

Pain and Suicide in a Population-Based Sample

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ABSTRACT

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Previous research suggests that individuals who experience chronic pain are at increased risk for suicidal behaviors. No studies, however, have specifically examined the association between headaches and fatal suicide behavior. Furthermore, it remains unclear whether gender moderates the relation between pain and suicide, and whether the relation is independent of the effects of depression. The present study aimed to characterize the relation between pain (headache, back, shoulder, and neck) and suicide. Data were obtained from two sources in the Swedish Twin Registry. A total of 42,928 individuals responded to headache questions in either 1967 or 1973 for the first data source. The second data source, which began in 1998, consisted of data from 40,912 individuals who responded to questions assessing for back, shoulder and neck pain along with 24,987 individuals who responded to headache questions. Survival analysis using Poisson regression was used to estimate the risk of suicide associated with pain variables. Analyses indicated that women who experienced headaches were two times more likely to die by suicide than women who did not experience headaches. Additionally, men who reported pain were almost four times more likely to die by suicide than men who did not report pain, even after controlling for depressive symptoms. The findings, obtained in one of the largest studies examining pain and prediction of suicide in a population-based sample, support that pain (including headaches) is associated with suicide, and suggest that gender may be an important moderator in the relation between pain and suicide.

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Pain and Suicide in a Population-Based Sample

Suicide is a nationally significant problem. In 2006, suicide was the 11th leading cause of death in the United States (Heron et al., 2009). Although suicide may be caused by many factors, examining the possible pathways to suicidal behaviors is critical in the identification of possible risk factors. The knowledge of these factors may aid in a more complete understanding of suicidal behaviors. With this understanding, identifiable risk factors may be used to help tailor treatments for individuals who may be at increased risk for suicidal behaviors.

Individuals who experience chronic pain may be particularly at risk for suicide (Fishbain, 1999; Tang & Crane, 2006). Research suggests that individuals who experience chronic pain are at least two times more likely than individuals who do not experience chronic pain to have suicidal ideation, nonfatal suicidal behaviors and fatal suicidal behaviors (Fishbain; Tang & Crane). This study seeks to extend the literature by examining the relation between chronic pain conditions (i.e., headaches, back, neck, and shoulder pain) and fatal suicidal behavior in a population-based sample.

The interpersonal theory of suicide provides one explanation as to why individuals who experience chronic pain may be more likely than individuals who do not experience chronic pain to die by suicide. According to the interpersonal theory of suicide, one of the dominant theories on suicidal behavior, an individual will not engage in suicidal behavior unless he or she has both the desire to die by suicide and the ability to do so (Joiner, 2005). This theory argues that there are three necessary factors that interact when determining whether an individual has both the desire and the capacity to die by suicide. These factors include perceived burdensomeness, thwarted belongingness, and the acquired capability to inflict self-injury (Joiner).

Perceived burdensomeness and thwarted belongingness, the two factors that are theorized to contribute to an individual's desire to die by suicide, increase levels of emotional pain. Individuals who characterize their life as being a burden on others feel that their death is worth more than their life to people who care about them. Their existence is perceived to be a liability to the ones they love because they feel as though they are an extra load that needs to be carried by others (Van Orden, Merrill, & Joiner, 2005). Another precursor to suicidal behaviors, according to this theory, is the alienation and social isolation that derives from thwarted belongingness. In fact, suicidal behaviors may be among the many negative outcomes of the unmet need to belong (Van Orden et al.).

According to Joiner and the interpersonal theory of suicide, perceived burdensomeness and thwarted belongingness contribute to the desire to die by suicide. However, one must also develop the ability to inflict self injury before fatal suicidal behavior is possible. One direct way an individual may acquire this capacity is through suicidal attempts and self-injurious behaviors. The repeated practice and exposure to attempts and injurious behaviors may habituate an individual to pain (Joiner, et al., 2005). Consequently an individual may become fearless as a result of habituating to situations that would normally arouse fear (e.g., threat of bodily injury). Over time, these bodily experiences increase one's tolerance of pain.

Habituation can occur through indirect mechanisms, as well. For example, Joiner suggests that physicians and medical trainees are at an increased risk for suicide because their occupation involves repeated exposure to pain and death (Cornette, deRoos-Cassini, Fosco, Holloway, Clark, & Joiner, 2009). Joiner's model may also explain why individuals with anorexia nervosa often die by suicide. For example, it was found that anorexic individuals chose highly lethal means when committing suicide (Holm-Denoma et al., 2008). The altered bodily

experiences that the individual with anorexia endures over the course of his/her disorder (i.e., self-starvation behaviors) are theorized to act as the habituating mechanism to pain and fear.

Individuals suffering from migraines often report that the pain they experience has direct consequences on their life. It impairs their quality of life and often disrupts the relationships they have with others (Jette, Patten, Williams, Becker, & Wiebe, 2007; Linde & Dahlöf, 2004). Social withdrawal often occurs as the individual begins restricting many of his or her daily activities, affecting their occupational, social and family relationships (Edmeads, 1993; Jette et al.; Linde & Dahlöf; Lipton, Diamond, Reed, Diamond, & Stewart, 2001). In addition to the emotional consequences of chronic pain, having migraines also involves the accumulation of many pain experiences over the lifetime. Because of the emotional pain endured in chronic pain conditions (i.e., thwarted belongingness and increased burdensomeness), individuals with chronic pain may be at greater risk for suicidal ideation. This thesis proposes that pain experiences will be associated with increased risk for suicide, and that this risk will be due, in part, to the habituation to pain that develops through repeated painful episodes.

Chronic Pain and Suicidal Behaviors

The association between chronic pain conditions and suicidal behaviors has been assessed in a variety of ways. In general, studies have found that suicide may be common in certain illnesses, especially those that involve mild or severe pain. Research has also examined the associations among suicide ideation, nonfatal suicidal behavior and fatal suicidal behavior in individuals who experience chronic pain. Finally, a subset of these studies has specifically assessed for the possible impact headaches have on suicidal ideation and suicidal attempts. Following the reviews on chronic pain, the research demonstrating an association between

headaches and suicidal behaviors will be presented. Studies examining suicidal ideation will be addressed first, followed by studies examining suicidal attempts and fatal suicide.

Researchers have investigated the association chronic pain may have with current suicidal ideation. Smith, Edwards, Robinson and Dworkin (2004) examined suicidal ideation in adult chronic pain patients drawn from a tertiary care pain center and found that 19% of the sample reported passive suicidal ideation and 13% reported active suicidal ideation over the past two weeks. Querying about lifetime ideation, the authors found that 20.3% of the sample had a history of a plan to end life. In another study, Hitchcock, Ferrell, and McCaffery (1994) found that an alarming rate of 50% of chronic pain patients report having seriously considered suicide because of pain. Examining geriatric psychiatry inpatients, Meeks et al. (2008) investigated the relation between chronic pain and suicidal ideation among depressed older adults. The researchers found that depressed older adults with chronic pain were significantly more likely than depressed older adults without chronic pain to report suicidal ideation (Meeks et al.). The presence of chronic pain was associated with having over a two times higher odds of having suicidal ideation (Meeks et al.). Using a larger study with a broader age range, and including an important predictor of suicidal behavior, Karp et al. (2005) found that even after controlling for depression, patients with pain reported more suicidal ideation.

Several studies have found an association between nonfatal suicidal behaviors and chronic pain as well. In the previously mentioned study by Smith et al. (2004), the researchers also found that 5.3% of the adult sample of chronic pain patients had a lifetime history of suicidal attempts (Smith et al.). Even if suicidal behavior does not have a fatal outcome, it appears that chronic pain patients may have higher suicidal intent than other self-harm patients (Theodoulou, Harriss, Hawton, & Bass, 2005). A study analyzing data from the National

Comorbidity Survey Replication, found that chronic back and neck problems were associated with lifetime and 12-month suicide plans and attempts (Braden & Sullivan, 2008). However, after adjusting for lifetime mood, anxiety and substance use disorders, chronic back and neck problems were no longer significantly associated with lifetime suicidal plans, suggesting that psychiatric comorbidities may mediate this relation.

When comparing suicide rates for chronic pain patients to suicide rates of the general population, Fishbain, Goldberg, Rosomoff, and Rosomoff (1991) found that the rates of chronic pain suicide were significantly greater than suicide rates of the general population. Using a psychological autopsy study, Rowe, Bruce, and Conwell (2006) found chronic pain to be one of the correlates of suicide among home health care utilizers. Researchers have also used qualitative analyses of suicide notes to better understand the possible variables associated with a patient's death by suicide. When examining a large sample of suicide notes in an Australian study, Lester, Wood, Williams and Haines (2004) found that older adults were more likely than younger adults to be motivated by escape from pain.

In a population-based case-control study examining risk factors for suicide in rural south India, Manoranjitham and colleagues (2010) found that chronic pain heightened the risk of suicide, with an estimated odds ratio of 17.5 (95% CI: 2.3-135.0). Similarly, in a population-based, prospective cohort study in Japan, Kikuchi et al. (2009) found that men reporting pain were at increased risk of dying by suicide when compared to men who did not report pain. Multivariate hazard ratios indicated that increasing pain levels (i.e., mild, moderate or severe pain) were associated with increased risk. In a study of 4,199 Finnish male farmers, Penttinen (1995) reported that within a 10 year follow-up, Finish male farmers who reported back pain were at nine times greater risk (after controlling for age) of dying by suicide than male farmers

who did not report back pain at initial interview. Miller et al. (2008) also found that older adult healthcare utilizers who died by suicide were more likely to report painful back and neck conditions relative to individuals who did not die by suicide.

Studies also suggest that pain may be related to suicide even after controlling for physical illness. To determine the association between specific diseases and suicide, Juurlink, Herrmann, Szalai, Kopp, and Redelmeier (2004) explored the relation between medical illnesses and risk of suicide in elderly patients. After controlling for other psychiatric conditions and physical illnesses, severe pain was found to be an independent predictor that increased risk for suicide (Juurlink et al.). Moderate pain was found to have a smaller effect size in both univariate and multivariate models but still a significant risk factor for suicide (Juurlink et al.). Harwood and colleagues (2006) found that pain was one of the most common identifiable symptoms contributing in suicide events. In this study, pain contributed to an individual's suicide in about one fourth of the suicide cases.

Other studies, however, have found no association between pain conditions and suicide. For example, in a study of Swedish suicide cases, Stensman and Sundqvist-Stensman (1988) found no association between what the authors described as "chronic benign pain" (including low back pain and rheumatoid arthritis) and suicide. Additionally, in a retrospective case-control study comparing 86 people over the age of 50 who died by suicide with a comparison group of 86 community dwelling participants, Conwell et al. (2010) found no association between pain reported in the last four weeks and suicide. Although most studies suggest that individuals who experience chronic pain are at greater risk of suicide, not all studies find this outcome.

Research has identified an increased risk of suicidal behaviors in individuals who experience pain conditions. However, assessing all chronic pain conditions together may be

masking critical differences that distinguish chronic pain conditions. For example, there may be types of chronic pain that are more strongly associated with suicidal behaviors that are driving the relations reported in the chronic pain literature. Additionally, no studies were found that examined the possible moderating role sex may play in the association between pain and suicide. The following section reviews the literature that pertains specifically to headaches and suicidal behavior.

Headaches

The International Classification of Headache Disorders (ICHD) (IHS, 2010) provides a framework for headache symptom classification. These classification hierarchies underwent changes in 2004. There are three major types of primary headache syndromes: Migraine, tension, and cluster. Migraine headaches are typically thought of as severe, throbbing, unilateral headaches that usually last for several hours and can at times last for a period of several days (Davenport, 2008). Seen as less disabling, tension headaches are usually mild to moderate in intensity, bilateral and non-pulsatile in nature (Davenport). In contrast, cluster headaches consist of episodic attacks that are comprised of very severe unilateral pain which typically centers over one orbital region (Davenport). Migraine sufferers generally report more severe pain than tension-type sufferers (Rasmussen, 1995).

Rasmussen and Olesen (1994) estimate that 25% to 50% of the population will suffer from recurrent primary migraine or tension headaches at some point during their lifetime, whereas cluster headaches appear to be much less common in the population (Swanson et al., 1994). Studies have found similar prevalence estimates of migraine cross-culturally. For example, in 1999, four European and four American studies found the one-year prevalence of migraine to be between 10-12% (Dahlöf & Linde, 2001; Rasmussen, 1999; Rasmussen &

Stewart, 2000). In Sweden, depending on the level of International Headache Society (IHS) criteria used, the lifetime prevalence of migraine headaches falls between 10.3% to 23.5% (Svensson, Waldenlind, Ekbom, & Pederson, 2004). Similarly, Dahlöf and Linde found that 21% of the Swedish population suffered from severe headaches and 61% of these sufferers met IHS criteria for migraine. From these results, the one-year prevalence of migraine in Sweden was found to be $13.2 \pm 1.9\%$ (Dahlöf & Linde).

Research has shown that migraines effect an individual's quality of life both during an attack and between attacks (Brandes, 2007; Linde & Dahlöf, 2004). This disruption in one's normal daily functioning affects the individual, the family, and social life (Brandes). Areas of concern to a person suffering from migraines include the unpredictable nature of attacks, inability to pursue educational opportunities, and effects on personal finances due to lost wages and medical costs (Linde & Dahlöf). These quality of life issues may be important determinants in the association between psychiatric comorbidities, like depression and anxiety, and migraines.

Psychiatric Comorbidity in Migraine

For quite some time, physicians and researchers have clinically observed a relation between migraine and affective disorder symptomology (Radat & Swendsen, 2004). Since then, several studies have sought to identify the relation between migraines and psychiatric comorbidity. Radat and Swendsen reviewed the migraine literature to synthesize information on the possible connection between migraines and psychiatric comorbidity. All studies included in the review used IHS criteria to diagnose migraine. Psychiatric diagnoses were based on the Diagnostic and Statistical Manual of Mental Disorders. The association between psychiatric disorders and migraine was examined both in general population and clinic-drawn samples.

Clinic-drawn samples comparing migraines with other types of headaches found no differences in the prevalence of psychiatric comorbidity between migraine and tension headache (Radat & Swendsen). Research indicates, however, that individuals who experience headaches chronically may be at a greater risk for anxiety and depression than are patients who only experience episodic or time-limited headaches (Radat & Swendsen; Verri, Progetti, Galli, Sandrini, & Nappi, 1998).

Radat and Swendsen (2004) reviewed a total of nine community-drawn sample studies that assessed the relation between migraine and psychiatric disorders. Patients with migraines were at increased risk for anxiety disorders, particularly panic disorders and phobias, when compared to non-migraine patients (Radat & Swendsen). The literature suggests that migraine patients may be three to six times more likely to suffer from panic disorder (Radat & Swendsen). Results from a recent nation-wide population study in France also confirm that anxiety and depression frequently occur together in migraine patients (Lantéri-Minet, Radat, Chautard, & Lucas, 2005).

Similarly, investigations of mood disorders have also been consistent in finding an increased prevalence of major depressive disorder (MDD) in patients with migraine (Radat & Swendsen, 2004). Odds ratios for major depression indicate that patients with migraines may be about three to four times more likely to suffer from MDD than non-migraine patients (Radat & Swendsen). In fact, the presence of chronic pain, especially headaches and backaches, has been found to increase the duration of a depressive episode (Ohayon & Schatzberg, 2003; Karp et al., 2005). Additionally, the incidence of migraine and depression have both been found to significantly decrease a patient's health-related quality of life (Lipton, Hamelsky, Kolodner, Steiner & Stewart, 2000).

It is difficult to assess the etiological mechanism underlying migraine psychiatric comorbidity. For example, Breslau et al. (2000) found that patients with migraine and patients with depression were both three times more likely to suffer from depression and migraine respectively. The mechanism of comorbidity might be explained by chance, shared environmental risks, or common biology underlying both conditions (Jelinski, Magnusson, & Becker, 2007; Sheftell & Atlast, 2002). These factors may be further explained by the role of learned helplessness (Seligman, 1975). Migraine attacks are often unpredictable and at times uncontrollable, which would serve to reinforce the belief that action is futile. This learned helplessness state, then, could lead to increased levels of depression and anxiety for the patient. Research has found that migraine patients who suffer from depression and/or anxiety also have lower perceived efficacy of acute treatment for their migraine symptoms (Lantéri-Minet, Radat, Chautard, & Lucas, 2005). It is especially relevant that depression and anxiety are associated with migraines because both depression and anxiety (e.g., panic disorder) have been linked to suicidal behavior (Cavanagh, Carson, Sharpe, & Lawrie, 2003).

Migraine and Suicidal Behaviors

Several studies have found an increased risk of suicidal behaviors in headache patients by utilizing different methodological designs. Using a cross-sectional study, Ratcliffe, Enns, Belik, and Sareen (2008) found that the presence of one or more chronic pain conditions (conditions identified were migraine, back problems, arthritis and fibromyalgia) was uniquely associated with retrospective reporting of 12 month suicidal ideation and suicidal attempts even after adjusting for psychiatric conditions in a large, nationally representative sample of Canadians aged 15 years and above. To measure suicide ideation, respondents were asked if they had seriously thought about committing suicide or taking their own life over the past year. In this

study, after adjusting for the other chronic pain conditions, there remained a strong positive association between migraine and suicidal ideation and attempt.

Seeking to control for other factors that may have been relevant in this study (e.g., commonly co-occurring medical conditions), Ilgen, Zivin, McCammon, and Valenstein (2008), examined four measures of pain and 12 month suicidal thoughts, plans and attempts in a nationally representative sample of US households ages 18 and up. Using data from the National Comorbidity Survey Replication (NCS-R), suicidal ideation was assessed using similar questions to the Ratcliffe et al. (2008) study: “Have you ever seriously thought about committing suicide,” “Have you ever made a plan for committing suicide,” and “Have you ever attempted suicide?” Respondents who endorsed the ideation item were further queried by the plan and attempt questions. The authors found that headaches had the strongest bivariate association with suicidal behavior compared to other chronic pain conditions (including back and neck problems). Chronic headache patients were 4.3 times more likely to have suicidal ideation, 4.6 more likely to have suicidal plans, and 6.5 times more likely to make a suicidal attempt than those without chronic head pain (Ilgen et al.).

These findings were replicated by Breslau (1998) with results from a random population based study of 1007 young adults (ages 21-30). Breslau found increased rates of suicide attempt in migraine patients even after controlling for major depression. Specifically, Breslau found that individuals suffering from migraine with aura had a three times higher increase in suicide attempts, independent of major depression, other psychiatric comorbidity and sex than individuals without migraines. Similarly, Wang et al. (2007) also found that after controlling for anxiety and major depressive disorder, adolescents who reported experiencing migraines with aura were almost eight times more likely to be classified as having current suicidal risk. This

study, however, only assessed for current suicidal risk (i.e., past month) and did not examine possible sex effects. When using data from the National Longitudinal Survey of Children and Youth, Gordon et al. (2004) found that young adolescents who reported frequent (“about once a week”) headaches were 3.6 times more likely to seriously consider suicide.

Utilizing a longitudinal design, Woolley, Fredman, Goethe, Lincoln and Heeren (2008) evaluated the association between headaches and suicidal thoughts and behaviors among respondents of the National Institute of Mental Health’s Epidemiological Catchment Area (ECA) study. For this study, 80.0% of respondents who remained noninstitutionalized completed a follow-up in-person interview one to two years after the ECA study. Suicidal thoughts and behaviors were assessed with three questions that queried respondent’s wish to die, thoughts about committing suicide and previous attempts. In their sample of 6832 adults, severe headaches were associated with suicidal thoughts and behaviors after controlling for psychiatric conditions and relevant demographics (Woolley et al.). Specifically, severe headache pain was found to be an independent risk factor even after controlling for depression, anxiety and the interaction of anxiety and depression (Woolley et al.). Based on the literature which has relied on both cross-sectional and longitudinal designs, chronic headaches, especially migraines, may be associated with increased risk for suicidal ideation and attempts.

Statement of the Problem

Most of the literature examining the relation between chronic pain and suicidal behaviors has found that individuals who experience chronic pain are at greater risk of suicidal ideation, suicidal attempts and fatal suicide when compared to individuals who do not experience chronic pain. Some studies, however, did not find evidence linking chronic pain to fatal suicidal behavior, limiting the ability to make overall conclusions on the relation between chronic pain

and suicide. Additionally, results are mixed as to the extent to which psychiatric disorders may explain the relation between pain and suicidal behaviors. Finally, no studies have assessed for gender moderation of effects.

Several studies suggest that headaches are associated with suicidal ideation and suicidal attempts but no study has examined the relation between migraines and fatal suicidal behaviors. Though examining suicidal ideation and attempts in chronic pain patients is important, there may be a distinct mechanism underlying the relation between chronic pain and suicidal behavior that differs when examining deaths by suicide when compared to ideation and attempts. Additionally, no studies have tested effects of sex on the relation between headaches and suicidal behaviors. The current study will provide one of the largest studies examining pain and prediction of suicide in a population-based, nonclinical sample.

Present Study

The present study aimed to characterize the association between pain and suicide. Based on previous research, we hypothesized that individuals who have experienced headaches or back/shoulder/neck pain would be more likely than individuals who have not reported pain to die by suicide. Furthermore, based on the premise that habituation to pain may increase the risk of suicide, it was hypothesized that pain would be an independent risk factor for death by suicide above and beyond depressive symptoms. Additionally, this study aimed to characterize the association between time since migraine onset and suicide. Based on the premise of habituation in Joiner's (2005) interpersonal theory, we hypothesized that individuals who had experienced migraines over a longer period of time would be more likely to die by suicide than those who had experienced migraines over a shorter period, or those who had not experienced migraines.

Method

Participants and Procedures

Data were obtained through the Swedish Twin Registry (STR) (Lichtenstein et al., 2006). The twin registry originated in 1959 to obtain information concerning multiple births between 1886 and 1925 (Cederlöf, 1966). Questionnaires were sent to all like-sexed twins in 1960-61, 1963 and 1967. In 1970, a new cohort of twins born between 1926-1967 was compiled. In 1973 a questionnaire was mailed to all like-sexed pairs born between 1926-1958. In 1994, opposite sexed twins born between 1906 and 1925 were mailed a questionnaire and respondents were added to the STR. In 1998, an additional study referred to as Screening Across the Lifespan Twin study (SALT) began aiming to contact all twins born before 1958. For the current study, separate sets of analyses were conducted based on the source of data. Information from two STR questionnaires that included relevant measures (1967 and 1973) were combined and analyzed together, whereas data from the SALT interview were analyzed separately.

STR questionnaires. The first data source included information obtained on the 1967 questionnaire (mentioned above) from the cohort of individuals born 1886-1925 (termed “old cohort”). A total of 14,398 individuals responded to study-specific variables (i.e., headache). The second data source included information obtained on the 1973 questionnaire from the cohort of individuals born 1926-1967 (termed “mid cohort”). A total of 28,530 individuals responded to study-specific variables (i.e., headache). Together these two sources included data from 42,928 individuals (54% female and 46% male).

SALT interview. The final data source included one of the many projects based on the STR referred to as the Screening Across the Lifespan Twin study (SALT) (Pedersen, Lichtenstein, & Svedberg, 2002). The SALT study, initiated in 1998, consisted of a telephone

interview aimed at screening all twins born before 1958 for common complex diseases (Pederson, Lichtenstein, & Svedberg). By 2002, the data collection for the entire cohort of twins born 1886 to 1958 was completed (Pederson, Lichtenstein, & Svedberg). This data source included information from 40,912 individuals (54% female and 46% male) who responded to study-specific pain variables (i.e., back, shoulder, neck). After SALT data collection began, the headache interview protocol was altered to better assess for comorbid headaches. A total of 24,957 individuals (74% female and 26% male) responded to study-specific headache variables (i.e., headache) in this redesigned headache interview protocol which was utilized in the current study.

Measures

STR headaches. For the cohort born between 1886 and 1925, participants were asked in 1967 questionnaire if they had "...ever had a migraine (characterized by one-sided headache, nausea, and sensitivity to light)" (Appendix A). For the purpose of this study, an individual was classified as experiencing a headache if they responded affirmatively to the first question, whether or not they had visited a physician. For the cohort born between 1926 and 1958, participants were asked in the 1973 questionnaire if they had "...recurring headaches which have been so severe that you have found it difficult to work" (Appendix A). For the purpose of this study, an individual was classified as experiencing a headache if they responded affirmatively to having experienced headaches, whether or not they experienced visual disturbances or vomiting with these headaches. These two headache questions (from the 1967 and 1973 questionnaires) were combined and analyzed together. Although the specific symptoms mentioned in the questionnaires differed, this approach was used as a way to capture headaches in a general way.

This strategy was deemed appropriate because no study has yet examined the relation between headaches and suicide.

SALT pain. Participants in the SALT study were asked if they had experienced any of the following types of pain: back, neck and shoulder (Appendix B).

SALT headaches. In the SALT study, twins were interviewed with a structured headache questionnaire by trained personnel to assess lifetime recurrent headache as diagnosed by IHS criteria (Appendix C). Participants were asked to report lifetime history of recurrent headache not associated with infection, fever, or hangover. Endorsement of this question was necessary before specific IHS criteria were applied. Migraine diagnosis was assessed by the following IHS criteria: Attacks lasting 4-72 hours with at least two out of four pain characteristics (moderate or severe intensity, unilateral location, pulsation quality, and aggravation by physical activity), and at least one of three accompanying symptoms (nausea, vomiting, and increased sensitivity to light and sound). For the current study, individuals ($n = 86$) who reported that they did not know whether their headaches lasted from 4-72 hours yet met all other IHS criteria for migraine were labeled as meeting IHS migraine diagnostic criteria. The inclusion of these individuals accounted for a relatively small proportion of the number of individuals who met criteria for migraines (.03%) and has been used in previous studies examining headaches in the SALT sample (Svensson, Waldenlind, Ekbom, & Pederson, 2004). To measure migraine age of onset, participants with birth years between 1945-1958 ($n = 1909$) were asked how old they were when they first experienced this type of headache. Information on migraine age of onset was not asked of participants with birth years before 1945. Tension headache diagnosis was assessed by the following IHS criteria: Headaches, which have occurred at least 10 times, lasting from 30 minutes to 7 days, with at least two out of four pain characteristics (bilateral location,

pressing/tightening quality, mild/moderate intensity, and not aggravated by physical activity). Additionally, to receive a diagnosis of tension headaches, an individual must not have experienced nausea or vomiting with their headache and could not have experienced both sensitivity to light and sound. Cluster diagnosis was assessed with the following IHS criteria: Pain that lasts from 15 minutes to 3 hours, severe pain around one eye or temple, pain on same side of head and cluster related symptoms (stuffed up nose, runny nose, teary-eyes, red-eyes, or hanging eye-lids).

In addition to creating IHS diagnoses, headache classification was also made using a broad classification for each type of headache. Individuals who were only missing one portion of the specific headache diagnostic rubric, but met criteria for all other symptoms, were given a broad diagnosis. There were an additional 22 people who met criteria for migraine-broad, 124 for tension-broad, and 26 for cluster-broad.

SALT depressive symptoms. Depressive symptoms were assessed with a modified version of the Iowa form of the Center for Epidemiological Studies-Depression Scale (Appendix D) (CES-D) (Kohout, Berkman, Evans, & Cornoni-Huntley, 1993). This abbreviated version includes 11 of the original 20 items with collapsed response categories, leaving three response options (Iowa 11 x 3). Factor analysis indicated that the Iowa 11 x 3 version maintained the same four-factor solution as the original CES-D (Kohout et al.). Reliability analyses suggested good internal consistency for the short form. For the current study, response choices were not collapsed and included 4 response options: Never or almost never, seldom, often, always or almost always.

Suicide. All participant data were cross-referenced with the Swedish death registry. Linkage to the registry was obtained up to and including 2003. ICD-7, ICD-8 and ICD-9 codes

for suicide as well as undetermined deaths were used to create the dependent variables in this study.

Analyses

Survival analysis is a family of statistical methods specifically designed for analysis of duration data (Wright, 2002). With this analysis, one can estimate the amount of time to the occurrence of an event. This study used Poisson regression analysis, a method based on proportional hazard models that is especially helpful when utilizing a rare event as a dependent variable. Poisson regression analysis was used to estimate the strength of the associations between each set of independent variables and the dependent variable (suicide or suicide and undetermined deaths). Attained age was used for the measurement of time in all analyses. Ages were categorized into the following bands: 15-34 years, 35-64 years, and 65-95 years. For the STR questionnaires, study entry was defined as January 1, 1967 or January 1, 1973 depending on participant cohort. Exit from study was defined as death by suicide, death by another cause, or study end date (December 31, 2003). For the SALT interview, study entry was defined as the SALT interview date. If the salt interview date was missing, March 1, 1998 was used. Exit from study was also defined as death by suicide, death by another cause, or study end date (December 31, 2003).

Age and sex were controlled for in all analyses as described below. In all models, interactions between the independent variable and age were conducted to test whether risk was constant across the entire age range. Additionally, all interactions between each independent variable and sex were run. Models were run separately for men and women when these interactions were significant. To adjust for non-independence of observations (a consequence of including both members of twin pairs), all models were re-run specified to account for the effect

of clustering by twin pair. This adjustment resulted in slight changes to confidence intervals but did not change the significance of any findings for pain-related variables.

Results

STR Questionnaires

Descriptives. A total of 4,209 females (18.3%) and 1,753 males (8.8%) in the STR sample had headaches (Table 1). Specifically, 2,861 individuals (20%) in the 1967 questionnaire reported experiencing headaches and 3,101 individuals (11%) in the 1973 questionnaire reported experiencing headaches. A total of 270 individuals who responded to the 1967 or 1973 questionnaires died by suicide by 2003 (Males: 195, Females: 75) (Table 2). Of the individuals who answered headache questions, a total of 23 females (.10%) who had headaches died by suicide, whereas only 11 males (.06%) who had headaches died by suicide. When using the outcome variable of suicide and undetermined deaths ($n = 340$, Males: 243, Females: 97), a total of 28 females (.12%) who had headaches died by suicide or undetermined cause and 14 males (.07%) who had headaches died by suicide or undetermined cause.

Survival analysis. To determine whether headaches increased the risk of dying by suicide, an overall model testing the effect of headaches, controlling for sex and age, on suicide (or suicide and undetermined) was run on the full sample. In this model, there was a significant interaction of Headache*Sex ($\chi^2(1) = 9.01$, $p < .01$). Due to this significant interaction, all further analyses were conducted separately by sex. In males, headaches did not increase the risk of suicide, $\chi^2(1) = 3.38$, $p = .07$ (Table 3). Additionally, headaches did not increase the risk of suicide or undetermined death, $\chi^2(1) = 3.69$, $p = .05$, IRR: 0.64 (0.37-1.10). In females, headaches did increase the risk of death by suicide, $\chi^2(1) = 5.15$, $p = .02$. This finding held when examining suicide or undetermined deaths, $\chi^2(1) = 5.04$, $p = .02$, IRR: 1.83 (1.17-2.87). Table 3

provides further model estimates, including person years, incident rate ratios and confidence intervals for males and females in the adjusted models.

SALT Interview

Descriptives. A total of 10,714 females (48.6%) and 12,719 males (67.4%) in the SALT sample reported having experienced back, neck, or shoulder pain. Of the individuals who answered pain questions, 3 females (.01%) and 18 males (0.10%) died by suicide and 4 females and 21 males died by suicide or an undetermined cause. Suicides by pain type and gender are included in Table 4.

A total of 2,729 females (20.7%) and 1,127 males (9.5%) in the SALT sample met IHS diagnostic criteria for at least one type of headache. There were 56 suicides in the sample (Males: 44, Females: 12). Of the individuals who met IHS diagnostic criteria for at least one type of headache, 1 female and 1 male who had headaches died by suicide (.04% and .09%, respectively). Including undetermined deaths along with suicide ($n = 71$, Males: 55, Females: 16), there was 1 female and 2 males who had headaches who died by suicide. Suicides by headache type and gender are included in Table 5.

Survival analysis. To determine whether pain (back, shoulder or neck) increased the risk of death by suicide, an overall model testing the effect of pain, controlling for sex, age, and depressive symptoms, on suicide (or suicide and undetermined) was run on the full sample. There was a significant interaction of Ageband*Sex ($p < .05$); suicide risk was higher for women in the 35-64 ageband compared to women in the 65-95 ageband. Pain was associated with increased risk of death by suicide, $\chi^2(1) = 6.48$, $p = .01$, as well as suicide and undetermined deaths, $\chi^2(1) = 5.07$, $p = .02$, IRR: 2.53 (1.01-6.29). Table 6 provides further model estimates, including person years, incident rate ratios and confidence intervals for the adjusted models.

Next, models assessing the relation between pain and suicide, controlling for age and depressive symptoms, were run separately for each sex (interaction between Pain*Sex was non-significant). In males, pain was associated with increased risk for suicide, $\chi^2(1) = 7.03, p = .01$, as well as suicide and undetermined deaths, $\chi^2(1) = 4.64, p = .03$, IRR: 2.62 (0.97-1.23) (Table 6). Follow-up analyses were conducted to explore what type of pain increased the risk of suicide. These analyses indicated that back pain was the only significant predictor of suicide, after controlling for age and depressive symptoms, $\chi^2(1) = 6.57, p = .01$, IRR: 3.61 (1.31-9.92). In females, pain was not associated with increased risk for suicide, $\chi^2(1) = .08, p = .78$, or suicide and undetermined deaths, $\chi^2(1) = .47, p = .49$, IRR: 2.03 (0.21-19.96) (Table 6).

To determine whether headaches increased the risk of death by suicide, an overall model testing the effect of headaches, controlling for sex and age, on suicide (or suicide and undetermined) was run on the full sample. There was a significant interaction of Ageband*Sex ($p < .05$); suicide risk was higher for women in the 35-64 ageband compared to women in the 65-95 ageband. Because the interaction between Headache*Sex was non-significant ($p = .24$) models were tested with men and women combined. Headaches did not increase the risk of death by suicide, $\chi^2(1) = .08, p = .78$, IRR: 1.39 (0.12-15.61), or suicide and undetermined death, $\chi^2(1) = .57, p = .45$, IRR: 2.28 (0.23-22.21). Models adjusting for non-independence of observations did not converge, most likely due to the sparse dependent variable, rendering insufficient power to test the hypothesis. No differences were found when using the IHS broad diagnoses in analyses.

Because there were no individuals who reported migraine age of onset who died by suicide, it was not possible to run a model to assess if duration was a moderator in the relation between headache pain and suicide.

Discussion

The results of this study provide information on the association between pain and suicide. In the 1967 and 1973 questionnaires, women who reported that they experienced headaches were two times more likely to die by suicide than women who did not report headaches. No study has previously examined the association between headaches and suicide; thus, this finding is a new addition to the headache and suicide literature. There was no association between headaches and suicide for men in this sample. Additionally, headaches did not significantly increase the risk for suicide in the SALT sample. Post-hoc power analyses indicated a lack of power for this set of analyses (power = .08). Results of the STR questionnaires suggest that gender may moderate the relation between headaches and suicide. No studies have examined gender as a moderator in the relation between headaches and suicide, which based on this study's findings, may be an important factor to consider as increased risk may disproportionately affect the sexes.

When examining other types of pain, the results of this study indicate that men who report experiencing pain have an almost four times increased risk of dying by suicide, even after controlling for depressive symptoms and age. Women who report experiencing other pain did not have greater risk of suicide, although examination of the estimated incidence rate ratio suggests that women who suffer from pain may have a small increase in suicide risk as the finding was in the expected direction. Again, this finding was not significant due to power issues. Similar to results obtained in headache models, the association between pain (back, shoulder, neck) and suicide may be moderated by gender. Although the interaction between sex and pain was not significant, due to insufficient power, there may be a differential effect for pain and suicide in men when compared to women. The results of this study also suggest that pain is an independent risk factor above and beyond depressive symptoms. The finding that gender may moderate the

relation between pain and suicide and that pain is an independent risk factor for suicide after controlling for depressive symptoms, is an important contributor to the current literature.

By utilizing the Swedish Twin Registry, a strength of this study, we were able to characterize the relation between pain and suicide in a population-based sample. Previous research that has examined pain and suicide has often relied upon selected samples (e.g., inpatient hospitalizations, autopsy studies, treatment-seeking populations) and other forms of suicidal behavior (i.e., suicidal ideation, suicide attempt).

This study has several limitations. A limitation of the STR questionnaires was that headaches were assessed on each questionnaire with one question. Previous studies, however, also have relied upon a single question to assess headache experience (Braden & Sullivan, 2008; Ilgen et al., 2008; Kikuchi et al., 2009; Scott et al., 2010; Wooley et al., 2008). The percentage of the sample that endorsed experiencing headaches was similar to what would be expected based on epidemiological estimates of headache prevalence in Sweden, suggesting that our data are a valid estimate of headache prevalence (Dahlöf & Linde, 2001). It should be noted, however, that the percentage of the sample that endorsed experiencing headaches in the 1967 questionnaire was higher than what might be expected based on these epidemiological studies. The discrepancy between the percentages of the sample reporting headaches in each cohort may be due to the fact that different headache questions were used in each questionnaire, a limitation of the study.

Another limitation of this study was that there was no measurement of pain severity. Previous research, however, has found a relation between even mild and moderate forms of pain and suicide. We cannot make direct inferences on the relation between pain severity and suicide in this study. By using various ways to measure headaches (i.e., self-report migraine, functional impairment due to headache, and diagnostic criteria), though, the findings across measurements

may be utilized as a way to begin addressing the potential role severity may play in the relation between headaches and suicide.

Due to the restricted length of follow-up and low number of suicides reported, another limitation of this study was the lack of sufficient power to detect an association between headaches and suicide in the SALT sample. The association between headaches and suicide, however, was in the expected direction, suggesting that individuals with headaches may be at greater risk of suicide. Based on the low number of suicides in individuals who responded to the headache questionnaires, this finding was not significant. We are unable to test the relation between headaches and suicide for men in the SALT study due to the small numbers of suicides among men with headache data. The study also aimed to characterize the association between headache duration and suicide as well as headache type (migraine, tension, cluster) and suicide. Again, due to power issues, testing these associations were not possible. Nevertheless, this study is one of the largest, well-characterized population-based samples in which cause and date of death are available.

In the design of this study, pain was measured at a single point in time. Because we were only able to measure current or past pain experiences, we cannot determine what pain experiences an individual may have had after study measurement. Thus, individuals who died by suicide may not have been experiencing pain when they died by suicide. Furthermore, other individuals who did die by suicide, who did not report pain experiences initially, may have developed chronic pain conditions in the period after assessment and before death by suicide. Although we cannot be sure that an individual was experiencing chronic pain during the time they committed suicide, the types of pain measured in this study tend to be chronic, suggesting

that the pain endured for a substantial number of people who reported pain on the questionnaires might be chronic in nature.

Finally, because the sample consisted of Swedish twins, the findings may only generalize to similar populations. Suicide rates in Sweden, however, do correspond to rates seen in other westernized cultures (i.e., rates between 15-20 per 100,000), suggesting that results from this study may mirror suicidal behaviors in similar cultures. Additionally, age and gender suicide patterns are also similar to other westernized rates.

Conclusions and Future Directions

This thesis proposed that chronic pain, and specifically headache pain, would predict suicide presumably due to the repeated experience of pain, in addition to disruptions in belongingness and perceived burdensomeness associated with chronic pain conditions. According to the interpersonal theory of suicide, the habituation to pain that a chronic pain sufferer is forced to endure may be the distinct mechanism that will translate into the ability to die by suicide. This thesis provides preliminary evidence that supports this theory, as women who suffer from headaches were at increased risk of suicide, as were men who experienced back pain.

Continued examination of the association between pain and suicide in population-based samples is warranted. It will be interesting to track the SALT sample individuals as future death registry linkages become available. An extremely well characterized sample, including diagnostic headache classification and various self-reported pain experiences, the SALT sample may help in better understanding the relation between pain and suicide. Because the majority of research examining suicidal behaviors in individuals with headaches has relied only upon migraine classification, future research examining potential differences among various headache

types and suicide is necessary. It also is recommended that future studies test the potential mechanisms (i.e., whether pain leads to habituation, desire for death, or both) that are associated with increased risk of suicidal behavior in chronic pain.

By better understanding the relation between pain and suicide, treatments may be more appropriately tailored to help individuals in coping with the emotional consequences of chronic pain conditions that may play a large role in the desire to die by suicide. Future studies addressing the potential role habituation may play in the association between chronic pain and suicide may also be informative to treatment and prevention programs.

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Table 1
STR (n = 42,928) Suicides by Headache and Gender

Group	# reporting headaches	% of sample	# of suicides
Males	1,753	8.8%	11
Females	4,209	18.3%	23
Total	5,962	13.9%	34

Table 2

Suicide Rates by Ageband

Age	Suicides	Person Years	Rate	95% CI
15-34	36	220,601	16.36	11.80-22.67
35-64	182	743,028	24.49	21.18-28.32
65-95	52	243,600	21.35	16.27-28.01

Note. Suicide rates are based on person-years at risk and suicides from study entry for STR

Questionnaires (01/01/1967 or 01/01/1973) through 12/31/2003. Suicide rates are per 100,000 population per year.

Table 3

Survival Analysis Predicting Suicide from Headaches: STR Questionnaires

Sample	Suicides	Person Years	Chi Square	IRR	95% CI
Males	11	550,093	3.38	0.62	0.34-1.15
Females	23	656,651	5.15*	2.01	1.22-3.31

df = 1, **p* < .05.

Table 4

SALT Suicides by Pain Type and Gender

Group	# reporting pain	% of sample	# of suicides
Males (<i>n</i> = 18,874)			
Back	8,286	43.90%	16
Shoulder	4,522	23.96%	7
Neck	4,329	22.94%	6
Females (<i>n</i> = 22,038)			
Back	8,637	39.19%	2
Shoulder	7,155	32.47%	3
Neck	7,301	33.13%	2
Total (<i>n</i> = 40,912)			
Back	16,923	41.36%	18
Shoulder	11,677	28.54%	10
Neck	11,630	28.43%	8

Note. Follow-up data ranges from study start (1998-2001) through 2003.

Table 5

SALT Suicides by Headache Type and Gender

Group	# meeting IHS criteria	% of sample	# of suicides
Males (<i>n</i> = 6,523)			
Migraine	560	4.74%	1
Tension	704	6.00%	0
Cluster	63	0.53%	0
Females (<i>n</i> = 18,434)			
Migraine	2,018	15.33%	0
Tension	1,275	9.68%	1
Cluster	87	0.66%	0
Total (<i>n</i> = 24,957)			
Migraine	2,578	10.32%	1
Tension	1,979	7.92%	1
Cluster	150	0.60%	0

Note. Follow-up data ranges from study start 1998-2001 through 2003.

Table 6

Survival Analysis Predicting Suicide from Pain: SALT Interview

Sample	Suicides	Person Years	Chi Square	IRR	95% CI
Males	18	101,438			
Pain			7.03**	3.92	1.15-13.37
CES-D			3.66	1.15	1.07-1.24
Females	3	115,199			
Pain			0.08	1.37	0.13-13.84
CES-D			2.33	1.20	1.08-1.33
Total	21	216,637			
Pain			6.48*	3.27	1.11-9.66
CES-D			5.78*	1.16	1.09-1.23
Sex			15.24**	8.91	3.04-26.13

Note. Measurement of pain included back, neck or shoulder pain.

df = 1, **p* < .05, ** *p* < .001.

Appendix A
1967 & 1973 Headache Questions

1967 Questionnaire

Have you ever had migraine (characterized by onesided headache, nausea and sensitivity to light)?

No

Yes → Have you seen a doctor about your migraine?

No

Yes

1973 Questionnaire

During the last years have you had recurring headaches which have been so severe that you have found it difficult to work?

No

Yes → Is the headache usually accompanied by visual disturbances or vomiting?

No

Yes

Appendix B

SALT Pain Questions

Do you have or have you ever had...

Back pain

Neck pain

Shoulder pain

Appendix C

SALT Headache Questions

Head Gateway Question

Do you or have you ever suffered from recurrent headaches, that were not caused by infections, fever or hangovers?

Cluster Headaches

Do you or have you had attacks of severe or very severe pain around one eye or temple?

Does/did the pain always come on the same side of the head?

If you do/did not take medicine against the pain, does/did the pain last from 15 minutes to at the most 3 hours?

When you have/had this headache, do/did you have these attacks twice a week or more?

Do/did you have the attacks every day?

Do/did you have the attacks from one to eight times in 24 hours?

Do/did you have these headache attacks for periods of a few weeks or longer?

Have the attacks recurred regularly during a years period or longer?

Do/did you have any of the following symptoms during the attacks; stuffed up nose, runny nose, teary-eyes, red-eyes, or hanging eye-lids?

Migraine Headaches

Do/did you have headaches that last from 4 hours up to 3 days, if you don't take medicine?

Does/did the headache usually feel moderate or severe?

Is/was the headache usually on one side of the head?

Does/did the pain move from one side to the other from time to time, or change sides during a longer attack?

Is/was the pain usually throbbing or pulsating?

Does the headache usually get worse during physical activity, for example, when climbing stairs?

Do/did you usually feel sick or vomit during the headache?

Are/were you usually sensitive to both light and sound during the headache?

Do/did you suffer from visual problems for example flashes, zigzag-lines or the like before the headache comes?

Do/did these visual problems usually last 5-60 minutes?

Tension Headaches

Do/did you have headaches that are usually mild?

Do/did you have headaches that are usually in the whole head?

Does/did the headache feel dull or pressing?

While you have this headache that mild, dull/pressing, in the whole head, do/did you vomit?

Do/did you feel sick during this headache?

Are/were you sensitive to sound during this headache?

Does the headache get worse during physical activity, for example, when climbing stairs?

Does/did the headache last from 30 minutes to 7 days?

Have you had this headache at least 10 times?

Have you had this headache every or every other day during at least 6 months?

Age of Onset

How old were you when you for the first time got this type of headache with {wretching} {light and sound sensitivity}?

Appendix D

Center for Epidemiological Studies-Depression Scale

For each of the following statements, please tell me if you experienced the feeling during the past week, and if so, how often?

1. You did not feel like eating. Your appetite was poor.

Never or almost never Seldom Often Always or almost always Refuse

2. You felt depressed.

Never or almost never Seldom Often Always or almost always Refuse

3. You felt that everything you did was an effort.

Never or almost never Seldom Often Always or almost always Refuse

4. Your sleep was restless.

Never or almost never Seldom Often Always or almost always Refuse

5. You were happy.

Never or almost never Seldom Often Always or almost always Refuse

6. You felt lonely.

Never or almost never Seldom Often Always or almost always Refuse

7. People were unfriendly.

Never or almost never Seldom Often Always or almost always Refuse

8. You enjoyed life.

Never or almost never Seldom Often Always or almost always Refuse

9. You felt sad.

Never or almost never Seldom Often Always or almost always Refuse

10. You felt that people disliked you.

Never or almost never	Seldom	Often	Always or almost always	Refuse
11. You could not “get going.”				

Never or almost never	Seldom	Often	Always or almost always	Refuse
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