with a health-focused form of well-being (Cerin, Leslie, Sugiyama, & Owen, 2009). A review of cross-sectional studies found that although most surveys were conducted on older adults, physical activity has a small, but significant association with both forms of well-being (Warburton, Katzmarzyk, Rhodes, & Shephard, 2007). Cross-cultural research found an association between exercise and satisfaction with life for young adults from 21 countries (Grant, Wardle & Steptoe, 2009). Lastly, a meta-analysis indicated that acute levels of aerobic exercise were associated with positive affect at a Cohen’s d effect size of .47 (Reed & Ones, 2006).

Other studies have found associations between exercise and well-being at the within-person level. A review of studies that used momentary assessment to investigate the association between self-reported exercise and positive affect revealed that eight studies included a significant positive association, whereas three did not (Kanning, Ebner-Priemer, & Schlicht, 2013). The studies that involved objective measures of physical activity found consistent positive relations. Scholars subsequently studied the impact of daily exercise on daily affect and found that on days in which a person exercised more than their personal average they had decreased negative affect and increased positive affect (Flueckiger, Lieb, Meyer, Witthauer, & Mata 2017; Flueckiger,
Lieb, Meyer, & Mata, 2014; Hyde, Conroy, Pincus, & Ram, 2011). A within-person association between exercise and satisfaction with life was found in college students, despite no between-person associations (Maher, Doerksen, Elavsky, & Conroy, 2014; Maher et al., 2013), whereas older adults reported both between- and within-person associations (Mahera, Pincusb, Ramc, & Conroy 2015). Lastly, in a large sample of Koreans, exercise was one of the strongest predictors of same-day meaning in life and happiness (Choi, Catapano, & Choi, 2017). Thus, although reviews and meta-analyses generally resulted in an association between exercise and PD and WB at the between and within-person levels, inconsistencies in the findings indicate that continued assessment of the between- and within-person associations of exercise with PD and WB would be beneficial, especially in relation to other lifestyle behaviors.

Nutrition

In conjunction with average decreases in physical activity, people from Western and other developing regions have had significant changes in their food consumption (Cordain et al., 2005). From 1977 to 1996, individuals in the U.S. increased their caloric intake and ate fewer in-home snacks and meals, while eating more out-of-home food (Nielsen, Siega-Riz, & Popkin, 2002). The increase was partially related to higher intake of fast food, salty snacks, and high-sugar soft drinks. The number of eating/drinking occasions and the number of calories per occasion, rather than the nutrient density of the food, predicted the increase in calories (Duffy & Popkin, 2011). Also, as of 2005, most adults in the U.S. fail to eat the daily recommended amounts of fruits and vegetables (Blanck et al., 2007). Following these trends, and in combination with a more sedentary lifestyle, from 1988 to 2015 the prevalence of obesity went from 16.0% to 37.9% among
men and 21.5% to 41.1% among women (Ezzati et al., 2006; Hales, Carroll, Fryar & Ogden, 2017).

**Nutrition and psychological distress.** Walsh (2011) reviewed the literature on nutrition and mental health and concluded that a diet that consists of a variety of fruits and vegetables, includes fish, and reduces excessive calories, has the greatest impact on mental health. The Whitehall II cohort study indicated that across a five-year period the risk of depression was associated with a processed-food oriented diet (Akbaraly et al., 2009). Alternatively, eating more vegetables, fruits, and fish was negatively associated with risk of depression. Another prospective study found that adolescents with poor diets had worse mental health at a two-year follow-up (Jacka et al., 2011). Importantly, mental health at baseline did not predict changes in diet, which can offer some support in the temporal direction of the association. Further, another longitudinal study found that among 10,094 individuals in Spain, degree of adherence to a Mediterranean diet negatively predicted chances of depression (Sanchez-Villegas et al., 2009). This diet includes many plant-based foods such as fruits, vegetables, potatoes, seeds, beans, nuts, breads, and olive oil (as the main source of fat), dairy products, moderate poultry and fish, minimal red meat, and moderate amounts of wine that is usually consumed with meals (Willet et al., 1995). Despite these and other studies that found significant associations, authors of recent systematic reviews revealed inconclusive evidence linking traditional diets with depression due to non-significant findings (Quirk et al., 2013; Rahe, Unrath, & Berger, 2014) and potential biases in research design (Sanhueza, Ryan & Foxcroft, 2012). Some well-designed studies did not find an association between Mediterranean or otherwise healthy diets and depression (Quirke et al., 2013), and
potential biases include single time point assessments, unclear control of confounds, and many statistical tests (Sanhueza, Ryan & Foxcroft, 2012). However, a more recent meta-analysis indicates that across 24 prospective studies, a healthy overall diet, vegetables, and fish were negatively associated with depression symptoms, although this association did not hold after controlling for baseline depression (Molendijk, Molero, Sánchez-Pedreño, Van der Does, & Martínez-González, 2018).

Some specific foods and supplements are associated with PD. Fish intake has been negatively associated with rates of depression and bipolar disorders across countries (Hibbein, 1998; Noaghiul & Hibbeln, 2003). A meta-analysis of 10 observational studies indicated that fruit and vegetable consumption was negatively associated with depression (Liu, Yan, Li, & Zhang, 2016). Omega-3 fatty acids, important nutrients obtained mainly from fish, seeds, and nuts, are also important in reducing cognitive decline in older adults, improving brain plasticity, improving school performance, and has been implicated in a variety of mental disorders (c.f., Gomez-Pinilla, 2008). Foods with high levels of antioxidants, such as berries, grapes, and nuts, have demonstrated protective effects for cognitive functioning during the aging process (Joseph, Shukitt-Hale, & Willis, 2009) and may protect individuals from depression (Payne, Steck, George & Steffens, 2012). Folate, which is found in cruciferous vegetables (e.g., cauliflower, broccoli, and Brussels sprouts), leafy vegetables, and dried legumes, has also been negatively linked to depression in prospective studies and a meta-analysis (Tolmunen et al., 2004; Gilbody, Lightfoot, & Sheldon, 2006). Vitamin D, zinc, magnesium, curcumin, and S-adenosyl methionine are supplements that have been found to reduce depression (Mehdi et al., 2017; Lopresti & Drummond, 2017; Sarris et al., 2015; Yu, Pei, Zhang,
Wen, & Yang, 2015). Lastly, the amount of sugar intake has been positively linked to
depression across six countries (Westover & Marangel, 2002).

A few randomized trials have revealed mixed findings on the impact of dietary
interventions on PD. A recent study comparing individuals randomized to either a dietary
support or social support intervention indicated that at a 12-week follow-up those in the
dietary support condition had fewer depression symptoms compared to the social support
condition (\(d = 1.16;\) Jacka et al., 2017). Importantly, the individuals’ actual diets in the
dietary condition improved, whereas the diet of those in the social support condition did
not. One post hoc analysis of a multi-site primary prevention study in Spain revealed that
older adults with diabetes had a reduced risk of depression when assigned to a
Mediterranean diet intervention, although this effect was not maintained with the whole
sample (Sanchez-Villegas et al., 2013). Another recent randomized controlled trial did
not find differences in treatment effects on anxiety and depression between a dietary
intervention and an attentional control (Forsyth, Deane, & Williams, 2015). One current
trial is investigating a Mediterranean diet and fish oil supplementation intervention for
depressed individuals that may contribute to the research supporting dietary change as a
treatment for mental health disorders (Zarnowiecki et al., 2016). Using omega-3 fatty
acids as a supplement in a randomized trial revealed a small positive effect on depressive
and bipolar disorders (Appleton, Rogers, & Ness, 2010; Freeman et al., 2006. Lin & Su,
2007). Omega-3 supplementation appears to prevent the transition into psychotic
disorders for youth who were at high risk for psychotic diagnoses (Amminger et al.,
2010).
Researchers have identified several potential mechanisms by which changes in diet may affect mental health symptoms (Akbaraly, Brunner, Ferrie, Marmot, & Singh-Manoux, 2009). Omega 3 fatty acids, often obtained through fish and through plants such as flaxseed, walnuts, camelina, and safflower are important nutrients for the neuronal system and play a role in serotonin transport (Fernstrom, 1999). Folate is also involved in serotonin and other neurotransmitter functioning (Sanchez-Villegas et al., 2009). Diet quality has also been linked to brain-derived neurotrophic factor, a protein which may play a role in mood states and depression (Molteni et al., 2002). Some have suggested that the effect of nutrients is likely synergistic as they work in combination, rather than individual nutrients affecting mental health symptoms or disorders separately (Rucklidge, Johnstone, & Kaplan, 2013; Jacobs, Gross, & Tapsell, 2009). Of note, interesting research is beginning to reveal how the effects of diet on mental health can be transmitted across generations through epigenetic processes (Gómez-Pinilla, 2008). Diet can impact DNA methylation or translational modifications, which can be inherited phenotypic changes. One study found that a mother’s early-life diet influenced the genes that help regulate cortisol in their offspring (Drake et al., 2012).

**Nutrition and well-being.** In their review, Boehm and Kubzansky (2012) indicated that diet is associated with both EWB and HWB, although the findings depended on the component of the diet being observed. At the time, they also reported that most of the studies were cross-sectional. However, since their review was published, a variety of large-sample longitudinal studies have been published. A longitudinal study with 12,385 randomly sampled Australian adults found that an increase in daily fruit and vegetable consumption over a two-year period significantly increased HWB, even when
controlling for several covariates (Mujcic & Oswald, 2016). In fact, to move from the lowest level of vegetable and fruit intake (0 per day) to the highest (8 or more per day) resulted in a .24 unit increase on their satisfaction scale, which was a similar sized effect (in the opposite direction) to losing one’s job and about half the size (in the opposite direction) of experiencing a marital separation. This finding also appeared in a sample of 13,983 British adults, where a combined EWB and HWB measure was associated with fruit and vegetable intake (Stranges, Samaraweera, Taggart, Kandala, & Stewart-Brown, 2014) and in a study of over 80,000 British adults where fruit and vegetable consumption was associated with satisfaction and happiness (Blanchflower, Oswald, & Stewart-Brown, 2013). In one short-term randomized trial, young adults who normally did not eat many fruits or vegetables were randomized into one of the following groups: (1) that received two servings of fruits or vegetables a day, (2) that received text reminders and a voucher for purchasing fruits and vegetables, or (3) that was diet-as-usual (Conner et al., 2017). The group who received the extra fruits and vegetables reported increased flourishing and vitality relative to the other two groups.

Of interest for this project, a daily diary study by Conner, Brookie, Richardson, and Polack (2015) found that young adults’ EWB, creativity, and curiosity were positively related to fruit and vegetable intake at the between- and within-person level. Another study similarly found that young adults reported greater happiness on the days in which they consumed more fruits and vegetables (White, Horwath, & Conner, 2013). A lagged analysis of those data offered preliminary evidence that the consumption of the healthy foods predicted well-being, as opposed to well-being predicting the consumption of the healthy foods. Lastly, the number of snacks (high fat sweet, high fat savory, low fat
savory, or others) in a day was related to positive affect in one daily diary study, but not the other, whereas the number of snacks was unrelated to negative affect in both studies (Flueckiger et al., 2017). Thus, although substantial evidence shows that diet plays an important role in PD and WB, more research needs to be conducted to explore the relationship between daily food intake and the multiple components of PD and WB.

**Social Interaction**

The literature on the importance of social relationships for health is large and continually growing (Cohen, 2004). Specifically, social integration and a lack of loneliness strongly predict mortality across time (Holt-Lunstad, Smith, & Layton, 2010; Holt-Lunstad, Smith, Baker, Harris & Stephenson, 2015). The experience of community, social support, and trust have all been linked to health as well (Gilbert et al., 2013).

**Social interactions and psychological distress.** Social interaction, social integration, social support, and quality relationships are negatively linked to several cognitive and emotional impairments, including cognitive decline, depression, and anxiety (Cacioppo & Hawkley, 2009; Schwarzbach, Luppa, Forstmeier, König, & Riedel-Heller, 2014). Depression in single mothers was strongly negatively associated with social support (Cairney, Boyle, Offord, & Racine, 2003). Loneliness has also been linked to feelings of insecurity and sensitivity to rejection (Cacioppo et al., 2006). Interestingly, one experience sampling study found that loneliness was associated with poorer interactions, which fed into later negative affect (Hawkley, Preacher & Cacioppo, 2007). The negative affect was also negatively associated with quality of later interactions, creating a feedback loop of loneliness, poor social connections, and negative affect. Importantly, it is not just the number of social interactions that predicts improved health,
but the quality of these interactions, which further explains health status (Fiorillo & Sabatini, 2011). Other diary research indicated that depressed individuals spent less time engaging in social interactions than non-depressed individuals (Hopko & Mulane, 2008). One other daily diary study found an association between negative social interactions and depression at the daily level (Rook, 2001).

An alternative conception of social integration is social capital, which in one study was measured as one’s interaction with neighbors, involvement in community groups, and perceptions of crime. This version of social capital was associated with previous 30-day PD in a large sample of South African adults (Myer, Stein, Grimsrud, Seedat & Williams, 2008). Similarly, in a sample of adult Finns, aspects of social capital, including social participation and trust were negatively linked to general psychological symptoms including depression and anxiety (Nieminem et al., 2010). Importantly, this association held true when controlling for longstanding illness, education, income, and current living situation.

With the drastically changing social landscape we face today (McPherson, Smith-Lovin, & Brahsears, 2006; Wilson, Gosling, & Graham, 2012), questions arise about the role of digitally based social relationships (e.g., Facebook friends) in PD and well-being. Early research found that more time spent on the internet meant that individuals would spend less time in face-to-face interactions, potentially affecting health and well-being (Kraut et al., 1998; Moody, 2001). Although some of the research has been mixed, overall, social media friendships have not been strongly implicated in PD and WB. For example, one recent set of studies revealed that at least in two samples, face-to-face relationships contributed to improved well-being, mental health, and physical health,
whereas the number of Facebook friends had no effect, or in one case a negative effect on these outcomes (Lima, Marques, Muinos, & Camilo, 2017). For this reason, I focus on face-to-face interactions as they predict PD and WB.

Several mechanisms have been proposed to explain the relationship between PD and social interaction (or lack thereof). Isolation is a stressor that can overstimulate the HPA axis, thus resulting in elevated levels of cortisol and alterations in circadian rhythm (Cacioppo, Cacioppo, Capitanio, & Cole, 2015). This sort of disruption is the same as what is often found in depressed patients (Varghese & Brown, 2001). In contrast, strong relationships can bring about positive emotions, which in turn can bring about healthy physiological consequences and improved immune functioning (Salovey, Rothman, Detweiler, & Steward, 2000). Further, social relationships may help in coping with stressful life events and encourage healthy lifestyle behaviors (e.g., exercise), which in turn improve mental health outcomes (Kawachi & Berkman, 2001).

Social interaction and well-being. Widely cited research has shown that individual happiness is partially dependent upon the happiness of those in one’s social network, including spouses and geographically close friends, siblings, and neighbors (Fowler & Christakis, 2008). The more relationships that are happy and the closer they are, the more likely one is to be happy with this effect carrying over across time. The quality of one’s friend relationships has been associated with happiness and well-being in children (Goswami, 2012; Holder & Coleman, 2007), adolescents (Demir & Urberg, 2004; Cheng & Furnham, 2002; Raboteg-Saric & Sakic, 2013), early adults (Demir & Weitekamp, 2007; Demir, Özdemir & Weitekamp, 2007; Demir & Özdemir, 2010), middle-aged adults (Wrzus, Wagner, & Neyer, 2012) and older adults (Pinquart &
Sörensen, 2000; Larson, Mannell, & Zuzanek, 1986). Giving and receiving support in a close relationship has been negatively associated with negative affect and positively related to positive affect in daily diary research (Gleason, Iida, Bolger, & Shrout, 2003). Within-person experiences of relatedness have been shown to relate to positive affect, negative affect, and vitality (Reis et al., 2000). Happiness has been predicted by socializing in two diary studies (Choi et al., 2017; Bernstein, Zawadzki, Juth, Benfield, & Smyth, 2017).

Some research has demonstrated that social relationships are predictive of EWB, wherein perceived romantic partner responsiveness predicts EWB 10 years later, even when controlling for personality characteristics, baseline EWB, baseline HWB, and other demographics (Selcuk, Gunaydin, Ong, & Almeida, 2016). Daily positive social interactions have been associated with meaning in life in one daily diary study (Machell, Kashdan, Short, & Nezlek, 2014). Another large daily diary study found that dating and socializing were some of the strongest predictors of meaning in life (Choi et al., 2017). Further, assessment of positive relationships is one of the six components of Ryff’s (1989) Psychological Well-being. HWB is predicted by the size of in-person social networks, but is not predicted by the size of online social networks (Helliwell & Huang, 2013). For this reason, I focus on in-person interactions in this study. Social interaction is an important lifestyle behavior that I measure at the daily level to investigate its effect on daily PD and WB.

**Substance Use**

Legal and illegal substance use can be a problematic lifestyle behavior for many individuals. Alcohol and tobacco use cost the U.S. economy a total of $249 and $289
billion respectively (Sacks, Gonzales, Bouchery, Tomedi, & Brewer, 2015; U.S. Department of Health and Human Services, 2014). Substance use is an important predictor of PD and WB, although we do not know much about day-to-day fluctuations in substance use as a predictor of daily PD and WB.

**Tobacco use and psychological distress.** Tobacco use is also a major contributor to the burden of disease and has been linked to a variety of mental health symptoms (Sarris et al., 2014). Nicotine use and dependence have been associated with mood and anxiety disorders across a 10-year period in longitudinal research (Swendsen et al., 2010). Across late adolescence and into young adulthood, nicotine dependence in the previous 12 months has been linked with depression symptoms, even when controlling for various demographics, neuroticism, comorbid alcohol use disorder, and anxiety disorders (Fergusson, Goodwin, & Horwood, 2003). Any tobacco use was associated with a 31.7% 12-month prevalence of having a mental disorder, which compares poorly to the 20% prevalence in the average population (Lawrence, Mitrou, Zubrick, 2009). A review of longitudinal studies investigating the link between depression and smoking in adolescents found significant bidirectional effects of each predicting the other (Chaiton, Cohen, O’Loughlin & Rehm, 2009). Even among those who have never smoked, exposure to second-hand smoke has been significantly associated with depressive symptoms while controlling for a variety of demographic characteristics, alcohol consumption, and medical conditions (Bandiera et al., 2010). With the increasing popularity of e-cigarettes, it is important to note that their use was positively associated with depression in a multi-state sample of college students (King, Reboussin, Spangler, Ross, & Sutfin, 2018).
A review of the literature indicated that some biological mechanisms, including the functioning of the dopamine system, serotonin, and norepinephrine that are implicated in mental disorders, are also negatively affected by tobacco use (Morisano, Bacher, Audrain-McGovern, & George, 2009). That same review also showed that a variety of genetic factors may predispose individuals to comorbidity of mental disorders and tobacco use.

**Tobacco use and well-being.** Tobacco use is also related to HWB. Individuals who quit smoking have been shown to have less negative affect and more positive affect at one-year post-quitting, whereas those who did not quit smoking have increased negative affect and decreased positive affect (Piper, Kenford, Fiore, & Baker, 2012). In a cross-sectional assessment of 17,246 students, higher levels of satisfaction with life were consistently associated with not smoking (Grant, Wardle & Steptoe, 2009), and in a random sample of 13,983 British adults, the number of daily cigarettes was linearly and negatively associated with a scale measuring both EWB and HWB (Stranges, Samaraweera, Taggart, Kandala, & Stewart-Brown, 2014). Regular tobacco users who quit using reported increased negative affect in the days immediately following the quit date (Vandrey, Budney, Hughes, & Liguori, 2008).

EWB was negatively associated with smoking status in a cross-sectional sample of 350,000 U.S. adults, even after controlling for a variety of variables including socioeconomic status (SES), race, age, and personality (McCann, 2010). Meaning in life was also negatively linked to smoking status in a representative sample of Hungarians (Thege, Bachner, Kushnir, & Kopp, 2009). The results indicated that those who never smoked and ex-smokers had higher self-reported meaning in life relative to current
smokers. Using the same sample, the average number of daily cigarettes was negatively associated with meaning in life for women, with a tendency toward significance for men (Thege, Stauder, & Kopp, 2010)

**Alcohol use and psychological distress.** Alcohol misuse is a major contributor to the global burden of disease (Rehm et al., 2017). Large epidemiological research in the U.S. indicates a 13.9% and 29.1% twelve-month and lifetime prevalence of alcohol use disorder (Grant et al., 2015). Although alcohol abuse and dependence have been linked to poor mental health across a broad range of research studies (Sarris et al., 2014), light to moderate alcohol use, especially wine, has been linked to a lower risk of depression in at least one large study (Gea et al., 2013). In terms of disordered drinking, having either depression or an alcohol use disorder resulted in a two-fold increase in risk of having the other disorder (Boden & Fergusson, 2011). High quality epidemiological studies that control for many potentially confounding variables strongly indicate that mood and anxiety disorders are linked with alcohol use disorders and that this association is likely not due completely to confounding variables (Hasin, Stinson, Ogburn, & Grant, 2007; Grant et al., 2004; Paljarvi et al., 2009). These findings were replicated in twin studies after controlling for shared genetic and environmental variables (Shivola et al., 2008). In terms of direction of causality, evidence favors alcohol use disorders leading to later depression relative to depression causing alcohol use disorders or a reciprocal interaction (Fergusson, Boden, & Horwood, 2009; Rehm et al., 2017). Also, evidence indicates that after a period of detoxification, depression and anxiety symptoms significantly improve relative to baseline symptoms (Liappas, Paparrigopoulos, Tzavellas, & Christodoulou, 2002; Davidson, 1995). At the daily level, one study found that alcohol use was
negatively associated with anxiety (Steptoe & Wardle, 1999). A central mechanism of action that may link alcohol use to mental disorders is the damage done to the hippocampus in individuals who drink excessively (Geil et al., 2014). Clear connections exist between alcohol use and mental health, with stronger evidence for heavy alcohol use leading to worsening mental health symptoms at the between-person level.

**Alcohol use and well-being.** Boehm and Kubzansky (2012) reviewed the literature linking forms of well-being with both moderate and excessive alcohol use. Two cross-sectional studies found positive associations between moderate alcohol use and self-mastery, which some consider to be part of EWB (van Loon, Tijhuis, Surtees, & Ormel, 2001; Bailis, Segall, Mahon, Chipperfield, & Dunn, 2001). In those studies, mixed evidence positively links moderate alcohol use with HWB. More recently, in a study of 13,983 British adults, moderate alcohol use was associated with lower odds of reporting lesser HWB and EWB (Stranges, Samaraweera, Taggart, Kandala, & Stewart-Brown, 2014). At the daily level, alcohol use was associated with positive mood, but only for those who reported low likelihood of drinking to cope with difficulties (Steptoe & Wardle, 1999).

Considering excessive alcohol use, Boehm and Kubzansky (2012) indicated that in cross-sectional studies heavy alcohol use tends to be inversely related to EWB (e.g., Marsh, Smith, Piek, & Saunders, 2003). Research findings have linked alcohol use as a teenager with less satisfaction with life during young adulthood (Bogart, Collins, Ellickson, & Klein, 2007). HWB was inversely related to excessive alcohol use for adolescents or young adults (e.g., Zullig, Valois, Huebner, Oeltmann, & Drane, 2001). Lastly, a study of 14,083 Finnish twins found that over a period of 15 years, satisfaction
was negatively associated with problematic alcohol use, with alcohol use more strongly predicting satisfaction over time than vice versa.

**Mindfulness Meditation**

Recently, Western society has been inundated with an increasing number of claims about the benefits of mindfulness and mindfulness meditation. Substantial press coverage has evolved, and an industry of self-help books, seminars, and apps have been designed to improve mental health and well-being by means of increased mindfulness. An estimated 10% of all U.S. workers engage in meditation (Kachan et al., 2017), and the rise of cell phone apps such as Headspace, which has been valued at $250 million, speaks to the current popularity of the practice (Chaykowski, 2017). Although not the panacea that some suggest, mindfulness can have benefits for PD and WB.

Mindfulness is described as a process of attending to present-moment experiences with acceptance, curiosity, and non-judgmentalness (Brown & Ryan, 2003; Kabat-Zinn, 1990). Mindfulness meditation often involves attending to one’s breath, body, thoughts, or environment as they are in the present moment for set periods of time. Confirmatory factor analyses have demonstrated a multi-factor structure of the construct of mindfulness, including non-reactivity to inner experience, acting with awareness, describing experiences, nonjudgmental approach to experience, and observing one’s experience (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006).

**Mindfulness meditation and psychological distress.** Several meta-analyses have revealed positive effects for meditation and mindfulness interventions. Pre-to-post anxiety and depressive symptoms in uncontrolled and controlled clinical trials were improved for those who received mindfulness interventions (Vøllestad, Nielsen, &
One meta-analysis including trials that implemented a mindfulness-based therapy found a moderate effect of the intervention on anxiety (Hedge’s $g = .63$) and depression (Hedge’s $g = .59$) symptoms. This effect was stronger when considering studies that only included individuals diagnosed with anxiety or mood disorders (Hofmann, Sawyer, Witt, & Oh, 2010; see also Khoury et al., 2013). A separate meta-analysis indicated that meditation programs reduced depression and anxiety symptoms more than non-specific active control conditions, but not more than active treatments such as psychotherapy or exercise (Goyal, Singh, & Sibinga, 2014). A slightly updated meta-analysis of randomized controlled trials that included individuals who were diagnosed with an anxiety disorder or depression found a moderate effect for depressive symptoms (-.73) and a non-significant effect for anxiety symptoms (-.52, CI 95% [-1.01, .06]; Strauss, Cavanagh, Oliver, & Pettman, 2014). Mindfulness-based cognitive therapy has been found to be efficacious as a means of preventing relapse into depression relative to treatment as usual (Kuyken et al., 2016). Mindfulness interventions have also been used to treat substance use disorders, resulting in small improvements in substance use, moderate improvements in craving, and large reductions in degree of stress (Li, Howard, Garland, McGovern, & Lazar, 2017). Importantly for the present study, meta-analyses investigating the impact of a mindfulness intervention on stress and anxiety in healthy individuals found moderate effects (Khoury, Sharma, Rush, & Fournier, 2015; Virgili, 2015). Mindfulness interventions have also been successfully delivered as Internet-based interventions (Spijkerman, Pots, & Bohlmeijer, 2015). In terms of mechanisms by which mindfulness brings about changes, a meta-analysis of meditation studies found that the relationship between mindfulness-based therapies and mental health were mediated by
changes in emotional reactivity, mindfulness, worry, and rumination (Gu, Strauss, Bond, & Cavanaugh, 2015).

Brain differences between meditators and non-meditators represent evidence for potential neurological mechanisms of action. These differences are found in the frontopolar cortex (related to meta-awareness), the anterior cingulate cortex (an area linked to self and emotion regulation), and the corpus callosum (involved in cross-hemisphere communication) (Fox et al., 2014). A review indicated that meditation may bring about changes in self-referential processing and higher awareness of present experiences which, together, are suggested to improve mental health by reducing evaluative judgments and increasing general awareness (Tang, Holzel, & Posner, 2015). Further, emotional regulation is improved in those who meditate, and it is theorized that increasing activity in the prefrontal cortex downregulates the activity in areas that are involved in emotion processing, including the amygdala. Lastly, attention abilities are improved in those who practice meditation with most MRI studies finding activation differences in the anterior cingulate cortex, which is important for executive control (Tang et al., 2015). Interestingly, changes in brain structure have been found after only brief meditation training and practice (Fox et al., 2014).

Aside from mindfulness and mindfulness meditation, other forms of meditative practices including tai chi, qui gong, guided imagery, and yoga have been linked to mental health benefits, but because of limited research, conclusions about their efficacy in improving mental health are tenuous (Walsh, 2011). Due to practical constraints, the present study focused on mindfulness meditation in daily life.
Mindfulness meditation and well-being. Various forms of well-being have been associated with mindfulness in several studies. Meditation frequency was associated with happiness in one sample, and this relationship was partially mediated by describing thoughts and emotions, self-compassion, and experiencing common humanity (Campos et al., 2016). Other research has also demonstrated links between trait mindfulness and satisfaction (Kong, Wang, Zhai, 2014), positive affect, and components of EWB (Brown & Ryan, 2003). In two small randomized trials, a mindfulness intervention increased satisfaction with life relative to a control group (Poulin, Mackenzie, Soloway, & Karayolas, 2008). At both the within- and between-person levels in a small randomized trial, mindfulness was associated with improved well-being, including reduced emotional exhaustion and increased job satisfaction (Hülshofer, Alberts, Feinhold, & Lang, 2012). Some research suggests a link between mindfulness and relationship satisfaction, which is a key component to many aspects of well-being (Barnes, Brown, Krusemark, Campbell, & Rogge, 2007).

A large meta-analysis that included 47 randomized trials with an active control group revealed lower-quality evidence that receiving a mindfulness-based intervention reduced stress and improved mental health-related quality of life (Goyal, Singh, & Sibinga, 2014). An alternative form of intervention, a kindness-based meditation, was associated with increased positive emotions and self-compassion according to a 22 study meta-analysis (Gallante, Gallante, Bekkers, & Gallacher, 2014). Also of note, a correlation between creativity and mindfulness across 22 studies was found to be significant (Lebuda, Zabalina, & Karwowski, 2016). As with PD outcomes, well-being outcomes are predicted by time spent practicing mindfulness (Carmody & Baer, 2008).
Nature

About 54% of individuals currently live in cities, and that number is expected to increase to 66% by 2050. This may result in less access to natural environments (World Health Organization, 2014; Soga & Gaston, 2016). Walsh (2011) suggested that nature plays an important role in helping humans regulate their emotions, sleep, and attention. Research has shown a link between both physical health and longevity with green space, which may be mediated by increased physical activity (Tzoulas et al., 2007). The idea that nature can protect individuals from physical and PD has become increasingly popular among those invested in city design and public health approaches to improving PD and WB (Shanahan et al., 2015).

Nature and psychological distress. Some research links time spent in nature and PD. One epidemiological study carried out in Auckland, New Zealand found that close-by and usable green space were negatively associated with anxiety and mood disorders (Nutsford, Pearson, & Kingham, 2013). Another large study in England revealed that the positive effect of green space on mental health varied in strength across time for men and was curvilinearly related to mental health for women; a medium amount of green space was more protective for women than low or high amounts (Astell-Burt, Mitchell, & Hartig, 2014). An increase in street trees has also been linked to a reduction of anti-depressant usage, even when controlling for several confounding variables (Taylor et al., 2015). In a meta-analysis of randomized and cross-over trials, adults who were exposed to a natural environment relative to a synthetic environment reported less anger, sadness and fatigue, with small to medium effect sizes (Hedges g = .36 to .46; Bowler Buyung-Ali, Knigth & Pullin, 2010). Exposure to natural environments has also been negatively
associated with attention-deficit hyperactivity disorder (ADHD) symptoms (Kuo & Taylor, 2004). One review indicated that the evidence for the influence of the quantity of green space in the environment on mental health was quite strong, but the evidence for the role of quality of green space was less established (van den Berg et al., 2015). Another review indicated that urban green spaces are negatively correlated with PD, but that the quality of the evidence was somewhat weak, and the overall effects appeared to be small (Lee & Maheswaran, 2010). Similarly, a separate review found limited evidence for a causal relationship between long-term exposure to greenness and mental health for adults and very little evidence for children (Gascon et al., 2015).

The mild and sometimes mixed effects of nature on PD can be explained by two theories: biophilia and biophobia. The first emphasizes that humans have an inherent need to affiliate with living things and other lifelike processes (Kellert & Wilson, 1993). On the other hand, the biophobia indicates that living things can, due to our evolutionary history, elicit fear and avoidance because they historically may have been dangerous for our ancestors (Ulrich, 1993). These disparate effects of nature were found in a large twin study carried out in the U.S. A significant negative association between amount of green space and symptoms of depression exists, but not a significant relationship between green space and anxiety symptoms or stress (Cohen-Cline, Turkheimer, & Duncan 2015). Thus, green space did not reduce worries or fears (biophobia), but did reduce low mood and lack of interest (biophilia).

Potential mechanisms linking exposure to greenness with health outcomes are increased physical activity, stress reduction, noise reduction, pollution filtration, sunlight, and increased social connection (Dadvand et al., 2015; James, Banay, Hart, & Laden,
Rook (2013) suggested that along with the psychological and physical benefits of these aspects of nature, exposure to microbiota, largely reduced in our modern urban environments, can also improve health outcomes through improved immunoregulation. Thus, time spent in or by nature may find much of its influence on mental health mediated by some of the other lifestyle behaviors implicated in mental health. In fact, one large study of middle-age to older adults in Australia found that greenness predicted physical activity and reduced PD, but that the least active individuals did not benefit from increased greenness (Astell-Burt, Feng, & Kolta, 2013).

**Nature and well-being.** Nature, especially perceptions of connectedness to nature, has been positively linked to forms of well-being in several studies. Across countries, a nation’s natural capital or natural resources predicts average national life satisfaction, while controlling for life expectancy and perceptions of personal influence on society and personal accountability (Abdallah, Thompson, & Marks, 2008). A review of articles published in *Landscape and Urban Planning* suggested that access to nature as a means of aesthetics and opportunities to play is an important contributor to satisfaction (Matsuoka & Kaplan, 2008). This is complemented by a systematic review that indicates that exercise in nature as opposed to in human-made structures tends to lead to greater satisfaction and improved mood (Coon et al., 2011). A thorough review of the association between nature and different forms of well-being by Russell et al. (2013) concluded that overall (but not in every case or for every person), nature does tend to improve HWB and EWB.
A few studies are helpful in demonstrating aspects of the nature-well-being connection. One cross-sectional study of college students found that the relationship between connectedness to nature HWB and EWB was fully mediated by purpose in life (Howell, Passmore, & Buro, 2013). Zhang, Howell, and Iyer (2014) also found that connecting to nature more often and having a greater tendency to perceive natural beauty are positively associated with life satisfaction. A trait conception of nature connectedness was not found to moderate the positive relationship between nature interaction and positive affect in a small randomized trial, suggesting that the benefits of engaging in nature may not depend on a natural tendency to connect with nature (Passmore & Howell, 2014). Passmore and Holder (2016) found that an intervention that encouraged participants to simply pay attention to nature improved affect and a sense of connectedness compared to a control intervention. EWB and HWB seem to be influenced to some degree by individuals’ access to natural resources in his/her environment.

**Lifestyle Behaviors in Context**

As the literature reveals, lifestyle behaviors are important predictors of PD and WB. Political, economic, and social contexts play important roles in the areas of lifestyle behaviors and PD and WB separately, but little research has been done on how the associations among these variables change depending on the broader environmental and social contexts. For example, research indicates that some geographic areas have fewer grocery stores with high quality produce (Cummins & Macintyre, 2005). Thus, one’s place of residence may make it more or less likely to engage in healthy eating (Weatherspoon et al., 2013). The research linking geography and diet generally supports the claim (Beaulac, Kristjansson, & Cummins, 2009; Caspi, Sorensen, Subramanian, &
Kawachi, 2012), although other research reveals mixed or non-significant findings (Pearson, Russell, Campbell, & Barker, 2005; Winkler, Turrell, & Patterson, 2006; Black & Macinko 2008). In addition to food availability, a review of the influence of SES on lifestyle behaviors found that it was negatively correlated with tobacco use and positively correlated with physical activity and diet quality (Pampel, Krueger, & Denney, 2010). The authors state that the mechanisms by which low SES impacts engagement in lifestyle behaviors was unclear and needs further study. Overall, engaging in lifestyle behaviors depends at least partially on the community where an individual lives (Buki & Salem, 2012; Office of Disease Prevention and Health Promotion, 2019).

Most interestingly for the present study, the research on demographic and contextual variables investigates either if these variables impact engagement in lifestyle behaviors or if the variables influence health and well-being, but they rarely investigate the relationship between the two from this perspective. Thus, while minorities often have less access to lifestyle behavior opportunities such as physical activity (Brown, Werner, Smith, Tribby, & Miller, 2014), access to green space (Wolch, Byrne, & Newell, 2014), and healthy food (Coleman-Jensen, Gregory, & Singh, 2018), the evidence clearly linking their lower engagement in lifestyle behaviors to their impaired health is less developed. Further, no research has investigated the impact of these contextual variables on within-person processes or associations. It is unknown whether between-person and within-person associations differ for individuals based on race, ethnicity, or SES.

The Counseling Psychology Approach

The counseling psychology perspective offers important insights that guide this study. In particular, counseling psychologists use a perspective based developing an
individual’s strengths, so that he can make decisions and take responsibility for his health and well-being as much as possible (Kaczmarek, 2006). Strengths can often be called upon to cope with problematic life circumstances and societal injustice. For example, whereas SES has been found to correlate with health, not all individuals with low SES have poor health, in part due to their strategies for coping with stressors (Chen & Miller, 2013). Counseling psychology also emphasizes that culture, geography, SES, and other factors may influence one’s ability to engage in healthy lifestyle behaviors, one’s likelihood of achieving optimal health, and the relationship between those two variables. Findings from this study, which consider both between- and within-person associations, may be helpful in orienting counseling psychologists to best know how to help individuals trying to reduce their PD and improve their well-being. This study may provide evidence for which behaviors will be most beneficial for clients and may be helpful in laying the groundwork for eliminating lifestyle and health disparities (Buki, 2007). Because it is the first study that investigated potential impacts of demographic and contextual variables on within-person processes, much more research needs to be done to solidify our understanding of these concepts.

**Model and Hypotheses**

I designed this project to build on other relevant studies that have investigated the daily fluctuations in lifestyle behaviors and mental health and well-being. I collected multiple reports per person, so that multilevel modeling can be used to decompose between- and within-person variance in the relationship between health behaviors and PD and WB. The present study is innovative in that it assessed many lifestyle behaviors and their relationships to PD and WB.
The central aim of this study is to assess the within-person associations between lifestyle behaviors and PD and WB. Because this study is the first of its kind and represents an exploration of the relationships between the variables, a many hypotheses are involved. Any findings need future replications to be adequately substantiated.

**Hypotheses:**

Daily PD will be associated with daily amount of physical exercise, fruit and vegetable intake, meaningful social interaction with close others, alcohol use, tobacco use, mindfulness meditation practice, and time spent enjoying nature.

Daily EWB will be associated with daily amount of physical exercise, fruit and vegetable intake, meaningful social interaction with close others, alcohol use, tobacco use, mindfulness meditation practice, and time spent enjoying nature.

Daily HWB will be associated with daily amount of physical exercise, fruit and vegetable intake, meaningful social interaction with close others, alcohol use, tobacco use, mindfulness meditation practice, and time spent enjoying nature.
CHAPTER THREE

METHODS

Participants

One hundred four adults, who were users of the survey participant pool website www.prolific.ac, clicked on the link to the online baseline survey. Two individuals did not proceed past the consent form, one person chose not to consent, and one person missed an attention check item. Four additional individuals completed the baseline survey, but did not complete any daily surveys. Eighteen individuals completed less than 7 usable daily surveys (i.e., no missed attention check items on at least 7 completed surveys). Upon inspection of the data, two individual’s responses appeared mindless with no variation in any of the items across days, despite completing the attention check items. Motivation for payment may have driven this behavior. After excluding the participants described above, the sample consisted of 76 adults who fully participated in the study.

The participants were drawn from the 7,000+ individuals who are signed up to take surveys on Prolific and currently live in the U.S. Palan and Schitter (2017) indicated that Prolific is a quality resource for obtaining research participants and that it is a valuable alternative to other forms of online recruitment.

I stratified the sample by age and gender using the participant filters made available on the Prolific web portal, but differences in drop out and rate of completion impacted the balance of the stratification. Exclusion criteria included women who were pregnant or breast feeding, anyone under the age of 18, and individuals who could not understand English. The sample was 57.9% female and 40.8% male with one participant who selected “other” for sex (1.3%), and another participant identified as transgender.
The average age of the participants was 40.29 years ($SD = 13.69$). Four participants identified ethnically as Latinx (5.3%). The sample was predominantly White (85.5%), with other participants identifying as Black, African American (9.2%), Chinese (1.3%), Vietnamese (1.3%), “Other” (self-entered Laotian, 1.3%), and bi-racial (selected Black, African American and White, 1.3%). Participants relationship status was reported as single (34.2%), married (32.9%), in a relationship (22.4%), divorced (9.2%), or separated (1.3%). In terms of sexual orientation, 80.3% of participants were heterosexual or straight, 6.6% were homosexual, 10.5% were bisexual, and 2.6% were “other.” Average BMI for participants was 27.79 ($SD = 5.90$).

**Procedure**

A description of the study was listed on the Prolific website for the users to review (Appendix A.). The description included the survey procedures, including the daily diary component of the study and the compensation structure for participation. If the participants clicked on the study link, they were directed to an online, self-administered survey via Qualtrics software. They were first provided with a consent form that described their rights, the voluntary nature of the study, and relevant contact information (Appendix B.). After providing their consent to participate in the study, participants filled out a variety of baseline survey questions including demographic items.

For the next 14 days, the participants were sent an email through Prolific at 7 PM EST to remind them to complete the study for that day. The link in that email led the participants to the description of the daily survey (Appendix C.). Participants had access to the researchers through Prolific’s email service. The researchers answered questions and provided guidance on the research process as needed. Participants were paid $12 if
they completed the baseline survey and 7 daily surveys. They were paid $1.50 per each additional survey and a bonus of $3.50 if they completed 13 or more surveys. At the end of the 14 days, participants were compensated according to their level of completion.

Measures

Measures were completed during two phases. The first phase included a longer survey that consisted of demographic questions and other measures (Appendix D.). The second phase occurred over the next 14 days with the participant filling out one shorter survey each evening (Appendix E.).

Baseline. For the baseline survey, participants filled out a series of demographic items including age, gender, race, ethnicity, relationship status, sexual orientation, perceived SES, urban/suburban/rural residence, weight, height, nutritional supplement consumption, and average physical activity at work. Some of these variables were best measured by single items (weight, height, etc.), and others were measured with single items (perceived SES, physical activity at work, etc.) to keep the survey from being too burdensome for participants.

Baseline functional impairment related to physical and mental health was assessed with the 12-item version of the Medical Outcomes Study short-form health survey (SF-12; Ware, Kosinski, & Keller, 1996; Appendix D.). This measure is widely used, correlates strongly with the full 36-item measure (90% shared variance), and the total scale has adequate internal consistency (α > .70; Luo et al., 2003). In this sample, the Cronbach’s alpha was .85. The measure can provide two scale scores: the Physical Component Summary and the Mental Component Summary. The scoring procedure is described by Ware and colleagues (1995), and it involves weighting the items with U.S.
population norms and standardizing the scores. Thus, all 12 items are used in each scale, but with different weights applied to each item response depending on the mental or physical scale.

The participants completed a 10-item version of the UCLA loneliness scale to assess for an overall self-reported loneliness (Russell, 1996). This is a 4-point scale with the item choices ranging from 1 “never” to 4 “often.” The item values are summed to create a composite value. The measure has strong internal consistency ($\alpha > .80$) and correlates negatively with social support and positively with burnout (Russell, 1996). In this study, the internal consistency was .94.

To assess a tendency to respond in socially desirable ways, participants also completed the 16-item Balanced Inventory of Desirable Responding (BIDR), which has demonstrated strong internal consistency ($\alpha = .83$) in previous research (Paulhus, 1991). It is a 7-point scale with the item choices ranging from 1 “Not true” to 7 “Very true.” The measure has two subscales: impression management (tendency to try and please others) and self-deceptive enhancement (having an overly positive outlook of one’s self). In this study, the internal consistency of the self-deceptive enhancement scale was .78, and the impression management scale was .80. The items for the respective subscales were summed to create two composite values.

**Daily diary.** To ensure that variables measured at the daily level had adequate psychometrics, an alternative form of computing reliability estimates was needed to reduce the bias that is created with nested data. This process relies on the separation of within- and between-person variance of the measures. Day-level and person-level reliabilities can be calculated. For more reliable measures, individual’s items on a given
day tend to cluster around the mean of those items on a given day (day-level reliability), while an individual’s scale means for each day cluster around each other to a high degree (person-level reliability). The procedures described by Bonito, Ruppel, and Keyton (2012) for obtaining reliability estimates in multilevel group research were modified to obtain within-person estimates. Three three-level unconditional models (one for each DV) were run to obtain variance estimates at the item-, day-, and person-level for each scale. These variances were used to calculate the reliabilities. This required creating three datasets that had a row for each item from each scale, per day, per person.

PD was assessed by the 6-item the Kessler Scale for Psychological Distress (Kessler et al., 2002). This scale assesses non-specific PD, meaning the symptoms that are commonly experienced across psychological disorders (e.g., “During the past day how often did you feel hopeless?”). The 5-point Likert, self-response format of the scale has been widely used and exhibits adequate psychometrics (Kessler et al., 2003). The scale choices ranged from 1 “All of the time” to 5 “None of the time.” The multilevel internal consistencies were calculated to be .75 for day-level reliability and .96 for person-level reliability, which are acceptable. When calculating descriptive statistics, the items from this scale were summed to create a composite score.

To assess HWB, the 5-item satisfaction with life scale (SWLS) was used (Diener et al., 1985). The 7-point scale has item choices that range from 1 “Strongly disagree” to 7 “Strongly agree.” This widely used measure, which has strong reliability and validity, was modified to ask about the day of reporting, following the work of Maher et al. (2013; e.g., “I was satisfied with my life today”). The multilevel internal consistencies for SWLS were calculated as .90 for day-level reliability and .92 for person-level reliability,
which are acceptable. The items from this scale were summed when calculating some of the descriptive statistics.

Diener et al.’s (2010) 8-item Flourishing scale (FS) was used to assess EWB. It is based on a 7-point Likert scale and assesses individuals’ EWB (e.g., “I lead a purposeful and meaningful life”). The item choices range from 1 “Strongly disagree” to 7 “Strongly agree.” This measure has demonstrated adequate internal consistency ($\alpha = .87$) and appropriate convergent and divergent validity (Diener et al., 2010; Hone, Jarden, & Schofield, 2014). It was modified to ask about the participant’s perceptions of the day of reporting EWB rather than their overall EWB. The multilevel internal consistencies for the FS were calculated to be .80 for day-level reliability and .93 for person-level reliability, which are acceptable. The sum of these items was used for some of the descriptive statistics described below.

For exercise, the participants completed three items from the modified Godin Leisure-Time Exercise Questionnaire (Flueckiger et al., 2014; Godin & Shepard, 1985). Specifically, the participants reported how many minutes they spent engaging in mild (e.g., easy walking, golf, bowling), moderate (e.g., fast walking, easy swimming, volleyball), and intense (e.g., running, vigorous swimming, basketball) exercise. Reported periods of exercise that were greater than 15 minutes were counted. Each report of exercise was given a metabolic unit provided by Godin and Shepard (1997). These are 3 for mild exercise, 5 for moderate exercise, and 9 for strenuous exercise. Those were then summed to create a single daily activity value ranging from 3 to 17. Previous research indicates a test-retest consistency of $\alpha > .70$ (Godin & Shepard, 1985).
Importantly, this measure has been found to have adequate concurrent validity with actigraph measurement (Jacobs, Ainsworth, Hartman, & Leon, 1993).

For nutrition, participants reported on the number of servings of fruits (fresh, frozen, or canned, but not dried or juiced) and vegetables (fresh, frozen, or canned, but not juiced or in chips) they consumed that day. The questions are like those used in previous research (Connor et al., 2015) and were combined with the images used by Mujcic and Oswald (2016) to demonstrate serving sizes. Participants reported on a scale with the values none, <1 serving, 1 serving, 2 servings, 3 servings, 4 servings, 5 servings, ≥6 servings. The responses from these two items were summed to create the fruits and vegetable consumption variable.

Social interactions were assessed by asking the participants to rate how much time they spent having meaningful conversations with close others in a single item (family, friends, coworkers, peers etc.). Meaningful conversation has been associated with overall social connectedness in a daily diary study (Reis, Sheldon, Gable, Roscoe, & Ryan, 2000) and was selected as a proxy for overall social interaction.

Tobacco use was assessed by asking how many occasions the participants used tobacco in the past day in a single item. Alcohol use was assessed by asking the participants how many drinks they had in the previous 24 hours with a single item. To provide the participants with a visual guide, an image displaying serving sizes from the National Institute on Alcohol Abuse and Alcoholism (n.d.) was provided.

To assess daily mindfulness meditation, participants were asked “How many minutes did you engage in formal mindfulness practice (sitting/breathing meditation,
body scan meditation, or open-awareness meditation)?” This single item was used to represent mindfulness meditation.

Time spent in nature was assessed with a single item that asks participants how much time they were outside during the previous day with a single item. They also reported on the amount of their time outside was spent enjoying nature. To help the participants identify what a natural space is, Kuo and Taylor’s (2004) description of a natural/green area was used (“a park, a farm, or just a green backyard or neighborhood space.”)

**Analysis Plan**

The first step in data analysis was an assessment of the data using descriptive statistics and a review of missingness in the data. Multivariate multilevel models were built in steps, first adding random slopes for lifestyle behaviors, then adding fixed slopes for within-person lifestyle behaviors, between-person lifestyle behaviors, and then demographic and control variables. Assumptions for multilevel models were assessed. Lastly, the within-person fixed slopes were compared to find differences between the lifestyle behaviors’ influence on the three DVs.
CHAPTER FOUR
RESULTS

Data Analysis

The data collection resulted in 894 days of data from 76 participants. Multilevel or ILM was used to account for the nested nature of the data and to explore both within- and between-person associations (Bolger & Laurenceau, 2013). I assessed the relationship between lifestyle behaviors measured over time and three dependent variables (DVs): satisfaction with life (as a measure of HWB, EWB, and PD). Because I was interested in the relative impact of lifestyle behaviors on the each of three DVs, I used a multivariate multilevel modeling approach that can simultaneously model multiple DVs and their relation to within- and between-person variations in lifestyle behaviors. Descriptive statistics, plots, and multilevel models were performed using SPSS 24 (IBM Corp). Multilevel models were analyzed using the “MIXED” and “GENLINMIXED” commands.

Diary data usually consists of two levels of data, with the daily surveys nested within the person. However, to analyze diary data with multiple DVs, a third level was modeled at the item level. I created three dummy coded variables for the DVs (EWB, HWB, & PD) and one “response” variable that contains the item values of the DVs. These item values (level 1) were nested within the day (level 2), which were nested within the person (level 3). Level 1 can be considered a measurement model of the DVs, and levels 2 and 3 essentially comprised a two-level multivariate model (e.g., Bleidorn & Peters, 2011).
The daily predictor variables were person mean centered to parse out the impact of the individual’s daily fluctuations in lifestyle behaviors from their average levels of lifestyle behavior. The person means of the lifestyle behaviors were also used to assess the between-person association between these behaviors and the DVs. The between-person continuous variables were centered on the grand mean. Correlations at each of level of analysis were calculated to look for signs of multicollinearity.

Using full information maximum likelihood estimation (FIML), I addressed Aim 1 by building a model following recommendations from Hox (2010) and Nezlek (2014). The first step was to create three unconditional models without any level 2 or 3 predictors. Using these models, the intraclass correlation coefficient (ICC) was calculated for the DVs. The ICC indicates how much of the variance in the DVs occurs at the between-person level, which allows for an inference of the amount of variance that occurs at the within-person (daily) level combined with residual error (1 – ICC). Because level 1 is essentially a measurement model, I focused my ICC calculations on the level 2 and level 3 variances.

The second step in model building consisted of adding level-2 predictors as random slopes, one at a time, in order of the prevalence of their effects in previous research: exercise, fruit and vegetable intake, time in social interaction, tobacco use, alcohol use, mindfulness meditation practice, and time spent enjoying nature. The lifestyle behavior random slopes were added singly, and only those that were significantly associated with at least one of the DVs were retained in the model. I used significance values from F tests with the Satterthwaite approximation, the percent of additional variance explained by the random slope, and AIC and BIC model fit indices.
These slopes tested the amount of within-person (daily) variance in the association between each of the different lifestyle behaviors and each of the DVs, controlling for the association of the other behaviors. The third step added daily level predictors including time, a dummy coded variable for weekend, and the lifestyle behaviors. All of the within-person lifestyle variables were retained as the central variables of interest. The fourth step added between-person, level-3 predictors that included the person-means of lifestyle behaviors, demographics, and control variables (loneliness, physical/mental functional impairment, and desirable responding). Unretained variables were excluded to prevent this already complex model from becoming too bloated with predictor variables (Nezlek, 2012b). After I arrived at a final model, I compared the size of the coefficients for the within-person associations between the lifestyle behaviors and the DVs. A significant test statistic indicated that the coefficients were different from each other, revealing which coefficients were the strongest predictors of PD, HWB, and EWB. Equations for the hypothesized model are listed below.

Level 1 (Item-level):

\[ y_{itk} = \pi_{1tk}(PD) + \pi_{2tk}(EWB) + \pi_{3tk}(HWB) + e_{ijk} \]

For this equation, \( y_{itk} \) represents the response value of item \( i \) from one of the DV scales, on day \( t \), for person \( k \). When the dummy coded variables for the scales were entered as predictors of \( y_{itk} \), the \( \pi_{1tk} \), \( \pi_{2tk} \), and \( \pi_{3tk} \) coefficients became the estimates of the means for the PD, EWB, and HWB scales. \( e_{ijk} \) represents the measurement error of the different scales. Of note, no intercept is included in this equation, which results in the estimates of the mean scores of the DV scales being brought up to the second level. The
three separate level 2 equations predicting these mean scores allowed for the simultaneous analysis of the three DVs.

Level 2 (Day-level):

\[ \pi_{1tk}(PD) = \beta_{10k} + \beta_{11k}(Time) + \beta_{12k}(Exercise) + \beta_{13k}(FruitsVegs) + \beta_{14k}(SocialInt) + \beta_{15k}(Tobacco) + \beta_{16k}(Alcohol) + \beta_{17k}(Meditation) + \beta_{18k}(Nature) + r_{1tk} \]

\[ \pi_{2tk}(EWB) = \beta_{20k} + \beta_{21k}(Time) + \beta_{22k}(Exercise) + \beta_{23k}(FruitsVegs) + \beta_{24k}(SocialInt) + \beta_{25k}(Tobacco) + \beta_{26k}(Alcohol) + \beta_{27k}(Meditation) + \beta_{28k}(Nature) + r_{2tk} \]

\[ \pi_{3tk}(HWB) = \beta_{30k} + \beta_{31k}(Time) + \beta_{32k}(Exercise) + \beta_{33k}(FruitsVegs) + \beta_{34k}(SocialInt) + \beta_{35k}(Tobacco) + \beta_{36k}(Alcohol) + \beta_{37k}(Meditation) + \beta_{38k}(Nature) + r_{3tk} \]

Each of the level 2 equations include a random intercept and up to eight random slopes. The random intercept values, \( \beta_{10k}, \beta_{20k}, \) and \( \beta_{30k}, \) represent the averages of the respective DVs across all days and, as random intercepts, they can vary person-to-person. The first random slope coefficient, Time, was entered into the model as a control because I expected that the impact of responding to questions about lifestyle behaviors participant’s later responses would vary by person. The rest of the random slopes represent the association between the various daily lifestyle behaviors (e.g., time spent exercising, fruits and vegetables consumed, and time spent in nature) and the daily DVs. For example, \( \beta_{12k} \) is the coefficient of the slope of daily exercise predicting daily PD. Up to seven lifestyle behaviors could be included in the model, depending on the software’s ability to accurately estimate parameters within the limits of the dataset. As random slopes, the association between the daily lifestyle behaviors and DVs were allowed to vary for each person. For example, daily exercise may have a strong positive relationship with PD for some individuals, whereas daily exercise may have a minimal or even negative relationship with PD for others. Lastly, for each of the three level 2 equations,
an error term is included (e.g., \( r_{1tk} \) in the equation predicting PD), which represents the day-level variation in the relationship between the intercept and slope coefficients with the DVs.

Level 3 (Person-level):

**DV intercepts**

\[
\beta_{10k} = \gamma_{100} + \gamma_{110}(\text{Exercise-Mean}) + \ldots (\text{other lifestyle means}) + \gamma_{120}(\text{Loneliness}) + \ldots (\text{other significant between-person variables}) + u_{10k}
\]

\[
\beta_{20k} = \gamma_{200} + \gamma_{210}(\text{Exercise-Mean}) + \ldots (\text{other lifestyle means}) + \gamma_{220}(\text{Loneliness}) + \ldots (\text{other significant between-person variables}) + u_{20k}
\]

\[
\beta_{30k} = \gamma_{300} + \gamma_{310}(\text{Exercise-Mean}) + \ldots (\text{other lifestyle means}) + \gamma_{320}(\text{Loneliness}) + \ldots (\text{other significant between-person variables}) + u_{30k}
\]

**Lifestyle-DV slope coefficients**

\[
\beta_{11k} = \gamma_{130} + u_{11k}
\]

\[
\beta_{21k} = \gamma_{230} + u_{21k}
\]

\[
\beta_{31k} = \gamma_{330} + u_{31k}
\]

\[
\beta_{12k} = \gamma_{140} + u_{12k}
\]

\[
\beta_{22k} = \gamma_{240} + u_{22k}
\]

\[
\beta_{32k} = \gamma_{340} + u_{32k}
\]

\[
\ldots
\]

\[
\beta_{18k} = \gamma_{1100} + u_{18k}
\]

\[
\beta_{28k} = \gamma_{2100} + u_{28k}
\]

\[
\beta_{38k} = \gamma_{3100} + u_{38k}
\]

The level 2 random intercepts, \( \beta_{10k}, \beta_{20k}, \) and \( \beta_{30k} \), are predicted, in part, by fixed intercepts (\( \gamma_{100}, \gamma_{200}, \) and \( \gamma_{300} \)) at level 3, which represent the grand average of the respective DVs across all participants. These random intercepts are also predicted by fixed slope coefficients for the person-means of lifestyle behaviors, demographic variables, and other control variables (e.g., exercise averages and loneliness, \( \gamma_{110} \) & \( \gamma_{120} \), in the first level 2 equation). Lastly, each random intercept is also predicted by an error term (\( u_{10k}, u_{20k}, \) \& \( u_{30k} \)), which represents the variation in person-averages of the DVs.
The level 2 random slopes are predicted by an average slope relationship between the lifestyle behavior and the respective DV across all people and an error term. For example, $\gamma_{140}$ represents the average slope for the exercise and PD relationship for all participants, and $u_{12k}$ represents the difference of person $k$’s slope from the average slope.

An unstructured covariance structure was modeled. This allowed the random intercepts and slopes to covary with each other. To account for the correlations of error terms for variables that were measured closely in time, a first order autoregressive heterogeneous (ARH1) pattern was used to model the error structure. This variance covariance structure allows errors terms that are measured more closely in time to correlate more than errors that are separated by longer periods of time. Further, it also allows for heterogeneity in error variances that was present in the data.

**Preliminary Analyses**

**Missing data.** The only missing values were for the variables time spent in social conversation (.3%) and time spent meditating (.7%). This was due to researcher error in programming the Qualtrics survey, which was corrected after the first group of participants completed the first day. Those data were missing completely at random as determined by Little’s MCAR test ($\chi^2(10) = 13.09, p = .22, N = 894$). Maximum likelihood estimation is a robust method to handle missingness in the data.

**Assumptions.** The validity of multilevel models depends on certain assumptions being met. These assumptions include normally distributed residual values, linearity of relationships, homogeneity of variance, and examination of influential outliers. A histogram with a superimposed normal curve (Figure 1) and a QQ plot (Figure 2) indicates that the level 1 standardized residuals for the model seem to be generally
normally distributed. A histogram of the level 2 standardized errors also indicates a generally normal distribution of errors (Figure 3). An investigation of the residual distribution for each participant indicated that heterogeneity of variance was evident between participants with some individuals having large error variance and some participants having minimal error variance (Figure 4). A plot examining the relationship between the model predicted values and the level 1 residuals indicated a linear relationship, with a generally symmetrical spread of standardized residuals above and below 0, but the figure also indicated a heterogeneity of variance across the predicted values (Figure 5). Plotting that same relationship, but for each DV separately, also indicated a linear relationship as indicated by a generally symmetrical spread of standardized residuals above and below 0 and heterogeneity of variance moving across predicted values (Figures 6, 7, & 8). A plot showing the associations between level 2 residuals by predicted values also demonstrated general homogeneity of variance at that level (Figure 9). Plots showing the relationship between the model residuals and the individual predictor variables included in the final model were investigated to assess normality, linearity, and homogeneity of variance. Although the plots generally showed normality and linearity, the assumption of homogeneity of variance was violated. To adjust for this violation, a heterogeneous autoregressive covariance structure was used for the multivariate multilevel models, and robust standard errors were used for the negative binomial model described below.

Standardized scores for the between-person continuous baseline variables were calculated. The values were generally normally distributed, and no values were greater than 3 standard deviations from the mean on any variable. Between-person averages of
the daily lifestyle behaviors indicated that each lifestyle variable at the between-person level had at least one outlier (and up to four). New variables were created with the outliers changed to be equal to 2.5 SD from the mean. The final model was run using the original and the trimmed variables. No appreciable change occurred in model fit, and the impact on the fixed and random effects was very minimal. For that reason, and to retain as much original data as possible, the untrimmed variables were used in the final analyses. Three individuals had mean scores on the PD scale that were between three and four standard deviations above the mean. Analyses were run with and without these individuals and the levels of significance were not impacted. Within-person outliers (a person engaging in much more or much less activity than their own average) were also present for each of the daily lifestyle behaviors. The final model was run with and without the outliers greater than 3.25 SDs from the mean, and some fixed effects were different. The results from models with and without these outliers are described below.

An investigation of the DVs revealed that PD was significantly non-normal with a distribution of values that had zero as the modal response. Zero-inflated distribution of values are often better analyzed with forms or regression other than ordinary least squares regression. In this case, the high number of zero values and the high amount of variance indicate that a negative binomial regression is likely a more robust approach to analysis. To do this, PD had to be analyzed in a separate model from HWB and EWB, which were more normally distributed. The original 3 DV model and the other two separate models are all presented below.

**Descriptive statistics.** Participants completed 12 of 14 diary entries on average ($M = 11.80; SD = 1.86; \text{range: } 7-14$). Descriptive statistics for the daily variables are
presented in Table 1. Composite variables for the DVs are listed in this table, which were calculated by summing the individual items for each DV. Unconditional multilevel models were run for each daily predictor variable and each DV to obtain the ICC. The ICC represents the percentage of the overall variance that can be attributed to between-person differences. The equation for calculating the ICC is as follows:

$$\rho = \frac{\sigma_{u0j}^2}{\sigma_{u0j}^2 + \sigma_{eij}^2}$$

In this equation $\sigma_{u0j}^2$ represents the variance of the level-2 residuals and $\sigma_{eij}^2$ represents the variance of the level-1 residuals. The ICC values varied greatly, with the largest being tobacco use, which was .95. This indicates that tobacco use is almost entirely a between-person variable (i.e., most variation occurs in the differences between whether people smoke or not) when measured at the daily level. Most individuals did not report smoking over the 14 days of the study (86%; $N = 65$). To best account for the impact of smoking on the DVs, a dummy code was used for anyone who reported smoking over the past 14 days. This makes smoking status a between-person variable and it was not included in any further within-person analyses. Exercise and time spent outside represented the daily variables with the lowest ICC, indicating that most of the variation in these variables occurred at the within-person level. All of the daily variables except smoking had ICCs that fell between .37 and .68 and are listed in Table 1.

Correlations between the composites of the DVs and the lifestyle behavior variables were calculated at the within- and between-person levels (Table 2). To calculate the composites of the DVs, the items were summed and then divided by the total number of items in the given scale. The DVs were significantly correlated, especially HWB and EWB, at the between-person level ($r = .85$). As expected, higher levels of PD were
negatively correlated with HWB and EWB at the within- and between-person levels. Investigation of collinearity diagnostics for each of the 14 days also indicated that the HWB and EWB variables were correlated, with variance inflation factor (VIF) values ranging from 1.70 to 5.82 for HWB and 1.79 to 5.88 for EWB. High VIF values indicate that two variables are so highly correlated that they often cannot be distinguished statistically. Despite the occasionally elevated levels of multicollinearity in this sample, the model can still be considered valid because the peak VIF values are lower than the commonly recommended maximum value of 10 (O’Brien, 2007).

**Multilevel models.** To run a multivariate multilevel model comparing the relationships between the various lifestyle variables and the three DVs, the DVs need to be on the same scale. The items were rescaled, so that they had the same mean and standard deviation ($M = 0$, $SD = 1$). All of the DVs moved in the same direction, with higher scores indicating greater well-being.

The final 3-DV model results can be seen in Table 3, which lists the fixed effects for the multivariate baseline model, the model with the within-person lifestyle behaviors, and the final model with between-person variables entered. As mentioned previously, the person-centered lifestyle behavior variables had some outliers. These included days in which individuals engaged in lifestyle behaviors to a greater or lesser degree than their own personal average. All values for these variables 3.25 SDs above and below the mean were deleted, which resulted in 10-16 values deleted per lifestyle behavior variable. Then the models were run on the data set without outliers revealing some fluctuations in the estimates as reported below (Table 4). The variance-covariance matrix for the final 3-DV model without outliers is listed in Table 5. The benefit of the 3-DV model is the ability to
compare across the three DVs, but as mentioned above, the distribution of PD makes any conclusions from the 3-DV model somewhat tenuous. The 2-DV model with HWB and EWB and the negative binomial model for PD are also described below and are likely less biased.

The model’s random coefficients for the dummy-coded DVs represent two levels of variation. At the item level, a significant coefficient for each of the dummy-coded DVs indicates that the daily mean of that scale had variation around a person’s overall mean of that scale. Dummy codes are used, so that when the associations between one DV and the predictor variables are being assessed, the other DVs drop out. These random coefficients at the item-level essentially help create latent means of the DVs that are carried up to the next level resulting in a two-level (day nested within person) model with three DVs. At the daily level, a significant dummy-coded coefficient indicates that a given participant’s overall mean of that scale varies around the grand mean of that scale for all participants. Only one random slope for the lifestyle behaviors improved model fit and appeared to explain additional variance. That is the association between time spent in social interaction and EWB. This indicates that the associations between these variables randomly vary by person, such that for some individuals the association between fluctuations in social interaction and EWB is stronger than for other individuals. Allowing this random slope made it possible to explain some of this variation in the model due to between-person differences in the social interaction EWB slopes. In the PD negative binomial model, time spent meditating was also included as a random slope indicating that the association between mindfulness meditation and PD varied by person.
As discussed in the analysis plan, the fixed effects of all six within-person lifestyle behaviors were retained in the three-DV model (with tobacco use being used as a between-person variable). From that point, between-person variables were added and retained based on their significance and their impact on model fit. Many of the demographics and other control variables such as race, ethnicity, gender, ethnicity, body mass index, nutritional supplement use, neighborhood safety, nearby green space, and desirable responding were not significant and did not improve the fit of the model, which resulted in their removal from analyses to avoid an overly complicated model. Adding the between-person predictors, including between-person lifestyle behaviors, demographics, and control variables did not have major impacts on the fixed effects for the daily lifestyle behaviors.

**Psychological distress.** In the final 3-DV model that included the within-person outliers, PD was significantly predicted by within-person variations in social interaction (b = .04 SDs, 95% CI [.02, .06]), with each hour spent in social interaction predicting a .04 SD decrease in PD. This held true while controlling for the between-person variables of average time socializing and loneliness. PD was also associated with fruit and vegetable intake PD (b = .03 SDs, 95% CI [.00, .05]) and alcohol use (b = .06 SDs for every alcoholic drink, 95% CI [-.09, -.02]). PD was not significantly associated with the within-person reports of exercise, time spent meditating, or time spent outside. For between-person variables, PD was positively associated with age (b = .18, 95% CI [.02, .34]), physical labor at work (b = -.39, 95% CI [-.71, -.07]), and functional impairment due to mental health challenges (b = -.23, 95% CI [-.42, -.04]).
In a comparison of the PD associations in the 3-DV model with and without outliers, the main difference was that PD was significantly positively associated with within-person mindfulness in the analysis without outliers \( (b = -0.65, 95\% \text{ CI } [-1.25, -0.04]) \). The same association in the analysis with the outliers was not significant \( (b = -0.09, 95\% \text{ CI } [-0.46, 0.27]) \), although it is important to note that the confidence intervals are quite wide for both coefficients.

Along with the 3-DV multivariate multilevel model, a negative binomial multilevel model was used to assess the associations between PD and the study variables, while accounting for the non-normality of the PD variable (Table 6). For this model, the only significant associations in the model were within-person hours spent in social interaction \( (b = -0.04, 95\% \text{ CI } [-0.33, -0.11]) \) and between-person functional impairment due to mental distress \( (b = -0.04, 95\% \text{ CI } [-0.27, -0.09]) \). Table 7 shows the covariance parameters for the negative binomial model. Thus, whereas the associations between within-person social interaction and PD and functional impairment and PD appeared robust across models, the other significant associations found in the 3-DV model are less consistent.

**Hedonic well-being.** In the 3-DV model, HWB was associated with social interaction \( (b = 0.08 \text{ SDs}, 95\% \text{ CI } [0.05, 0.11]) \), exercise \( (b = 0.02 \text{ SDs for every metabolic unit}, 95\% \text{ CI } [0.00, 0.03]) \), and fruit and vegetable intake \( (b = 0.04 \text{ SDs for every fruit/vegetable}, 95\% \text{ CI } [0.01, 0.06]) \). HWB was not associated with the other lifestyle behaviors: alcohol use, time spent meditating or time spent outside. When the between-person variables were added, HWB was positively associated with average time spent socializing \( (b = 0.07, 95\% \text{ CI } [0.00, 0.14]) \) and negatively associated with loneliness \( (b = -
.32, 95% CI [-.47, -.18]) and functional impairment due to physical health challenges (b = -.12, 95% CI [-.24, -.01]). The HWB associations did not significantly change in the models that did or did not include the outliers.

Along with the 3-DV model, a 2-DV model was run with only HWB and EWB, which were more normally distributed than the PD variable (Table 8). The 3-DV model and the 2-DV model were not appreciably different with respect to the associations between HWB and any of the other model variables.

**Eudaimonic well-being.** EWB was predicted by four within-person lifestyle variables: time spent in social interaction (b =.09 SDs, 95% CI [.07, .12]), fruit and vegetable consumption (b =.04 SDs, 95% CI [.02, .07]), alcohol use (b =.05 SDs for every alcoholic drink, 95% CI [-.09, -.01]), and time spent outside (b =.05 SD for every hour spent outside, 95% CI [.01, .08]). Between-person predictors of EWB included average time spent socializing (b =.09, 95% CI [.03, .15]), urban living (b = -.13, 95% CI [-.22, -.03]), and loneliness (b = -.25, 95% CI [-.37, -.12]). Individuals tended to report higher EWB when they socialized more often on average, had lower feelings of loneliness, and lived in non-urban environments.

In a comparison of the 3-DV model with and without the within-person outliers, the EWB variable had some differences. Exercise, which was previously not significant (b =.01 SDs, 95% CI [-.01, .02]), became significant (b =.01 SDs, 95% CI [.00, .03]), and alcohol which was significant (b =.05 SDs, 95% CI [-.09, -.01]), became nonsignificant (b = -.02 SDs, 95% CI [-.63, .58]). The inconsistent findings between the two models indicate that they should be interpreted with caution.
In comparing the EWB associations from the 3-DV and 2-DV models, two changes were significant. First, time outside was no longer significant (b = .05 SDs, 95% CI [-.03, .08]) in the 2-DV model, while smoker status became significant (b = .36 SDs, 95% CI [.03, .68]). The changes from 3-DV model to 2-DV model indicate that the inclusion of the PD variable may have impacted some of the EWB associations.

Overall, it is unclear which dataset (outliers or non-outliers) offers the best understanding of the relevant variables, and it is important to recognize the differences in estimates across the models. The no-outlier dataset appeared to be more conservative and was used in subsequent analyses.

**Comparison of within-person lifestyle behaviors.** The next set of analyses involves testing the differences in the size of the associations between the lifestyle behaviors and the three outcomes. One question of interest was: Is the strength of the association different between all the lifestyle behaviors for a given DV? For example, does exercise or time spent socializing more strongly associate with HWB? A second question was: Is the strength of the association different between a single lifestyle behavior across all DVs? For example, does fruit and vegetable intake more strongly relate to EWB than PD and HWB? To test these hypotheses, only the lifestyle variables that demonstrated significant associations with the DVs in the main model were used as the variables of interest. An accurate comparison of the effect of the lifestyle behaviors depends on predictors that are on same scale. Therefore, the SDs of the person-centered predictors were rescaled to equal .2. This value was chosen because it offered the proper scaling to avoid non-positive definite Hessian matrices. Because increased alcohol tended to predict increased PD and decreased HWB and EWB, the alcohol variable was reverse
coded to make more accurate comparisons. The comparisons that include PD were part of the 3 DV model, which should be interpreted with caution due to the non-normal distribution of the PD variable. The comparisons between HWB and EWB from the 2 DV model are reported.

**Psychological distress.** First, significance tests investigated the strength of predictor-DV relations within each DV (Table 9). For PD, the standardized unit of time spent in social interaction was a stronger predictor than time spent meditating (.48, \(t(747.15) = 3.48, p = .001, 95\% \text{ CI } [.21, .75]\)) and time spent outside (.33, \(t(738.86) = 2.10, p = .04, 95\% \text{ CI } [.02, .64]\)). In an hour-to-hour comparison (rather than when each lifestyle behavior was scaled to .2 SDs) social interactions and the other time-based lifestyle behaviors, time spent in social interaction was more strongly associated with PD than time spent meditating (.69, \(t(755.49) = 2.26, p = .02, 95\% \text{ CI } [.09, 1.29]\)), but not spending time outside (.06, \(t(738.83) = 1.79, p = .07, 95\% \text{ CI } [-.01, .13]\)). The strength of the relationship was significantly different in mindfulness meditation with PD relative to the relationship of exercise with PD (-.32, \(t(745.36) = -2.32, p = .02, 95\% \text{ CI } [-.60, -.05]\)) and fruit and vegetable consumption with PD (-.45, \(t(1263.50) = -3.06, p = .002, 95\% \text{ CI } [-.73, -.16]\)). Mindfulness tended to predict increased PD (with a negative coefficient), while exercise (.01, 95\% CI [.00, .02]) and fruit and vegetable intake (.02, 95\% CI [-.01, .04]) had positive point estimates, but zeros within their 95\% confidence intervals.

**Hedonic well-being.** From the 2 DV model, there are differences in how strongly the lifestyle behaviors are associated with HWB. Standardized time spent in social interactions is more strongly associated with HWB than fruit and vegetable intake (.36, \(t(748.43) = 2.34, p = .02, 95\% \text{ CI } [.06, .68]\)), alcohol use (.55, \(t(58.59) = 3.47, p = .001,\)
95% CI [.24, .87]), meditation (.56, \(t(769.02) = 3.37, p = .001, 95\% \text{ CI} [.23, .88]\)), and time spent outside (.54, \(t(753.95) = 2.81, p = .005, 95\% \text{ CI} [.16, .91]\)). Direct hour-to-hour comparisons found an hour of time spent socializing was significantly more strongly associated with HWB than an hour spent outside (.09, \(t(755.85) = 1.98, p = .05, 95\% \text{ CI} [.00, .16]\)), but not an hour of time spent meditating (-.07, \(t(787.32) = -.18, p = .86, 95\% \text{ CI} [-.78, .65]\)). The HWB variable had no other differences.

**Eudaimonic well-being.** The pattern with EWB was similar, where time spent in social interactions was more strongly associated with EWB than exercise (.48, \(t(202.98) = 3.21, p = .02, 95\% \text{ CI} [.19, .78]\)), fruit and vegetable intake (.50, \(t(187.70) = 3.43, p = .001, 95\% \text{ CI} [.21, .78]\)), alcohol use (.64, \(t(186.26) = 4.32, p < .001, 95\% \text{ CI} [.35, .93]\)), and time spent outside (.36, \(t(748.43) = -2.34, p = .02, 95\% \text{ CI} [.06, .68]\)). In the hour-to-hour comparison an hour of time spent socializing was not significantly more strongly associated with EWB than an hour of meditation (.14, \(t(772.02) = .45, p = .65, 95\% \text{ CI} [-.47, .74]\)) or an hour spent outside (.06, \(t(507.63) = 1.64, p = .10, 95\% \text{ CI} [-.01, .13]\)). Like HWB, no other differences between the associations of within-person lifestyle behaviors and EWB were significant.

**Individual lifestyle behaviors across DVs.** Across the DVs, social interaction had a weaker association with PD than with HWB (-.33, \(t(751.89) = -2.80, p = .005, 95\% \text{ CI} [-.57, -.10]\)) and EWB (-.42, \(t(118.35) = -3.46, p = .001, 95\% \text{ CI} [-.66, -.18]\)). The difference in the association of mindfulness meditation with PD and HWB was significant (-.25, \(t(772.99) = -2.21, p = .03, 95\% \text{ CI} [-.48, -.03]\)). Further, the test also suggests that time outside may have a stronger positive association with EWB than with PD (-.29, \(t(752.54) = -2.53, p = .01, 95\% \text{ CI} [-.51, -.06]\)). No other differences were
significant across the DVs in their associations with the lifestyle behaviors in the 3 DV model or in the 2 DV model that only included HWB and EWB. Outcomes from these tests can be seen in Table 10.
CHAPTER FIVE
DISCUSSION AND CONCLUSION

The focus of the present study was exploring the within-person relationships between various lifestyle behaviors and three DVs: PD, HWB, and EWB. The study was innovative in that it considered a larger number of lifestyle behaviors within a multivariate multilevel model. Using an online sample and web-based surveys, the lifestyle behaviors were successfully measured multiple times for each person with minimal missing data. This exploratory study tested many hypotheses primarily within a single multivariate multilevel model.

Lifestyle Behaviors and DVs

The main hypotheses of this study were that within-person lifestyle behaviors would be significantly related to the DVs, while controlling for the other within-person lifestyle behaviors, the between-person level of lifestyle behaviors, and a variety of other baseline between-person variables. Social interaction was the lifestyle behavior that was most consistently and strongly related to the three DVs. These findings support the already large literature that documents that increased social interaction leads to a multitude of positive outcomes such as positive affect, negative affect, meaning in life, vitality, and happiness at the between- (Cacioppo & Hawkley, 2009; Gilbert et al., 2013; Holt-Lundstad et al., 2015; Wrzus, Wagner, & Neyer, 2012) and within-person levels (Bernstein et al., 2017; Choi et al., 2017; Gleason et al., 2003; Machell et al., 2014). The within-person form of analysis is less common, making the findings from this study important because they add descriptive power to the large cross-sectional and large-interval longitudinal studies. Thus, social interaction contributes to HWB and EWB, but
this study uniquely indicates that even controlling for several other important lifestyle behaviors, social interaction plays a very important role in HWB, EWB, and PD. Social interaction might be such a strong and consistent predictor of PD, EWB, and HWB because of humans’ deeply social nature. Some scholars have indicated that depression itself can be understood in evolutionary terms as an adaptation that encourages rumination as a form of problem solving when one’s social functioning is impaired (Andrews & Thomson, 2009). Thus, if one is having important social interactions in a given day, that may be a clear sign that one is performing relatively well in the world and thus reducing the need for intense ruminative problem solving and anxiety. From a well-being perspective, belonging, which may stem from daily social interactions, is a central pursuit and motivation for humans (Baumeister & Leary, 1995). In fact, Aristotle (1999) claimed that “No one would choose to live without friends, even if one had all other goods” (1155 a 5-6). Theoretically, close social interactions are expected to predict reduced PD and increased HWB and EWB.

A similar pattern of findings occurred relative to fruit and vegetable consumption, which is an approximate replication of Conner et al.’s (2015) findings that fruit and vegetable consumption was associated with EWB at the within-person level. In this study, fruit and vegetable consumption was consistently related to EWB and HWB, but less consistently with PD. This also falls in line with other research in this area that shows within-person relationships between fruit and vegetable consumption with positive affect, happiness, and anxiety (Smith & Rogers, 2014; White et al., 2013). No research has demonstrated clear causal mechanisms for the influence of diet on these DVs, but folate, found in vegetables such as leafy greens and broccoli as well as fruits such as
citrus and bananas, is associated with neurotransmitter transport (Sanchez-Villegas et al., 2009), which may reveal why fruit and vegetable intake was associated with PD, EWB and HWB. Magnesium, found in many plant-based foods has also been shown to negatively predict depressive symptoms (Mehdi et al., 2017). Antioxidants, also found in abundance in most fruits and vegetables, may promote health and well-being (Payne et al., 2009). One consideration with this sample is that the participants, like most adults in the U.S., were eating less than the daily recommended servings of fruits and vegetables (M = 3.32, SD = 2.53; American Heart Association, n.d.; U.S. Department of Agriculture, 2018). Any fluctuations from that mean, either greater or less, may have a strong influence on PD, HWB, and EWB relative to those within-person fluctuations in a sample that was consuming a greater average number of servings. Despite no clear mechanism of action, fruit and vegetable intake at the within-person level is an important factor to consider when investigating lifestyle interventions, especially given the many other variables being controlled for in this study.

Interestingly, exercise was not significantly associated with PD at the within- or the between-person levels. This contradicts many previous studies that found a relationship among these variables. The finding is difficult to explain although some of the limitations in measurement, which are discussed next, may explain the lack of statistically significant results with these variables. However, it also may be a result of a decreased effect size due to other correlated variables (e.g., fruits and vegetable intake and time outside). A post hoc examination of another negative binomial model without the other within-person lifestyle behaviors did in fact result in a significant (albeit small) association between PD and exercise (-.01, $p = .02$, 95% CI [-.01, 00]), which helps
demonstrate the importance of measuring multiple lifestyle behaviors. Unlike its relationship with PD, exercise was predictive of EWB and HWB in the models that included the other lifestyle variables. Exercise may bring about a sense of personal growth that is often considered a component of EWB. Further, participants may feel more satisfied with their day when they engage in physical activity because it is a personal goal they have. Also, physical activity may increase positive affect, which is often considered to relate strongly to HWB, despite the minimal association with on negative affect and PD in this study.

As discussed previously, smoking was not a particularly useful within-person variable because of the limited within-person variation that was captured in this sample. If future samples exclude non-smokers or naturally include a higher proportion of tobacco users, the variable may be of interest, but it was not particularly helpful as a within-person variable in this study because of its lack of within-person variation.

Alcohol use was positively associated with PD and negatively associated with HWB and EWB in the original dataset. However, when outliers of the person-centered alcohol use variable were removed, the association with EWB was no longer significant. The association between PD and alcohol was still significant in that model, but not the negative binomial model. One explanation for the lack of significance in the models without outliers may be that some data points problematically skewed the analysis and disrupted any meaningful interpretation. The change in significance occurred when less than 16 values were removed from the 894 total data points. Another explanation may be that extremely heavy drinking on a given day, above one’s average level of drinking, may indicate a binge drinking episode, which might be strongly related to PD, HWB, and
EWB. Otherwise, on days when one experiences an increase in PD and drop in HWB and EWB, individuals may find themselves drinking more heavily to cope with their functioning on that day. The outlier data points merit further investigation as a potentially significant subgroup. The results related to alcohol use are clouded by the differences across the various models.

Mindfulness meditation was only significantly associated with PD in one of the models. Upon reflection, mindfulness meditation may be a less helpful within-person variable in the general population because as mentioned previously only 10% of U.S. workers reported engaging in mindfulness meditation exercises. Interestingly, about 53% of this sample reported engaging in at least one session of mindfulness meditation across the duration of the study. That discrepancy indicates that the participants may not have fully understood what mindfulness is. They may have felt compelled to report some mindfulness practice because they were likely to report some activity on most of the other variables (i.e., time outside, physical activity, fruits and vegetables). Thus, over-reporting of mindfulness practice may cloud the analyses, and future studies should consider that only a minority of the population engages in such practices. A more thorough explanation of meditation and an inclusion of non-mindfulness meditation or spiritual practices may capture more of this type of activity in individuals’ lives.

Time spent outside was generally not a strong predictor of the DVs, although it was somewhat related to increased EWB. Individuals who spent more time outside than their average also tended to report higher levels of EWB. This indicated that due to the separation of between- and within-person variance of time spent outside, this study was able to tentatively show that more time spent outside is associated with higher EWB.
While people generally reported significant time spent outside, the time outside variable may have suffered from a lack of nuance in the measurement of the variable. It is possible that the characteristics of the area may need to be accounted for to best explain variance in the outcome variables. Some evidence indicates that green space as opposed to non-green outdoor space is associated with better mental health outcomes (Brown et al., 2018).

In general, the lifestyle behaviors tended to have stronger associations with EWB and HWB than with PD. One way to interpret this is that changes in more positive outcomes may be better targets for lifestyle interventions, but that is a very tentative conclusion. At least in this sample, the ICC value of PD was numerically higher than HWB and EWB (.68 vs .52 and .55) indicating that PD may be understood as slightly more characterological in nature with less daily fluctuations. The inclusion of three outcome variables revealed some differences in their associations with lifestyle behaviors. This is important because depending on a person’s presenting complaint, future lifestyle interventions may emphasize time spent outside to encourage flourishing, whereas exercise may be important for an increased sense of satisfaction. Social interaction and the consumption of fruits and vegetables are behaviors that have a cross-cutting impact on the three outcome variables indicating that they might form a core for newly developed lifestyle interventions. Social interaction showed significantly stronger associations with EWB and HWB than the other lifestyle behaviors, even the other significant predictors. Any future studies on lifestyle interventions may benefit from the inclusion of all three outcome variables to determine how various changes in behaviors may differentially influence each.
Limitations

Some limitations affected the outcomes in this study. The best form of measurement of various lifestyle behaviors would include self-reported behaviors along with objective forms of measurement (e.g., actigraph measurement of physical activity). For example, research has indicated that objective measures of exercise are only modestly correlated with self-reported activity, resulting in an overall correlation of .37 across 187 studies (Prince et al., 2008). Future research would be well-served to include biometric measurements of exercise such as actigraph assessments alongside self-report measures, to better assess the impact of exercise on the outcome variables. Physical fitness, when measured objectively, may be another important variable to include in the model because it more clearly represents physical health than physical activity (Fogelholm, 2010; Myers et al., 2004). Some have argued that the links between daily behaviors and mood or well-being should be assessed more frequently than daily to adequately obtain true associations (Kanning, Ebner-Priemer, & Schlicht, 2013). Participant fatigue might become a competing concern when considering more frequent measurement of lifestyle behaviors and increased incentivization may be necessary to keep participants engaged. However, future research may benefit from additional measurement points each day.

Although ILM allows for a finer grained analysis of the association between constructs, it still lacks the ability to determine causality. Daily diary studies, which only assess individuals once per day, may also not be able to fully assess feedback loops between increased positive or reduced negative mood and the various lifestyle behaviors (c.f., Emerson, Dunsinger, & Williams, 2017). For example, mood has been correlated
with food choice quality in cross-sectional studies and causally linked in experimental studies (White et al., 2013). Lagged analyses are one potential option for assessing direction of causality, but this is beyond the scope of this exploratory study.

Another limitation is that simply reporting on the various lifestyle behaviors and PD, EWB and HWB may affect individuals’ responses. Being reminded daily of these constructs and reporting on them may affect individuals’ actual or reported behavior and PD, EWB, and HWB. This effect, which is often called reactivity, must be considered a limitation of daily diary research (Iida et al., 2012). Importantly, when the fixed effect of time was entered into the model, it was not significantly associated with any of the DVs and did not improve model fit. However, using only objective measures, such as digital actigraph activity technology, may reduce this possible effect.

To reduce the burden on the participants, some of the measures may have lacked reliability and validity. For example, the participants’ ratings of time spent outside were determined by one item, which may not adequately assess that construct and nutrition was limited to fruit and vegetable intake, rather than a more comprehensive analysis of macronutrient and micronutrient content. I was seeking to innovate by assessing a wider variety of lifestyle behaviors, but this breadth of assessment required some sacrifice in measurement depth to avoid excessively burdening the participants. Further, some constructs are best measured by a single item, especially when that single item is asked close to the event to reduce recall effects. That was the case for many of the variables in this study, such as number of fruits and vegetables consumed, and number of alcoholic drinks consumed.
Other potentially important moderators were not assessed, such as perceived discrimination, neighborhood safety, and access to nearby exercise facilities, which might play a role in the relevant findings of the study. I was limited in the number of structural, personal, and social predictors of lifestyle behaviors I could assess and thus added simple single-item measures of some of these constructs. This limited some variables, like SES to a single item assessing perceived SES, as opposed to a more thorough assessment that included education level and income. The evidence linking these variables with lifestyle behaviors and PD, HWB and EWB is mostly at the between-person level, raising questions about whether they have any impact at the within-person level. By the end of the model building, only age, physical demands at work, the level of urban environment, loneliness, and functional impairment significantly predicted at least one of the DVs. Other important variables such as race, ethnicity, perceived SES, nearby natural space, neighborhood safety, body mass index, use of nutritional supplements, sexual orientation, relationship status and gender were assessed during the model building phase, but were not retained because of their lack of association with the DVs. These and the other unmeasured variables will continue to be interesting avenues for future research.

This study was exploratory, and as such, included a larger number of predictor and DVs than usual. The analyses thus included many significance tests, which problematically inflate the Type I error-rate. Knowing that this study would be exploratory and at least partially data-driven, it should be clear that future research involving the adaptations that will help resolve some of the study’s other limitations will be necessary to substantiate the findings. This study can help set a baseline for future
research in terms of effect sizes and expected differences in the impact of the lifestyle behaviors on the various DVs.

To expand the generalizability of these findings, there was an attempt to stratify the sample on age and gender. This was generally successful, but the sample was largely white and entirely from one Western, industrialized country. The differences between the Prolific (and other digital) participant pools and the general public are unknown. Individuals who have taken tens or even hundreds of surveys may have different backgrounds than other adults and may also have different response patterns due to their extensive exposure to surveys. That the participants completed the surveys wherever they had access (on phones, computers, or tablets) means that they could do so in their everyday environments. The daily surveys tended to be brief (<5 minutes), which suggests that the individual surveys were not burdensome. Repeated surveys may have been tiresome, but the random presentation of many of the scales and the items within the scales was aimed at making each individual survey a novel experience.

Lastly, this study may be somewhat limited by its modest sample size, which is a result of modest research funding. Smaller sample sizes reduce the “carrying capacity” of the data, wherein models cannot converge because of the exponentially increasing size of parameter matrices. This is especially true when attempting to assess multiple random intercepts and slopes. In this study, through rescaling variables (e.g., from minutes to hours of time outside), the models were able to converge relatively consistently. Sample sizes comparable to that of this study have limited ability to detect effects at the between-person level. However, having multiple data points per person made it possible to detect small significant effects at the within-person level. Other diary studies with similarly
sized samples also found significant associations (Mojza et al., 2011; Reis et al., 2000). A replication study may be conducted to increase the sample size, which is the most efficient way to increase power, as opposed to extending the survey to include more days (Scherbaum & Ferreter, 2008). The findings of this study can help fuel further questioning in this area as well and would benefit from replication.

**Conclusion**

The aim of this study was to explore the within-person association between lifestyle behaviors and three DVs. It was guided by a desire to add nuance to the previous literature regarding some of these relationships and to examine whether previous results would be replicated when testing multiple lifestyle predictors simultaneously. Additionally, another goal of this study was to compare the strength of these associations to determine which lifestyle behaviors might be most significantly associated with the several outcomes. As a study without any prescribed intervention component, the present findings are not causal and cannot be interpreted as such. These daily diary findings may prove helpful for the development of new lifestyle interventions by showing which within-person changes are associated with better HWB and EWB and less PD. Counseling psychologists may be particularly interested in these findings to use preventative interventions aimed at improving the health and well-being of clients and the public. The emphasis on relational interactions also aligns well with the emphases of the counseling psychology field. Obtaining these improvements early in the life of the intervention may provide participants with an increased sense of efficacy in dealing with their mental health problems and may improve retention in the treatment.
The findings indicate that within-person social interaction was generally the strongest predictor of the three DVs. Within-person fluctuations in social interaction was negatively associated with PD and positively associated with HWB and EWB. As has been demonstrated by a breadth of scholarship, social interaction is a very important factor in well-being. A similar series of associations was found for fruits and vegetable consumption, but to a smaller degree. Exercise was associated with improved HWB and EWB, while time outside was associated with increased EWB. Alcohol intake was associated with increased PD and reduced EWB in an initial full model, but when outliers were removed, only the PD association was significant.

When directly comparing the strength of the associations, time spent in social interaction was often, but not always, significantly stronger than other lifestyle behaviors in predicting these outcomes. An interesting question that can be asked in future research might be, controlling for previous-day PD, HWB, and EWB, will the lifestyle behaviors still have a within-person impact on that day’s PD, HWB, and EWB. Further, with the large impact of social interaction, future research may address whether eating fruits and vegetables, exercising, and/or spending time outside while engaging in social interaction produce additive effects, as opposed to doing those things alone. Lifestyle interventions that focus on diet, exercise, meditation, substance use, or spending time outside should also consider social interaction and the relatively large associations it has with important outcomes at the within-person level.

The power of increased social interaction that is included in the delivery of lifestyle interventions may be like the common factors approach to understanding the effectiveness of psychological treatments (Messer & Wampold, 2002). To assess the
mechanisms of lifestyle interventions, it would be wise to see if actual changes in lifestyle behaviors (e.g., increased fruit and vegetable consumption and time spent outside) are associated with changes in the outcomes of interest. It is recommended that, eventually, digital versions of lifestyle interventions should be compared to in-person delivery. This will allow us to assess whether social interaction in in-person treatments is a major factor in improved well-being and reduced PD.

The lifestyle behaviors not included in this study might make for interesting additions to future research including time spent on social media, time spent in religious and spiritual practice, time spent on hobbies, consumption of fish/fish oil and plant sources of omega-3 fatty acids, and volunteering. This area of lifestyle medicine for PD, HWB, and EWB is ripe for additional studies that can build on these findings using the present study’s nuanced and comprehensive approach.
Table 1

*Descriptive Statistics*

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<tr>
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<th>Min</th>
<th>Max</th>
<th>M</th>
<th>SD</th>
<th>ICC</th>
</tr>
</thead>
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<td>.37</td>
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<td>2.53</td>
<td>.67</td>
</tr>
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<td>134.46</td>
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<td>.39</td>
</tr>
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<td>1.24</td>
<td>4.14</td>
<td>.95</td>
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<td>41.02</td>
<td>9.42</td>
<td>.55</td>
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</table>

M = Mean; Max = Maximum value; Min = Minimum value; SD = Standard deviation; ICC = Intra-class correlation
Table 2

*Within- and Between-Person Correlations of Daily Variables*

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<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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<tbody>
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<td>.08</td>
<td>.07</td>
<td>.21</td>
<td>.28*</td>
<td>-.12</td>
<td>.27*</td>
<td>.28*</td>
</tr>
<tr>
<td>Fruits and Vegetables</td>
<td>.12*</td>
<td>-</td>
<td>-.09</td>
<td>-.06</td>
<td>-.01</td>
<td>.21</td>
<td>.05</td>
<td>.01</td>
<td>.12</td>
</tr>
<tr>
<td>Social Interaction</td>
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<td>-.01</td>
<td>-</td>
<td>.05</td>
<td>-.19</td>
<td>-.03</td>
<td>-.25*</td>
<td>.42*</td>
<td>.45**</td>
</tr>
<tr>
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<td>-.01</td>
<td>.10*</td>
<td>-</td>
<td>-.12</td>
<td>-.14</td>
<td>-.12</td>
<td>.17</td>
<td>.11</td>
</tr>
<tr>
<td>Mindfulness Meditation</td>
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<td>-.01</td>
<td>.03</td>
<td>.02</td>
<td>-</td>
<td>.19</td>
<td>.00</td>
<td>-.15</td>
<td>-.04</td>
</tr>
<tr>
<td>Time Outside</td>
<td>.26*</td>
<td>-.01</td>
<td>.32*</td>
<td>.09*</td>
<td>.05</td>
<td>-</td>
<td>.07</td>
<td>-.01</td>
<td>.03</td>
</tr>
<tr>
<td>Psychological Distress</td>
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<td>-.08*</td>
<td>-.14*</td>
<td>.09*</td>
<td>.00</td>
<td>-.05</td>
<td>.75/.96</td>
<td>-.47**</td>
<td>-.53**</td>
</tr>
<tr>
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<td>.08*</td>
<td>.22*</td>
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<td>.03</td>
<td>.13*</td>
<td>-.43**</td>
<td>.90/.92</td>
<td>.85**</td>
</tr>
<tr>
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<td>.08*</td>
<td>.10*</td>
<td>.28*</td>
<td>-.07*</td>
<td>.01</td>
<td>.14*</td>
<td>-.44**</td>
<td>.67**</td>
<td>.80/.93</td>
</tr>
</tbody>
</table>

Within-person correlations are on the lower half. Between-person correlations are on the upper half. For the three DVs, the within-person reliabilities are listed first on the diagonal, followed by the between-person reliabilities.

**p < .01 level (2-tailed)**

*p < .05 level (2-tailed)*
Table 3

*Three DV Multivariate Multilevel Model with Outliers Included*

<table>
<thead>
<tr>
<th>Variable</th>
<th>PD</th>
<th>HWB</th>
<th>EWB</th>
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</thead>
<tbody>
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<td></td>
<td>Estimate</td>
<td>SE</td>
<td>p value</td>
</tr>
<tr>
<td>Intercept</td>
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<td>0.15</td>
<td>.94</td>
</tr>
<tr>
<td>Soc</td>
<td>0.04</td>
<td>0.01</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Ex</td>
<td>0.01</td>
<td>0.01</td>
<td>.146</td>
</tr>
<tr>
<td>FV</td>
<td>0.03</td>
<td>0.01</td>
<td>.03</td>
</tr>
<tr>
<td>Alc</td>
<td>-0.06</td>
<td>0.02</td>
<td>.003</td>
</tr>
<tr>
<td>Med</td>
<td>-0.09</td>
<td>0.19</td>
<td>.62</td>
</tr>
<tr>
<td>Out</td>
<td>-0.01</td>
<td>0.02</td>
<td>.74</td>
</tr>
<tr>
<td>Smoker</td>
<td>-0.14</td>
<td>0.24</td>
<td>.57</td>
</tr>
<tr>
<td>Soc Mean</td>
<td>0.06</td>
<td>0.05</td>
<td>.17</td>
</tr>
<tr>
<td>Ex Mean</td>
<td>-0.01</td>
<td>0.03</td>
<td>.83</td>
</tr>
<tr>
<td>Age</td>
<td>0.18</td>
<td>0.08</td>
<td>.03</td>
</tr>
<tr>
<td>Work Ex</td>
<td>-0.39</td>
<td>0.16</td>
<td>.02</td>
</tr>
<tr>
<td>Urban</td>
<td>-0.09</td>
<td>0.07</td>
<td>.23</td>
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<tr>
<td>Loneliness</td>
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<td>.46</td>
</tr>
<tr>
<td>MCS12</td>
<td>0.23</td>
<td>0.10</td>
<td>.02</td>
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<tr>
<td>PCS12</td>
<td>0.06</td>
<td>0.08</td>
<td>.50</td>
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</table>

| AIC   | 31815.27 |
| BIC   | 32464.88 |

Alc = Alcohol use; EWB = Eudaimonic well-being; Ex = Exercise; Ex Mean = Between-person exercise; FV = Fruit and vegetable consumption; HWB = Hedonic Well-Being; MCS12 = Mental component score of the Short Form – 12; Med = Meditation; Out = Time spent outside; PCS12 = Physical component score of the Short Form – 12; PD =
Psychological distress; Soc = Time spent socializing; Soc Mean = Between-person social interaction.
Table 4

*Three DV Multivariate Multilevel Model without Outliers Included*

<table>
<thead>
<tr>
<th>Variable</th>
<th>PD Estimate</th>
<th>SE</th>
<th>p value</th>
<th>PD Estimate</th>
<th>SE</th>
<th>p value</th>
<th>HWB Estimate</th>
<th>SE</th>
<th>p value</th>
<th>HWB Estimate</th>
<th>SE</th>
<th>p value</th>
<th>EW B Estimate</th>
<th>SE</th>
<th>p value</th>
</tr>
</thead>
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<tr>
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<td>.004</td>
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</tr>
<tr>
<td>Soc</td>
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<td>0.02</td>
<td>.005</td>
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<td>0.02</td>
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<td>&lt;.001</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Ex</td>
<td>0.01</td>
<td>0.01</td>
<td>.20</td>
<td>0.02</td>
<td>0.01</td>
<td>.004</td>
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<td>0.01</td>
<td>.05</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>.009</td>
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<td>.64</td>
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<td>0.02</td>
<td>0.03</td>
<td>.49</td>
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<td>0.03</td>
<td>.03</td>
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</tr>
<tr>
<td>Smoker</td>
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<td>.57</td>
<td>0.24</td>
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<td>.21</td>
<td>0.30</td>
<td>0.17</td>
<td>.08</td>
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</tr>
<tr>
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<td>0.05</td>
<td>.14</td>
<td>0.08</td>
<td>0.04</td>
<td>.05</td>
<td>0.11</td>
<td>0.04</td>
<td>.004</td>
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</tr>
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</tr>
<tr>
<td>Age</td>
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<td>.27</td>
<td>0.07</td>
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<tr>
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<td>.60</td>
<td>-0.30</td>
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<td>&lt;.001</td>
<td>-0.24</td>
<td>0.07</td>
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<td>.06</td>
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</tr>
<tr>
<td>PCS12</td>
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<td>.04</td>
<td>0.09</td>
<td>0.06</td>
<td>.12</td>
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</tbody>
</table>

AIC = 29163.76

BIC = 29806.47

Alc = Alcohol use; EWB = Eudaimonic well-being; Ex = Exercise; Ex Mean = Between-person exercise; FV = Fruit and vegetable consumption; HWB = Hedonic well-being; MCS12 = Mental component score of the Short Form – 12; Med = Meditation; Out = Time spent outside; PCS12 = Physical component score of the Short Form – 12; PD =
Psychological distress; Soc = Time spent socializing; Soc Mean = Between-person social interaction;
Table 5

*Covariance Parameters from the Three-DV No Outliers Model*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>SE</th>
<th>Z</th>
<th>p</th>
<th>95% CI</th>
</tr>
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<td>ARH1 rho</td>
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<td>.01</td>
<td>-6.56</td>
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<td>-0.08, -0.05</td>
</tr>
<tr>
<td>(1,1)</td>
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<td>5.75</td>
<td>&lt;.001</td>
<td>0.24, 0.47</td>
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<tr>
<td>(2,1)</td>
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<td>0.03</td>
<td>1.68</td>
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<td>4. EWB*Social</td>
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<td>0.08, 0.12</td>
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<td>0.16, 0.22</td>
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EWB = Eudaimonic well-being; HWB= Hedonic well-being; PD = Psychological distress; Soc = Time spent socializing.
### Table 6

**Negative Binomial Model for PD**

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<td>Out</td>
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<td>0.01</td>
<td>.92</td>
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<td>.68</td>
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<tr>
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</table>
Alc = Alcohol use; EWB = Eudaimonic well-being; Ex = Exercise; Ex Mean = Between-person exercise; FV = Fruit and vegetable consumption; HWB = Hedonic well-being; MCS12 = Mental component score of the Short Form – 12; Med = Meditation; Out = Time spent outside; PCS12 = Physical component score of the Short Form – 12; PD = Psychological distress; Soc = Time spent socializing; Soc Mean = Between-person social interaction.
Table 7

*Covariance Parameters from the Negative Binomial PD No Outliers Model*

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<td>0.02</td>
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<td>0.45</td>
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Table 8

Two DV Multivariate Multilevel Model without Outliers Included

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<th>p value</th>
<th>EWB Estimate</th>
<th>SE</th>
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<td>0.12</td>
<td>0.02</td>
<td>&lt;.001</td>
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<tr>
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<td>0.01</td>
<td>.004</td>
<td>0.02</td>
<td>0.01</td>
<td>.01</td>
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<tr>
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<td>.02</td>
<td>0.04</td>
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<td>.01</td>
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<td>0.36</td>
<td>.63</td>
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<td>0.31</td>
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<tr>
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<td>0.03</td>
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<td>0.18</td>
<td>.11</td>
<td>0.36</td>
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<td>0.02</td>
<td>.23</td>
<td>0.03</td>
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<td>.28</td>
<td>0.08</td>
<td>0.06</td>
<td>.18</td>
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<td>.15</td>
<td>-0.13</td>
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<td>.07</td>
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<td>0.06</td>
<td>.13</td>
</tr>
</tbody>
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AIC 19956.00
BIC 20494.12

Alc = Alcohol use; EWB = Eudaimonic well-being; Ex = Exercise; Ex Mean = Between-person exercise; FV = Fruit and vegetable consumption; HWB = Hedonic well-being;
MCS12 = Mental component score of the Short Form – 12; Med = Meditation; Out = Time spent outside; PCS12 = Physical component score of the Short Form – 12; Soc = Time spent socializing; Soc Mean = Between-person social interaction.
Table 9

*Comparison of Lifestyle Behavior Associations within Outcome*

<table>
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<th>t</th>
<th>p value</th>
<th>95% CI</th>
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<tr>
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<td>0.16</td>
<td>0.14</td>
<td>737.54</td>
<td>1.15</td>
<td>.25</td>
<td>-0.11, 0.42</td>
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<tr>
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<td>1.32</td>
<td>.19</td>
<td>-0.08, 0.43</td>
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<td>752.96</td>
<td>-1.20</td>
<td>.23</td>
<td>-0.49, 0.12</td>
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<td>1.75</td>
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<td>745.36</td>
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<tr>
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<td>752.68</td>
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<td>.23</td>
<td>-0.12, 0.49</td>
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<td>752.93</td>
<td>0.98</td>
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<td>-0.16, 0.48</td>
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<td>754.61</td>
<td>1.37</td>
<td>.17</td>
<td>-0.08, 0.47</td>
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</table>

Alc = Alcohol use; EWB = Eudaimonic well-being; Ex = Exercise; FV = Fruit and vegetable consumption; HWB = Hedonic well-being; Med = Meditation; Out = Time spent outside; PD = Psychological distress; Soc = Time spent socializing.

<sup>a</sup>These values are from the Negative Binomial model.

<sup>b</sup>These values are from the 2-DV model.
Table 10

*Comparison of Lifestyle Behaviors Across Outcomes from 3-DV Model*

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>SE</th>
<th>df</th>
<th>t</th>
<th>p value</th>
<th>95% CI</th>
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<tbody>
<tr>
<td><strong>Social interaction</strong></td>
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</tr>
<tr>
<td>PD - HWB</td>
<td>-0.33</td>
<td>0.12</td>
<td>751.89</td>
<td>-2.80</td>
<td>.005</td>
<td>-0.57, -0.10</td>
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<td>PD - EWB</td>
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<td>-3.46</td>
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<tr>
<td>HWB - EWB</td>
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<td>.07</td>
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<td>743.12</td>
<td>-0.62</td>
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<tr>
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<td>0.09</td>
<td>742.95</td>
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<td>.12</td>
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<td><strong>Fruits and Vegetables</strong></td>
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<tr>
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<td>.20</td>
<td>-0.36, 0.07</td>
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<td>PD - EWB</td>
<td>-0.14</td>
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<td>-0.33, 0.06</td>
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<td>PD - EWB</td>
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<td></td>
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<td>Mindfulness</td>
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<td>-2.21</td>
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<td>Time Outside</td>
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<td>.15</td>
<td>-0.35, 0.05</td>
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</tbody>
</table>

EWB = Eudaimonic well-being; HWB = Hedonic well-being; PD = Psychological distress.
Figure 1

Level 1 Residual Histogram

Mean = -6.40E-15
Std. Dev. = .5221
N = 16,587
Figure 2

Normal Q-Q Plot of Residuals
Figure 3

Level 2 Residuals

Mean = .00
Std. Dev. = .371
N = 76
Figure 4

Residual Distribution for Each Participant
Figure 5

Level-1 Predicted Values by Level-1 Residuals
Figure 6

*PD Item-Level Residuals by Predicted Values*
Figure 7

*HWB Item-Level Residuals by Predicted Values*
Figure 8

*EWB Item-Level Residuals by Predicted Values*
Figure 9

*Level-2 Predicted Values by Level-2 Residuals*
References


Ware, J., Kosinsky, M., & Keller, S. D. (1995); *SF-12: How to score the SF-12 physical and mental health summary scales*. Boston, MA: The Health Institute.


Daily Lifestyle Behaviors and Psychological Functioning - Baseline

This is the first phase of a multi-part survey study that is investigating lifestyle behaviors and psychological functioning. This initial survey will be followed by 14 daily surveys over the next 14 days. Only by completing this initial survey will you be able to participate in the daily surveys. To be compensated for this phase of the study you will be required to participate in a minimum of 7 daily surveys. This initial study will consist of answering some demographic questions as well as items about your personality and well-being. The subsequent daily surveys will ask about daily lifestyle behaviors such as diet and exercise, as well as about your mental health and well-being. These daily surveys will begin tonight and continue for 14 days. You must complete the daily surveys at the end of your day, sometime between 8pm and 2am Eastern Standard Time (5pm and 11pm Pacific Standard Time).

- By completing this survey and 7 of the 14 daily surveys you will be compensated with $12
- By completing each subsequent daily survey you will be compensated $1.50 per survey
- A bonus of $3.50 will be provided if you complete at least 13 daily surveys

In sum, you have the opportunity to earn $26 if you complete all parts of the study. You will be paid according to your participation approximately 15 days from today.

This survey should take about 30 minutes. The daily surveys should take less than 10 minutes.
Appendix B

Daily Lifestyle Behaviors and Psychological Functioning

University of Miami

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

This page describes the research study in which you are being asked to participate. Please read the information carefully. At the end, you will be asked if you agree to participate.

We are asking you to participate in a research study. We want to learn more about daily lifestyle behaviors and mental functioning.

Participation in this study involves two phases. In the first phase, you will complete a set of questionnaires through an online link that we will provide. These questionnaires include questions about your personality, health, and mental well-being. These will take about 30 minutes to finish. In the second phase, you will complete a set of questions once per day for 14 days between 8:00 pm EST and 2:00 am EST. You will decide when to begin the study within that time. Each daily survey should take less than 10 minutes. We will check whether you respond to the daily surveys and we may contact you to help you participate consistently.

It is possible that some questions could upset you. Your participation in this study is
voluntary and you are free to leave the study at any time. If you say no or leave the study, there will be no negative consequences to you. Your standing with Prolific will not be changed as long as you return your survey entry.

We do not expect that you will receive any direct benefits in this study. By participating you are helping us better understand these important aspects of human health and well-being.

You have the opportunity to be compensated for your participation, up to $26. If you are only able to complete the baseline and any 7 of 14 daily surveys, you will be paid $12. You will be paid an additional $1.50 per daily survey after the 7th survey and will receive a $3.50 bonus for completing 13 or more of the surveys. The payment will be made through Prolific, Inc.

We will consider your responses confidential to the extent permitted by law. The U. S. Department of Health and Human Services may ask to review your responses. Your records may also be reviewed for audit purposes by University employees or other individuals who follow rules about confidentiality. The information that you provide to us will be linked to your participant ID number instead of your name to help maintain confidentiality. We will not collect personally identifying information from you.

You may ask questions and receive answers while participating in this study. If you have any questions about this study, please contact Dr. Blaine Fowers at 305-284-5261. If you
have any questions about your rights as a research participant, you may contact The
University of Miami Human Subjects Research Office at 305-243-3195.

PARTICIPANT AGREEMENT:

By clicking on the “I Agree” button below, I acknowledge that I have read the
information in this consent form and agree to participate in this study.
Appendix C

Daily Lifestyle Behaviors and Psychological Functioning – Day # [__]

This is the second phase of a multi-part survey study that is investigating lifestyle behaviors and psychological functioning. This is daily survey # [__] of a total of 14 daily surveys. Only those who completed the initial survey will be able to participate in this survey. You must complete a minimum of 7 daily surveys to be compensated. This survey will ask about daily lifestyle behaviors such as diet and exercise, as well as about your mental health and well-being. You must complete the daily surveys at the end of your day, sometime between 8pm and 2am Eastern Standard Time (5pm and 11pm Pacific Standard Time).

- By completing the baseline survey and 7 of the 14 daily surveys you will be compensated with $12
- By completing each subsequent daily survey you will be compensated $1.50 per survey
- A bonus of $3.50 will be provided if you complete at least 13 daily surveys

In sum, you have the opportunity to earn $26 if you complete all parts of the study. You will be paid according to your participation 15 days from the baseline survey. This daily survey should take less than 10 minutes.
Appendix D

BASELINE MEASURES

Demographics

How old are you?
☐ 15
☐ 16
☐ 17
☐ ...
☐ 99

What is your sex?
☐ Male
☐ Female
☐ I wish to specify ____________________
☐ I prefer not to answer

Do you consider yourself to be transgender?
☐ Yes
☐ No

Are you of Hispanic, Latino or Spanish origin?
☐ No, not of Hispanic, Latino, or Spanish origin
☐ Yes, Mexican, Mexican Am., Chicano
☐ Yes, Puerto Rican
☐ Yes, Cuban
☐ Yes, Other ________________

What is your race?
☐ White
☐ Black, African American
☐ Asian Indian
☐ Chinese
☐ Japanese
☐ Filipino
☐ Korean
☐ Vietnamese
☐ Native Hawaiian
☐ American Indian/Alaskan Native
☐ Guamanian or Chamorro
☐ Samoan
☐ Other Pacific Islander ____________________
☐ Some other race ____________________

What is your current relationship status?

☐ Single
☐ Married (How many years?) ____________________
☐ In a romantic relationship (How many years?) ____________________
☐ Divorced
☐ Separated
☐ Widowed

Do you consider yourself to be:

☐ Heterosexual or straight
☐ Homosexual
☐ Bisexual
☐ I prefer not to answer

Think of this ladder as representing where people stand in the United States. At the top of the ladder are the people who are the best off - those who have the most money, the most education and the most respected jobs. At the bottom are the people who are the worst off - who have the least money, least education, and the least respected jobs or no job. The higher up you are on this ladder, the closer you are to the people at the very top; the lower you are, the closer you are to the people at the very bottom. Where would you place yourself on this ladder? Select the number of the rung where you think you stand at this time in your life, relative to the other people in the United States.

☐ Select one
☐ 10
☐ 9
☐ 8
☐ 7
☐ 6
☐ 5
☐ 4
☐ 3
☐ 2
☐ 1
Which of the following best describes the area you live in?
- Urban
- Suburban
- Rural

How many parks and tree lined streets are near your place of residence?
- Plenty
- Some
- Little
- Very little

(Urban residential environments and senior citizens’ longevity in megacity areas: the importance of walkable green spaces)

Would you say the safety of your neighborhood is excellent, very good, good, fair or poor?
- Excellent
- Very good
- Good
- Fair
- Poor

(Health and Retirement Study, 2004)

What is your weight in pounds? ___________

What is your height? ___________

Do you take a nutritional supplement?
- Yes
- No

Is your work:
- Primarily sitting, i.e. at a desk
- Sitting or standing and now and then walking (e.g. teacher)
- Walking, now and then lifts (e.g. post-office worker or parent with small children)
- Heavy manual work (e.g. mover, road construction worker)

(All-Cause Mortality Associated With Physical Activity During Leisure Time, Work, Sports, and Cycling to Work)
The Big Five Inventory (BFI)

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who likes to send time with others? Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement.

<table>
<thead>
<tr>
<th>Disagree strongly</th>
<th>Disagree a little</th>
<th>Neither agree nor disagree</th>
<th>Agree a little</th>
<th>Agree strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

I see Myself as Someone Who…

___1. Is talkative  ___12. Starts quarrels with others
___2. Tends to find fault with others  ___13. Is a reliable worker
___3. Does a thorough job  ___14. Can be tense
___4. Is depressed, blue  ___15. Is ingenious, a deep thinker
___5. Is original, comes up with new ideas  ___16. Generates a lot of enthusiasm
___6. Is reserved  ___17. Has a forgiving nature
___7. Is helpful and unselfish with others  ___18. Tends to be disorganized
___8. Can be somewhat careless  ___19. Worries a lot
___9. Is relaxed, handles stress well  ___20. Has an active imagination
___10. Is curious about many different things  ___21. Tends to be quiet
___11. Is full of energy  ___22. Is generally trusting
___23. Tends to be lazy
24. Is emotionally stable, not easily upset
25. Is inventive
26. Has an assertive personality
27. Can be cold and aloof
28. Perseveres until the task is finished
29. Can be moody
30. Values artistic, aesthetic experiences
31. Is sometimes shy, inhibited
32. Is considerate and kind to almost everyone
33. Does things efficiently
34. Remains calm in tense situations
35. Prefers work that is routine
36. Is outgoing, sociable
37. Is sometimes rude to others
38. Makes plans and follows through with them
39. Gets nervous easily
40. Likes to reflect, play with ideas
41. Has few artistic interests
42. Likes to cooperate with others
43. Is easily distracted
44. Is sophisticated in art, music, or literature
SF-12 Health Survey

This survey asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. Answer each question by choosing just one answer. If you are unsure how to answer a question, please give the best answer you can.

1. In general, would you say your health is:
   - Excellent (1)
   - Very Good (2)
   - Good (3)
   - Fair (4)
   - Poor (5)

The following two questions are about activities you might do during a typical day. Does YOUR HEALTH NOW LIMIT YOU in these activities? If so, how much?

2. MODERATE ACTIVITIES, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf:
   - Yes, Limited A Lot (1)
   - Yes, Limited A Little (2)
   - No, Not Limited At All (3)

3. Climbing SEVERAL flights of stairs:
   - Yes, Limited A Lot (1)
   - Yes, Limited A Little (2)
   - No, Not Limited At All (3)

During the PAST 4 WEEKS have you had any of the following problems with your work or other regular activities AS A RESULT OF YOUR PHYSICAL HEALTH?

4. ACCOMPLISHED LESS than you would like:
   - Yes (1)
   - No (2)

5. Were limited in the KIND of work or other activities:
   - Yes (1)
   - No (2)

During the PAST 4 WEEKS, were you limited in the kind of work you do or other regular activities AS A RESULT OF ANY EMOTIONAL PROBLEMS (such as feeling depressed or anxious)?

6. ACCOMPLISHED LESS than you would like:
   - Yes (1)
   - No (2)

7. Didn’t do work or other activities as CAREFULLY as usual:
Yes (1)  
No (2)

8. During the PAST 4 WEEKS, how much did PAIN interfere with your normal work (including both work outside the home and housework)?
   Not At All (1)  
   A Little Bit (2)  
   Moderately (3)  
   Quite A Bit (4)  
   Extremely (5)

The next three questions are about how you feel and how things have been DURING THE PAST 4 WEEKS. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the PAST 4 WEEKS –

9. Have you felt calm and peaceful?
   All of the Time (1)  
   Most of the Time (2)  
   A Good Bit of the Time (3)  
   Some of the Time (4)  
   A Little of the Time (5)  
   None of the Time (6)

10. Did you have a lot of energy?
    All of the Time (1)  
    Most of the Time (2)  
    A Good Bit of the Time (3)  
    Some of the Time (4)  
    A Little of the Time (5)  
    None of the Time (6)

11. Have you felt downhearted and blue?
    All of the Time (1)  
    Most of the Time (2)  
    A Good Bit of the Time (3)  
    Some of the Time (4)  
    A Little of the Time (5)  
    None of the Time (6)

12. During the PAST 4 WEEKS, how much of the time has your PHYSICAL HEALTH OR EMOTIONAL PROBLEMS interfered with your social activities (like visiting with friends, relatives, etc.)?
    All of the Time (1)  
    Most of the Time (2)  
    A Good Bit of the Time (3)  
    Some of the Time (4)
A Little of the Time (5)
None of the Time (6)
The following statements describe how people sometimes feel. For each statement, please indicate how often you feel the way described by writing a number in the space provided.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. How often do you feel that you lack companionship?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>*6. How often do you feel that you have a lot in common with the people around you?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>7. How often do you feel that you are no longer close to anyone?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8. How often do you feel that your interests and ideas are not shared by those around you?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>*9. How often do you feel outgoing and friendly?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11. How often do you feel left out?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13. How often do you feel that no one really knows you well?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14. How often do you feel isolated from others?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>*16. How often do you feel that there are people who really understand you?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>18. How often do you feel that people are around you but not with</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>*19. How often do you feel that there are people you can talk to?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>*20. How often do you feel that there are people you can turn to?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Items marked with * are reverse scored
BIDR-16

Using the scale below as a guide, write a number beside each statement to indicate how true it is.

+ + + + + + +
1 2 3 4 5 6 7
not true somewhat very true

1. I have not always been honest with myself.
   ___

2. I always know why I like things.
   ___

3. It's hard for me to shut off a disturbing thought.
   ___

4. I never regret my decisions.
   ___

5. I sometimes lose out on things because I can't make up my mind soon enough.
   ___

6. I am a completely rational person.
   ___

7. I am very confident of my judgments
   ___

8. I have sometimes doubted my ability as a lover.
   ___

9. I sometimes tell lies if I have to.
   ___
10. I never cover up my mistakes.

11. There have been occasions when I have taken advantage of someone.

12. I sometimes try to get even rather than forgive and forget.

13. I have said something bad about a friend behind his/her back.

14. When I hear people talking privately, I avoid listening.

15. I never take things that don't belong to me.

16. I don't gossip about other people's business.
Appendix E

DAILY MEASURES

Kessler Psychological Distress Scale – 6

During the past day, about how often did you feel…

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>…nervous?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>…hopeless?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>…restless or fidgety?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>…so depressed that nothing could cheer you up?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>…that everything was an effort?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>…worthless?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Satisfaction with Life Scale

(Modified following Maher, Doerksen, Elavsky, Hyde, Pincus, Ram, & Conroy, 2013)

Look back on everything that happened to you today and consider the day as a whole. Below are five statements with which you may agree or disagree. Using the 1-7 scale below, indicate your agreement with each item by placing the appropriate number on the line preceding that item. Please be open and honest in your responding.

1= strongly disagree
2= disagree
3= slightly disagree
4= neither agree nor disagree
5= slightly agree
6= agree
7= strongly agree

1. In most ways today was close to ideal. ______
2. The conditions of today were excellent. ______
3. I was satisfied with my life today. ____ *
4. Today I got the important things I want in life. ______
5. If I could live today over, I would change almost nothing. ______
(modified to ask about the past day)

Below are 8 statements with which you may agree or disagree. Using the 1–7 scale below, indicate your agreement with each item by indicating that response for each statement.

- 7 - Strongly agree
- 6 - Agree
- 5 - Slightly agree
- 4 - Neither agree nor disagree
- 3 - Slightly disagree
- 2 - Disagree
- 1 - Strongly disagree

___ I led a purposeful and meaningful life
___ My social relationships were supportive and rewarding
___ I was engaged and interested in my daily activities
___ I actively contributed to the happiness and well-being of others
___ I was competent and capable in the activities that were important to me
___ I was a good person and lived a good life
___ I was optimistic about my future
___ People respected me

Scoring:

Add the responses, varying from 1 to 7, for all eight items. The possible range of scores is from 8 (lowest possible) to 56 (highest PWB possible). A high score represents a person with many psychological resources and strengths.
**Godin Leisure-Time Exercise Questionnaire**


1. How many minutes did you do the following kinds of exercise today during your free time

<table>
<thead>
<tr>
<th>Exercise Description</th>
<th>Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a) STRENUOUS EXERCISE (HEART BEATS RAPIDLY)</strong></td>
<td></td>
</tr>
<tr>
<td>(e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>b) MODERATE EXERCISE (NOT EXHAUSTING)</strong></td>
<td></td>
</tr>
<tr>
<td>(e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing, weightlifting)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>c) MILD EXERCISE (MINIMAL EFFORT)</strong></td>
<td></td>
</tr>
<tr>
<td>(e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)</td>
<td></td>
</tr>
</tbody>
</table>
Nutrition questions

How many servings of fruits (fresh, frozen, or canned, but not dried or juiced) did you eat today? _____

none, <1 serving, 1 serving, 2 servings, 3 servings, 4 servings, 5 servings, ≥6 servings

How many servings of vegetables (fresh, frozen, or canned, but not juiced or in chips) did you eat today? _____

none, <1 serving, 1 serving, 2 servings, 3 servings, 4 servings, 5 servings, ≥6 servings

Did you consume fish or fish oil today? Yes / No
Guideline for Vegetable serving sizes: (These are examples only)

Mujcic and Oswald (2016)
Guideline for fruit serving sizes: (These are examples only)

Mujcic and Oswald (2016)
Mindfulness meditation:

How many minutes did you engage in formal mindfulness practice (sitting/breathing meditation, body scan meditation, or open-awareness meditation)? ______

Alcohol use:

How many drinks of alcohol did you consume in the past 24 hours? ______


Nicotine use:

How many occasions did you use a tobacco product today? ______

How many times did you use an electronic cigarette today? ______
**Time spent in nature:**

How much time did you spend outside yesterday? ______

How much time did you spend enjoying natural spaces yesterday? (A natural space could be a park, a farm, or just a green backyard or neighborhood space.) ______

**Social interaction:**

How much time did you spend having meaningful interactions with close others? (family, friends, coworkers, peers etc.) _____