SOCIAL FACTORS IN HEALTHY AGING: STRAIN AS RISK AND SUPPORT AS RESILIENCE

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ABSTRACT

Social factors are an important contributor to the healthy aging of older adults. Previous research has investigated the effects of social strain and social support on older adults' health separately and jointly. However, most previous work was limited to special populations or single time points. The current study examined indicators of social support and strain as predictors of six physical and mental health outcomes among a nationally representative sample of community-dwelling older adults in the United States, above and beyond sociodemographic factors. Changes in the outcomes were investigated with three waves of data spanning a ten-year period. Results from longitudinal multilevel models indicated that social support significantly predicted higher levels of self-rated health; lower levels of negative affect, loneliness, and unhappiness; and a slower decline in loneliness over time. Social strain significantly predicted higher levels of negative affect, loneliness, and unhappiness, as well as increased daily living difficulties over time.

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DEDICATION

For my parents, whose commitment to their own healthy aging has inspired me to pursue higher education in gerontology.

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LIST OF ABBREVIATIONS

ADL	Activity of daily living
AR(1)	First-order autoregressive matrix
CESD	Center for Epidemiological Studies Depression Scale
CHD	Coronary heart disease
ELSA	English Longitudinal Study of Ageing
HADS	Hospital Anxiety and Depression Scale
HRS	Health and Retirement Survey
IADL	Instrumental activity of daily living
LGBTQ+	Lesbian, Gay, Bisexual, Transgender, Queer and other marginalized sexual and gender identities
MIDUS	Midlife in the United States
ML	Maximum likelihood estimation
MLM	Multilevel model
NSHAP	National Social Life, Health, & Aging Project
PSS	Perceived Stress Scale
SST	Socioemotional Selectivity Theory
US(A)	United States (of America)

1. INTRODUCTION

In the field of gerontology, there is a focus on "healthy aging." Gerontologists and others who work in aging services want to help older adults (i.e., people aged 65 and up) maintain their physical, mental, and emotional health. It is well-established in the research literature that both physical and emotional factors are related to older adults' health and well-being. However, studies of social factors have tended to focus primarily on loneliness and social isolation (e.g., Cornwell & Waite, 2009). Knowing about loneliness in older adults is valuable, but it is only one part of a spectrum of social support.

Evidence demonstrates that having adequate social support can help to protect older adults' health (e.g., Kong et al., 2021). Social relationships can be sources of support at times, while at other times they might be sources of stress, anxiety, or feelings of insufficiency. These more negative outcomes, collectively, are termed "social strain," a construct frequently studied alongside social support. Research generally shows that social strain is associated with worse health outcomes in middle and older adults: those with higher levels of social strain have shown higher levels of cortisol, chronic stress (Friedman et al., 2012), poorer sleep quality (Chung, 2017), and lower functional health (Ge et al., 2017). Being stereotyped or judged for one's age may cause some level of strain whether it comes from friends, family, neighbors, or health professionals (e.g., Lyons et al., 2017; Levy et al., 2020).

Many existing studies of social support, strain, or both have been limited to specific contexts that may not generalize to the wider population. For example, many studies on the health effects of social strain are focused on datasets limited to women (e.g., Hendryx et al., 2020; Wang et al., 2021; Kershaw et al., 2014; Jonasson et al., 2020). Other studies focus on

specific target groups, such as Ge and colleagues (2017), which investigated how social support and strain affected cognitive function on Chinese older adults living in the United States (US).

There is also a need for more longitudinal research on social factors. There has been some previous longitudinal research investigating social support's effects on health (Cornwell & Waite, 2009; Doménech-Abella et al., 2019; Santini et al., 2019). Similarly, there has been some longitudinal research on the health effects of social strain (Grundy & Read, 2015; Vittengl, 2017; Friedman et al., 2012). However, there is a need for more research that investigates how social support and strain, independently and in combination, relate to health in a longitudinal context. Assessing social support and strain in combination, in a longitudinal context, can help us to determine whether these factors have an interaction effect, whether in general, in specific situations, or over time. For example, how a person's social network grows or shrinks over time might change how much its strain and supportiveness affects the person's health.

It is common for longitudinal studies to draw from large, nationally specific datasets like the Midlife in the United States (MIDUS) dataset (e.g., Yang, Schorpp, & Harris, 2014), or the English Longitudinal Study of Ageing (ELSA; e.g., Scholes & Liao, 2023), which may also be focused around adults of a specific nationality. The dataset used in the current study, the National Social Life, Health, and Aging Project, focuses broadly on US older adults. When considering longitudinal research on social support and strain, it is important to distinguish research that truly uses a longitudinal *method* from single-timepoint or time-agnostic methods used upon longitudinally collected *data*. Not all existing research takes advantage of longitudinal data to conduct analyses that depend on multiple timepoints. Still, research that does conduct true longitudinal analyses generally tends to find a clear relationship between social strain and health risks (e.g., Friedman et al., 2012; Scholes & Liao, 2023).

Theories related to how social networks and identities change can also provide insight into the role of social support and strain in the lives of older adults. For the current study, socioemotional selectivity theory and social identity theory were most considered when building hypotheses and models, as these frameworks are highly relevant.

The current study investigated relationships between social and demographic factors, as well as health-related outcomes, using the National Social Life, Health, and Aging Project (NSHAP; Waite et al. 2005-2023). NSHAP contains three waves of data collected over a ten-year period. Participants who were present for the first, or baseline, wave were included in the current study. There were three outcome variables that measured physical health, and three outcome variables that measured mental health.

The current study addressed the following research questions:

Research Question 1: Do social support and strain have significant independent relationships with levels of physical and mental health indicators, above and beyond demographic and sensory factors, within the NSHAP sample? Are these findings consistent with those in other studies?

Research Question 2: Do social support and strain predict changes in physical and mental health over time, and if so, how?

Research Question 3: Are there any significant moderation effects (that is, interactions) between social support and strain that predict levels of, or changes in, physical and mental health?

Consistent with previous research, it was hypothesized that social support would be positively associated with physical and mental health, while social strain would be negatively associated with those outcomes, after controlling for demographic factors. In the models used,

sources of social support and strain included one's spouse or partner (if the subject had one), close family members, and close friends.

Furthermore, significant changes over time were expected. First, physical and mental health were expected to decline overall in the sample, corresponding to normal age-related changes. Second, it was hypothesized that these declines would be significantly related to social support and social strain. Social support was expected to be associated with slower age-related health declines (i.e., act as a buffer). Social strain, on the other hand, was expected to be associated with faster age-related health declines.

Because social relationships are complex and older adults may simultaneously experience both high social support and high social strain (that is, ambivalence), interaction effects between the two were also examined. It was hypothesized that ambivalent relationships (as well as indifferent relationships, where there was low support and low strain) would be associated with worse health outcomes than supportive (high support only) ones, but better health outcomes than aversive (high strain only) ones. However, the relationship between ambivalent and indifferent relationships is unclear in previous literature, so this study is more exploratory.

Investigating and understanding the interplay between social support, social strain, and healthy aging can help people be more cognizant of their own relationships with older adults, understand the challenges and triumphs of caregiving relationships, and improve quality of life for older adults and those connected to them. Understanding social factors can also be useful to those who may serve as potential sources of social interaction for older adults, to raise awareness about the needs of their older friends, family members, clients, patients, and neighbors. Even for those who have little contact with older adults, understanding the link between health and social

factors can be helpful to break down the societal stigma around aging and discourage ageist and potentially social strain-inducing behaviors.

2. REVIEW OF LITERATURE

To understand how social strain and social support relate to health, introductory information about social strain will be discussed first in this literature review, including what it is and why it is important to study as a separate construct from social support. Practical applications in which social strain would be a concern for older adults will also be discussed. Examples of how social strain may pose a risk to physical and mental health will be described next, including how social strain may disproportionately affect people of different genders and ages. Then, background information on social support will be discussed, including different sources of social support, as well as information on how social support may affect health. Social support may serve as a buffer against health risks due to social strain, and to health risks caused by other factors, including aging itself. Last, literature on social strain and social support in longitudinal contexts will be described.

2.1. The Construct of Social Strain

The terminology of "social strain" is attributed to the criminology field, where it serves as part of the broader General Strain Theory (see Agnew, 1992 for a discussion). In this context, social strain serves as a possible explanation for delinquent or criminal behavior. Yet social strain's reach extends beyond criminology. Any person may have social relationships and experience social strain. Thus, it is necessary to look to other fields to consider how social factors influence health.

In the field of sociology, Karen Rook (1990) noticed a trend relating to social support and social strain in research, linking the potential of social relationships to have positive or negative outcomes together. While other researchers had noticed the duality of social relationships, Rook collected this information using the terms "social support" and "social strain," and linked them to

individuals' emotional and physical health. Rook describes social strain as the capability of some social relationships to serve as "a source of stress" (1990, p.118).

As discussed by Rook (1990) and supported by many others in the decades since, it is important to study social strain alongside social support because each social relationship is complex and multifaceted. Any relationship between at least two people can provide support and strain, in more complex ways as those dyads develop stronger ties, have more shared experiences, or interact with others. Some relationships can serve as net positives, others as negatives. However, for the purpose of the current study, overall levels of social support and strain will be considered.

In previous studies, social strain (and, for that matter, social support) have generally been measured similarly to how they are in the NSHAP, using a series of self-reported items. For instance, the Midlife in the United States (MIDUS) data, another large dataset on US older adults, uses four items including how often the person felt demands, criticism, let down, or like a social contact was getting on their nerves, from three different groups: friends, spouse, and family (Friedman et al., 2012, describe these). The English Longitudinal Study of Ageing (ELSA), a large dataset on English older adults, used items related to criticism, feeling let down, and getting on nerves from four groups: friends, spouse, children, and other family members (Scholes & Liao, 2023, describe these). Other studies, especially older studies, have used other measures (e.g., Sherman, 2003) which vary in exact number of questions and exact groups of social connections, but they still tend to be relatively consistent in assessing negative feelings relating to different groups of social connections. Social support measures are conducted similarly, but assess positive feelings.

Certain sources of social strain may be especially applicable for older adults. One such source is caregiving relationships. While these relationships are often intended as sources of social (and instrumental) support, they can also become strained, creating unique consequences for physical and mental health.

2.2. Consequences of Social Strain

While the work of Rook (1990) investigated primarily the effects of social strain on emotional health, it can have tangible effects on physical health as well. This linkage is especially relevant when social strain comes from caregivers and others responsible for their health and wellness. One study of community-dwelling older adults with dementia found that different types of caregiving relationships had different effects on social strain and on health outcomes (Lai et al., 2022). A different study found that more intense caregiving could cause increased social strain (Cook et al., 2018), potentially increasing negative health outcomes for caregivers.

Because each older adult is a unique person, there is high individual variation in the types and severity of strain experienced. However, certain groups of older adults, such as the old-old or those dealing with a chronic illness, may be more at risk for experiencing social strain from their caregivers or others (Townsend et al., 2010). Risk factors can also compound over a person's lifetime, a process known as cumulative disadvantage (see Umberson & Montez, 2010 for a more in-depth description related to social ties).

Several aspects of health are negatively associated with social strain, including physical and mental health. Social strain is a risk factor for numerous chronic health conditions, including long-term stress due to increased cortisol level (Friedman et al., 2012), type 2 diabetes and cardiovascular diseases in women (Hendryx et al., 2020; Kershaw et al., 2014), and osteoarthritis

(Sherman, 2003; Luger et al, 2009). Some researchers have also studied social strain and health in other contexts. Wang and colleagues, for instance, discuss the effects of social strain on women's coronary heart disease (CHD) alongside job strain and other stressful life events. Even when accounting for factors such as socioeconomic status and age, Wang and colleagues found that social strain significantly increased CHD risk (2021).

Social strain can also put older adults' mental health at risk. Social strain has been associated with higher cortisol levels, an indicator of higher stress, in the Midlife in the US (MIDUS) dataset (Friedman et al., 2012). Social strain may disrupt sleep, leading to a number of physical and mental health impacts (Chung, 2017). It may serve as a risk factor for depression and anxiety (Vittengl, 2017; Teo et al., 2013) or increase depressive symptoms in those who have not been diagnosed with clinical depression (Sherman, 2003).

Aside from what are commonly thought of as "health" factors (i.e., chronic conditions and diagnosable diseases), social strain can have general impacts on functional status and quality of life. Functional status describes an older adult's ability to take care of him- or herself, complete daily tasks and function independently, which greatly impacts quality of life. Cognitive and physical functioning both contribute to functional status, and there is evidence that social strain inhibits cognitive functioning (Ge et al., 2017). How it impacts physical functioning is unclear, but it is consistently associated with lower psychological health (Wilkinson et al., 2023). Social strain may also be related to lower life satisfaction on its own, or it may be related to other factors associated with lower life satisfaction, such as pessimism (Luger et al., 2009).

From the breadth of consequences of social strain on health demonstrated in existing research, it is clear that social strain negatively impacts health. To protect older adults' health, it is important to find ways to buffer this effect. One such way may be through social support.

2.3. Protective Effects of Social Support

Social support refers to any support provided to a person by anyone within their social networks. Social strain puts the health of older adults at risk, but social support may serve as a buffer against that risk. One study found that emotional regulation and social support were associated with lower levels of cortisol in older adults (Gaffey et al., 2016), mitigating the effects of chronic stress. Social support has also been directly linked to resilience in both urban and rural older adults (Wells, 2010). Such resilience factors have been associated with lower depression levels and longer life span (MacLeod et al, 2016); therefore, social support may buffer the impact of social strain on older adults' physical, mental, and socioeconomic well-being. Social support has also been linked to overall quality of life in older adults (Kong et al., 2021). Evidence from the NSHAP data has shown that such protective effects can extend longitudinally over several years.

For example, a study on a subsample of men from the baseline wave found that being married was a protective factor against high levels of C-reactive protein, even when other predictors were accounted for (Sbarra, 2009). C-reactive protein, in turn, is a marker and risk factor for cardiovascular disease and inflammation. Thus, having the support of a spouse may help prevent cardiovascular disease, at least for men. A different group of researchers found that marital quality between baseline and wave 2 of the NSHAP was associated with diabetes risk. However, the association showed some variation based on gender. An increase in positive marital quality was protective for women, while an increase in negative marital quality was protective for men (Liu, Waite, & Shen, 2016). Although they do not use exactly the same variables, marital quality and social support and strain are measured in similar ways in the NSHAP data. Therefore, measures of marital quality in NSHAP may mirror social support and

strain, with positive marital quality mirroring social support given by one's spouse, and negative marital quality mirroring social strain. The authors also anticipated that both positive and negative qualities may exist in the same marriage, and examined them as two separate dimensions (Liu, Waite, & Shen, 2016).

An earlier study by the same researchers also found gender differences in the effect of marriage on heart disease risk, finding that the link between marital quality and risk was more pronounced for women (Liu & Waite, 2014). This study also found that the effect of marital quality was more pronounced for older married people than younger ones (Liu & Waite, 2014), suggesting that age may be a potential covariate in the relationship between social support, strain, and health factors.

While social support may have protective effects on its own or depending on age- and gender-based covariates, it is only one part of the older adult's social environment. Some aspects of this environment may be protective or have a buffer effect, while others pose a risk. Naturally, social strain may also be part of this environment, and so social support and strain should be investigated together as factors that may interact to affect older adults' well-being, health, and quality of life.

2.4. Social Support and Strain Interacting

Older adults' social environments are incredibly complex. Family members, medical and care professionals, co-workers, workers in the service industry, church members, intimate partners, and others who are part of older adults' social networks may each provide social support or be sources of social strain. When sources of social support can also serve as sources of strain, it is important to investigate previous research on the overlap between the two, as well as

literature on ambivalence, which investigates opposing attitudes originating from one person in a social network (Minkowich et al, 1966), such as support and strain.

Some researchers have investigated social support and strain interacting together independent of ambivalence research. However, some of these studies have been limited to specific contexts. For the NSHAP data, there are relatively few studies investigating these social factors together, although data on social support and strain have been collected for all three waves (Waite et al., 2021, discuss the NSHAP's scales of social interaction). Although this dataset is limited to older adults in the USA, and the sample is proportionally more heavily female and White, investigating it could still provide another piece of the puzzle of social factors and health.

Ambivalence is also a key concept to consider in terms of social support and strain. Originally proposed in the psychiatry field (Bleuler, 1910/1912), the definition of ambivalence was eventually refined to "the coexistence of opposed emotional attitudes toward a significant figure in the social environment" (Minkowich et al., 1966, p. 31). In the context of the current study, an ambivalent relationship is one in which both social support and social strain can be found.

Ambivalence grew beyond its roots in psychiatry and psychopathology. It was eventually adopted in marriage and family therapy (as Lüscher summarizes, 2002), where it is sometimes used to study conflict in older adults' relationships. In the field of gerontology, ambivalence research considers older adults' relationships with family (e.g., Pine & Steffen, 2017; Ha & Ingersoll-Dayton, 2008), friends (Fingerman et al., 2004), and partners (Liu & Upenieks, 2020; Hsieh & Hawkley, 2018).

Given its history in psychiatry, psychopathology, and marriage and family therapy, it is perhaps no surprise that ambivalence has been linked to health and well-being. Some of this research uses the NSHAP data. Two such studies considered ambivalence in spousal dyads. Each used spousal measures of social support and social strain to determine "marital quality" (Liu & Upenieks, 2020; Hsieh & Hawkley, 2018). The first investigated loneliness, but did not find a significant difference in loneliness between supportive and ambivalent relationships (Hsieh & Hawkley, 2018). The second investigated depression, happiness, and self-rated physical health, and although the authors expected older adults in ambivalent marriages to have the worst health outcomes, they did not find the evidence to support this (Liu & Upenieks, 2020). As both of these studies investigated the same data as the current study, their results may help to inform expected outcomes.

There is some longitudinal research on ambivalence as well. As with much of the ambivalence research on older adults, most of this seems to focus on the relationship between older adults and their adult children (e.g., Lendon, 2016; Lendon et al., 2014). This is commonly studied because of the prevalence of adult children serving in family caregiver roles. Some research has expanded this beyond the parent-child dyad (Girardin et al., 2018), but even this emphasizes family relationships over friend relationships. Thus, there may be some value in investigating ambivalence between social support and strain overall, not just in family relationships.

Beyond the ambivalence literature, perceptions of social strain and social support may also affect the relationship between these factors. The level of social support or strain perceived may be different from what is received (del Pino-Casado, 2018), and this may lead to different outcomes. For instance, Ong and colleagues found that differences in perceived support were

associated with differences in caregiver burden (2018). Another study found that those who perceive themselves as having lower levels of social support may have worse outcomes when it comes to mental health (Wang et al., 2018).

Finally, relationships between social strain and health, social support and health, or both may also proceed in the other direction, if they are not tested longitudinally. That is, health changes can affect whether a person receives more support from caregivers, friends, and others in their life; or whether the relationship becomes more strained. For example, Zhaoyang and colleagues discuss that cognitive impairment may lead to social strain in caregiving relationships (2021). In general, most analyses on social support, strain, or both as predictors of health factors, including the Zhaoyang study, use cross-sectional or limited longitudinal methods. Thus, they are limited in describing change over time (e.g., limited to a short time frame). What these studies do accomplish is demonstrating that there is a negative association between social strain and health. Understanding this relationship in more depth, including in a longitudinal context, is one of the objectives of the current study. Existing theories can help researchers understand what this relationship may look like well enough to form informed research questions and hypotheses.

2.5. Theories About Social Support and Strain

Several theories in gerontology describe the effects of social support and strain on health and well-being. A theory focused on investigating how social networks, and thus social support and strain, change across the lifespan is socioemotional selectivity theory (SST). Proposed by Laura Carstensen, this theory challenged previous theoretical models that shrinking social networks are inherently negative. Instead, Carstensen argued, older adults have a reduced number of social connections because they selectively prune away unhelpful relationships. In

place of these relationships, they nurture the connections that are strongest, most meaningful, or most supportive to them (1995).

Some previous research has investigated, directly or indirectly, social support in the context of SST. Weiner and colleagues, for example, hypothesized that support would predict fewer mental health difficulties in older veterans as compared to younger ones, because the older group had selected for supportive relationships (2016). Guida and colleagues discussed that a cancer diagnosis could cause social pruning to happen, in a fashion similar to normal aging (2020). However, their study also found that adding *new* relationships could have protective effects for physical and mental well-being in both cancer survivors and older adults (Guida et al., 2020), which is in line with the present study's hypothesis that social support can serve as a protective factor overall.

A number of other theoretical perspectives may also be relevant to social support and strain. Lakey and Cohen describe how stress, social construction, and relationships may interplay with social support (2000). While their work is two decades old, it may be worthwhile to highlight some of these perspectives. One notable theoretical perspective Lakey and Cohen describe is the stress and coping perspective. This includes the stress-support matching hypothesis (attributed by Lakey & Cohen, 2000, to Cohen & McKay, 1984; and Cutrona & Russell, 1990). This hypothesis describes the role of social support in "reducing the effects of a stressor", or in other terms, buffering it. The authors go on to describe that this buffering may be more or less effective depending on what the stressor is. A stressor that is strongly associated with social relationships is, theoretically, more likely to be buffered by social support (Lakey & Cohen, 2000). Social strain may serve as such a stressor, being not only *associated with* social relationships, but, like social support, a *product* of those relationships. Thus, this perspective

may provide a framework for answering one of the current study's research questions. Specifically, part of the first research question asks what combined effects social support and strain have on health. While this perspective focuses on coping with stress, it may be possible to test if this model holds up for other physical and mental health factors.

Building on the basis of SST and other theories, it may be possible to predict how social support and strain may impact older adults' health. However, SST inherently looks at the longitudinal patterns in older adults' social networks, and the levels of support and strain in a person's relationships vary over time. To get a bigger picture, longitudinal research is necessary.

2.6. Longitudinal Data on Social Support, Social Strain, and Health

Longitudinal data are needed to establish causal relationships between social support, social strain, health, and other factors. While true longitudinal studies of social support and strain are relatively few, many cross-sectional studies have investigated these factors in tandem. Studies that consider the complex supports and strains associated with caregiving are important to consider, as is the historical context of these studies. Finally, it is also important to consider previous longitudinal studies conducted with the NSHAP data, especially those which involve these social factors (or others, such as social isolation).

A few studies have been conducted on the individual longitudinal effects of social support, but these tend to be focused on specific populations, as mentioned earlier in this review. Populations may be limited to a specific setting (e.g., an online setting, such as in Szabo et al., 2019), population (e.g., the Irish population in Doménech-Abella et al., 2019), or health outcome (e.g., PTSD in Zalta et al., 2021). Some may have an even narrower focus. For example, Beam and Collins (2019) investigated depressive symptoms in LGBTQ+ older adults – a specific health outcome within a specific population. Individual longitudinal research on social strain is

also rare – strain is nearly always studied in tandem with support – but it faces the same issue of being limited to certain populations (e.g., Wang et al., 2021).

Apart from the issue of being limited in scope, some existing research on social and health factors that uses longitudinal *data* is not always conducted using a longitudinal *method*. One cross-sectional study that does investigate both social support and social strain in a large dataset was conducted by Yixin Chen and Thomas Hugh Feeley (2014). Chen and Feeley used the Health and Retirement Study (HRS), a national dataset consisting of adults 50 and over in the US, social support and strain are linked to well-being. The authors describe loneliness as a likely mechanism for this, and account for the role of family caregivers (2014). Overall, this study considers many of the same variables of interest as the current study. However, Chen and Feeley's study was not longitudinal; they used only the 2010 HRS dataset.

The few true longitudinal studies that have investigated effects of social support, strain, or both are important to consider. One study by Friedman and colleagues used a two-wave repeated-measures design to study the effects of social strain on cortisol regulation, which relates to stress. This study found that social strain could be a significant source of stress, and thus predicted higher cortisol levels (2012). This study was limited to two waves of data, but it did provide support for the hypothesis that social strain can influence health factors.

Scholes and Liao conducted another longitudinal study, this one focusing on data from the multi-wave English Longitudinal Study of Ageing (ELSA; 2022). The authors investigated the effects of social support and strain on verbal memory, a marker of functional health. Using baseline data and data from each timepoint, they established a "rate of decline" model. They found that rate of memory decline was associated with differences in social support and strain

(2022). While the NSHAP data does not have as many waves as the ELSA, it contains relevant variables that were not measured in ELSA.

Finally, Wilkinson and colleagues conducted a longitudinal analysis of social support and strain that older adults receive from their children (2023). Using data from the Health and Retirement Study (HRS), they conducted a new type of longitudinal analysis as pioneered by one of the authors. Their results support the idea that social support and strain could affect psychological well-being, but found no linkage between social factors and physical health (Wilkinson et al., 2023). This seems to be inconsistent with previous research, which could be a result of their new analytical approach.

Historical context should also not be ignored, especially when discussing caregiving. While the NSHAP data was collected pre-COVID-19 pandemic (the collection of NSHAP Wave 4 was delayed by the pandemic), more recent research tends to be informed by it. Many studies report that caregivers experienced additional strain during the COVID-19 pandemic, especially in caring for older family members, who are considered a vulnerable population. For instance, a study of speech-language pathologists supporting informal caregivers found that the pandemic was a perceived source of caregiver burden and social strain (Chen, Shune, & MacDonald, 2021). A study focused on family relationships, including family caregivers, found that the pandemic could increase social strain within families (Thomeer, Yahirun, & Colón-López, 2020). These patterns are likely to be visible in the most recent research, but will not appear in the current study because the data were collected before the pandemic.

Previous longitudinal multilevel models would also be able to inform the current study's approach. However, most previous multilevel research is not longitudinal. Instead, it has used nested multilevel models (MLMs), where individuals are studied within nested groups, in many

cases their spousal dyad (e.g., Capreol, 2000; Ryan, Wan, & Smith, 2014; DeLongis et al., 2004). In previous actual longitudinal MLMs, social support and strain were often not the primary focus. For example, Vittengl (2017) treated those variables as covariates. Nevertheless, Vittengl found a link between social factors and depression and anxiety symptoms. In this study, lower social support and higher social strain both predicted more depression and anxiety symptoms (2017).

One recent study investigated social support (or a lack of it) in a broader context using the NSHAP data. Ziggi Santini and colleagues (2020) examined the effects of social *isolation* on mental health outcomes. Similar to the proposed study, Santini and colleagues investigated different pathways of how this isolation may affect health (2020). However, in the current study, emphasis was placed not on the lack of social support, but on the varieties of social support that may enrich older adults' lives.

Some other studies using the NSHAP data have also considered social strain, social support, health, or related factors in longitudinal contexts. The research team which put together the dataset recently published a study demonstrating how the NSHAP data can be used to assess cohort effects (Waite et al., 2021). Possibly relating to social strain, Wong and colleagues (2017) compare the NSHAP data to previous research on elder mistreatment, though this research is foundational, not longitudinal. Hawkley and Kocherginsky (2018) use NSHAP data to consider risk factors for loneliness, which relates to a lack of social support. There have also been other studies of health factors over time, including chronic physical health conditions (Vasilopoulos et al., 2014) and mental and psychological health (Payne et al., 2014; Shiovitz-Ezra et al., 2009). However, these other studies do not account for the social factors of interest; they are included as examples of longitudinal work done with the NSHAP data. Prior research done with both the

NSHAP data and other longitudinal data has helped to inform the proposed study. Investigating this previous research has demonstrated what areas still need to be studied longitudinally, and what areas have not been investigated together at all.

2.7. Current Study

Previous research has established that there may be a relationship between social strain and health, and between social support and health. Given the theoretical frameworks mentioned previously, these relationships are likely longitudinal, but they have not always been studied in a longitudinal context. When they have, it is usually with a narrow focus, on one population, type of relationship, or health outcome. Existing research and theory also hint that social support and strain are each part of a broader environment of social factors that is unique to each older adult.

The NSHAP dataset is useful for conducting broader research because it does not focus on a special population, such as individuals with dementia or disabilities. It does include some data on demographic factors that may affect the relationship between social support, social strain, and health. Some previous research has found differing effects based on some of these factors, including sex, age, socioeconomic status, race, and ethnicity. There is also evidence that people who are in more than one socially "disadvantaged" category may experience social relationships differently and may be more at risk for health complications (Umberson & Montez, 2010). This cumulative disadvantage is important to consider because older adults may be considered a disadvantaged group, discriminated against because of their ages. It may be useful to investigate whether these demographic factors, as well as age, affect how much social strain a person experiences, as well as their health outcomes. However, this is beyond the scope of the current analysis; further discussion can be found in the future research directions (section 5.3).

Each of the current study's primary research questions was investigated using the NSHAP data. The first question asked, "Do social support and strain have significant independent relationships with levels of physical and mental health indicators, above and beyond demographic and sensory factors, within the NSHAP sample? Are these findings consistent with those in other studies?" To address this question, measures of social support and strain were created and analyzed as predictors in longitudinal multilevel models with physical and mental health outcomes. Various sociodemographic covariates were also included in the models,

such as age, sex, race, marital status, and ethnicity. It was hypothesized that social support would be positively associated with physical and mental health, while social strain would be negatively associated with physical and mental health. Higher age, being Hispanic or non-white, female sex, and lack of a spouse or partner can disadvantage participants in terms of health, but associations between those demographic factors, and how they change alongside social support and social strain, were expected to vary.

The second research question asked, "Do social support and strain predict changes in physical and mental health over time, and if so, how?" This question was investigated via examining interactions between the predictors and time in the models. Health was expected to decline overall, consistent with age-related changes. It was expected that social strain would exacerbate these declines, while social support would protect (or buffer) against them.

Finally, the third research question asked, "Are there any significant moderation effects (that is, interactions) between social support and strain that predict levels of, or changes in, physical and mental health?" That is, what role does ambivalence play? Supportive (high support and low strain) relationships would be expected to show the best health outcomes, and aversive (low support and high strain) relationships would be expected to show the worst. This research

question asks how ambivalent (high support and high strain) and indifferent (low support and low strain) relationships compare. To examine this question, interaction terms between social support and strain were analyzed as predictors. Given that previous studies (Liu & Upenieks, 2020; Hsieh & Hawkley, 2018) did not find a significant difference between ambivalent or indifferent relationships and supportive ones using this data, it is expected that ambivalent and indifferent relationships will fall somewhere in between supportive and aversive ones. However, how they will compare to each other, and how big any differences will be, is unknown.

Overall, the current study sought to investigate more deeply the relationships between social support, social strain, and physical and mental health. How these factors relate to each other, how they change over time, and how someone's position of social advantage or disadvantage might affect them can all help to foster an understanding of the healthiest ways for older adults to live their lives.

3. METHOD

3.1. Participants and Procedures

Data from the first three waves of the National Social Life, Health, and Aging Project (NSHAP) was used in the current study (a fourth wave was underway, but not yet publicly available). The initial or baseline wave was conducted in 2005-2006, Wave 2 was conducted in 2010-2011, and Wave 3 was conducted in 2015-2016. Waves 2 and 3 included participants who were present at baseline, as well as newly recruited participants. Inclusion criteria for the study included being community-dwelling and able to communicate clearly in written and oral formats. Trained field interviewers visited participants' homes to collect data. Data included face-to-face interviews and assessments, self-report questionnaires about social relationships and health, and various biomeasures (e.g., vital signs; saliva; blood spots). For more details about NSHAP, see Waite et al. (2005-2021).

The current study was limited only to participants who provided data at baseline and were therefore followed across all subsequent waves (N = 3,005). At baseline, these participants were between 57 and 85 years of age (M = 69.30, SD = 7.85). See Table 1 for demographic descriptive statistics of this sample. At Wave 3, 1,592 of the original participants provided data, and 1,413 had dropped out of the study. Of those that dropped out, 33% were confirmed deceased, and 8% were too ill to be interviewed. The remainder were lost to follow-up.

3.2. Measures

3.2.1. Physical and Mental Health Outcomes

Outcome measures for physical and mental health were selected based on three criteria: whether they were available and coded consistently across all three waves; how highly correlated and conceptually similar they were; and whether they showed significant change over time in

Table 1

Sociodemographic Characteristics of the Sample at Baseline

Characteristic	Number of Participants	Percent of Sample
Biological Sex		
Male	1,454	48.4
Female	1,551	51.6
Race		
White	2,295	76.4
Other	702	23.4
Ethnicity		
Non-Hispanic/Latino	2,681	89.2
Hispanic/Latino	311	10.3
Marital Status		
Married or Living with Partner	1,861	61.9
Other	1,144	38.1
Education Level		
Less than High School	699	23.3
High School or Equivalent	793	26.4
Some College/Associates	856	28.5
Bachelors or Higher	657	21.9
Number of Friends		
None	131	4.4
One	82	2.7
2-3	547	18.2
4-9	856	28.5
10-20	649	21.6
More than 20	543	18.1
Number of Family/Relatives Feel Close To		
None	69	2.3
One	138	4.6
2-3	711	23.7
4-9	1211	40.3
10-20	464	15.4
More than 20	203	6.8

Note. N = 3,005. Participants' ages ranged from 57 to 85 years of age (M = 69.30, SD = 7.85).

unconditional growth models. Unfortunately, many potentially relevant variables were either added or dropped after the baseline wave, or were not coded consistently. The following measures of physical health were evaluated as potential outcomes: self-rated physical health, number of selected comorbidities, and difficulties performing selected activities of daily living (ADL)s. Five mental health measures, as described in Payne et al. (2014), were also examined as potential outcomes: depressive symptoms, anxiety symptoms, perceived stress, felt loneliness, and self-rated happiness.

Self-Rated Physical Health. This was a single item in which participants rated their general physical health on a 5-point scale from "poor" to "excellent." For the current study, this variable was scaled such that higher scores indicated worse health, and could range from 1 to 5.

Comorbidities. NSHAP included a self-report questionnaire in which participants indicated whether or not a physician had ever diagnosed them with various health conditions. Not all the listed health conditions were measured consistently across all three waves. However, six of them were: ever had hypertension, ever had a heart attack, ever had arthritis, ever had cancer other than skin cancer, ever had diabetes, and ever had pulmonary disease. These items were answered yes/no, and coded such that 0=no and 1=yes. Then, the items were summed together to create a composite of limited comorbidities. Total scores could range from 0 to 6, where higher scores indicated greater comorbidities.

ADL Difficulties. Participants were asked to rate how well they could perform various daily living tasks. A subset of six ADLs were measured consistently across the three waves: difficulty walking one block, difficulty dressing, difficulty bathing or showering, difficulty eating, difficulty getting in our out of bed, and difficulty using the toilet. Ratings for these items were scored as 0 = no difficulty, 1 = some difficulty, 2 = much difficulty, and 3 = unable to do.

Then, the six items were summed to create a composite of ADL difficulties that could range from 0-18, in which higher scores indicated greater difficulties.

Depressive Symptoms. Depressive symptoms were measured by an 11-item version of the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977; Kohout et al., 1993). Participants were asked to indicate how often they experienced various feelings over the previous week. As suggested by Payne et al. (2014), items were scored as 0 = rarely or none of the time, 1 = some of the time, and 2 = much or most of the time, with higher scores indicating more depressive symptoms. The 11 items were then summed together to create a composite total score ranging from 0 to 22.

Anxiety Symptoms. Symptoms of anxiety were assessed by a 7-item version of the Hospital Anxiety and Depression Scale's Anxiety Subscale (HADS-A; Zigmond & Snaith, 1983; Snaith, 2003). On this measure, participants indicated the frequency of experiencing feelings of anxiety over the previous week, with response categories of 0 = rarely or none of the time, 1 = some of the time, 2 = occasionally, and 3 = most of the time. Items were summed into a composite ranging from 0 – 21, with higher scores indicating greater anxiety.

Perceived Stress. Participants rated perceptions of their daily stress using a modified form of the Perceived Stress Scale (PSS; Cohen & Williamson, 1988; Cohen, Kamarck, & Mermelstein, 1983) containing four items. Each item described a symptom of feeling stressed, and was rated on a scale from 0 = rarely or none of the time, 1 = some of the time, and 2 = much or most of the time. Item scores were summed to yield a composite score ranging from 0 to 8, with higher scores indicating greater perceived stress.

Loneliness. Participants' feelings of loneliness were measured using a 3-item scale adapted from the Revised UCLA Loneliness Scale (R-UCLA; Russell, Peplau, & Cutrona,

1980). Participants rated how often they felt lonely using the response categories of 0 = never or hardly ever, 1 = some of the time, and 2 = often (Payne et al., 2014), where higher ratings corresponded to greater loneliness. Item scores were summed into a composite ranging from 0-6.

Happiness. Finally, respondents rated their level of happiness on a single item that stated, "If you were to consider your life in general these days, how happy or unhappy would you say you are, on the whole…extremely happy, very happy, pretty happy, unhappy sometimes, or unhappy usually?" These five response categories were scaled from 1 (extremely happy) to 5 (unhappy usually).

Selection of Outcomes. Again, each of the variables described above were available and consistently coded across the three waves. Conceptually, the physical health variables were notably different from each other. Comorbidities indicate the presence of clinical diseases, ADLs measure everyday functioning, and self-rated physical health measures subjective perceptions of one's health. The mental health variables have also been treated as conceptually distinct in the literature (Payne et al., 2014). Two principal component analyses were conducted, one with the physical health factors and one with the mental health factors, to see if any variables would cluster together. Each group of variables loaded on a single factor, with no clear clusters. Bivariate correlations between all of the variables are shown in Table 2. None of the correlations exceeded 0.7, although the CESD, HADS, and PSS had substantial moderate correlations with each other and could form a composite to reduce redundancy. Finally, unconditional growth models were run for each individual outcome to see which ones showed statistically significant change over time. All variables showed significant change, with the exception of the CESD. Given the evidence, the CESD was not utilized further as an outcome variable. HADS and PSS scores were averaged so they would have equal weight, then summed into a composite termed

"negative affect." All other potential outcome variables were examined individually. Therefore, the current study analyzed six distinct outcome variables measuring physical health (comorbidities, ADL difficulties, and self-rated physical health) and mental health (negative affect, loneliness, and happiness).

Table 2

Correlations between Physical Health and Mental Health Variables as Measured at Baseline

Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. Self-Rated Physical Health	—	0.46**	0.41**	0.38**	0.24**	0.30**	0.21**	0.32**
2. ADL Difficulty		—	0.30**	0.34**	0.20**	0.26**	0.15**	0.22**
3. Comorbidities			—	0.19**	0.12**	0.11**	0.10**	0.14**
4. CESD				—	0.62**	0.57**	0.50**	0.50**
5. HADS					—	0.57**	0.38**	0.33**
6. PSS						—	0.38**	0.36**
7. Loneliness							—	0.41**
8. Self-Rated Happiness								—

*$p < 0.05$. **$p < 0.01$.

3.2.2. Social Support and Strain Predictors

Measures of social support and strain consisted of four questions that participants applied to three types of relationships: spouse, family/relatives, and friends. Two of the questions had a negative valence, and two had a positive valence. The negative items included "How often do you feel criticized by [group]?" and "How often do you feel you can't meet [group]'s demands?". The positive items included "How often can you open up to [group]?" and "How

often can you rely on [group]?". Each item was scored as follows: 0 = never or not applicable, 1 = hardly ever or rarely, 2 = some of the time, and 3 = often.

Items with a negative valence were summed together to create a composite measure of social strain from all sources, with a range of 0-6 where higher scores indicated more strain. Likewise, items with a positive valence were summed to create a composite of social support from all sources. These measures are intended by the research team collecting the NSHAP data to be summed together (see Waite et al., 2021). Additionally, the composites for support and strain were centered by subtracting the mean from each score. The centered composites were then multiplied together to create an interaction term for examining moderation effects.

Perceptions of social strain and support were likely to change over the ten-year period of the study, due to changes in relationship closeness and the composition of participants' social networks. To examine whether strain and support should best be structured as time-invariant (i.e., measured only at baseline) or time-varying predictors, unconditional growth models were run with strain and support as separate outcomes. Both variables showed significant change over time. Therefore, they were treated as time-varying predictors in subsequent analyses, as was the interaction term. The inclusion of time-varying predictors increases the complexity of longitudinal models and the amount of error variance, so covariates were not treated as time-varying. The following variables were controlled for as time-invariant covariates.

3.2.3. Sociodemographic Covariates

Age. Participants' age was measured at baseline in years. This variable was centered at the sample mean.

Biological Sex. Biological sex may affect social relationships and physical and mental health. The NSHAP questionnaire did not include an option to identify as intersex. Options for

"not applicable," "don't know," and "refused" were possible, but all participants specified that they were either female (coded 0) or male (coded 1) at baseline.

Race and ethnicity. Race and ethnicity may have impacts on the number and type of social relationships a person makes, may intersect with social support and strain levels, and may be linked to a person's physical and mental health for reasons other than social support or strain. Thus, race and ethnicity were included as covariates. The public NSHAP data coded race into three groups, White, Black, and Other. For the current study, race was dichotomized to White (coded 0) and Other (coded 1). Ethnicity was dichotomized as non-Hispanic (coded 0) and Hispanic (coded 1).

Marital Status. As one's relationship with one's spouse or partner can be a primary source of social support and strain, baseline marital status was considered as a sociodemographic covariate. Marital status was dichotomized to a dummy variable representing whether the participant had a current spouse or partner at baseline (coded 0) or not (coded 1; encompassed divorced, separated, widowed, and never married). This measure was included in the analysis to account for the presence or absence of a spouse or partner relationship, while the spousal social support and social strain items indicated the *quality* of relationship.

Level of Education. In addition to marital status, race, and ethnicity, a person's level of education may impact the number and dynamic of social relationships that person has. Participants' education level at baseline was coded into four categories in the NSHAP study: less than high school (coded 0), high school or equivalent (coded 1), some college/vocational program/associates degree (coded 2), and bachelors degree or higher (coded 3).

Number of Close Family or Relatives. At baseline, respondents answered the question of "how many family members or relatives do you feel close to?", as this may influence

opportunities for social support and strain from family relationships. The response options were none, one, 2-3, 4-9, 10-20, and more than 20. This measure was included to account for the *quantity* of family relationships, while the familial social support and strain items indicated the *quality* of these relationships.

Number of Friends. Similarly, respondents indicated how many friendship relationships they had at baseline. Response options were again none, one, 2-3, 4-9, 10-20, and more than 20. Similar to the marital status and number of close family covariates, this measure was included to account for the quantity of friend relationships, while the friend social support and strain items indicated the quality.

Attrition. One more demographic covariate was controlled for, though this was not measured at baseline. This was attrition, dichotomized as participants who provided data at Wave 3 (coded 0) or dropped out (coded as 1).

3.3. Statistical Analyses

A series of longitudinal multilevel models were used to examine associations between age, sex, race, ethnicity, marital status, education, number of family/relatives, number of friends, social support (time-varying), social strain (time-varying), the interaction between support and strain (time-varying), and ten-year changes in the six physical and mental health outcomes. The timing variable (time) was linear and coded as number of years from baseline (so 0 years at baseline, 5 years at Wave 2, and 10 years at Wave 3). For all models, Maximum Likelihood (ML) estimations were used.

First, for each outcome, an unconditional growth model (Model 1) was used to determine whether significant variation existed between timepoints. Intercept and time were examined as both fixed and random effects, in order to take individual differences into account. A diagonal

covariance structure was used to estimate random effects; several models with a completely unstructured covariance structure failed to converge. If the fixed effect of time was significant, a conditional growth model (Model 2) was run with the sociodemographic covariates included as fixed-effect variables. Linear time effects were assessed via covariate*time interactions. Finally, a second conditional growth model was run (Model 3) with social support, strain, social support*strain, and predictor*time interactions added as fixed effects. Model fit for each model was evaluated using -2 Log Likelihood (-2LL), and changes in -2LL from one nested model to another were evaluated using $\chi 2$, where df = the difference in model parameters. Finally, the models were interpreted in terms of the research questions, providing insight into why it is so important to consider social factors in the lives of older adults.

4. RESULTS

4.1 Physical Health Models

4.1.1. Comorbidities

Multilevel longitudinal models for comorbidities are summarized in Table 3. The fixed effect of linear time was statistically significant in Model 1, the unconditional growth model. Thus, longitudinal analyses could proceed. Regarding random effects, residual and intercept variance were significant, but the variance for slope was not. Model 2, which included baseline sociodemographic covariates and their interactions with time, showed significantly improved fit over Model 1, $\chi 2(18) = 1650$, $p < 0.05$. Likewise, Model 3, which included social strain and support, had significantly better fit than Model 2, $\chi 2(6) = 1577$, $p < 0.05$. However, social support and strain were not significant predictors of comorbidities. In Model 3, number of comorbidities were significantly associated with older age, non-white race, non-Hispanic ethnicity, not being married, lower levels of education, having more close family members, and dropping out of the study. Age*time, sex*time, and ethnicity*time interactions were also significant, indicating that older age, male sex, and Hispanic ethnicity were associated with increases in comorbidities over time.

Table 3

Changes in Comorbidities Over Time as Predicted by Social Support and Strain

Effect	Model 1		Model 2		Model 3	
	Estimate	***SE***	**Estimate**	***SE***	**Estimate**	***SE***
Intercept	1.67***	0.02	1.55***	0.09	1.60***	0.09
Time	-0.02***	<0.01	-0.03*	0.01	-0.04**	0.01
Age			0.02***	<0.01	0.02***	<0.01
Sex[a]			-0.06	0.19	-0.05	0.04
Race[b]			0.20***	0.05	0.17***	0.05
Ethnicity[c]			-0.19**	0.07	-0.21**	0.07
Marital Status[d]			0.12*	0.05	0.18**	0.06
Education[e]			-0.10***	0.02	-0.10***	0.02
# Close Family[f]			0.05*	0.02	0.04*	0.02
# Friends[g]			<-0.01	0.02	-0.01	0.02
Attrition[h]			0.20***	0.05	0.20***	0.05
Age*Time			<0.01***	<0.01	<0.01***	<0.01
Sex*Time			0.01*	0.01	0.01*	0.01
Race*Time			-0.01	0.01	-0.01	0.01
Ethnicity*Time			0.03**	0.01	0.03***	0.01
Marital Stat*Time			<0.01	0.01	<0.01	0.01
Education*Time			<-0.01	<0.01	<-0.01	<0.01
# Family*Time			<0.01	<0.01	<0.01	<0.01
# Friends*Time			<0.01	<0.01	<0.01	<0.01
Attrition*Time			0.02	0.01	0.02	0.01
Social Support					<0.01	0.01
Social Strain					0.01	0.01
Support*Strain					<-0.01	<0.01
Support*Time					<0.01	<0.01
Strain*Time					<0.01	<0.01
Support*Strain*Time					<0.01	<0.01

Table 3

Changes in Comorbidities Over Time as Predicted by Social Support and Strain (Continued)

Effect	Model 1		Model 2		Model 3	
	Estimate	***SE***	**Estimate**	***SE***	**Estimate**	***SE***
Random Effects						
Residual	0.61***	0.02	0.60***	0.02	0.59***	0.02
Var (Intercept)	0.69***	0.03	0.62***	0.03	0.64***	0.03
Var (Time)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Model Fit						
-2 Log Likelihood	19554.00		17914.14		16336.75	
AIC	19564.00		17960.14		16394.75	
BIC	19598.09		18115.29		16587.80	
# of Parameters	5		23		29	

Note. All *p*-values in this table are two-tailed. The covariance structure for random effects was diagonal.

[a]Reference = Female; [b]Reference = White; [c]Reference = Non-Hispanic; [d]Reference = Married/Living with Partner; [e]Reference = < High School; [f]Reference = 0; [g]Reference = 0; [h]Reference = Non-Dropouts.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

4.1.2. ADL Difficulties

Multilevel longitudinal models for ADL difficulties are displayed in Table 4. The fixed effect of linear time was statistically significant in Model 1, so analysis proceeded to the conditional models. Random effects showed significant residual, intercept, and slope variance. Model 2 showed significantly better fit than Model 1, $\chi2(18) = 2474$, $p < 0.05$, and Model 3 showed better fit than Model 2, $\chi2(6) = 2374$, $p < 0.05$. Levels of social support and strain were not significant predictors of ADL difficulties. However, there was a significant interaction

between social strain and time, suggesting that increases in social strain over time were associated with increases in ADL difficulties over time. There was not a significant interaction between time and social support, or between social support and social strain.

In Model 3, ADL difficulties were significantly associated with female sex, non-white race, lower levels of education, and dropping out of the study. The only covariate that had a significant interaction with time was age; older age was associated with increases in ADL difficulties.

4.1.3. Self-Rated Physical Health

Multilevel longitudinal models for self-rated physical health are displayed in Table 5.

In Model 1, There was a significant decrease over time in self-rated physical health, although the parameter estimate was small. Analysis proceeded to the conditional models. Residual and intercept variance were significant, but slope variance was not. Model 2 showed significantly better fit than Model 1, $\chi2(18) = 1876$, $p < 0.05$, and Model 3 showed improved fit over Model 2, $\chi2(6) = 1464$, $p < 0.05$. Social support had a significant main effect, but social strain did not. Increased social support was associated with better levels of self-rated health. However, no significant interactions were found between the social factors with each other or with time. In Model 3, worse self-rated health was associated with non-white race, lower levels of education, fewer friends, and dropping out of the study. Significant interactions included age*time and sex*time; older age and male sex were associated with greater declines in self-rated health.

Table 4

Changes in ADL Difficulties Over Time as Predicted by Social Support and Strain

Effect	Model 1		Model 2		Model 3	
	Estimate	***SE***	**Estimate**	***SE***	**Estimate**	***SE***
Intercept	1.06***	0.04	1.22***	0.17	1.16***	0.17
Time	0.06***	0.01	0.09***	0.02	0.08**	0.03
Age			0.01	0.01	0.01	0.01
Sex[a]			-0.31***	0.08	-0.31***	0.08
Race[b]			0.32***	0.10	0.33***	0.10
Ethnicity[c]			0.05	0.13	0.08	0.14
Marital Status[d]			0.13	0.09	0.08	0.11
Education[e]			-0.24***	0.04	-0.24***	0.04
# Close Family[f]			0.05	0.04	0.06	0.04
# Friends[g]			-0.09**	0.03	-0.08*	0.03
Attrition[h]			0.79***	0.08	0.74***	0.08
Age*Time			0.01***	<0.01	0.01***	<0.01
Sex*Time			<-0.01	0.01	<0.01	0.01
Race*Time			<-0.01	0.01	-0.01	0.01
Ethnicity*Time			<-0.01	0.02	-0.02	0.02
Marital Stat*Time			<0.01	0.01	<0.01	0.02
Education*Time			<-0.01	0.01	<-0.01	0.01
# Family*Time			-0.01	0.01	-0.01	0.01
# Friends*Time			0.01	0.01	0.01	0.01
Attrition*Time			0.01	0.02	0.03	0.02
Social Support					-0.02	0.01
Social Strain					0.01	0.02
Support*Strain					<-0.01	0.01
Support*Time					<-0.01	<0.01
Strain*Time					**0.01***	<0.01
Support*Strain*Time					<0.01	<0.01

Table 4

Changes in ADL Difficulties Over Time as Predicted by Social Support and Strain (Continued)

Effect	Model 1		Model 2		Model 3	
	Estimate	***SE***	**Estimate**	***SE***	**Estimate**	***SE***
Random Effects						
Residual	1.47***	0.05	1.46***	0.05	1.44***	0.05
Var (Intercept)	3.23***	0.12	2.72***	0.11	2.59***	0.10
Var (Time)	0.02***	<0.01	0.02***	<0.01	0.02***	<0.01
Model Fit						
-2 Log Likelihood	28466.43		25992.38		23617.82	
AIC	28476.43		26038.39		23675.82	
BIC	28510.58		26193.80		23869.24	
# of Parameters	5		23		29	

Note. All *p*-values in this table are two-tailed. The covariance structure for random effects was diagonal.

[a]Reference = Female; [b]Reference = White; [c]Reference = Non-Hispanic; [d]Reference = Married/Living with Partner; [e]Reference = < High School; [f]Reference = 0; [g]Reference = 0; [h]Reference = Non-Dropouts.

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

Table 5

Changes in Self-Rated Physical Health Over Time as Predicted by Social Support and Strain

Effect	Model 1		Model 2		Model 3	
	Estimate	***SE***	**Estimate**	***SE***	**Estimate**	***SE***
Intercept	2.80***	0.02	2.98***	0.08	2.90***	0.09
Time	0.02***	<0.01	0.01	0.01	0.02	0.01
Age			<0.01	<0.01	<-0.01	0.01
Sex[a]			-0.04	0.04	-0.02	0.04
Race[b]			0.25***	0.05	0.26***	0.05
Ethnicity[c]			0.13*	0.07	0.11	0.07
Marital Status[d]			0.08	0.04	-0.02	0.06
Education[e]			-0.22***	0.02	-0.21***	0.02
# Close Family[f]			<0.01	0.02	0.02	0.02
# Friends[g]			-0.05**	0.02	-0.04*	0.02
Attrition[h]			0.42***	0.04	0.40***	0.04
Age*Time			<0.01**	<0.01	<0.01***	<0.01
Sex*Time			0.02***	0.01	0.02**	0.01
Race*Time			<-0.01	0.01	-0.01	0.01
Ethnicity*Time			<-0.01	0.01	-0.01	0.01
Marital Stat*Time			<-0.01	0.01	0.01	0.01
Education*Time			<0.01	<0.01	<0.01	<0.01
# Family*Time			<-0.01	<0.01	<-0.01	<0.01
# Friends*Time			<0.01	<0.01	<0.01	<0.01
Attrition*Time			0.01	0.01	0.01	0.01
Social Support					**-0.03*** **	0.01
Social Strain					<-0.01	<0.01
Support*Strain					<0.01	0.01
Support*Time					<0.01	<0.01
Strain*Time					<0.01	<0.01
Support*Strain*Time					<0.01	<0.01

Table 5

Changes in Self-Rated Physical Health Over Time as Predicted by Social Support and Strain (Continued)

Effect	Model 1		Model 2		Model 3	
	Estimate	***SE***	**Estimate**	***SE***	**Estimate**	***SE***
Random Effects						
Residual	0.48***	0.01	0.47***	0.01	0.45***	0.01
Var (Intercept)	0.71***	0.03	0.56***	0.02	0.56***	0.02
Var (Time)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Model Fit						
-2 Log Likelihood	18691.04		16814.99		15351.49	
AIC	18701.04		16860.99		15409.49	
BIC	18735.19		17016.44		15602.92	
# of Parameters	5		23		29	

Note. All *p*-values in this table are two-tailed. The covariance structure for random effects was diagonal.

[a]Reference = Female; [b]Reference = White; [c]Reference = Non-Hispanic; [d]Reference = Married/Living with Partner; [e]Reference = < High School; [f]Reference = 0; [g]Reference = 0; [h]Reference = Non-Dropouts. $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

4.2 Mental Health Models

4.2.1. Negative Affect

Multilevel longitudinal models for negative affect are displayed in Table 6. The linear effect of time was significant in Model 1, although like for physical health, the parameter estimate was small. Analysis proceeded to the conditional models. Variance for residual and intercept was significant, but slope variance was not. Model 2 showed significantly better fit than Model 1, $\chi2(18) = 1282$, $p < 0.05$, and Model 3 showed improved fit over Model 2, $\chi2(6) = 1811$,

$p < 0.05$. Both social support and social strain had significant associations with level of negative affect. Social support predicted lower negative affect, while social strain predicted higher negative affect. However, the social factors did not have any significant interactions with each other or with time. In Model 3, greater level of negative affect was associated with younger age, female sex, lower levels of education, and fewer friends. Age and attrition had significant interactions with time in this model, although attrition did not have a main effect. Older age and dropping out of the study were associated with increases in negative affect over time.

4.2.2. Loneliness

Loneliness increased significantly over time, although like in the physical health and negative affect models, the parameter estimate was small. Analysis proceeded to the conditional models. Variance for residual and intercept was significant, but slope variance was not. Model 2 showed stronger fit than Model 1, $\chi2(18) = 1143$, $p < 0.05$, and Model 3 showed better fit over Model 2, $\chi2(6) = 1372$, $p < 0.05$. There were significant main effects for both social support and strain in the loneliness model. Social support predicted lower levels of loneliness, while social strain predicted higher levels. In addition, social support interacted significantly with time, suggesting that increases in social support over time may be associated with decreases in loneliness. There was not a significant interaction between strain and time, or between social support and social strain. In Model 3, covariates that were associated with higher loneliness were younger age, female sex, non-white race, non-Hispanic ethnicity, not being married, lower levels of education, and fewer close family members or friends. Age, marital status, and attrition had significant interactions with time in this model. Like in the negative affect model, attrition had an interaction effect despite not having a main effect. Older age, being married, and dropping out of the study were associated with increases in loneliness over time.

Table 6

Changes in Self-Rated Negative Affect Over Time as Predicted by Social Support and Strain

Effect	Model 1		Model 2		Model 3	
	Estimate	***SE***	**Estimate**	***SE***	**Estimate**	***SE***
Intercept	1.08***	0.03	4.11***	0.20	3.78***	0.20
Time	0.01*	<0.01	0.13***	0.03	0.16***	0.03
Age			-0.02***	0.01	-0.02***	0.01
Sex[a]			-0.43***	0.10	-0.49***	0.09
Race[b]			0.18	0.12	<0.01	0.12
Ethnicity[c]			0.03	0.16	0.06	0.16
Marital Status[d]			-0.01	0.10	0.24	0.14
Education[e]			-0.29***	0.05	-0.29***	0.05
# Close Family[f]			-0.08	0.05	<-0.01	0.05
# Friends[g]			-0.19***	0.04	-0.16***	0.04
Attrition[h]			0.10	0.10	0.50	0.10
Age*Time			0.01***	<0.01	0.01***	<0.01
Sex*Time			-0.10	0.02	-0.02	0.02
Race*Time			<0.01	0.02	0.01	0.02
Ethnicity*Time			-0.01	0.03	-0.02	0.03
Marital Stat*Time			-0.03	0.02	-0.03	0.02
Education*Time			<0.01	0.01	<0.01	0.01
# Family*Time			-0.01	0.01	-0.02*	0.01
# Friends*Time			0.01	0.01	0.01	0.01
Attrition*Time			0.17***	0.02	0.19***	0.03
Social Support					**-0.09*** **	0.02
Social Strain					**0.26*** **	0.02
Support*Strain					<0.01	0.01
Support*Time					<0.01	<0.01
Strain*Time					<-0.01	<0.01
Support*Strain*Time					<0.01	<0.01

Table 6

Changes in Self-Rated Negative Affect Over Time as Predicted by Social Support and Strain (Continued)

Effect	Model 1		Model 2		Model 3	
	Estimate	***SE***	**Estimate**	***SE***	**Estimate**	***SE***
Random Effects						
Residual	0.97***	0.03	3.61***	0.11	3.62***	0.11
Var (Intercept)	1.07***	0.04	2.48***	0.13	2.11***	0.13
Var (Time)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Model Fit						
-2 Log Likelihood	27250.31		25967.67		24157.45	
AIC	27260.31		26013.67		24215.46	
BIC	27293.75		26166.62		24406.47	
# of Parameters	5		23		29	

Note. All *p*-values in this table are two-tailed. The covariance structure for random effects was diagonal.

[a]Reference = Female; [b]Reference = White; [c]Reference = Non-Hispanic; [d]Reference = Married/Living with Partner; [e]Reference = < High School; [f]Reference = 0; [g]Reference = 0; [h]Reference = Non-Dropouts.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Table 7

Changes in Self-Rated Loneliness Over Time as Predicted by Social Support and Strain

Effect	Model 1		Model 2		Model 3	
	Estimate	***SE***	**Estimate**	***SE***	**Estimate**	***SE***
Intercept	1.08***	0.03	1.83***	0.12	1.62***	0.12
Time	0.01*	<0.01	0.01	0.02	0.01	0.02
Age			-0.01***	<0.01	-0.02***	<0.01
Sex[a]			-0.07	0.06	-0.13*	0.06
Race[b]			0.24***	0.07	0.17*	0.07
Ethnicity[c]			-0.20*	0.10	-0.22*	0.10
Marital Status[d]			0.63***	0.06	0.50***	0.08
Education[e]			-0.08***	0.03	-0.06*	0.03
# Close Family[f]			-0.12***	0.03	-0.07*	0.03
# Friends[g]			-0.17***	0.02	-0.12***	0.02
Attrition[h]			0.05	0.06	0.01	0.06
Age*Time			<0.01***	<0.01	<0.01***	<0.01
Sex*Time			-0.01	0.01	-0.01	0.01
Race*Time			-0.01	0.01	-0.02	0.01
Ethnicity*Time			-0.02	0.01	-0.02	0.01
Marital Stat*Time			-0.04***	0.01	-0.05***	0.01
Education*Time			<0.01	<0.01	-0.01	0.01
# Family*Time			0.01	<0.01	0.01	0.01
# Friends*Time			<0.01	<0.01	<0.01	<0.01
Attrition*Time			0.04***	0.01	0.05***	0.01
Social Support					**-0.10*** **	0.01
Social Strain					**0.13*** **	0.01
Support*Strain					<0.01	0.01
Support*Time					**-0.01**	<0.01
Strain*Time					<0.01	<0.01
Support*Strain*Time					<0.01	<0.01

Table 7

Changes in Self-Rated Loneliness Over Time as Predicted by Social Support and Strain (Continued)

Effect	Model 1		Model 2		Model 3	
	Estimate	***SE***	**Estimate**	***SE***	**Estimate**	***SE***
Random Effects						
Residual	0.97***	0.03	0.92***	0.03	0.45***	0.01
Var (Intercept)	1.07***	0.04	0.90***	0.04	0.56***	0.02
Var (Time)	<0.01	<0.01	<0.01*	<0.01	<0.01	<0.01
Model Fit						
-2 Log Likelihood	18711.57		17568.58		16196.53	
AIC	18721.57		17614.58		16254.53	
BIC	18754.68		17765.95		16443.50	
# of Parameters	5		23		29	

Note. All *p*-values in this table are two-tailed. The covariance structure for random effects was diagonal.

[a]Reference = Female; [b]Reference = White; [c]Reference = Non-Hispanic; [d]Reference = Married/Living with Partner; [e]Reference = < High School; [f]Reference = 0; [g]Reference = 0; [h]Reference = Non-Dropouts.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

4.2.3. Happiness

The final series of models was for self-rated happiness. There was a significant increase over time in self-rated happiness, albeit with another small parameter estimate. Analysis proceeded to the conditional models. Variance for residual, intercept, and slope were all significant. Model 2 showed better fit than Model 1, $\chi 2(18) = 1487$, $p < 0.05$, and Model 3

showed improved fit over Model 2, $\chi 2(6) = 1551$, $p < 0.05$. Both social support and social strain had significant main effects in the happiness model. Social support predicted higher levels of happiness, and social strain predicted greater unhappiness. However, there were no significant interactions between social factors and time, or between social support and social strain.

In Model 3, covariates that were associated with greater happiness were male sex, being married, higher education, more friends, and being a non-dropout. Significant interactions included age*time, sex*time, marital status*time, and close family relationships*time. Older age, female sex, married status, and having fewer close family members were associated with increases in unhappiness over time.

Table 8

Changes in Self-Rated Happiness Over Time as Predicted by Social Support and Strain

Effect	Model 1		Model 2		Model 3	
	Estimate	***SE***	**Estimate**	***SE***	**Estimate**	***SE***
Intercept	2.41***	0.02	2.87***	0.07	2.77***	0.07
Time	0.01***	<0.01	0.03**	0.01	0.02*	0.01
Age			<-0.01	<0.01	<-0.01	<0.01
Sex[a]			-0.07*	0.03	-0.09**	0.03
Race[b]			-0.04	0.04	-0.07	0.04
Ethnicity[c]			-0.07	0.05	-0.09	0.05
Marital Status[d]			0.29***	0.03	0.19***	0.05
Education[e]			-0.07***	0.02	-0.07***	0.02
# Close Family[f]			-0.05***	0.02	-0.02	0.02
# Friends[g]			-0.10***	0.01	-0.07***	0.01
Attrition[h]			0.10**	0.03	0.07*	0.03
Age*Time			<0.01*	<0.01	<0.01*	<0.01
Sex*Time			-0.01*	0.01	-0.01*	0.01
Race*Time			-0.01	0.01	-0.01	0.01
Ethnicity*Time			<0.01	0.01	-0.01	0.01
Marital Stat*Time			-0.02***	0.01	-0.02**	0.01
Education*Time			<0.01	<0.01	<0.01	<0.01
# Family*Time			<-0.01*	<0.01	-0.01*	<0.01
# Friends*Time			<0.01	<0.01	<0.01	<0.01
Attrition*Time			-0.01	0.01	-0.01	0.01
Social Support					**-0.06*** **	0.01
Social Strain					**0.06*** **	<0.01
Support*Strain					<-0.01	0.01
Support*Time					<-0.01	<0.01
Strain*Time					<0.01	<0.01
Support*Strain*Time					<0.01	<0.01

Table 8

Changes in Self-Rated Happiness Over Time as Predicted by Social Support and Strain (Continued)

Effect	Model 1		Model 2		Model 3	
	Estimate	***SE***	**Estimate**	***SE***	**Estimate**	***SE***
Random Effects						
Residual	0.40***	0.01	0.39***	0.01	0.39***	0.01
Var (Intercept)	0.35***	0.02	0.30***	0.01	0.27***	0.01
Var (Time)	<0.01**	<0.01	<0.01***	<0.01	<0.01*	<0.01
Model Fit						
-2 Log Likelihood	16592.38		15105.50		13553.97	
AIC	16602.38		15151.50		13611.97	
BIC	16636.53		15306.94		13805.39	
# of Parameters	5		23		29	

Note. All *p*-values in this table are two-tailed. The covariance structure for random effects was diagonal.

[a]Reference = Female; [b]Reference = White; [c]Reference = Non-Hispanic; [d]Reference = Married/Living with Partner; [e]Reference = < High School; [f]Reference = 0; [g]Reference = 0; [h]Reference = Non-Dropouts.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

5. DISCUSSION

5.1. Summary of Results and Implications

When interpreting the findings of the current study, the research questions should be considered first. The first research question asked what individual main effects social support and social strain had on different physical and mental health indicators. The second question asked whether social support and strain predicted changes in health over time. Finally, the third question asked whether there were significant moderation (or interaction) effects between social support and social strain which predicted changes in health. The covariates included in these models were not included in any particular research question, but some significant interactions between other covariates and time may warrant discussion as well.

5.1.1. Main Effects of Social Support

Significant main effects of social support (that is, where differences in social support predicted the outcome intercept, but not slope) were found in the self-rated physical health model, the negative affect model, the loneliness model, and the happiness model. However, significant main effects of social support were not found in the comorbidities or ADL difficulty models. That is, social support had a significant main effect on each of the mental health outcomes studied as well as self-rated physical health, but not the other two physical health outcomes.

In general, these main effects were associated with better health. For the self-rated physical health model, increased social support predicted higher self-ratings of physical health. Increased social support also predicted lower negative affect, lower levels of loneliness, and higher levels of self-rated happiness.

These effects are partially consistent with the hypotheses (see section 1). Social support was expected to be associated with better health outcomes in general. For four of the outcomes, this was the case; however, for the other two, no association was found.

These outcomes are also only partially consistent with the existing body of literature. They are inconsistent with previous literature where social support *was* associated with physical health (e.g., Sbarra, 2009; Liu, Waite, & Shen, 2014). However, this literature has been relatively inconsistent within itself, and much of the research on social support and health does focus on mental health (see section 2.3). It is possible that the strongest protective effects of social support are present in mental health outcomes, rather than physical health outcomes.

Although associations between social support and physical health were limited, the mental health of older adults is still important, and promoting the mental health of older adults is still a key component of healthcare and aging services practice. Older adults' self-ratings of their physical health are also important. As for self-rated physical health, believing oneself to be in good (or at least acceptable) physical health for one's age may also be helpful in reducing self-stigmatization and stress. As self-rated physical health and all the mental health outcomes studied were associated with social support, it may be helpful for healthcare and aging services professionals (including formal caregivers), as well as informal caregivers and other people in older adults' social networks, to focus on being as supportive as possible.

5.1.2. Main Effects of Social Strain

Significant main effects of social strain were found in the negative affect model, the loneliness model, and the happiness model. These effects were not found in the comorbidities, ADL difficulties, or self-rated physical health models. That is, social strain had a significant

main effect on each of the mental health outcomes studied, but none of the physical health outcomes studied.

Like the social support main effects, these effects were only partially consistent with the hypotheses, as they only applied to mental health outcomes. However, these effects were also consistent with Wilkinson and colleagues' (2023) work with the Health and Retirement Study, wherein social strain did not influence older adults' physical health but did negatively affect their mental health. Also consistent with the current study's hypotheses and with the Wilkinson et al. study (2023) is that in all three of these models, more social strain was associated with worse mental health: a higher combined HADS & PSS score (i.e. negative affect), more loneliness, and less happiness.

As with social support (section 5.1.1), these results are also only partially consistent with other literature. Several existing studies describe associations between social strain and disease morbidity (e.g., Hendryx et al., 2020; Kershaw et al., 2014, Wang et al, 2021); however, the current study did not find any association between *co*morbidity and social strain. The reason for this discrepancy is unclear. Perhaps it is simply related to the difference in studying morbidity (the prevalence of one condition, which each of the aforementioned studies do) rather than comorbidity (the co-existence of multiple conditions). Another possibility is that there is some sex difference involved; Hendryx (2020) and Kershaw (2014) and their respective colleagues studied health outcomes in women specifically. Sex as a covariate was significant in some, but not all, of the current study's models as well; however, these models do not line up neatly with those in which the effect of social strain was significant.

The implications of these outcomes for practice are similar to those for social support. Because the promotion of older adults' mental health is part of a holistic approach to improving

overall health and well-being, individuals who frequently interact with older adults have a responsibility to limit strain in their interactions.

Ultimately, although social support and social strain are individually associated with slightly different groups of health outcomes, aging services and healthcare professionals should strive to promote both physical and mental health for the older adults they serve. The same is true for family and spousal caregivers, family members who do not care for their older relatives but still socially interact with them, and friends. Thus, a dual focus on promoting social support and limiting social strain may be helpful, even if the main effects are more prevalent in mental health outcomes.

5.1.3. Social Factors and Health Changes Over Time

There were two interactions between social factors and time. These effects were seen above and beyond controlling for socially relevant covariates. These results were consistent with the second hypothesis that social factors would moderate health trajectories over time, although their effects were small.

The existence of some interactions between social factors and time are also consistent with the work of Scholes and Liao (2022), who found that changes in health, in their case cognitive health, could be moderated by time. Yet the limited amount of other research on time-moderated social factors suggests a picture that is more consistent with the current study: time and social factors do not interact with each other in influencing all health outcomes; in fact, such relationships are probably uncommon. Still, those that were found in the current study may be investigated.

There was a significant interaction between support and time in loneliness, suggesting that social support can affect the trajectory of change in loneliness. Higher levels of social

support were associated with a faster decline in feelings of loneliness over time. The reason why is probably self-evident; those who feel more supported are likely to feel less lonely. However, this also lends an additional consideration to how social support should be included in practice. If those who feel more supported experience more decrease in feelings of loneliness over time, it is important to exhibit strong support in relationships starting as early as possible. Of course, the well-being of the supporter also needs to be considered, and every situation will be different. However, as socioemotional selectivity theory suggests, building supportive relationships is one way to help those relationships endure.

There was also a significant interaction between strain and time in ADL difficulty. Higher levels of social strain were associated with a slower increase in ADL difficulty. This is an interesting finding because the direction is opposite to what is expected. Previous literature has shown a negative connection between social strain and health (see section 2.2), yet this finding suggests that social strain may lessen the rate at which older adults develop difficulties completing ADLs. Effectively, social strain acts as a buffer to help maintain better health in this case. One possible reason for this is the way strain was measured. The measures of strain ask about feeling criticized and unable to meet demands, but with those feelings might come pressure to perform, whether to meet demands or avoid criticism. That pressure may lead to more effort being put towards maintaining ADL abilities, and thus, a slower rate of difficulty development.

What this interaction means for practice is uncertain because the reason for it is also uncertain. However, individuals who are in social relationships with older adults where strain is likely to be perceived by the older adult might be the best people to determine what it means for

their relationships. For instance, an adult child serving as a caregiver might need to take a different approach from a spouse (even if serving in the same role).

Due to the small effect sizes for these interactions, applicability may be limited. However, they may still be meaningful, because moderation effects and interactions often have small effect sizes and are difficult to detect in non-experimental research (McClelland & Judd, 1993). Thus, individuals who are in close social relationships with older adults, especially family and spousal caregivers, are urged to examine their own relationships and determine the best approach to promoting the health of their older adult companions.

5.1.4. Social Support and Strain Moderation Effects

While some interaction between social support and strain was expected, the current study found no moderation or interaction between social support and social strain for any of the outcomes, nor were there support-by-strain-by-time interactions for any of the outcomes. Thus, the current study's hypothesis relating to an interaction between social support and strain was not supported, and no directional relationship or ranking was determined among supportive, ambivalent, indifferent, and aversive relationships. While studying social support and social strain side-by-side may be useful in some situations, they are not inseparable, nor necessarily parts of the same scale. There may be justification for studying the interplay between social support and strain further, perhaps for other outcomes, or in a time-invariant model. However, the results of the current study suggest that it may be more useful to focus on other covariates or on modulations in social factors over time.

5.1.5. Covariates Over Time

A few of the other covariates included in the models had significant interactions with (i.e. were moderated by) time. Most of the covariates were included simply to make sure the effects

of social support and strain accounted for them, and these moderation effects were small. Additionally, the interaction between covariates and time was not related to the current study's research questions, so this discussion will be kept brief. Only a few of these relationships will be discussed here; however, investigating these moderators (and the possible reasons for them) may be a topic for future research. This might be done with the NSHAP or with another large dataset, or it might be done with multiple datasets as part of a meta-analysis. Two covariates will be discussed here: marital status and Hispanic ethnicity.

In the loneliness and happiness models, time interacted significantly with marital status. This covariate interaction is of note because in both models, unmarried status was related to a better trajectory of change in health: Individuals without partners showed, on average, a faster decrease in loneliness and increase in happiness over time. It is possible that this difference is due to some of those *with* a spouse or partner losing their partner over time and having difficulty adjusting, while those without a spouse or partner did not have to make this adjustment (or had already made it earlier in their life).

The other interaction was of time and Hispanic ethnicity. This appeared only in the comorbidity model, and is of note because it may demonstrate the concept of cumulative disadvantage. Individuals who were Hispanic showed a slightly faster increase in number of comorbid conditions over time. This is consistent with other research in which minority, including Hispanic, older adults are more likely to be diagnosed with chronic conditions (e.g., Odlum et al., 2020). The current study's results suggest, however, that rather than Hispanic older adults being simply more likely to be diagnosed, they may be likely to be diagnosed with *more* chronic conditions in a shorter time period. This pattern is not directly related to the current

study's research questions, but may be interesting to those looking to study the intersection of ethnicity, culture, and community as they relate to social relationships and health.

5.2. Limitations

A major limitation of the current study is the use of a pre-existing large dataset. While such datasets are a convenient way to study a large sample of older adults, researchers are required to work with data already available. The research questions that can be answered from this data are similarly dependent on what has already been collected, especially when conducting longitudinal research.

In the case of the NSHAP data, many of the available variables are self-reported. This is especially true for those available across all three waves; the self-report variables included among the outcomes were chosen because of their availability across waves, but a more fully objective measure would have been preferable. In addition to the outcomes, the social support and social strain measures were self-reported.

Aside from the limitations of self-reported data, there is a limitation in operationalizing data on something as expansive as social support or social strain. Data on these items was gathered by referring to participants' "friends," "family members," and "spouse or partner." However, participants likely have many friends and family members, and some may not have a spouse or partner at every time point, or may have a different spouse or partner at different time points. The structure of these questions cannot adequately represent the depth nor breadth of human relationships. There is a supplementary dataset available within the NSHAP which includes more information on participants' social networks (see Cornwell et al., 2009). However, this dataset is restricted access; it can be accessed only by members of partner institutions to the University of Chicago, where the NSHAP data is collected. The current study was conducted

outside of those institutions; a collaboration with a University of Chicago or partner researcher is a possibility for future research.

The NSHAP data also leans slightly more heavily female than male. This is a common and known problem in social science research, as women are more likely to volunteer for studies than men. However, it still deserves acknowledgment.

The operationalization of other physical health variables is also a limitation. Physical health may not be well represented by such a small collection of comorbidities or ADLs, or by considering "number of comorbid conditions" or "amount of total ADL difficulties" as single variables. However, the MLM design requires a single outcome for each model, and requires those outcomes to be available across waves as well.

Research focusing on ADLs specifically could consider these at a more granular level, investigating effects on different ADLs one at a time, or could use a different methodological approach. An approach other than MLM could also incorporate measures of physical health or functioning that were not measured at all three timepoints, including instrumental activities of daily living (IADLs), which were added in later waves.

Finally, relating to the MLM approach, the small number of timepoints is a major limitation of the current study. MLM requires data from three timepoints as a bare minimum, but more data is better, including more timepoints. Unfortunately, in gerontology research, it is difficult to collect data across many timepoints for the same participants, especially when those timepoints are spaced years apart. Gerontology focuses on later life, and death is a part of this picture, as is poor health. This is the most important reason to conduct an analysis of attrition (considered in the current study as the "attrition" variable). Attrition itself was not the focus of

the current study, but supplementary data to the NSHAP include some data on why participants could not be interviewed in later waves, for interested researchers (Waite et al., 2005-2021).

5.3. Future Research

A few directions might be taken for future research. Such research might continue to use the NSHAP data, delve deeper into social factor data from other sources, or add to the literature of non-longitudinal research on social support and strain.

In using the NSHAP data to investigate social factors, as well as take a broader look at the structure of participants' social networks, it may be useful to consider some other variables. Possible variables of interest include measures of how often a participant has socialized with others, volunteered, or attended religious services in the past year. Some information available in the restricted NSHAP datasets includes how much social support a person *gives*, not just how much they *receive* (see Hawkley et al., 2021 for a description). Finally, existing variables may also be considered at different levels of granularity. For instance, is there a difference between older adults who are married and those who are not married but cohabiting with a partner? In the current study, these were coded together, but in a future exploration, these may be investigated more specifically.

There is also more research to be done as more waves are collected, although the size of the sample returning from baseline will continue to decrease wave by wave as some participants die and others do not return for other reasons. Integrating attrition more closely with the research questions may produce interesting and useful results.

In future MLM models, social factors could be considered in interaction with demographic ones, although a research basis would certainly need to be established. This may help in understanding unexpected results, such as the covariate-by-time interactions that were

found (see section 5.1.5). The effects of culture may tie to both social factors and demographic factors, especially race and ethnicity. Given that the NSHAP is mostly made up of White participants, however, it may not be the best data to use for this direction in research. A study that either focuses on non-White participants, or one that makes an effort to be as representative as possible of the total population of a state, region, or the entire United States, would be more suited.

As mentioned in the discussion of covariates over time (section 5.1.5), it may also be useful and interesting to focus on how time moderates the effects of various demographic and other factors on health. Not included in the current study for the sake of time, but included in some trial models, were variables about participants' sensory capabilities, specifically eyesight and hearing. How changes in these affect health and perception of health over time may be an interesting direction to take; it was simply too different from the current study and the chosen research questions.

Ultimately, the deciding factor in what future research to pursue remains what is helpful and useful in promoting the health, happiness, and well-being of older adults. In the case of the current study, the path forward may be focusing more specifically on the ways and situations in which social factors are moderated by time, but the NSHAP data is full of other possibilities to explore in the future.

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