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Lifestyle Behaviors and Illness Related Factors as Predictors of Recurrent Headache in
US Adolescents

Suzy Mascaro Walter

Dissertation submitted to the
School of Nursing
at West Virginia University
In partial fulfillment of the requirements for the degree of

Doctor of Philosophy
In
Nursing

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Morgantown, West Virginia
2009

Key Words: headache, adolescents, skipping meals, water intake, tobacco, alcohol use,
physical activity, depression, somatic complaints, insomnia and obesity
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Abstract

Lifestyle Behaviors and Illness Related Factors as Predictors of Recurrent Headache in US Adolescents

Purpose: Successful management of recurrent headache among adolescents requires an understanding of the lifestyle behaviors (skipping meals, water intake, tobacco use, alcohol use, and physical activity) and illness related factors (depression, somatic complaints, insomnia and obesity) reported to be associated with this headache type. This study describes a multivariate model demonstrating how lifestyle behaviors and illness related factors work together to predict recurrent headache in an adolescent population.

Method: A descriptive, cross-sectional, secondary analysis using survey data from the National Longitudinal Study of Adolescent Health (Add Health) (1996) will be reported. Add Health is a large database providing a nationally representative sample of adolescents (ages 11-17, n=13,570). The database evaluated adolescent headache and is inclusive of all the predictors specific to this study. Add Health was obtained from the UNC Carolina Population Center after an IRB Security Plan was approved. Frequency analysis and forward logistic regression were performed using each of the lifestyle behaviors and illness related factors.

Results: Approximately 26% of the adolescents experienced recurrent headache. Recurrent headache was reported by 19% of males and 26% of females. A multivariate model was developed that demonstrated how lifestyle behaviors and illness related factors predict recurrent headache in adolescents. Main effects demonstrated that the odds of having recurrent headache were significantly associated with gender (OR .36, CI .32, .42), chest pain (OR 2, CI 1.8, 2.9), depression (OR 1.87, CI 1.6, 2.2), insomnia (OR 2.03, CI 1.6, 2.5), muscle and joint pain (OR 1.9, CI 1.6, 2.1), skipping breakfast 3 or more times a week (OR 1.2, CI 1.08, 1.33), and skipping lunch one or more times a week (OR 1.14, CI 1.02, 1.27). The main effect of race was significant for Hispanics (OR .59, CI .46, .75), African Americans (OR .62, CI .53, .72), and Asians (OR .42, CI .29, .61). Significant results were found when comparing “no sports activity” with “sports activity 5 or more times a week” (OR 1.17, CI 1.0042, 1.3714) as well as when comparing “sports activity 1 or more times a week” with “sports activity 5 or more times a week” (OR 1.28, CI 1.06, 1.56). The final model consisted of the following predictors: chest pain, muscle and joint pain, skip breakfast three or more times a week, skip lunch one or more times a week, and physical activity. The interactions of gender and age group, race and smoke regularly and depression and insomnia were also included in the final model.

Conclusion: Providing evidence to clinicians that lifestyle behaviors and illness related factors are associated with adolescent recurrent headache may improve overall headache assessment and may result in a more comprehensive plan of treatment. Future studies include development of interventions based upon the reported model and subsequent evaluation of the effectiveness of such interventions on adolescent recurrent headache.

The Add Health contract and data use agreement require that the following be included:

This research uses data from Add Health, a program project designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris, and funded by a grant P01-HD31921 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development, with cooperative funding from 17 other agencies. Special acknowledgment is due Ronald R. Rindfuss and Barbara Entwisle for assistance in the original design. Persons interested in obtaining data files from Add Health should contact Add Health, Carolina Population Center, 123 W. Franklin Street, Chapel Hill, NC 27516-2524 (addhealth@unc.edu). No direct support was received from grant P01-HD31921 for this analysis.

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Chapter 1

Introduction

Recurrent headache is a common chronic pain syndrome in the adolescent population. Successful management of recurrent headache requires an understanding of lifestyle behaviors and illness related factors reported to be associated with this headache type. The aims of this study were fourfold: (1) to examine the prevalence of recurrent headache in an adolescent population, (2) to explore the relationship between lifestyle behaviors (skipping meals, water intake, tobacco and alcohol use, and physical activity) and recurrent headache in an adolescent population, (3) to explore the relationship between illness related factors (depression, somatic complaints, insomnia and obesity) and recurrent headache in an adolescent population and (4) to create a multivariate model that will demonstrate how lifestyle behaviors and illness related factors work together to predict recurrent headache in an adolescent population.

Recurrent headache represents a common chronic pain syndrome occurring in adolescents and is second only to seizure as the most common referral to pediatric neurologists (Connelly M, 2003). Recurrent headache impacts a child's quality of life in terms of reduction in school functioning, decreased physical functioning, and decreased social functioning (Powers, Patton, Hommel, & Hershey, 2004).

Lifestyle behaviors associated with recurrent headache in the adolescent population include: skipping meals, water intake, use of tobacco and alcohol and physical activity (Leviton, Slack, Masek, Bana, & Graham, 1984; Shirreffs, Merson, Fraser, & Archer, 2004; Miller, Palermo, Powers, Scher, & Hershey, 2003; Gallelli et al., 2005; Jarvelaid, 2004; Varkey, Hagen, Zwart, & Linde, 2008). Depression, somatic

complaints, insomnia and obesity are illness related factors reported to be associated with recurrent headaches (Gilman, Palermo, Kabbouche, Hershey, & Powers, 2007; El-Metwally, Salminen, Auvinen, Macfarlane, & Mikkelsen, 2007; Pakalnis, Butz, Splaingard, Kring, & Fong, 2007; Esposito & Gherpelli, 2004; Hershey, 2006). Although multiple studies have reported the association of the above lifestyle behaviors and illness related factors with adolescent recurrent headache, there are no reported studies in the literature that have explored the associations among these variables with recurrent headache.

This chapter includes the classification of recurrent adolescent headache, and an overview of adolescent health promotion/illness prevention in terms of adolescent lifestyle behaviors and illness related factors. In addition, the significance of the study, specific aims and an overview of the methodology are presented.

Classification of Recurrent Adolescent Headache

Recurrent headache is classified into two major categories of primary or secondary headache types (Hershey, 2005). Primary headache does not have a direct cause and headache pain is the sole manifestation of the illness (Hershey, 2005). Secondary headache is caused by a known etiology such as analgesic overuse, dental disease, stroke, vascular malformation, infection, or intracranial neoplasm (Rothner & Hershey, 2001). Table 1 provides an illustration of the headache types and is followed by a more detailed discussion of both primary and secondary headache types.

Table 1 Classification of Recurrent Headache Type*Classification of Recurrent Headache type (International Headache Society, 2004)*

Type	Number of Episodes	Characteristics
Primary		
Migraine (w/o aura)	At least five attacks lasting 2-48 hours	Nausea and vomiting, photophobia, phonophobia; unilateral, pulsating, moderate to severe; aggravated by activity
Migraine (w/ aura)	Two migraine attacks with 3 of the following characteristics: 1. one or more reversible aura symptoms 2. one aura developing gradually over more than 4 minutes or two or more symptoms occurring in succession 3. no auras lasting more than 60 minutes 4. headache follows less than 60 minutes after the aura	Characteristics as above typically preceded by: visual changes, unilateral weakness or numbness
Tension	At least 10 previous episodes lasting 30 minutes to 7 days	Pressing, tightening quality; mild to moderate intensity; bilateral location; no aggravation with activity; no N/V; photophobia or phonophobia may be present
Secondary		
Chronic daily headache	Average frequency of 15 headache days per month without underlying serious medical condition	Same as migraine or tension type headache

International Headache Society (2004). Headache Classification Committee of the International Headache Society: The International Classification of Headache Disorders. Cephalalgia, 24 Suppl 1, 9-160.

Primary Headache: Migraine (with and without aura) and Tension Type Headache

The two most common primary headache types in adolescents are migraine (with and without aura) and tension type headache.

Migraine (with and without aura)

According to the International Headache Society (IHS) classification (2004), migraine (without aura) is a recurrent headache type consisting of at least five attacks lasting 2-48 hours having two of the following characteristics: unilateral location, pulsating quality, moderate to severe intensity and aggravation by routine physical activity. In addition, during the migraine headache, at least one of the following must be reported: nausea and/or vomiting, phonophobia (noise sensitivity), or photophobia (light sensitivity). Classification of migraine with aura (i.e. visual changes, unilateral weakness or numbness) consists of at least two attacks previously described with at least three of the following characteristics: one or more fully reversible aura symptoms indicating focal cortical and/or brain stem dysfunction; at least one aura developing gradually over more than four minutes or two or more symptoms occurring in succession; no auras lasting more than 60 minutes; or headache follows less than 60 minutes after the aura (International Headache Society, 2004).

Tension Type Headache

IHS classification (2004) of recurrent tension type headache includes at least 10 previous episodes lasting 30 minutes to 7 days with at least two of the following characteristics: pressing tightening quality, mild to moderate intensity, bilateral location, or no aggravation with walking stairs or similar routine physical activity. In tension type

headache, there is no nausea or vomiting. Photophobia and phonophobia are either absent or one of the symptoms (photophobia or phonophobia) may be present.

Secondary Headache: Chronic Daily Headache

Chronic Daily Headache

Chronic daily headache is classified as a secondary headache disorder since it is thought to be caused by other etiologies such as depression or chronic analgesic overuse (Hershey, 2005). An adolescent with chronic daily headache has a recurrent headache (migraine, tension type), with an average frequency of 15 headache days/month without an underlying serious medical condition (Winner & Gladstein, 2002).

Adolescent Health Promotion: Lifestyle Behaviors/Illness Related Factors

Health promotion and illness prevention have been placed at the top of America's health care agenda (Pender, Murdaugh, & Parsons, 2002). One of the goals of the agenda is to advance research on health promotion and to encourage access to services that promote health and prevent illness (Pender et al., 2002). The importance of addressing lifestyle behaviors and illness related factors is recognized as essential for overall good health and preventing later life morbidity and mortality for adolescents (Pender et al., 2002).

This study was based on the premise that recurrent headache in adolescents is related to lifestyle behaviors and illness related factors (Leviton et al., 1984; Shirreffs et al., 2004; Miller et al., 2003; Gallelli et al., 2005; Jarvelaid, 2004). Although studies on adolescent headache have examined specific lifestyle behaviors or illness related factors,

the association between lifestyle behaviors and illness related factors was not found in the literature related to adolescent headache. This study will explore the relationship among the lifestyle behaviors and illness related factors of skipped meals, water intake, tobacco and alcohol use, physical activity, depression, somatic complaints, insomnia, obesity and recurrent adolescent headache.

Significance of the Study

There are important social and economic consequences associated with recurrent headache in the adolescent population. Adolescents with recurrent headache who missed more than two days of school in the past six months had lower academic performance than those students who missed less school (Breuner, Smith, & Womack, 2004). Due to the incidence of recurrent headache in adolescents, consideration should not only be made in regard to the individual effects of headache (missed school, decreased academic performance) but also to the costs which this chronic illness places on society. An analysis of the direct medical costs (including prescription drug costs as well as inpatient and outpatient services) in children and adolescents with recurrent headache (migraine) as compared to healthy cohorts was reported (Pesa & Lage, 2004). The medical costs over a one year period for adolescents with recurrent headache were significantly higher than for healthy subjects (\$4,272 vs \$1,400; $P < .0001$) and the medical costs were even higher in those children and adolescents with headaches and co-morbid anxiety and/or depression (\$9,875.4 vs \$1,165; $P < .001$).

This study addressed how lifestyle behaviors and illness related factors work together to predict adolescent recurrent headache by examining a large adolescent health

dataset. The constellation of these variables with recurrent adolescent headache has not been studied. Findings of the study on the relationships among lifestyle behaviors and illness related factors contributing to recurrent headache may offer adolescent health care providers evidence on predictors of headache. These findings may contribute to headache prevention, better headache outcomes, overall good health, and a healthy life as an adult. Findings may also lead to better clinical management of recurrent adolescent headache by providing evidence for lifestyle behaviors and illness related factors as predictors of recurrent adolescent headache. Providing evidence to clinicians that more than one lifestyle behavior or illness related factor may be associated with an adolescent's recurrent headache may improve overall headache assessment and planning of care. It is expected that an understanding of the factors related to recurrent adolescent headache will lead to a comprehensive plan of treatment and better patient outcomes.

Specific Aims

Recurrent headache in an adolescent population was the problem addressed. The association of recurrent headache with lifestyle behaviors and illness related factors was studied. This research was guided by the following specific aims:

- (1) to examine the prevalence of recurrent headache in an adolescent population,
- (2) to explore the relationship between lifestyle behaviors (skipping meals, water intake, tobacco use, alcohol use and physical activity) and recurrent headache in an adolescent population,

(3) to explore the relationship between illness related factors (depression, somatic complaints, insomnia and obesity) and recurrent headache in an adolescent population and

(4) to create a multivariate model that will demonstrate how lifestyle behaviors and illness related factors work together to predict recurrent headache in an adolescent population.

Overview of Methodology

A descriptive, exploratory study was performed using secondary data analysis from the Wave II in-home interviews of the National Longitudinal Study of Adolescent Health (Add Health) database. Add Health is a longitudinal study of the health-related behaviors of adolescents. The Wave II in-home interviews were conducted from April through August 1996. Although use of 13 year old data may be considered a limitation, the purpose of this study was to examine the relationships of the predictors (skipped meals, water intake, tobacco and alcohol use, physical activity, depression, somatic complaints, insomnia and obesity) and the outcome of adolescent headache. This research was concerned only with the relationships of the predictors with recurrent adolescent headache; therefore, any change in the occurrence of the above predictors over time was not a consideration in this study. Furthermore, this was a cross sectional study and neither changes in predictors over time nor interventions could be evaluated.

A sample of 80 high schools and 52 middle schools from the US were selected. Incorporating systematic sampling methods and stratification into the Add Health study design ensured the sample was representative of US schools with respect to region of

country, urbanicity, school size, school type and ethnicity (Harris et al., 2003). Due to the large adolescent sample size and questions addressing adolescent health-related behaviors, the Add Health database continues to be a widely used source of information in adolescent health. A database for Add Health research (UNC Carolina Population Center, 2005) was available and included approximately 1700 publications, presentations, unpublished manuscripts, and dissertations by Add Health researchers. Researchers continue to use Add Health for publications (Ahrens, DuBois, Richardson, Fan, & Lozano, 2008; Beaver, Vaughn, Delisi, & Wright, 2008; Buffardi, Thomas, Holmes, & Manhart, 2008) and for dissertations (Benatar, 2008; Cruz, 2008; Toussaint, 2008; Warren, 2008).

For this study, the Add Health database was chosen since it is a large nationally representative database which addressed adolescent headache and was inclusive of all the lifestyle behaviors and illness related factors specific to this study. This dataset provided an opportunity to perform a large population based study of adolescent recurrent headache. The number of observations used in this analysis was 13,512 (weighted count: 18,710,451). No other datasets addressed adolescent recurrent headache along with the lifestyle behaviors and illness related factors specific to this study. Also, Add Health provided a large nationally representative adolescent sample.

Justification for inclusion of each lifestyle behavior and illness related factor was guided by the adolescent health promotion literature which reported such behaviors and factors as significant health issues in the adolescent population. Further justification will be provided in the review of the literature which demonstrates the association of each lifestyle behavior and illness related factor with recurrent adolescent headache.

Chapter 2

Review of the Literature

The purpose of this study was to explore the relationship among lifestyle behaviors and illness related factors with recurrent adolescent headache. This review of literature describes the occurrence of the following lifestyle behaviors: skipped meals, water intake, tobacco and alcohol use, and physical activity as well as illness related factors of depression, somatic complaints, insomnia and obesity in the adolescent population. The above lifestyle behaviors and illness related factors were addressed in terms of health promotion and illness prevention literature as well as empirical research studies. This review will also discuss previous research on predictors of adolescent headache using multivariate analysis.

Adolescent Health Promotion / Illness Prevention

Lifestyle Behaviors

Skipping Meals and Water Intake

Adolescents tend to put themselves at risk for health problems due to poor nutritional and lifestyle choices (Dowdell & Santucci, 2004). Such choices include skipping meals, snacking between meals, and drinking soft drinks (rather than water) (Dowdell & Santucci, 2004; Loughridge & Barratt, 2005; Carmona, 2006). Dieting, lack of time, and media (watching TV or playing video games) have been reported by adolescents as reasons for meal skipping (Calderon, Yu, & Jambazian, 2004; Rampersaud, Pereira, Girard, Adams, & Metzl, 2005; Van den & Eggermont, 2006). Adolescents who use meal skipping to lose weight risk nutritional deficiencies and

compromised growth due to the reduction of food intake (Calderon et al., 2004). Reports have shown that older children and adolescents are most likely to skip breakfast (Rampersaud et al., 2005). This is concerning since breakfast consumption is thought to benefit cognitive function (memory); academic performance; school attendance rates; psychosocial function and mood (Rampersaud et al., 2005).

Health promotion and illness prevention literature addresses the importance of healthful eating habits and behavior modification (Tate & Patrick, 2000; Wilson, O'Meara, Summerbell, & Kelly, 2003; Hesketh, Waters, Green, Salmon, & Williams, 2005). Behavior modifications include: avoidance of meal skipping, teaching adolescents healthy meal choices and discouraging soft drinks (Rampersaud, Bailey, & Kauwell, 2003; Rampersaud et al., 2005). Since older children and adolescents are more likely to skip meals, practitioners should counsel those who are dieting and encourage healthful eating habits (Rampersaud et al., 2003; Rampersaud et al., 2005).

Skipping meals typically leads to subsequent hunger and increased snacking. One of the most common snacks for adolescents is soft drinks (Haines & Stang, 2005). In a study evaluating beverage consumption of 2379 female children and adolescents, >90% of all the diary entries excluded water as one of the types of beverages consumed (Striegel-Moore et al., 2006). Of all the beverages consumed (milk, soda, fruit juice, fruit drinks, coffee/tea), increased soda consumption predicted the greatest increase in BMI and lowest increase in calcium intake (Striegel-Moore et al., 2006). Studies have also shown that, by age 13, adolescents drank more carbonated soft drinks than healthful beverages (Rampersaud et al., 2003). Adolescents are especially at risk since consumption of carbonated soft drinks is particularly high in this age group (Rampersaud

et al., 2003). Public health efforts are needed to encourage healthful beverage choices and decrease soda consumption to improve adolescent health outcomes (Striegel-Moore et al., 2006). Providing cooled filtered water in schools and actively promoting water intake leads to increased consumption of water by students (Loughridge & Barratt, 2005).

Adolescent Tobacco and Alcohol Use

The age at which adolescents report taking their first drink is, on average, 12 years of age (Zeigler et al., 2005). A nationwide survey demonstrated that 25.5% of students (grades 9-12) had ≥ 5 drinks of alcohol in a row, within a couple of hours, on ≥ 1 occasion over the past 30 days (Eaton et al., 2006). Past studies have reported that eighty percent of tobacco users had begun smoking prior to 18 years and, if this trend continues, approximately five million of these youth will die prematurely due to smoking related illnesses (cancer, cardiovascular disease) (CDC, 2000). Nationwide, 54.3% of students (grades 9-12) tried smoking (over 1 or 2 puffs) and 23% had smoked one or more cigarettes in the past 30 days (Eaton et al., 2006).

Due to the occurrence of adolescent tobacco and alcohol use, these two behaviors are among the most widely discussed topics in adolescent health promotion and illness prevention. Health promotion and illness prevention articles focus on the importance of targeting at risk youth and developing appropriate interventions that will lead to behavior change (Mattey, 2003; Webster, Hunter, & Keats, 2002; Dunn & Pirie, 2005).

Physical Activity

When considering declines in adolescent physical inactivity, obesity is most often the topic of concern (Nader, Bradley, Houts, McRitchie, & O'Brien, 2008; McDermott et

al., 2009). However, physical activity also benefits the adolescent in terms of cardiovascular health (improvements in metabolic syndrome, lipid profiles, blood pressure, aerobic fitness), mental health (improvement of anxiety and depression scores), musculoskeletal health and fitness (improvements in muscular strength and endurance), and academic performance (positive effect on academic performance) (Strong et al., 2005). Declines in physical activity are not only concerning for future health outcomes for adolescents but it also important to consider physical inactivity as it relates to the demands of childhood (physical growth, biological maturation, behavioral development) (Strong et al., 2005).

In a study by Nader et al. (2008), physical activity was measured in a group of adolescents ages 9-15 years. Longitudinal descriptive analysis was used to evaluate moderate to vigorous physical activity (MVPA) (measured by using an accelerometer) of 1032 subjects (517 male, 515 female) from the 1991-2007 National Institute of Child Health and Human Development Study of Early Child Care and Youth Development (Nader et al. 2008). Accelerometer determined minutes of MVPA were obtained at ages 9 (year 2000), 11 (year 2002), 12 (year 2003), and 15 (year 2006). At the age of 9, a majority of the children exceeded the recommended 60 minutes of MVPA on weekdays and the weekend (Nader et al., 2008). By 15 years of age, only 31% and 17% met the guidelines for MVPA on weekdays and the weekend respectively (Nader et al., 2008).

Decreasing levels of MVPA were demonstrated in a second study using data from the National Health and Nutritional Examination Survey (Troiano et al., 2008). Cross sectional data of physical activity levels of children (6-11 years, 309 male; 288 female) and adolescents (12-19 years, 570 male; 611 female) were analyzed using

accelerometers. Overall, 42% of children (6-11 years) met the recommendations for physical activity on most days of the week as compared with 8% (12-15 years) and 7.6% (16-19 years) (Troiano et al., 2008). In terms of gender, adherence to guidelines dropped from 49% to 12% for boys and from 35% to 3% in girls when comparing children (6-11 age group) with adolescents (12-15 age group) (Troiano et al., 2008).

The above studies demonstrate concerns for decreasing physical activity with increases in age and in regard to gender. These findings also acknowledge the importance of interventions for increasing physical activity and implementing such interventions before adolescence when such declines occur (Kahn et al., 2008). Opportunities to increase physical activities should be made available to youths at home, in school, and in community and health care settings (Strong et al., 2005).

Illness Related Factors

Depression and Somatic Complaints

A nationwide survey found that 28.5% of students (grades 9-12) reported feeling sad or hopeless almost every day for 2 or more weeks and they stopped normal activities due to these feelings (Eaton et al., 2006). Also, 16.9% of the students surveyed seriously considered a suicide attempt and 8.4% actually attempted suicide one or more times over the past 12 months (Eaton et al., 2006). Mental health promotion is well described in the adolescent health promotion and illness prevention literature (Westman & Elena, 1996; Burns, Andrews, & Szabo, 2002; Licence, 2004; Harma, Kaltiala-Heino, Rimpela, & Rantanen, 2002; Walker et al., 2002). Cumulative adverse experiences known to put adolescents at risk for depression include parental depression, poverty, chronic medical

illness, parental separation, abuse, problems with relationships, and non-supportive school or familial environments (Westman & Elena, 1996; Burns et al., 2002).

Studies published in the public health literature addressed the occurrence of emotional disorders (depression) in adolescents with recurrent somatic complaints (Harma et al., 2002) as well as associations of smoking and intensity of physical exercise with recurrent somatic complaints (Vikat et al., 2000). In regard to interventions, the literature discusses the importance of clinician recognition of the causes of adolescent depression and the association of depression with adolescent pain (Vikat et al., 2000; Harma et al., 2002).

Sleep Habits

Evidence has shown that inadequate sleep in adolescents can result in significant barriers to learning, cognition and memory as well as contribute to behavior problems that negatively affect quality of health (Gibson et al., 2006). Previously reported sleep research data has indicated that adolescents require 9 to 10 hours of sleep per night (Carskadon et al., 1980; Mercer, Merritt, & Cowell, 1998) and subsequent recommendations suggest 8.5 to 9.5 hours of sleep per night (National Sleep Foundation, 2006). Adolescents frequently report compensating for missed hours of sleep during the weekdays by extending sleep time on weekends (Mercer et al., 1998).

There is a need to increase awareness of adolescent sleep problems in health communities and to translate this knowledge into interventions (Gibson et al., 2006). Studies investigating adolescent sleep habits identified the following factors associated with inadequate sleep: adults do not regulate adolescent sleep habits, adolescents have inconsistent bedtime habits, adolescents are not well skilled at time management,

adolescents drink caffeinated beverages before bed, or adolescents may have undiagnosed sleep disorders (Gibson et al., 2006; Chen, Wang, & Jeng, 2006). Such findings demonstrate the importance of recognizing sleep habits in adolescents and the need to design interventions. Sleep habits have been recognized in health promotion and illness prevention literature (Gibson et al., 2006; Chen et al., 2006). Preventative measures are needed to educate adolescents and parents on the importance of basic sleep regulation and avoiding development of sleep disorders which may serve to reduce the risk of chronic headache (Gibson et al., 2006; Chen et al., 2006). Development of interventions is in the early stages; however, there is agreement that clinicians should evaluate adolescents for the possibility of sleep problems.

Obesity

The percentage of overweight youth has more than doubled in the last 20 years (Ogden, Flegal, Carroll, & Johnson, 2002). In a nationwide survey of students (grades 9-12), 13.1% of students were overweight (Eaton et al., 2006). Obesity in childhood is predictive of obesity in adulthood and morbidity and mortality due to chronic diseases are increased in those adults who were overweight adolescents (Deckelbaum & Williams, 2001). For adolescents, a BMI of $\geq 95^{\text{th}}$ percentile is defined as obese (Barlow & Dietz, 1998). Health promotion and illness prevention literature addresses the importance of healthful eating habits and physical activity choices (Tate & Patrick, 2000; Wilson et al., 2003; Hesketh et al., 2005). Although there have been increased efforts to reduce adolescent obesity in the past decade, obesity continues to be a significant health problem throughout the developed world (Chen, Chou, & Hsu, 2005).

In summary, the review of health promotion/illness prevention literature on the specific variables of interest for this study demonstrates the significance of recognizing lifestyle behaviors and illness related factors of skipping meals, water intake, tobacco and alcohol use, physical activity, depression, somatic complaints, insomnia and obesity in the adolescent population. Although these lifestyle behaviors and illness related factors are described in the adolescent health promotion/illness prevention literature, the effects of these variables on adolescent health as a constellation has not been well studied in the adolescent population. This research studied adolescent health in terms of recurrent headache and explored the relationship between lifestyle behaviors, illness related factors and recurrent headache in adolescents.

Empirical Studies: Adolescent Recurrent Headache, Lifestyle Behaviors, and Illness Related Factors

Adolescent Recurrent Headache

In a study of 5847 adolescents aged 12-19 years, 29.1% reported having recurrent headache (Zwart, Dyb, Holmen, Stovner, & Sand, 2004). Similar findings have also demonstrated that 26.6% of adolescents (n=1998) ages 12-13 years reported frequent headaches of “about once a week” or more often (Gordon, Dooley, & Wood, 2004). Recurrent headaches occurring at least 15 days per month without underlying serious medical condition are referred to as chronic daily headaches (Grazzi, Usai, & Bussone, 2003; Chapman, 2005). In a study of children in an outpatient neurology practice, of the 79 children and adolescents (≤ 16 YO) presenting with headaches, 72% (57) fit the criteria for chronic daily headache (Wiendels, van der Geest, Neven, Ferrari, & Laan, 2005). A

second study evaluated 577 children and adolescents (ages 3-18) in an outpatient Neurology clinic with headaches (Hershey, Powers, Benti, LeCates, & deGrauw, 2001). Approximately, 34.6% (200) had at least 15 headache days/month (chronic daily headache) and 63% (126) of those with chronic daily headache had at least 30 headache days per month.

Several studies have reported that recurrent headache is more likely to be reported among females (Scalas & Calistri, 2005; Moore & Shevell, 2004; Larsson & Sund, 2005) and that headache persistence also increases with age (Larsson & Sund, 2005). In a study evaluating recurrent headache using Wave I data of the Add Heath database (n=6072), Rhee (2000) reported that girls (37.6%) reported more recurrent headache than boys (21.3%) and that American Indian adolescents (35.6%) had a higher rate of recurrent headache followed by white adolescents (32.1%).

The findings of the above studies support recurrent headache as a problem in the adolescent population. Evaluation and treatment of recurrent headache needs to be based on an understanding of the lifestyle behaviors and illness related factors that contribute to this headache type. A discussion of the association of each lifestyle behavior and illness related factor with recurrent adolescent headache follows.

Lifestyle Behaviors and Recurrent Headache

Skiping Meals

Studies regarding associations between headaches and missed meals in adolescents are reported in the literature. Patients >10 through <22 years of age with headaches were evaluated using a computerized behavioral assessment (Leviton et al.,

1984). The authors found that 26% (18/69) of children reported an association between headaches and missed meals. Similarly, in a study of 100 consecutive patients in a pediatric headache clinic (ages 3-16 years old), children were asked what factors consistently precipitated their headaches using frequency scores 1 to 10 (1 being never and 10 always) (Lewis et al., 1996). The factors recorded as “always” (scores > 8) included tension/pressure in 68%, loud noise in 40% and missed meals in 29%. Thus, missed meals were among the top three factors associated with headache in this adolescent population.

In a larger population study, data from the third National Health and Nutrition Examination Survey (NHANES III) were used to examine the relationship between family food insufficiency and health measures (including headache) in school aged children (n=5667) (Alaimo, Olson, Frongillo, Jr., & Briefel, 2001). A child was classified as “food insufficient” if the family respondent reported that the family “sometimes” or “often” did not get enough food to eat. One of the health measures included frequency of headaches (range: always, frequently, sometimes, never/rarely). The authors found that the “food insufficient” children were significantly more likely to have frequent headaches in comparison with “food sufficient” children (OR 1.69; 95%CI: 1.14,2.44) when adjusted for sociodemographic and family characteristics (race/ethnicity, health insurance status, family size, family income, employment status and education of the head of the family, location, past health risk, health care risk and environmental risk).

It has been recommended that adolescents with recurrent headache eat three consistent meals a day, including breakfast (Lewis, Yonker, Winner, & Sowell, 2005). Reports have shown a correlation between missed meals and headache, however, there is

debate as to the causative factor. Previous studies regarding headaches and missed meals reported low glucose as the causative factor (Blau & Cumings, 1966; Blau & Pyke, 1970). No reports were found regarding recurrent headache in adolescents related to serum glucose levels and fasting, however, several studies regarding adults and migraines have been published. These studies typically examined adults (18+ years old) with typical migraines (Blau & Cumings, 1966; Hockaday, Williamson, & Whitty, 1971; Robbins, 1994).

Blau & Cumings (1966) studied 19 hour fasting (10PM-5PM) in a group of 12 patients (ages 18-36, 6 male, 6 female) with migraines. Of those 12, six developed typical characteristics for headache on the fast day. Their headaches were associated with blood sugar levels reduced to 60-90 mg/100ml and were considered to have mild hypoglycemia. However, fluid intake was not monitored nor was hydration status assessed and the pre-fast diets were not recorded. Some of the participants may have become dehydrated during the fast, which may have contributed to headache occurrence.

In contrast to the findings above, no differences were found in blood glucose levels in 10 headache patients (ages not given) with a history of migraine after fasting (Hockaday et al., 1971). Six of the ten patients developed headache after fasting; however, no difference in blood glucose levels were found in the “headache” versus “non-headache” groups when baseline, peak and minimal blood sugar levels were compared. A relationship was not found between concentrations of blood sugar or direction of change at one hour and ½ hour before the onset of headache.

Robbins (1994) evaluated trigger factors in a group of 494 randomly selected migraine patients between the ages of 18 through 60. Missing a meal or hunger was

reported by 40% of the patients as a migraine precipitant (43% female, 31% male). It was hypothesized that the causative factor was probably not true hypoglycemia, but a “reaction” of the nervous system to a normal drop in blood sugar (Robbins, 1994).

The reported studies demonstrate an association of headache with missed meals; however, an association with serum glucose remains poorly understood. Other possible mechanisms for fasting-induced headaches include altered levels of serotonin and norepinephrine, release of stress hormones, and caffeine withdrawal (Martin & Behbehani, 2001). Researchers suggest that the role of hypoglycemia is unlikely since insulin induced hypoglycemia in diabetics is rarely associated with migraine and because hepatic glycogen stores prevent hypoglycemia in the first 24 hours of a fast (Hockaday, 2006; Martin & Behbehani, 2001).

Water Intake

Blau et al. (2004) were among the first to address the association of water deprivation in headaches. Twelve family members, colleagues, and acquaintances were interviewed and each described headaches which were relieved after water was consumed (Blau, Kell, & Sperling, 2004). In a second study, the authors then interviewed 95 migraine patients and found that 34 reported dehydration as a precipitant to migraine attacks (Blau, 2005). Other anecdotal reports of water deprivation and headaches were also reported (Spigt et al., 2004; Bhatia, Gupta, & Srivastava, 2006). Bhati et al. (2006) reported on a 28 year old male who reported that his migraines responded to oral water intake of 500-1000 ml in the acute phase. The patient reported that he was often deprived of water due to his job requirements and, if he did not drink water early on in the migraine episode, he would have a “full blown” migraine (Bhatia et al., 2006). Reduced

frequency and intensity of headaches in a 56 year old man participating in a study on the effects of increased water intake on voiding was reported (Spigt et al., 2004). Although voiding dysfunction was the study variable, his headaches improved after one month of increased water intake.

Experimental studies on fluid restriction tend to focus on physiological aspects (body mass changes, urine osmolality and serum osmolality) rather than subjective symptoms (headache) (Shirreffs et al., 2004). However, physiologic and subjective symptoms have been reported in the following studies (Shirreffs et al., 2004; Spigt et al., 2005). Symptoms following 13, 24 and 37 hours of fluid restriction (abstinence from all fluid intake and ingestion of food low in water content) were compared with a euhydration trial (those subjects following normal fluid ingestion patterns) of the same duration in 15 healthy participants (mean age 30) (Shirreffs et al., 2004). The experience of headache was significantly greater at 24 hours ($P<0.005$) and 37 hours ($P<0.05$) in the fluid restricted trial as compared with the euhydration trial of the same duration. Urine and blood samples were obtained and subjective symptoms recorded. Thirst increased from 1-13 hours of fluid restriction ($p<0.05$), but there was no statistically significant change from 13-37 hours. During fluid restriction, concerns arose that the headaches were occurring secondary to caffeine withdrawal. The authors noted 4 of the ten subjects whose diaries were evaluated would normally drink tea, coffee, cola or eat chocolate; however, the quantity of caffeine consumed was moderate. This study demonstrated that mild dehydration (decreased plasma volume, increased serum osmolality, increased serum sodium concentration) over a short period of time can contribute to the experience of headache in healthy volunteers.

Spigt et al. (2005) evaluated the effects of increasing daily water intake as prophylaxis for headache. Fifteen patients (8 water intervention, 7 placebo) were randomly assigned to two groups: (1) those patients who received a placebo medication for headache for 12 weeks (one tablet each day during dinner) or (2) those patients who were advised to increase water intake of 1.5 liters of water per day in addition to normally consumed beverages for a period of 12 weeks. Measurements consisted of a 2 week headache diary and the Migraine Specific Quality of Life (MSQOL) questionnaire. The intervention group reported a daily increase of water to be 1 liter. Although not significant, findings demonstrated a reduction in the total hours of headache in 2 weeks by 21 hours (95%CI: -48 to 5) and mean headache intensity decreased by 13 mm (95%CI: -32 to 5) on a visual analogue scale (VAS) in the intervention group. Only small differences were found on the MSQOL, number of headache episodes, and medication use (Spigt et al., 2005).

Tobacco Use

It is believed that most young people have little fear of future disease; therefore, current health problems may best serve as the motivation to encourage young smokers to quit or not start smoking at all (Holmen, Barrett-Connor, Holmen, & Bjermer, 2000). Studies report an association between cigarette smoking and headache activity (Payne et al., 1991; Holmen et al., 2000; Jarvelaid, 2004; Aamodt, Stovner, Hagen, Brathen, & Zwart, 2006). Payne et al. (1991) studied 189 headache sufferers (range= 17 to 70 years old) and found that smokers reported significantly higher mean weekly peak headaches (increase in intensity of more severe headache episodes) ($F(1,181)=3.91$ $p<.05$) than

nonsmokers. Holmen et al. (2000) also found that daily smoking among males/females and all age groups was significantly associated with headaches ($p < 0.001$).

In a study by Aamodt et al. (2006), prevalence rates for headache were greater in smokers compared with never smokers. Also, report of headache was more likely in those under 40 years and smoking more than 10 cigarettes per day (OR 1.5, 95% CI 1.3-1.6). Finally, Gordon et al. (2004) evaluated headache frequency and “having ever tried cigarette smoking” in a group of adolescents (12-13 years). The top three risk factors associated with adolescent report of weekly headaches were depression, “having ever tried cigarette smoking” and poor self image (Gordon et al., 2004).

Alcohol Use

Alcohol is a well known trigger for headache and is a diagnosis described in the IHS Classification (2004) as a “headache following alcohol consumption” (immediate or delayed). Headaches resulting from alcohol may be due to the vasodilatory effects of alcohol or the diuretic effects which result in loss of salt, vitamins and minerals through the kidneys resulting in dehydration (National Headache Foundation, 2009). In a previous study of delayed alcohol induced headaches, ninety-five university students (ages 18 to 36 years, 61 males) completed a headache questionnaire approximately 12 hours after high alcohol intake (Kuster, da Silva, Aquino, Ziviani, & Domingues, 2006). Fourteen of 34 women (41.2%) and 13 of 61 men (21.3%) reported alcohol induced headaches. Although women reported more headaches, there was no statistically significant difference between males and females (Kuster et al., 2006).

Evaluation of the relationship between alcohol use and chronic daily headache in patients followed in a headache clinic (mean age 42.8) demonstrated a significant

association between chronic daily headache and consumption of alcohol more than three times a week ($p<.0002$) (Bigal, Sheftell, Rapoport, Tepper, & Lipton, 2002). The relationship between alcohol use and recurrent headache has also been described in the adolescent literature. Gallelli et al. (2005) evaluated the incidence of headache in a population of secondary school students (14 to 18 years old). The incidence of recurrent headache was higher in alcohol users ($n=1,550$, 18.3%) than non-users ($n=430$, 21.7%) ($p<0.01$) (Gallelli et al., 2005).

Physical Activity

Practice guidelines for children and adolescents with recurrent headache include physical activity as a part of non-pharmacologic management (Gunner, Smith, & Ferguson, 2008; Mack & Gladstein, 2008). Exercise should be encouraged in those adolescents with chronic daily headache since they are more likely to miss school and become inactive (Mack & Gladstein, 2008). These behaviors put the adolescent at increased risk for sleep disturbances, depression, and autonomic dysfunction (Mack & Gladstein, 2008). Suggested amount of physical activity as a headache intervention varies from as little as 5-10 minutes a day to 30 minutes of aerobic activity 3 to 7 days per week (Mack & Gladstein, 2008; Gunner et al., 2008). The relationship between physical activity and headache has been documented in the adult and adolescent population (Varkey et al., 2008; Soderberg, Carlsson, & Stener-Victorin, 2006; Nader et al., 2008).

Varkey et al. (2008) studied the relationship between level of physical activity in those with migraine and those with non-migraine headaches in the Nord-Trondelag Health Study (HUNT). There were two phases of this study HUNT 1 (1984-1986) and HUNT 2 (1995-1997). In the first phase, 22,397 responses to physical activity were

evaluated in participants classified as unlikely to have headache (due to no analgesic use in the past month). Questions regarding physical activity were based on how often the participant exercised. Participants were considered “active” (participants answering “less than once a week”, “once a week”, “2 to 3 times a week”, or “nearly every day” to how often they exercise) versus “inactive” (answering “never” to how often do you exercise). Headache was indirectly determined if participants responded “no” to using analgesics in the past month. Then in the second phase (1995-1997), these participants were included in a cross sectional analysis of 46,648 participants and were again asked to complete questions regarding physical activity (which was now classified as low, medium or high activity level) and headache occurrence. If a participant answered “yes” to having had a headache in the past 12 months, the respondents were classified as having headaches and were then asked questions which further classified them into migraine versus non-migraine groups.

Logistic regression analysis was used to evaluate the influence of headache in both HUNT 1 and HUNT 2. Those who were physically inactive at baseline in 1984-1986 were more likely to have non-migraine headaches (headache without migraine characteristics) 11 years later (OR 1.14, CI 1.02, 1.28) than those individuals who exercised at baseline. However, there was no statistical significance in those who were inactive at baseline and had migraine headaches 11 years later. When looking at the cross sectional part of the study, those with a low activity level were more likely to have either headache type (migraine vs. non-migraine) when compared with those with a high activity level (OR1.28, CI 1.20, 1.38).

This study concluded that physical inactivity among those who were headache free at baseline can be considered a risk for future non-migraine headache (headache without migraine characteristics). However, headache was not evaluated directly in the HUNT 1 questionnaire. Participants were labeled as not having headache based upon lack of analgesic use in the previous month. This may have possibly incorrectly identified some of the respondents in this group. Also, those participants who responded “once a week or less” were included as physically active as compared to those classified as “inactive” if they responded “never” to physical activity. This may have incorrectly identified the respondents as “physically active” when “inactive” may have been a more appropriate classification.

In a study by Soderberg et al. (2006), physical activity was evaluated as a treatment for chronic tension type headache along with acupuncture and relaxation training. Ninety patients (17 men, 73 women, aged 18-65) were randomized blindly into the three different treatment groups: acupuncture (n=30), physical training (n=30), and relaxation training (n=30). The study encompassed a 4 week pretreatment period (baseline), a 2.5-3 month treatment period (last treatment) and a post-treatment period of 7 months. Those with history of somatic or psychiatric disease, drug abuse, analgesic or triptan use >10 days per month were excluded. Outcome measures included pain intensity (Visual Analog Scale), headache free days (range 0-7), and headache free periods (0-28). The patients made 4 entries in the diaries per day. The patients documented in the diaries for 4 weeks before treatment, 4 weeks immediately after treatment, 3 months after treatment for 4 weeks, and 6 months after treatment for 4 weeks. Non parametric tests

were used (due to the ordinal nature of the visual analog scale) including Kruskal-Wallis test and Fisher's non-parametric permutation.

Between group comparisons were made for differences at baseline, after last treatment, and after 3 and 6 months for headache intensity, headache free periods, and headache free days. The only significant difference occurred between the relaxation group and the acupuncture group immediately after the last treatment. The relaxation group had a significantly higher number of headache free periods ($p < .05$) and headache free days ($p < .01$) compared with the acupuncture group immediately after the last treatment (last relaxation therapy treatment versus last acupuncture therapy treatment) (Soderberg et al., 2006).

Within group comparisons were then made. In the acupuncture group, headache intensity decreased significantly at 3 and 6 months after the last treatment when compared with baseline (Soderberg et al., 2006). There were no significant findings for differences in headache free periods or headache free days. In the physical training group, decreases in headache intensity and increases in headache free days and headache free periods were statistically significant immediately after the last treatment and again at 6 month follow up (Soderberg et al., 2006). There were no significant differences at the three month follow up compared with baseline. Finally, in the relaxation group, decreases in headache intensity, increases in headache free days and headache free periods were significant immediately after last treatment, at 3 month follow-up and at 6 month follow up when compared with baseline (Soderberg et al., 2006).

No control groups were used in this study which may have given insight into any natural progression of CTTH (Soderberg et al., 2006). Treatments were given by a group

of physical therapists, which raises the question of consistency of therapies given to the different groups. However, the authors stated that similar treatment modes were given to the participants (Soderberg et al., 2006).

Illness Related Factors and Recurrent Headache

Depression

When evaluating children and adolescents with recurrent headache, depression is a factor to be considered. Undiagnosed psychiatric disorders increase the chronic nature of headaches and make headaches less responsive to treatment (Oelkers-Ax & Resch, 2004).

Studies investigating the occurrence of recurrent headache with a psychiatric co-morbidity relied on psychometric testing or questionnaires (Pakalnis et al., 2007; Wang, Juang, Fuh, & Lu, 2007; Just et al., 2003). Pakalnis et al. (2007) used the Children's Depression Inventory and Child Symptom Inventory to evaluate symptoms of depression in children 8-17 years old (n=133, n=72 for chronic daily headache group, n=61 for control group) with a diagnosis of chronic daily headache and compared such results with an age-matched healthy control group. Analysis was performed using t-test which compared the chronic daily headache group with the control group in order to determine the frequency of psychological symptoms (Pakalnis et al., 2007). Mean comparisons of the psychological measures between the chronic daily headache patients and the control group demonstrated higher levels of depression in the chronic daily headache group (Pakalnis et al., 2007). Mean scores on the Child Symptom Inventory for Depression for

the chronic daily headache group and control group were 62.21 and 54.86 respectively ($p<.01$) and mean scores for the Child Depression Inventory scale for the chronic daily headache and control group were 50.30 and 45.10 respectively ($p<.05$) (Pakalnis et al., 2007). Females reported higher levels of depression when compared with males ($p<.05$).

Wang et al. (2007) investigated the prevalence of psychiatric disorders and suicidal risk in adolescents with chronic daily headache using the Mini International Neuropsychiatric Interview-Kid (Mini-Kid) for children and adolescents. The authors recruited 121 adolescents (31 male/90 female, mean age 13.8 years, range 12 to 15 years) with chronic daily headache from a student sample ($n=7,900$). The presence of chronic migraine diagnosis was associated with major depression OR 4.6 (1.3 to 16.4, $p=0.01$) (Wang et al., 2007). High suicidal risk scores (scores > 10 , range 0 to 36) were reported in 20% ($n=24$) of the adolescents and subjects with chronic migraine were more likely to have high suicidal risk than those without (OR=4.3, 1.2 to 15.5, $p=0.02$) (Wang et al., 2007). Overall, almost half of the adolescents with chronic daily headache were found to have at least one psychiatric disorder, with major depression (21%) and panic disorder (19%) the two most common disorders and, as mentioned above, 20% of the adolescents with chronic daily headache were at high suicidal risk (Wang et al., 2007). Those subjects with chronic daily headache with a psychiatric co-morbidity did not consult physicians more frequently nor did they have more sick days when compared to those without psychiatric comorbidity (Wang et al., 2007).

Just et al. (2003) used the Child Behavior Checklist (CBCL), Depression Inventory for Children and Adolescents and the Anxiety Questionnaire for Pupils. When compared with matched controls, parental reports using the CBCL scales demonstrated

that children and adolescents with primary headache experienced depression/anxiety ($P < .001$), somatization ($P < .001$), and internalizing disorders ($P < .001$) greater than the controls (Just et al., 2003). Another study evaluated depressive symptoms in patients 18-60 years of age with episodic versus chronic migraine using the Beck Depression Inventory (BDI) (Galego, Cipullo, Cordeiro, & Tognola, 2004). Significant differences were found among the median BDI scores of the three groups ($p < 0.05$). Patients with chronic migraine headaches had greater likelihood of severe depression. Those with episodic migraine had moderate depression, while the control group had no depression (Galego et al., 2004). Kowacs et al. (2003) evaluated symptoms of depression, anxiety, and non-specific psychiatric disorders in patients with migraine headaches, and subjects with non-neurological chronic diseases using three scales: MADRS (depression), STAI-T (anxiety), and the SRQ (screening for mental disorders). Scores of all instruments were higher in the headache group, however, statistical significance was only found in SRQ scores (general psychiatric symptoms) ($P < .0001$) compared to controls (Kowacs et al., 2003).

Clinical characteristics of chronic daily headache in 40 children and adolescents with headache frequency ≥ 15 days/month were evaluated using the STAI for anxiety and for depression using the Child Depression Inventory (Esposito & Gherpelli, 2004). The authors found that 27% (10/37) had scores suggestive of a depressive trait, 19.5% (7/36) of the patients demonstrated scores indicative of a high anxiety status, and 11% of those that completed both questionnaires had scores suggestive of both anxiety and depressive traits.

The relationship between migraine and bipolar illness in adults was investigated using a migraine questionnaire (Low, Du Fort, & Cervantes, 2003). Of 108 patients with bipolar disorder, 43 (39.8%) reported a lifetime history of migraine (7% had experienced a migraine before the age of 10 years) and 31.2% reported a history of migraine between 10 and 20 years. Factors of frequent headache in adolescents using the self-administered questionnaire micro-data files of the National Longitudinal Survey of Children and Youth (NLSCY, 1996-1997) were also investigated (Gordon et al., 2004). There were significant findings between children reporting frequent headaches and those with infrequent to no headaches in terms of mental health. In those with frequent headaches, 13% reported serious consideration of committing suicide within the past 12 months, 21% were relatively depressed (depression score >13) and 19% reported anxiety or emotional disorder (emotional disorder score >7) (Gordon et al., 2004).

Using a population based cohort (established in 1958 in Great Britain), participants with frequent headache and psychosocial factors in childhood were studied to determine if there was increased risk for headache and psychiatric symptoms into adulthood (Fearon & Hotopf, 2001). Questionnaires were first completed by the participants' parents. The questionnaire addressed headaches, familial illness, and social circumstance. Teachers completed the Bristol adjustment guide which rated behavior at school. At age 33, participants were asked about specific somatic complaints, headache and psychiatric morbidity (based upon a 15 item subscale of the malaise inventory). Approximately 11,407 of the original participants were interviewed at age 33 (69%). Ordinal regression analysis was used to determine the relationship between headache in childhood and outcomes in adulthood regarding multiple physical symptoms, headache

and psychiatric morbidity. A significant association was found for all three in regard to headache in childhood ($p < .001$). An overall odds ratio of 1.75 (95% CI=1.46-2.10) was found for the association between headache in childhood and multiple physical symptoms. An odds ratio of 1.41 (1.20 to 1.66) was also found for the association of headache in childhood and psychiatric morbidity. Thus, children with frequent headaches had an increased likelihood to have multiple somatic complaints, frequent headaches and psychiatric co-morbidity in adulthood.

A longitudinal study using the Add Health data set evaluated the relationship of headaches and depression in adolescents participating in Waves I and II of the in-home interviews (Rhee, 2000). The data set consisted of 50% of the core sample chosen at random ($n=4591$) from Wave I and evaluated those same adolescents at Wave II. Rhee (2000) found 91% of the study subjects experienced a headache in the past 12 months, 61.5% reported having headaches a few times, 22.5% once a week, 6% almost every day and 1.2% every day. Path analysis examined the causal relationship between headache and depression. The path coefficient ($p=.08$, $P<.001$) from depressive symptoms in Wave I to headache in Wave II was 2.7 times as large ($p=.03$, $P<.001$) as that from headache (WI) to depressive symptoms (W2). Thus, depressive symptoms had an association with headache.

Another report evaluated patterns of multiple physical symptoms (somatic complaints) and the relationships between the patterns and psychosocial factors (depression) (Rhee, Holditch-Davis, & Miles, 2005a). This study used 9140 adolescents from Waves I and II of the Add Health Study. Ten physical symptoms were chosen including: headache, stomachache, musculoskeletal pain, fatigue, feeling hot, cold

sweats, sore throat, urinary problems, dizziness and chest pain. K-means and the Ward method were then used to cluster the sample into four groups according to patterns of the 10 symptoms: nonsymptom (41%), moderate symptom (38%), high symptoms (19%) and extreme symptoms (2%). Those adolescents reporting high and extreme symptoms showed greater depressive symptoms as compared with those in the nonsymptom and moderate symptom group (Rhee et al., 2005a).

Somatic Complaints

Depression is well known in terms of co-morbidity with headaches, however, less is known regarding somatic symptoms and recurrent headache (Maizels & Burchette, 2004). Somatic refers to a characteristic of the “soma” or “body” and complaint refers to a description of a symptom (Rieffe, Terwogt, & Westenberg, 2007). Somatic complaints in medicine are defined as physical complaints without medical origin (Chapman, 2005).

The co-occurrence of multiple somatic symptoms and headaches among US adolescent females was reported (Ghandour, Overpeck, Huang, Kogan, & Scheidt, 2004). Among girls who experienced headaches more than once a week, 53.3% also reported stomach pain and 74.3% reported morning fatigue more than once a week. In an adult study, Maizels & Burchette (2004) reported that patients (n=289, mean age 44.4) with chronic daily headache have a higher prevalence of somatic complaints as compared to those with less frequent headaches. The associated symptoms reported were fatigue (73%), insomnia (60%), nausea/indigestion (55%), extremity pain (49%), dizziness (48%) and back pain (46%). Fichtel & Larsson (2002) studied adolescent headache and its co-morbidity with other pains and found that adolescents who reported headaches at least once a week or more (n=258, 32%) reported the following other frequent pains:

32% muscle pain, 32% back pain, 25% abdominal pain, 23% joint pain, 7% earache and 4% toothache (Fichtel & Larsson, 2002).

Headache has been reported to be an independent risk factor for non-traumatic musculoskeletal pain (El-Metwally et al., 2007). A pain questionnaire was completed by 1756 children (ages 9-13) which assessed musculoskeletal pains (neck, upper limb, chest, upper back, lower back and buttock) during the last three months and questioned if the pain was due to trauma. The questionnaire also identified the presence of symptoms including headache, abdominal pain, feeling sad, daytime tiredness, difficulties in falling asleep, and waking up during the night.

Logistic regression was used to assess the potential risk factors (age, sex, six psychosomatic symptoms as described above, exercise and hypermobility scores) and the logistic models were first fitted with each individual variable separately to estimate the univariate odds ratios (El-Metwally et al., 2007). A total of 1113 children (538 at 9-10 years of age, 575 at 11-13 years of age) were originally identified as pain free. This group was then followed up in one year and completed the same pain questionnaire. Of those, 21.5% (239) reported new episodes of musculoskeletal pain with 19.4% (216) reporting non-traumatic pain, 4.0% (44) reporting traumatic pain and 21% of the children reporting both types of pain (9.7% of the non-traumatic pain group and 47.7% of the traumatic pain group) (El-Metwally et al., 2007). In the univariate analysis all of the psychosomatic symptoms (headache, abdominal pain, feeling sad, daytime tiredness, difficulties in falling asleep, and waking up during the night) were statistically significant risk factors of non-traumatic pain onset. Using multivariate analysis, the significant independent

predictive factors for development of non-traumatic pain were headache (OR=1.68, CI 1.16-2.44) and daytime tiredness (OR=1.53, CI 1.03-2.26) (El-Metwally et al., 2007).

Another study analyzing headache in schoolchildren and its association with other pains found that children with headache reported other physical symptoms more often than those without headache (Laurell, Larsson, & Eeg-Olofsson, 2005). A sub sample of 131 children (70 girls, 60 boys, aged 7-17 years) were randomly selected from 1371 children who previously participated in a questionnaire study on headache prevalence. Children with headache history were asked to grade the occurrence of different pains (abdominal, limb, back, shoulder and neck, chest, face, jaw and chewing pain) into one of four categories: (0) never, (1) seldom, (2) sometimes, or (3) often (Laurell et al., 2005). Differences in those with headache and those without were analyzed using Kruskal-Wallis test. Results demonstrated that those children with headaches reported significantly more neck pain ($\chi^2=9.73, df=2, p<.01$), pain in face and jaws ($\chi^2=7.13, df=2, p<.05$), sleep disturbances ($\chi^2=10.38, df=2, p<.01$), limb pain ($\chi^2=10.21, df=2, p<.01$ and chest pain ($\chi^2=6.17, df=2, p<.05$) than those without headache (Laurell et al., 2005).

One of the most comprehensive reports on adolescent somatic complaints used the Add Health dataset which looked at the prevalence of 10 recurrent physical symptoms in the adolescent population (Rhee, Miles, Halpern, & Holditch-Davis, 2005b). The analysis was based on adolescents ($n=18,722$) participating in the Wave I In-School survey during the 1994-1995 school year. Rhee et al. (2005) evaluated adolescents who experienced the following weekly or more often: headaches, musculoskeletal pain, fatigue, stomachache, frequent sore throat/cough, dizziness, feeling hot, chest pain,

painful/frequent urination, and cold sweats. In terms of prevalence, the top three physical symptoms reported were headaches (28.87%) followed by musculoskeletal pain (27.04%) and fatigue (20.62%). The authors then assessed the simultaneous report of physical symptoms and found 33% of adolescents reported multiple symptoms. Recurrent symptom combinations were also assessed. Recurrent symptom combinations inclusive of headache were: headache/musculoskeletal pain (10.93%, n=2,027), headache/fatigue (9.58%, n=1,1773), headache/stomachache (8.86%, n=1,631), headache/musculoskeletal pain/fatigue (4.52%, 855), headache/stomachache/musculoskeletal pain (4.42%, 810), headache/stomachache/fatigue (4.07%, 771) and headache/stomachache/musculoskeletal pain/fatigue (2.26%, 441). Overall, the research found that 30% of adolescents report recurrent physical symptoms occurring weekly or more frequently and 33% reported multiple symptoms.

Insomnia

Adolescents require at least 8.5 to 9.5 hours of sleep (National Sleep Foundation, 2006). Studies evaluating sleep in adolescents demonstrate that as age increases, sleep duration decreases (Millman, 2005). The relationship between sleep and headaches has been documented in medical literature and clinical texts address sleep as a headache precipitant (Kelman & Rains, 2005; Isik et al., 2007; Gilman et al., 2007). When evaluating risk factors for headaches, identification and treatment of sleep disorders (sleep-disordered breathing, insomnia) will improve headache outcomes (Kelman & Rains, 2005). Studies have shown that when headache patients improve poor sleep habits, mean duration and frequency of headaches were significantly reduced (Bruni, Galli, & Guidetti, 1999).

In a study by Gilman et al. (2007), headache pain intensity and sleep problems were evaluated in a group of adolescents (ages 13 to 17 years) from two pediatric neurology departments. Sixty nine adolescents with headache (90% migraine, 10% tension type) completed the School Sleep Habits Questionnaire (questions regarding sleepiness, sleep/wake behavior problems, depressive mood, preferences for eveningness or morningness) and a standardized headache questionnaire (Gilman et al., 2007). Pearson product moment correlation coefficients were used to examine relationships between headache characteristics and sleep behaviors (Gilman et al., 2007). Significant associations were found between higher headache pain intensity ($r=2.6$, $p<.04$) with longer sleep onset delay (amount of time required to fall asleep). Higher headache pain intensity was also significantly associated with being more likely to stay up all night ($r=.28$, $p<.02$), having extreme difficulty falling asleep ($r=.24$, $p<.05$), and having more nightmares ($r=.32$, $p<.007$) (Gilman et al., 2007). Independent sample t-tests were used to determine if the migraine headache group, tension headache group and chronic daily headache group differed significantly in regard to sleep patterns or behaviors. No significant differences were found between these groups (Gilman et al., 2007).

Parents of children aged 2-12 years were asked to complete a Children's Sleep Habits Questionnaire as well as a standardized questionnaire regarding headache characteristics (Miller et al., 2003). Through parent report, children with migraine demonstrated a significant amount of sleep disturbances including sleeping too little (42%), teeth grinding (29%), child co-sleeping with parents (25%), and snoring (23%). Children with migraines experienced more of these sleep disturbances as compared with the healthy norms. The frequency of migraines was positively correlated to the frequency

of daytime sleepiness ($r=.21, p<.05$) and bruxism (teeth grinding) ($r=.26, p<.01$) and was negatively correlated to sleep duration ($r= -.21, p<.05$). This study suggests the importance of including sleep behavior as a part of headache work-up and demonstrates findings consistent with other studies (Bruni et al., 1997; Bruni et al., 1999).

Bruni et al. (1997) performed a parent survey (a questionnaire of history, clinical data and sleep disturbances) of 283 children and adolescents with headaches and compared the results to 893 comparable normal subjects. Lower sleep duration (<8 hours) was reported by those with migraine (17.68%) and tension type headaches (17.65%) as compared with healthy subjects (9.63%) ($p<0.0005$). A higher percentage of those with headaches, 12.20% (migraine) and 10.92% (tension), reported a higher occurrence of daytime sleepiness (somnolence) as compared with the control group at 4.48% ($p<0.005$) (Bruni et al., 1997).

Bruni et al. (1999) studied children and adolescents (ages 5 to 14 years) with migraine and poor sleep habits. Subjects were randomly assigned to two groups. One group had improved sleep habits and the second group made no changes in sleep habits. The mean duration and frequency of migraine attacks (baseline observation: 234 mean migraine minutes, 3 months follow-up: 78 mean migraine minutes and 6 months follow-up: 65 mean migraine minutes) were significantly reduced in those with improved sleep habits at follow-up while the other group demonstrated no significant reduction in migraine attacks. According to the authors, modification of sleep decreased the number of migraine occurrences in the adolescents resulting in avoidance of medication interventions.

Obesity

Obesity is a known co-morbidity with chronic pain syndromes such as fibromyalgia, back pain and neck pain (Bennett, Jones, Turk, Russell, & Matallana, 2007; Janke, Collins, & Kozak, 2007; Webb et al., 2003). Studies in the adult literature have reported an association between headache frequency and obesity (Bigal, Liberman, & Lipton, 2006; Scher, Stewart, Ricci, & Lipton, 2003). Scher et al. (2003) studied factors that predicted chronic daily headache onset in an adult population. Using univariate comparisons, the researchers found a significant association between chronic daily headache and obesity (1.34, 95% CI 1.0 to 1.8; $p < .05$). Bigal et al. (2006) also found a significant association with the number of headache days/month (10-15 headache days) and obesity. Using normal weight as a reference, only 4.4% of the normal weight group reported 10-15 headache days/month as compared with the following groups: 5.8% of the overweight group (OR 1.3, 95% CI 1.1 to 1.9), 13.6% of the obese group (OR 2.9, 95% CI 1.9 to 4.4), and 20.7% of the morbidly obese group (OR=5.7, 95% CI 3.6 to 8.8).

Obesity has also been reported in the literature as a modifiable risk factor in adolescent migraine headache (Fanciullacci & De, 2005). Studies have evaluated and reported associations between overweight youth and adolescent headache (Hershey, 2006; Pinhas-Hamiel et al., 2008; Hershey et al., 2009). Results of one the first such studies were reported at the 48th Annual Scientific Meeting of the American Headache Society in Los Angeles (Hershey, 2006). Hershey (2006) reported that headaches in overweight youth occur more frequently. The study evaluated 466 children (ages 3-18) referred to a pediatric headache center. Those children diagnosed with headaches were 36% more likely to be overweight than children in the general population.

Pinhas-Hamiel et al. (2008) assessed the association between obesity and headache in children and adolescents aged 9-17 years of age (n=273, female=166, male=107). The subjects were asked questions regarding headache type. Measurement of height and weight for each subject was obtained and BMI was calculated. Evaluation of the 273 participants revealed that 116 (42.5%) were of normal weight, 45 were overweight (16.5%) and 112 (41%) were obese (Pinhas-Hamiel et al., 2008). Headaches occurred in 20 of the 112 overweight children (17.9%), 7 of the 45 children at risk for overweight (15.6%), and 12 of the 116 normal weight children (10.3%) (Pinhas-Hamiel et al., 2008). Using ANOVA, significant relationships were found between gender and weight group. For females, 7.7% of the “normal weight” group reported headaches, as compared with 14.8% of those females “at risk for overweight” and 20.3% of “overweight” females ($p=.04$) (Pinhas-Hamiel et al., 2008). Headache occurrence for males was similar across all three weight groups ($p=0.96$).

Multivariate logistic regression analysis was performed to determine predictors of headache using the following variables in the final model: age group (9-11, 12-14, 15-18 years), gender, weight group (normal, overweight, obese), and blood pressure (normal, pre-hypertension, hypertension), with gender and obesity group entered as one combined variable (due to the above trends in headache in obesity groups among males and females) (Pinhas-Hamiel et al., 2008). No significant relationships were found between headache and elevated blood pressure or male gender in all three weights, however, a significant risk for headache was present in adolescents (15-18 years of age) (OR = 2.62, 95% CI 1.07-6.45) (Pinhas-Hamiel et al., 2008). Thus, overweight adolescents had an increased risk of headaches when compared with normal weight adolescents.

Hershey et al. (2009) studied the relationship between BMI and headache frequency and the effect of weight change on pediatric headache outcomes. Data were collected on pediatric headache patients from 7 pediatric headache centers at initial visit and then at 3 month (n=213) and 6 month (n=174) follow up for comparative analysis. Data collected include height, age, weight, gender, and headache frequency. BMI percentiles were calculated using height, weight, age and gender. Correlation analysis was used to evaluate the relationship between BMI percentiles and headache presentation (Hershey et al., 2009). There was a significant positive correlation between BMI percentile and headache frequency ($r=0.10$, $p=.003$). The sample was then divided into non-overweight (BMI percentile <85) and overweight (BMI at or above the 85 percentile) groups. Within the overweight group, changes in raw BMI scores were significantly positively correlated with change in headache frequency at 3 month follow-up ($r=0.32$, $p=.01$) (Hershey et al., 2009). There was not a significant correlation within the non-overweight group and headache frequency at 3 month follow-up ($r=0.04$, $p>.05$) (Hershey et al., 2009). Findings were also significant at 6 month follow-up with changes in raw BMI scores being significantly positively correlated with changes in headache frequency in the overweight group ($r=0.34$, $p=.01$) and not significantly correlated in the non-overweight group ($r=-0.04$, $p>.05$) (Hershey et al., 2009).

Multivariate Analysis and Predictors of Adolescent Headache

Only a few studies analyzed predictors of recurrent adolescent headache using multivariate analysis (rather than univariate) (Larsson, 1988; Laurell et al., 2005; Kroner-Herwig, Morris, & Heinrich, 2008). Larsson (1988) studied 70 adolescents with recurrent tension headache (male=7, female=63) and compared them with matched headache free

controls. The adolescents were chosen from four high schools in Uppsala, Sweden.

Predictors of tension headache were analyzed and included sociodemographic (parental socio-economic status, parental marital status, custody status, students' residence, part time work, school grades); psychological problems (satisfaction with parents, peers and school, truancy, fears, anxiety/depression, stress, student nervous problem, parental nervous problem); health behaviors (psychomotor development, eating habits, sleeping habits, physical activity, use of tobacco, alcohol and narcotics, homework time); and medical (perinatal risk factors, illnesses, family illness, parental pain, headache characteristics, somatic symptoms, use of health services) (Larsson, 1988). Adolescents in this study had tension type headache greater than once a week and lasting a year.

Univariate analysis demonstrated significance for the following predictors: nervous problems ($p < .010$), anxiety ($p < .01$), stress ($p < .01$), divorce ($p < .01$), parent rating of student depression ($p < .01$), somatic symptoms ($p < .01$), school absence ($p < .01$), school nurse visits ($p < .01$), homework time ($p < .01$), and parent report of headache ($p < .01$). Only those variables with a p value $< .01$ were selected for the multivariate model (family relationship, parental nervous problem, teacher rating of student depression, smoking and parent rating of abdominal pain did not meet criteria for the model). The final multivariate model included: psychosocial variables (nervous problems, anxiety and depression); health behaviors (homework time) and medical (somatic symptoms, school absence due to pain).

Although several predictors were analyzed, this study did not control for the effects of age, gender or race and only 7 males participated in this study. The p value for variables included in the model was $p < .01$ [as opposed to the $p < .25$ criteria suggested by

Hosmer & Lemeshow (2000)], which inhibited testing of more variables for the final model.

Laurell et al. (2005) interviewed school children ages 7-15 years old (female 69, male 59) who were randomly selected from 1371 children participating in a study on headache prevalence from Uppsala, Sweden (one class from every grade of first thru ninth grade were chosen at random from each of the eight districts of the city). The purpose of the study was to identify associations between headache, family history of pain (first degree relative with history of migraine; unspecified headache; abdominal, limb, back, shoulder, neck, jaw, or chest pain; sleeping disturbance, tiredness, vertigo), and psychosocial factors (Child Behavior Check List, family situation including divorce) (Laurell et al., 2005). Those adolescents who met the criteria for tension type or migraine headache were chosen for the study. All other adolescents were classified as not having headache.

Bivariate analysis demonstrated the following as significant associations: age, gender, visits to school nurse, medication, injuries, total number of frequent symptoms, somatic complaints in CBCL, migraine among first degree relatives, and total number of symptoms among first degree relatives. The final model for adolescent recurrent headache demonstrated that the strongest predictors of headache included migraine among first degree relatives ($OR=2.83$, $CI_{95\%}=1.22-6.54$, $p<.05$) and total sum of physical symptoms (abdominal, limb, back, shoulder, neck, chest, face, jaw, chewing pain, sleep disturbances, tiredness and vertigo) ($OR=1.22$, $CI_{95\%}=1.09-1.36$, $p=0.01$). This study demonstrated migraine in first degree relatives and clustering of pain and physical symptoms to be the strongest predictors of headache in children. (Laurell et al.,

2005). Higher levels of depression and anxiety were not reported in those children who complained of headache. Children with headache in this sample reported mainly infrequent (≤ 3 headaches per month) and moderate headache, which may explain the insignificant association of depression/anxiety as reported in previous studies (Laurell et al., 2005).

Kroner-Herwig et al. (2007) analyzed 4043 adolescents randomly drawn from a population sample of families with children ages 9-14 from four districts of Lower Saxony and the city of Hannover, Germany. The purpose of the study was to identify bio-psychosocial risk factors for headache in children and adolescents using multinomial logistic regression (Kroner-Herwig et al., 2008).

Headache frequency in the past 6 months (less than monthly, 1/month, and 1/week) was evaluated. Variables assessed included the following: health related variables (global health, somatic symptoms, pain symptoms, chronic disease, parental headache); socioeconomic (single parent home, financial burden, working status of parent, housing space); family environment (family time together, quarreling, parental solicitousness, dysfunctional child rearing); school environment (school stress, number of school problems, time for homework, fear of failure); leisure/peer activities (physical/cognitive activities, free time, TV, time with friends, number of friends); psychological variables [depression/anxiety, dysfunctional coping, dysfunctional health behavior (tobacco, alcohol)]; hyperactivity, aggressive behavior, satisfaction with life, anger expression, anxiety sensitivity).

The model for the study included the following significant predictors for <1 headache per month over the past 6 months: health related variables [global health status

(OR 1.23; CI_{95%} 1.04-1.45), somatic symptoms (OR 1.09; CI_{95%} 1.05-1.13), pain symptoms (OR 1.24; CI_{95%} 1.15-1.34), and parental headache (OR 1.96; CI_{95%} 1.63-2.36)]; leisure/peer activities [number of friends (OR 1.29; CI_{95%} 1.07-1.54)]; and age (OR 1.10; CI_{95%} 1.04-1.16).

The model reporting significant predictors for 1 headache per month in the past 6 months included: health related variables [global health status (OR 1.54; CI_{95%} 1.27-1.86), somatic symptoms (OR 1.19; CI_{95%} 1.14-1.23), pain symptoms (OR 1.43; CI_{95%} 1.32-1.55), and parental headache (OR 2.61; CI_{95%} 2.08-3.26)]; leisure/peer activities [number of friends (OR 1.36; CI_{95%} 1.10-1.68)]; psychological variables [anxiety sensitivity (OR 1.17; CI_{95%} 1.03-1.33)]; and age (OR 1.10; CI_{95%} 1.04-1.19).

Finally, the model for children and adolescents reporting one headache per week over the past 6 months reported the significant predictors as follows: health related variables [global health status (OR 1.89; CI_{95%} 1.53-2.32), somatic symptoms (OR 1.26; CI_{95%} 1.20-1.31), pain symptoms (OR 1.53; CI_{95%} 1.40-1.67), and parental headache (OR 2.13; CI_{95%} 1.66-2.73)]; socioeconomic variables [financial burden (OR 1.41; CI_{95%} 1.08-1.86)]; family variables [quarreling (OR 1.55; CI_{95%} 1.1--2.20), parental solicitousness (OR .85; CI_{95%} .74-.97)]; leisure/peer activities [free time to play (OR .87; CI_{95%} .77-.98), number of friends (OR 1.73; CI_{95%} 1.36-2.19)]; psychological variables [anxiety sensitivity (OR 1.25; CI_{95%} 1.09-1.42)], and age (OR 1.08; CI_{95%} 1.00-1.16).

This study did not report on the p-value value for variables included in the model.

More than 30 variables were used in the regression analysis, 19 remained in the comprehensive model and only 11 contributed significantly to the model (Kroner-Herwig et al., 2008). In reviewing the variables assessed in the survey, sleep problems were

among predictors in the somatic complaint category (total 8 items) and were not assessed separately. Sleep problems may be an outcome due to “time for homework”, “time spent with friends”, “depression” or “hyperactivity”- all of which were variables assessed by the survey. Any relationships between sleep and other variables assessed in the study could not be directly assessed. When looking at more than 30 variables, such relationships should be considered among all the variables measured.

The above studies looked at a multivariate analysis for determining predictors of recurrent headache. Each study took a different approach in headache type and occurrence. The first study looked at mainly recurrent tension headache (Larsson, 1988). In the second study, the headache types evaluated included both migraine and tension type headache in those adolescents with infrequent headache pain (Laurell et al., 2005). In the third study, headache frequency ranging from less than monthly to weekly in the past 6 months was evaluated (Kroner-Herwig et al., 2008). Comparisons between studies need to take into account the differences in headache type and headache frequency between the studies. In the study by Laurell et al. (2005), the purpose of the study was to identify associations between headache, pain and psychosocial factors; whereas, the other studies looked at associations between headache and school issues, family functioning, socioeconomic variables, peer activities, hyperactivity and so forth (Kroner-Herwig et al., 2008; Larsson, 1988). Differences in predictors also make comparisons between studies difficult. The above studies evaluated adolescents in Sweden (Larsson, 1988; Laurell et al., 2005) and Germany (Kroner-Herwig et al., 2008). Thus, when comparing findings with US adolescents, location of the above studies needs to be taken into account.

Summary

This review began by discussing the occurrence of recurrent headache in the adolescent population. The review then discussed adolescent health promotion and illness prevention literature in regard to the importance of addressing the lifestyle behaviors and illness related factors specific to this study in the adolescent population. The review of literature also addressed studies demonstrating an association of each individual lifestyle behavior and each individual illness related factor with adolescent recurrent headache. Finally, previously reported multivariate models of predictors of adolescent headache were also reported. Although multivariate models were constructed, the predictors were not inclusive of the lifestyle behaviors (skipping meals, water intake, tobacco use, alcohol use, and physical activity) and illness related factors (depression, somatic complaints, insomnia and obesity) addressed in this research study of US adolescents with recurrent headache. The above review demonstrated that a gap exists in the literature evaluating how lifestyle behaviors and illness related factors work together to predict recurrent adolescent headache.

The literature review also included studies regarding relationships between recurrent adolescent headaches, depression, and somatic complaints using the Add Health dataset (Rhee, 2000; Rhee et al., 2005a; Rhee et al., 2005b). However, those studies did not look specifically at Wave II data (the focus for this study) nor did the studies evaluate the interrelationships of recurrent adolescent headache with lifestyle behaviors and illness related factors (skipped meals, water intake, use of tobacco and alcohol, physical activity, depression, somatic complaints, insomnia and obesity). This study was designed to

analyze the associations of lifestyle behaviors and illness related factors as predictors of recurrent adolescent headache.

Chapter 3

Methodology

The purpose of this research was to study adolescent health in terms of recurrent headache and explore the relationship between lifestyle behaviors, illness related factors and recurrent adolescent headache using the National Longitudinal Study of Adolescent Health (Add Health). This chapter will present an overview of Add Health. The following will include sampling and data gathering procedures used in developing the Add Health database. The design of the present study will then be discussed which will include justification of the predictor variables, operational definitions of the outcome variable (recurrent headache) and operational definitions of the predictor variables (skipped meals, water intake, tobacco and alcohol use, physical activity, depression, somatic complaints, insomnia and obesity) used in this analysis.

Overview of the Add Health Study

Data were obtained from the Add Health study conducted by the Carolina Population Center of the University of North Carolina at Chapel Hill with J. Richard Udry as the principal investigator (Harris et al., 2003). Add Health is a nationally representative school-based survey of 7th through 12th grade adolescents conducted between 1994 and 1996. The purpose of the Add Health project was to assess the health status of adolescents as well as explore the causes of adolescent health-related behaviors (Bearman, Jones, & Udry, 1997).

Sampling

Stratification and Cluster Sampling

Quality Education Data, Inc. provided the database for the primary sampling frame which included all United States (U.S.) high schools with an 11th grade and an enrollment of greater than 30 students (N=26,666). A list of the 26,666 U.S. high schools was then sorted or stratified into 80 clusters by region (Northeast, Midwest, South, West), urbanicity (urban/suburban/rural), school type (public/private/parochial), percent white (0, 1 to 66, 67 to 93, 94 to 100), enrollment size (<125, 126-350, 351-775, >=776 students) and grade span (those schools with an 11th grade) (Bearman et al., 1997; Chantala & Tabor, 1999; Chantala, 2006). Thus, school is the cluster identifier or primary sampling unit (PSU). Unlike simple random and stratified sampling where single subjects are chosen from the population, cluster sampling subjects are selected in groups or clusters. Cluster sampling enables the researcher to overcome the constraints of costs and time associated with large dispersed populations. The clustered sampling design was school based since this was considered the best way to screen for the respondents of interest (adolescents) (Bearman et al., 1997).

When clustering participants in schools, the following outcomes were recognized (Chantala, 2003): students sampled from the same schools will respond more alike than students sampled from different schools, students from the same schools are not statistically independent and identically distributed, responses typically demonstrate positive correlations within a cluster (school), and variance of sampling statistics is usually increased with cluster sampling.

Unequal Probability of Selection

A sample of 80 US high schools was selected systematically from this list with probability proportional to enrollment size (Chantala, 2006). Probability proportional to enrollment size means that high schools with higher enrollments had a greater chance of selection (i.e. if one sampling unit is twice as large as another it is given twice the chance of being selected) (Tourangeau & Shin, 1999). Since the study used systematic sampling (every n^{th} record) on a sorted (stratified) list, this assured that the sample was representative and is referred to as implicit stratification (Tourangeau & Shin, 1999).

Fifty-two feeder schools contributing students to the high schools without 7th or 8th grades were selected randomly with the feeder's probability of selection proportional to percentage of the number of students it contributed to the given high school (i.e. a feeder school that contributed $\frac{1}{4}$ of an entering freshman class to a sample high school had a selection probability of .25) (Rhee, 2002; Chantala, 2003; Tourangeau & Shin, 1999). Those high schools which spanned grades 7 through 12 functioned as their own feeder schools and the "pairing" was considered a single school (Bearman et al., 1997). Therefore, 132 schools- 80 high schools (one from each cluster) and 52 feeder schools - were included in the core study. Replacement schools were chosen from the stratum if a school originally chosen refused to participate (28 schools refused and were replaced by replacement schools). The replacement school was the school next in line following the initial sample school in the sorted (stratified) file (Tourangeau & Shin, 1999).

Sampling Weights

What also must be recognized is the use of sampling weights in the Add Health dataset. Sampling weights were calculated into the Add Health dataset for four main reasons (Tourangeau & Shin, 1999):

1. to allow the sample totals to serve as estimates of population totals. For example, members of the Wave II samples did not have identical selection probabilities; thus, without weights, projections to the population they are intended to represent will be biased;
2. to compensate for differences in selection probabilities across different members of a sample. For example, large schools were more likely to be selected for the Add Health sample than small schools, Cubans from large schools were more likely to be included than Cubans from small schools. Without the weights, results would reflect this over-representation of Cubans from the larger schools.
3. to compensate for differences in response rates across different subgroups of the sample. For example, even if the sample as selected is representative of the population, the sample of completed cases may differ from the population due to nonresponse. Weights can offset the effects of differential rates of nonresponse across different subgroups of the sample.
4. to adjust for chance fluctuations of the composition of the sample from the composition of the population as a whole.

Analytical methods appropriate for evaluating complex large survey datasets with stratification, clustering of students, unequal probability of selections and sampling weights are needed to compute unbiased estimates of variance and standard errors (Chantala, 2006). Table 2 illustrates Add Health sampling design attributes. Table 3 illustrates sampling weights created for everyone in the probability sample for the Wave II. These weights are appropriate for cross sectional analysis and will be used in this analysis.

Table 2 Add Health Sampling Design Attributes

Add Health Sampling Design Attributes

Design Attribute	Usual Impact on Analysis	Variables Provided with Add Health Data to Adjust for the Sampling Design
Stratification	Reduce Variance	POSTSTRATIFICATION VARIABLE: Census Region
Clustering of Students	Increase Variance	PRIMARY SAMPLING UNIT VARIABLE: School Identification Variable
Unequal Probability of Selection	Increase Variance	SAMPLING WEIGHTS: - Cross-sectional Weights for Schools - Cross-Sectional Weights for analyzing each Wave of Data

Chantala, K. (2006). Guidelines for analyzing ADD Health data. Carolina Population Center [On-line]. Available: <http://www.cpc.unc.edu/projects/addhealth/design.html>

Table 3 Sampling Weights Used in Cross Sectional Design Analysis*Sampling Weights Used in Cross Sectional Design Analysis*

Population of Interest	Data Used	Number of Participants in Analysis File	Sampling Weight
Adolescents in 1995 enrolled in Grade 7-12 during 1994-1995	Wave I	18,924	GSWGT1
Adolescents in 1996 Enrolled in Grade 7-11 During 1994-1995	Wave II	13,570	GSWGT2

Chantala, K. (2006). Guidelines for analyzing ADD Health data. Carolina Population Center [On-line]. Available: <http://www.cpc.unc.edu/projects/addhealth/design.html>

Collection of Data

To ensure confidentiality, no paper questionnaires were used and all data were recorded on laptop computers for the in home interviews. The interviewer read the questions and entered the respondent's answers for the less sensitive questions. For the more sensitive questions (i. e. questions regarding sexual behavior and substance abuse), the respondents listened to pre-recorded questions and entered the answers directly into the computer using Audio-CASI (audio enhanced-computer assisted self interviewing) software (Bearman et al., 1997). Audio-CASI allows respondents to feel less inhibited when answering sensitive questions since subjects wear headphones and record data on a laptop computer. Other advantages to using Audio-CASI include consistency of interviews using the same voice, asking the same question in the same sequence; low literacy is not a problem since subjects can listen to questions and responses are via keyboard entry; and cost reduction since fewer staff are needed for the interviews (Morse,

2006). Each interview lasted approximately 1 to 2 hours and all respondents were given the same interview.

A signed consent was obtained from the adolescent's parent or guardian as well as the adolescent's signed assent prior to the in-home interview. Procedures and questionnaires used in the Add Health database were approved by the Institutional Review Board for the Protection of Human Subjects (IRB) (Rhee, 2000).

Add Health collected multiple surveys on adolescents recruited from these schools: In-School Questionnaire, Wave I In-Home Interview and Wave II In-Home Interview. Although the focus for this study is the Wave II In-Home interview, sampling for this survey was derived from the In-School Questionnaire and the Wave I In-Home Interview. Therefore, it is important to describe sampling for both in order to understand Wave II sampling.

In-School Questionnaire (1994)

An in-school questionnaire was completed by 90,118 students and consisted of a self-administered instrument formatted for optical scanning (Bearman et al., 1997). The questionnaire was administered to students in grades 7 to 12 from September 1994 through April 1995 in which a 45 to 60 minute class period was devoted to completing the questionnaire (Bearman et al., 1997). Parents were informed in advance of the study and were given the opportunity to direct that their children not participate (Bearman et al., 1997).

Wave I In-Home Sample

Main (Core) Sample. As described above, an in-school questionnaire was completed by more than 90,000 students in grades 7 to 12 from September 1994 through April 1995. Although there was no “makeup” day for students not present, students not completing the questionnaire but who were listed on a school roster were still eligible for selection into the main (core) in-home sample. Students in each school were stratified by grade and sex and about 17 students were chosen randomly from each strata for a total of approximately 200 adolescents selected from each of the 80 pairs of schools for the first in-home interview (Bearman et al., 1997). The number of eligible adolescents from the core sample was 15,243, of those, 12,105 (79.5%) participated in the Wave I home interview (Rhee, 2002).

Special over-sample. At the time of sample selection, additional students were sampled on a non-probability basis among adolescents enrolled in one of the sample schools (Rhee, 2002). The special over-sample included: ethnic, disabled, genetic and saturation (sampling all students in a chosen school) (Bearman et al., 1997). Over-sampling for ethnicity allows for analysis of a specific subset of an ethnic population (i.e. performing an analysis of Asians only). The ethnic over-sample was based on self-reported data from the in-school questionnaire and included Black adolescents from well-educated families with a college educated parent (1,038), Chinese adolescents (334), Cuban adolescents (450), and Puerto Rican adolescents (437). Saturation refers to sampling all students from 16 schools. The saturation over-sample was implemented due to Add Health’s interest in social networks, thus, 16 schools were chosen from which all enrolled students were chosen for the in-home interviews: two large schools (total

enrollment 3,300) and 14 small schools (fewer than 300 total enrollment). The over-sample of disabled adolescents (589) was supposed to identify those students with a physical disability involving their limbs; however, when interviewed at home, many of those adolescents who stated they had such problems did not have a limb disability. The genetic sample consisted of sibling pairs residing in the same household: twins (2658), siblings of twins (208), and other full siblings (1611), half siblings (1177), non-related adolescents (491) and adoptees (394). This over-sample would make it possible to differentiate between parental social influence, parental genetic influence, and assess which environmental influences are shared among siblings. Due to the small sample size of sibling pairs using only the students from 132 schools, researchers had to augment the genetic sample with adolescents not part of the original sampling frame (Chantala & Tabor, 1999). A total of 8,640 adolescents were interviewed as a special over-sample (Rhee, 2002).

Wave I In-Home Interview (1995)

The in-home interview was conducted between April and December 1995. Interviews took one to two hours and each respondent was given the same interview. All responses were recorded on lap-top computers for confidentiality as previously described. Some of the topics of the in-home interviews included: health status, health utilization, nutrition, decision-making processes, and substance use.

Wave II In-Home Sample and Interview (1996)

Sampling for the Wave II in-home interview consisted of those adolescents responding to the Wave I in-home interview with the following exceptions: respondents

in the 12th grade at Wave I and not part of the genetic sample and respondents who were only in the Wave I disabled sample (Bearman et al., 1997).

The Wave II in-home surveys were conducted from April through August 1996. Interviews were similar to those of Wave I except questions regarding attributes (ethnicity) which are not expected to vary over time were not repeated; physical and functional limitations were not repeated (the disabled were not re-interviewed); and the adolescents were actually weighed and measured by the interviewer. Of the 20,745 adolescents who participated in Wave I (inclusive of the core and over-samples), 14,738 (71%) completed the Wave II In-Home interviews- 9,141 (62%) of the main sample and 5,597 (38%) of the over-sample) (Rhee, 2002). Sampling procedures are illustrated in Figure 1.

Figure 1 Add Health Sampling ProcedureAdd Health Sampling Procedure

Rhee, H. (2002). Physical Symptoms in US adolescents: Prevalence and patterns. University of North Carolina, Chapel Hill.

Design of the Present Study

This is a cross-sectional descriptive, exploratory study using secondary data analysis from the Add Health database.

Choosing Predictor Variables

When working with large datasets, many variables are at the disposal of the researcher to consider as predictive, however, without a theoretical basis, such variables are likely to be *junk variables* rather than good predictive variables (Dranove, 2009).

According to Dranove (2009) the following risks occur with the use of poorly chosen predictor variables: the junk variable may be significant due to random chance, a junk variable can affect interpretation of coefficients of other variables, and multicollinearity may occur between the junk variable and a valid predictor variable which may result in elimination of the valid predictor from the model.

Determination of lifestyle behaviors and illness related predictor variables used in the logistic regression analysis was guided by both the adolescent health promotion literature as well as the empirical studies addressing recurrent adolescent headache. Each predictor variable regarding lifestyle behaviors and illness related factors is a documented reported behavior or factor in the adolescent health promotion literature. Empirical studies also support the association of each predictor variable with adolescent headache. When developing a logistic regression model, reliability of the model is dependent upon application of a theoretical rationale when choosing predictor variables (Drakos, Moore, & Brant, 1999; Kleinbaum & Klein, 2002; Dranove, 2009). Establishment of a theoretical basis for the use of each predictor (as demonstrated in the review of literature) increased the likelihood of a reliable foundation for evaluation and development of a meaningful adolescent recurrent headache model.

Measurements

Operational Definitions

Adolescent responses (15,000) to Add Health questions regarding headache frequency, lifestyle behaviors (skipped meals, water intake, tobacco and alcohol use, physical activity) and illness related factors (depression, somatic complaints, insomnia

and obesity) were used in this analysis. Operational definitions of these variables are provided below:

Recurrent headache-Those adolescents who answered “once a week to every day” to the following question: How often have you had a headache in the past twelve months?

Skipped meals- Those adolescents who skipped breakfast three or more times per week, skipped breakfast two or more times per week, or skipped breakfast one or more times per week when asked the following : In the last 7 days, on how many days did you eat breakfast?

Those adolescents who skipped lunch three or more times per week, skipped lunch two or more times per week, or skipped lunch one or more times per week when asked the following : In the last 7 days, on how many days did you eat lunch?

Those adolescents who skipped supper three or more times per week, skipped supper two or more times per week, or skipped supper one or more times per week when asked the following : In the last 7 days, on how many days did you eat supper?

Water intake- Those adolescents who answered “no” to the following question:

Think about everything you had to drink yesterday, did you drink water?

Smoke regularly- Those adolescents who answered yes to the following question: Have you smoked cigarettes regularly, that is, at least one cigarette every day for 30 days?

Binge drink- Those adolescent who answered greater than or equal to “2 to 3 days per month” to the following question: Over the past 12 months, on how many days did you drink five or more drinks in a row?

Physical activity- Those adolescents who responded to the following: During the past week, how many times did you play an active sport, such as baseball, softball, basketball,

soccer, swimming, or football (responses: not at all, 1 or 2 times, 3 or 4 times, 5 or more times)?

Depression- The scores on the Center for Epidemiologic Studies Depression Scale (CES-D) will be used to measure depression (Radloff, 1977) which will be described in further detail below.

Somatic complaints- Those adolescents who answered “about once a week” or more to the following questions:

How often have you had each of the following conditions in the past 12 months-
chest pains?

aches, pains, or soreness in your muscles or joints?

Insomnia- Those adolescents who answered almost every day to daily to the following question: In the past 12 months how often have you had trouble falling asleep or staying asleep?

Obesity- Body Mass Index (BMI) according to height, weight and sex will be calculated using the parameters set by the Centers for Disease Control (CDC) to determine if an adolescent is overweight which will be described in further detail below (CDC, 2006).

Table 4 provides a summary of the variables assessed in this analysis.

Table 4 Variables Assessed by Add Health and Used in the Analysis*Variables Assessed by Add Health and Used in the Analysis*

<u>Child (Self-Report)</u>	<u>Items and Response Characteristics</u>
<i>Outcome Variable</i>	
Recurrent Headache	0=never,just a few times; 1=once a week,almost every day, daily
<i>Dependent Variables</i>	
<i>Demographics</i>	
Gender	1=Male; 2*=Female
Age Group	1=11 through 14; 2=18 through 19; 3*=15 through 17
Race/Ethnicity	1=Hispanic; 2=African American; 3=American Indian; 4=Asian; 5=Other; 6*=White
<i>Lifestyle Behaviors</i>	
Skip Breakfast three or more times	1=0 days through 4 days; 2*= 5 days through 7 days
Skip Breakfast two or more times	1=0 days through 5 days; 2*= 6 days through 7 days
Skip Breakfast one or more times	1=0 days through 6 days; 2*= 7 days
Skip Lunch three or more times	1=0 days through 4 days; 2*= 5 days through 7 days
Skip Lunch two or more times	1=0 days through 5 days; 2*= 6 days through 7 days
Skip Lunch one or more times	1=0 days through 6 days; 2*= 7 days
Skip Supper three or more times	1=0 days through 4 days; 2*= 5 days through 7 days
Skip Supper two or more times	1=0 days through 5 days; 2*= 6 days through 7 days
Skip Supper one or more times	1=0 days through 6 days; 2*= 7 days
No Water	1=No; 2*= Yes
Smoke Regularly	1=Yes; 2*=No
Binge Drink	1=2 or 3 days/month through daily; 2*=≤1 or 2 days in the past 12 months
Physical Activity	1=not at all; 2=1 or 2 times/wk; 3=3 or 4 times/wk; 4*=5 or more times/wk
<i>Illness Related Factors</i>	
Depression	Male: 1=Modified CES-D score ≥22; 2*=Modified CES-D score<22 Female: 1=Modified CES-D score ≥24; 2*=Modified CES-D score<24
Chest Pain	1=about once a week,almost every day,every day; 2*=never,just a few times
Muscle/Joint Pain	1=almost every day,every day; 2*=never,just a few times,about once a week
Insomnia	1=about once a week,almost every day,every day; 2*=never,just a few times
BMI	1=Underweight(less than 5 th percentile; 2=Healthy weight (5 th percentile to less than 85 th percentile); 3=At risk of overweight (85 th to less than 95 th percentile); 4*=Overweight/Obese (equal to or greater than the 95 th percentile)

* Reference category of item in regression analysis.

Recurrent Headache

The focus of this research was recurrent headache as defined by number of headache days per month ranging from “about once a week” to “every day”. Adolescents were asked how often they had headaches in the past 12 months. The responses included “never”, “just a few times”, “about once a week”, “almost every day”, and “every day”. The responses of “never” and “just a few times” will represent those with no headache since “never” refers to no headache and the response of “just a few times” does not fit the frequency criteria for any of the recurrent headache types. The responses of “about once a week”, “almost every day” and “every day” will represent those with recurrent headache since such responses fit the frequency criteria of the recurrent headache types.

The recurrent headache types are defined as 5 or more headache episodes (migraine), 10 or more episodes (tension headache) or 15 or more headache days/month (chronic daily headache) (Hershey, 2005). Thus, adolescents who experienced headaches once a week or more often in the past twelve months (at least 52 or more headaches a year) will be classified as having recurrent headache. There is no attempt to describe specific recurrent headache types (i.e. migraine, migraine with aura, tension type or chronic daily headache). The dataset only addresses headache frequency and does not include descriptions or clinical features needed to characterize the specific recurrent headache types.

The respondents included in the study were adolescents with recurrent headache. The in-home interview asked adolescents to rate the frequency of having experienced a headache in the past 12 months, using a five point scale: (0) never, (1) just a few times, (2) about once a week, (3) almost every day, and (4) every day. Frequencies were

dichotomized as “recurrent headache” (1) if the adolescent answered 2-4 (once a week or more) or “no recurrent headache” (0) if the headache occurred just a few times or never.

Lifestyle behaviors

Skipped Meals

This study focused on five lifestyle behaviors described in the Wave II Add Health in-home questionnaire. The lifestyle behaviors were: skipping meals, water intake, tobacco and alcohol use and physical activity. These were chosen based on their associations with recurrent headaches as reported in the literature.

In home interviews asked adolescents “In the last 7 days, on how many days did you eat breakfast?”. Responses ranged from 0 days to 7 days. To meet the criteria for the variable “SKIPBREAKFAST3” or those who skip breakfast 3 or more times a week, adolescents would have marked responses “0 days, 1 day, 2 days, 3 days or 4 days” for the number of days they ate breakfast. To meet the criteria for “SKIPBREAKFAST2” or those who skip breakfast 2 or more times a week, adolescents would have marked responses “0 days, 1 day, 2 days, 3 days, 4 days or 5 days” for the number of days they ate breakfast. Finally, to meet the criteria for the variable “SKIPBREAKFAST1” or those who skip breakfast 1 or more times a week, adolescents would have marked responses “0 days, 1 day, 2 days, 3 days, 4 days, 5 days, or 6 days” for the number of days they ate breakfast.

The variable for skipping breakfast 3 or more times was dichotomized as “SKIPBREAKFAST3” (1) if the adolescents answered 0 days up to 4 days or “NO SKIPBREAKFAST3” (2) if the adolescents answered 5 days up to 7 days. The variable for skipping breakfast 2 or more times was dichotomized as “SKIPBREAKFAST2” (1)

if the adolescents answered 0 days up to 5 days or “NO SKIPBREAKFAST2” (2) if the adolescents answered 6 days up to 7 days. The variable for skipping breakfast 1 or more times was dichotomized as “SKIPBREAKFAST1” (1) if the adolescents answered 0 days up to 6 days or “NO SKIPBREAKFAST1” (2) if the adolescents answered 7 days.

In home questions regarding lunch and supper had similar responses and were dichotomized as the above variables for breakfast (Table 4).

Water Intake

If the adolescent had no water on the previous day each frequency report was dichotomized as “no water” (1) or “yes water” (0) if the adolescent did have water (answered yes) for the previous day.

Tobacco Use

The in-home interviews also included adolescent tobacco and alcohol use. Adolescents were asked “Have you smoked cigarettes regularly, that is, at least one cigarette every day for 30 days?” Frequencies were dichotomized as “smoker” (1) if the adolescent reported that they smoked regularly or “no smoker” (0) if the adolescent reported that they did not smoke regularly.

Alcohol Use

Adolescents were also asked how many days they drank five or more drinks in a row over the past 12 months and responses included (1) every day or almost every day, (2) 3 to 5 days a week, (3) 1 or 2 days a week, (4) 2 or 3 days a month, (5) once a month or less, (6) 1 or 2 days in the past 12 months or (7) never. Frequencies were dichotomized as “drink” (1) if the adolescents answered 1-4 and “no drink” (0) if the adolescents answered 5-7.

Physical Activity

Adolescents were asked “During the past week, how many times did you play an active sport, such as baseball, softball, basketball, soccer, swimming, or football?” and responses included (0) not at all, (1) 1 or 2 times, (2) 3 or 4 times, or (3) 5 or more times. Responses for “ACTIVESPORT” were not dichotomized.

Illness related factors

Instrument: Center for Epidemiological Studies Depression Scale (CES-D)

The CES-D assesses depressive symptoms and was designed for use in general population surveys (Radloff, 1977). This scale is a 20-item self report that provides a unitary measure of current depressive symptomatology with an emphasis on the affective component of depression, feelings of guilt and worthlessness, feelings of helplessness, psychomotor retardation, and loss of appetite (Rhee, 2002; Windle, 1992).

The CES-D measures the current state of depressive symptoms and to emphasize this participants are asked: “*How often was each of the following things true during the past seven days?*”. Although the full version of the CES-D is a 20-item self report, the Add Health study removed two items: “*my sleep was restless*” and “*I had crying spells*”. Add Health then added one item regarding worthlessness: “*you felt life was not worth living*”. Each of the 19 questions consists of a 4 point response system and is scored from 0 (never or rarely) to 3 (most or all the time). According to (Radloff, 1977), in order to “break tendencies toward response set” (continuously ask for responses based on questions worded in a negative direction) as well as the presence or absence of positive affect, four items were worded with a positive direction: “*you felt you were just as good*

as other people", "you felt hopeful about the future", "you were happy" and "you enjoyed life". The possible range of scores for the full version of the CES-D is 0 to 60 whereas the range of scores for the modified Add Health version is 0 to 57. The higher scores are indicative of more depressive symptoms.

Radloff (1977) has reported reliability and validity (content, criterion, and construct) for the CES-D. Validity was established by patterns of correlations with other self report methods (Rockliff Depression Rating Scale, Raskin Depression Rating Scale, and SCL 90), by correlations with clinical ratings of depression, and by relationships with other variables which support its construct validity (Radloff, 1977). Good reliability with a Cronbach's alpha ranging from .85 to .91 has been demonstrated in the adolescent literature (Aseltine, Gore, & Colten, 1994; Schoenbach, Kaplan, Wagner, Grimson, & Miller, 1983; Windle, 1992).

Scores (cutoff points) of 24 for females and 22 for males have been found to maximize both sensitivity and specificity of the CES-D for predicting depression in the adolescent population (Roberts, Lewinsohn, & Seeley, 1991). Studies reporting depression using the modified Add health scale and established cutoff points have reported a Cronbach alpha of .87 (Goodman, Slap, & Huang, 2003; Needham & Crosnoe, 2005). Therefore, a dichotomous variable indicating the current state of adolescent depressive symptoms will be based on the above cutoff points established for males (22) and females (24) (Roberts et al., 1991). Frequencies will be dichotomized as "Depression" (1) if Add Health CES-D scores are ≥ 22 for males or ≥ 24 for females and "No depression" (2) if Add Health CES-D scores are < 22 for males or < 24 for females.

Somatic Complaints: Chest pain and Muscle and joint pain

The in-home interview included questions on the frequency of having experienced chest pain or “aches, pains, or soreness in muscle or joints” during the past 12 months, using a five point scale: (0) never, (1) just a few times, (2) about once a week, (3) almost every day, and (4) every day. Frequencies were dichotomized as “chest pain” (1) if the adolescents answered 2-4 (weekly or more) or “no chest pain” (2) if the adolescents answered 0-1 (never or just a few times). Frequencies were also dichotomized as “muscle/joint pain” (1) if pain occurred weekly or more and “no muscle/joint pain” (2) if the pain occurred just a few times or never.

Insomnia

In regard to insomnia, adolescents were asked “In the past 12 months how often have you had trouble falling asleep or staying asleep?”. Responses were dichotomized as “insomnia” (1) if adolescents had difficulty with sleep almost every day to daily or “no insomnia” (2) if adolescent had no difficulty with sleep, difficulty with sleep just a few times or about once a week.

Obesity

In Wave II, adolescents were weighed by interviewers and height was recorded. In order to evaluate obesity, BMI was calculated: $\text{weight (lb)} / [\text{height (in)}]^2 \times 703$ (CDC, 2006). BMI percentiles were computed and include the following: 1= Underweight (less than the 5th percentile), 2= Healthy weight (5th percentile to less than the 85th percentile), 3= At risk of overweight (85th to less than the 95th percentile), and 4= Overweight (Equal to or greater than the 95th percentile) (CDC, 2006).

Demographic characteristics

Gender, Age, Race and Ethnicity

Prevalence of recurrent headache for gender categories (Female (1) and Male (2)) and for each age group and will be reported. To test for age differences, age will be categorized into three different groups: 11 to 13 (1), 14 to 16 (3), 17 to 19 (2). Diversity of the population in terms of race and ethnicity will also be reported: Hispanic (1), African American (2), Asian (3), American Indian (4), Other (5), and White (6).

Logistic Regression Equation

Health promotion and illness prevention literature guided and supported the occurrence in the adolescent population of the lifestyle behaviors and illness related factors in this study. The association of the lifestyle behaviors and illness related factors with adolescent recurrent headache was supported through review of the empirical research. Logistic regression was used to develop a model to evaluate how the predictor variables (lifestyle behaviors and illness related factors) work together in determining adolescent recurrent headache.

Logistic regression is designed to predict the log odds of the categorical dependent variable (recurrent headache which was categorized as “1” when “yes” to recurrent headache and “0” when “no” to recurrent headache). The logistic equation (Appendix A, Equation 3), guided the development of the model. (Kleinbaum & Klein, 2002; Garson, 2006).

Chapter 4

Data Analysis

The purpose of this research was to study adolescent health in terms of recurrent headache and explore the relationship between lifestyle behaviors, illness related factors and recurrent adolescent headache using the Add Health dataset. The following will describe the data analysis used for this study.

Frequency analysis was used to determine the prevalence of recurrent headache in the adolescent population (Aim 1). Chi square analysis and univariate regression analysis were used to explore the relationship between each of the lifestyle behaviors and illness related factors with recurrent headache (Aim 2 and Aim 3). Logistic regression analysis was performed on each of the variables with the goal of creating a multivariate model to demonstrate how lifestyle behaviors and illness related factors work together to predict recurrent headache in an adolescent population (Aim 4).

Biased point estimates, inappropriate standard errors, inappropriate confidence intervals, and misleading tests of significance can result from using standard statistical software packages when evaluating complex surveys (Brogan, 1998). SUDAAN is a survey software package designed to implement the correct formulas for estimating variances when analyzing complex survey data and when analyzing observations that are not independent or identically distributed (Chantala & Tabor, 1999). SPSS 13 was the statistical software package used in conjunction with SUDAAN. The major difference between SUDAAN and SPSS is that SUDAAN takes into account the sample design

(Brown, 2006). Otherwise, the assumptions that SPSS and SUDAAN make about logistic models are similar (Brown, 2006).

Logistic Regression

Logistic regression is the statistical technique for testing hypothetical models between a categorical outcome variable and one or more categorical or continuous variables. It is often used in the public health, nursing and medical literature to predict condition or disease state (presence or not) (Peng, Lee, & Ingersoll, 2002). Equation 1 illustrates the proposed regression model as well as the predictor variables measured.

Equation 1 Proposed Regression Model*Proposed Regression Model Equation***PREDICTOR VARIABLES:** X_1 = Gender X_2 = Race X_3 = Age group X_4 = Skipped meals X_5 = No water X_6 = Smoke regularly X_7 = Binge drink X_8 = Physical activity X_9 = Depression X_{10} = Chest pain X_{11} = Muscle and joint pain X_{12} = Insomnia X_{13} = Obesity**OUTCOME VARIABLE:**

Recurrent Headache

Model: Predicted Logit of (RECURRENT HEADACHE) = $\alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13}$

 X_1 - X_3 Demographics X_4 - X_8 = Lifestyle Behaviors X_9 - X_{13} = Illness Related Factors

Assumptions

Logistic regression allows the researcher to overcome the following restrictive assumptions applicable to other types of regression (Garson, 2006): logistic regression does not assume a linear relationship between the dependent and independent variables; the dependent variable need not be normally distributed; the dependent variable does not need to be homoscedastic (equal variances assumption) for each level of the independent variable; normally distributed error terms are not assumed; logistic regression does not require that the independent variables are interval or unbounded. The following assumptions apply (Garson, 2006):

1. Logistic coefficients need to be coded meaningfully. The dependent class of greatest interest is coded as 1 and the other class coded as 0. Coding has been described and is shown in Table 4.
2. All relevant variables must be included in the regression model, if not, the variance shared with included variables may be wrongly attributed to those variables and the error term may be inflated. Also, if causally irrelevant variables are included in the model, variance shared can be wrongly attributed to the irrelevant variables resulting in greater standard errors of the regression coefficients for the independent variables. As mentioned above, the effectiveness of the model was evaluated using goodness of fit statistics (Peng et al., 2002).
3. In logistic regression, error terms are assumed to be independent; however, violations are likely to occur with cluster sampling. SUDAAN was used in this analysis to account for this violation.

4. Although logistic regression does not require linear relationships between the independent and dependent variables, it does assume a linear relationship between the logit of the independent variable and the logit of the dependent variable. If the assumption of the linear relationship of the logits is violated, the resulting effect is generation of a type II error (report of no relationship when one actually exists).
In SUDAAN, the EFFECTS statement can be used to construct a set of orthogonal polynomials for any categorical explanatory variable in the MODEL statement (Brown, 2006).
5. Logistic regression does not account for interaction effects unless interaction terms are created as additional variables in the analysis. Interactions can be specified in SUDAAN between categorical variables or between a categorical and continuous variable. The user has to specify the interactions in the MODEL statement (Brown, 2006).
6. Since outliers can affect results, they should be removed. Standardized residuals >2.58 at the .01 level were considered outliers (Garson, 2006).
7. In logistic regression with a bivariate outcome, dichotomies are coded 0 or 1 which violates the assumptions of normality and homoscedasticity. Normal distributions cannot occur with only two values. The dependent variable need not be homoscedastic in logistic regression for each level of the independents. There is no homogeneity of variance assumption in logistic regression using a dichotomous dependent; thus, variances need not be the same within categories (Garson, 2006).

8. Multicollinearity occurs when one independent is a linear function of another independent and large standard errors occur as a result of such independents increasing in correlation with each other (Garson, 2006). Pearson Product Moment correlations between predictors of adolescent recurrent headache were calculated and variables with a bivariate correlation of greater than 0.70 (variables may be strongly inter-related) would be removed from the analysis due to concerns for collinear relationships. Tolerance and Variance Inflation Factors were calculated. Values of VIF that exceed 10 and a tolerance value less than 0.1 will be regarded as indicating multicollinearity.

Several steps were followed to determine which of the variables provided the best fit for the logistic regression model. First, a bivariate analysis of each variable was performed using the Pearson chi-square test. Second, variables whose bivariate test demonstrated a $p\text{-value} < 0.25$ were included in the multivariable model. Recommendation of the < 0.25 level as a screening criterion was deemed necessary since the more traditional level (< 0.05) may fail to identify all important variables (Hosmer & Lemeshow, 2000).

Forward regression was the method of choice. Forward regression involves entering the variables one at a time, based on the designated significance value ($p < 0.25$) and the process ended when there were no additional variables to explain a significant portion of additional variance (George & Mallery, 2005). Once a model containing the essential variables was constructed, the effectiveness of the model was evaluated using the Hosmer-Lemeshow goodness of fit tests.

Analysis began with the receipt of both Waves 1 and 2 of the adolescent in-home interviews. In order to obtain the restricted use data, a contractual agreement with the Carolina Population Center needed to be made. Prior to entering the contract an IRB-approved security plan for handling and storing sensitive data was completed and the data-use contract agreeing to keep the data confidential was signed by all those with access to the dataset. The restricted use contractual data were provided as SPSS export files in separate linkable datasets. The export files could then be read with other statistical applications including SUDAAN which was used for this analysis.

The Wave 1 files were merged with Wave 2 files prior to preparing the data for analysis. Wave 1 was required to obtain demographic information regarding race/ethnicity. This question was asked in the Wave 1 in home interviews but not in the Wave 2 interviews. Prior to analysis with SUDAAN, variables were recoded in SPSS (see Table 4) and the data were prepared for analysis. Frequency analysis was used to examine the data and establish that missing variables would not be a concern. Frequency analysis was also used to examine the prevalence of recurrent headache in this adolescent population (Aim 1). Pearson Product Moment correlations between predictors of adolescent recurrent headache were obtained (Appendix B, Table 14).

Variables with a bivariate correlation of greater than 0.70 (variables may be strongly inter-related) would be removed from the analysis due to concerns for collinear relationships. No variables met this criteria. Tolerance and Variance Inflation Factor (VIF) were also calculated (Appendix B, Table 15). Values of VIF that exceed 10 and a tolerance value less than 0.1 are often regarded as indicating multicollinearity, neither of which were a concern in this analysis.

Using SUDAAN, a bivariate analysis of each variable was performed using the Pearson chi-square test. Except for the age variable, those variables whose bivariate test demonstrated a p-value < 0.25 were included in the multivariable model. Also, a univariate logistic regression analysis was performed in SUDAAN to determine significant univariate effects of each predictor using Wald F (Aim 2 and Aim 3). Wald F was used in determining order for which each predictor was placed in the model (Table 5).

Table 5 Univariate Logistic Regression*Univariate Logistic Regression with Recurrent Headache as the Outcome Variable*

Predictors	Degrees of Freedom	Wald F	P-value Wald F
Gender	1	258.44	0.00
Race	5	14.83	0.00
Age Group	2	0.51	0.60
Depression	1	161.35	0.00
Chest Pain	1	151.29	0.00
Insomnia	1	137.19	0.00
Muscle Joint Pain	1	129.39	0.00
Skip Breakfast Three or More Times	1	53.80	0.00
Smoke Regularly	1	51.34	0.00
Skip Breakfast Two or More Times	1	33.58	0.00
Skip Breakfast One or More Times	1	54.34	0.00
Skip Lunch Three or More Times	1	34.28	0.00
Skip Lunch Two or More Times	1	38.66	0.00
Skip Lunch One or More Times	1	39.46	0.00
Skip Supper Three or More Times	1	8.32	0.00
Skip Supper Two or More Times	1	22.28	0.00
Skip Supper One or More Times	1	33.89	0.00
Physical Activity	3	23.00	0.00
No Water	1	12.42	0.00
Binge Drink Monthly	1	3.77	0.05
BMI	3	1.12	0.34

*Highlighted predictors represent those predictors used in the logistic regression analysis which, after gender, race and age group, are listed in descending Wald F from the predictor Depression through BMI.

Forward regression was used in the determination of the final model in this study (Aim 4). However, forward stepwise regression was also used for initial exploratory analysis (Table 6).

Table 6 Exploratory Regression Analysis*Exploratory Regression Analysis*

Variables In Model	Wald F	P Value Wald	H-L P Value Chi Square	H-L P Value Wald	H-L P Value S-H
FORWARD REGRESSION					
1	135	.0000	.3874	.5218	.3540
1-2	127	.0000	.1089	.4637	.4224
1-3	120	.0000	.0299	.2652	.2975
1-4	111	.0000	.2301	.4360	.4456
1-5	122	.0000	.4695	.8977	.7865
1-6	112	.0000	.2831	.3488	.4308
1-7	114	.0000	.0139	.0844	.1612
1-8	117	.0000	.1190	.4955	.4930
1-9	113	.0000	.3233	.3826	.4779
1-10	108	.0000	.6238	.8256	.8778
1-11	104	.0000	.6914	.8828	.9109
1-12	99	.0000	.7543	.9324	.9430
1-13	90	.0000	.0660	.3814	.3929
FORWARD STEPWISE REGRESSION					
1	135	.0000	.3874	.5218	.3540
1-2	127	.0000	.1089	.4637	.4224
1-3	120	.0000	.0299	.2652	.2975
1-4	111	.0000	.2301	.4360	.4456
1-5	122	.0000	.4695	.8977	.7865
1-6	112	.0000	.2831	.3488	.4308
1-7	114	.0000	.0139	.0844	.1612
1-8	121	.0000	.1190	.4955	.4930
1-9	113	.0000	.3233	.3826	.4779
1-8,10	114	.0000	.6159	.7407	.7774
1-8,10,11	110	.0000	.4708	.7774	.8297
1-8,10,12	108	.0000	.7695	.8980	.9033
1-8,10,13	100	.0000	.0550	.4734	.4206

1. Gender, Age Group, Race
2. Depression
3. Chest Pain
4. Insomnia
5. Muscle and Joint Pain
6. Skip Breakfast Three or More Times
7. Smoke Regularly
8. Skip Lunch One or More Times
9. Skip Supper One or More Times (Not significant so removed from model.)
10. Physical Activity
11. No Water (Not significant so removed from model.)
12. Binge Drink (Not significant so removed from model.)
13. BMI (Not significant so removed from model.)

Gender, race and age group were demographics necessary for the model. Age was not significant in bivariate correlation and, in forward or stepwise regression, would not be considered a predictor ($p=.5998$). Thus, a forward regression was run in SUDAAN starting with gender, race and age group and then the rest of the predictors were included in descending order based upon the Wald values (Table 5). A model was developed with all fifteen predictors, several of which were nonsignificant (Skip Supper One or More Times, Physical Activity, No Water, Binge Drink and BMI) (Table 6). Since a goal of logistic regression is development of a parsimonious model, a forward stepwise regression analysis was also performed and compared with the forward logistic regression model. The final model in the forward stepwise logistic regression consisted of 11 predictors (Table 6). Excluded predictors, due to non-significance, included Skip Supper One or More Times, No Water, Binge Drink and BMI, all of which were nonsignificant in the forward regression model. Physical activity ($p=.067$) was kept in the model since it was close to significance. After comparing both models, the final 11 significant predictors (gender, age group, race, depression chest pain, insomnia, muscle and joint pain, skip breakfast three or more times, smoke regularly, skip lunch one or more times and physical activity) were then analyzed in SUDAAN using forward regression.

Interpretation of the results was based on an understanding of the measure of association referred to as odds ratio and customized odds ratio. The odds ratio approximates how much more likely (or unlikely) it is for the outcome to be present among those with $x=1$ than among those with $x=0$ (Hosmer & Lemeshow, 2000). For example, if y denotes the presence or absence of recurrent headache and if x denotes

whether or not an adolescent drinks alcohol, then an odds ratio of 2 estimates that recurrent headache is twice as likely to occur among alcohol users as non-users in the study population. An odds ratio of 1 means the predictor variable has no effect on the outcome variable; therefore, the two variables are statistically independent (Garson, 2006). Odds ratio is an estimate computed for main effect variables not involved in interactions (SAS Learning Center, 1999). When an interaction exists, computation of the odds ratio for a variable is dependent on the various levels of the reported interacting variables (SAS Learning Center, 1999). Customized odds ratios allow for prediction of recurrent headache at different combinations of variable values.

Risk will also be reported. Risk refers to the chance that an event will occur (Garson, 2006). When reporting risk, outcomes range from 0 (impossibility of an event) to 1 (possibility of an event). Risk is written as: $P(X)=Pr(\text{outcome}=1/\text{predictor})$.

Results

Characteristics of the Study Sample

Table 7 describes characteristics of the study sample. Of the 13,570 adolescents surveyed, 49% were male and 51% were female. Age groups were divided into 11 through 14 year olds, 15 through 17 year olds and 18 through 19 year olds and the percentage of adolescents in each group were 18%, 60% and 23% respectively. Race and ethnicity for this population of adolescents consisted of Hispanics (17%), African American (21%), Asian (7%), American Indian (2%), Other (1%), and White (52%).

Table 7 Characteristics of the Study Sample*Characteristics of the Study Sample (n=13,570)*

	Percent (n)
Gender	
Male	49(6606)
Female	51(6964)
Age group	
11 thru 14 years old	18(2357)
18 thru 19 years old	23(3051)
15 thru 17 years old	59(8005)
Race	
Hispanic	17(2298)
African American	21(2893)
Asian	7(946)
American Indian	2(247)
Other	1(124)
White	52(7051)

Prevalence of Recurrent Headache in an Adolescent Population (Aim 1)

Table 8 reports on the prevalence of outcome and predictor variables.

Approximately 26% of the adolescents had experienced recurrent headache over the past 12 months (Table 8).

Table 8 Characteristics of Outcome and Predictor Variables*Characteristics of Outcome and Predictor Variables (n=13,570)*

	Percent (n)
Recurrent Headache	
Never thru Just a Few Times	74(9986)
About Once a Week thru Everyday	26(3578)
Skipping Meals	
Skip Breakfast Three or More Times a Week	
Yes	51(6859)
No	49(6702)
Skip Breakfast Two or More Times a Week	
Yes	60(8159)
No	40(5402)
Skip Breakfast One or More Times a Week	
Yes	65(8793)
No	35(4768)
Skip Lunch Three or More Times a Week	
Yes	24(3205)
No	76(10357)
Skip Lunch Two or More Times a Week	
Yes	35(4713)
No	65(8849)
Skip Lunch One or More Times a Week	
Yes	40(5421)
No	60(8141)
Skip Supper Three or More Times a Week	
Yes	11(1475)
No	89(12087)
Skip Supper Two or More Times a Week	
Yes	18(2445)
No	82(11117)
Skip Supper One or More Times a Week	
Yes	24(3208)
No	76(10354)

Table 8 (con't)

Characteristics of Outcome and Predictor Variables (n=13,570)

	Percent (n)
Drink Water on Previous Day	
No	10(1412)
Yes	90(12155)
Smoke Regularly (Daily)	
Yes	20(2728)
No	80(10835)
Binge Drink Monthly (2 or 3 days a month or more)	
Yes	13(1710)
No	87(11814)
Play an Active Sport In the Past Week	
Not at all	30(4042)
1 or 2 times	29(3857)
3 or 4 times	18(2489)
5 or more times	23(3180)
Depression	
Yes	16(2139)
No	84(11394)
Somatic Complaints:	
Chest Pain	
About once a week thru everyday	4(485)
Never thru just a few times	96(13081)
Muscle or Joint Pain	
About once a week thru everyday	24(3311)
Never thru just a few times	76(10256)
Insomnia	
Yes	8(1059)
No	92(12509)
BMI	
Underweight	4(500)
Normal Weight	68(9210)
At Risk for Overweight	15(1993)
Obese	13(1692)

Chi square was used to demonstrate significant differences in headache prevalence by age group, gender and race (Table 9). This study is specific for adolescents whose age range is defined by the World Health Organization (WHO, 2009) to be 10-19 years old. Age was categorized into the following three groups: 11-14, 15-17, and 18-19. Ten year olds were not included due to low sample size. Headache was reported by 27%, 28.16% and 28.37% of the adolescents in the 11-14, 18-19 and 15-17 age groups respectively. No significant differences were found between the age groups and prevalence of recurrent headache ($\chi^2=.51$, $p=.60$) (Table 9). Significant differences were found in the prevalence of adolescent recurrent headache by gender and race. Approximately 19% of males and 38% of females reported recurrent headache ($\chi^2=157.87$, $p=.00$) (Table 9). Overall, significant differences in the prevalence of adolescent recurrent headache by race were also found ($\chi^2=9.83$, $p=.00$). The highest percentage of adolescent recurrent headache were reported by American Indian adolescents (33.50%), followed by other minorities (32.8%), Whites (30.60%), Hispanics (23.41%), African Americans (23%), and Asian adolescents (15.19%).

Table 9 Prevalence of Predictors

Prevalence (%) of Adolescent Recurrent Headache by Age/RaceE/Gender/Lifestyle Behaviors/Illness Related Factors

Predictors	No Headache	Headache	ChiSq	p
Age Group				
Lowest thru 14 YO	72.99	27.01		
18 thru highest	71.24	28.76		
15 thru 17	71.63	28.37		
			.51	.5998
Gender				
Male	81.38	18.62		
Female	62.46	37.54		
			157.87	.0000
Race				
Hispanic	76.59	23.41		
African American	77.01	22.99		
Asian	84.81	15.19		
American Indian	66.50	33.50		
Other	67.19	32.81		
White	69.40	30.60		
			9.83	.0000
Lifestyle Behaviors				
Skip Breakfast 3 or more times	68.03	31.97		
			50.17	.0000
Skip Breakfast 2 or more times	69.34	30.66		
			31.08	.0000
Skip Breakfast 1 or more times	69.22	30.78		
			53.10	.0000
Skip Lunch 3 or more times	66.23	33.77		
			27.96	.0000
Skip Lunch 2 or more times	67.26	32.74		
			35.78	.0000
SkipLunch 1 or more times	67.85	32.15		
			34.87	.0000

Table 9 (con't)

Prevalence (%) of Adolescent Recurrent Headache by Age/RaceE/Gender/Lifestyle Behaviors/Illness Related Factors

Predictors	No Headache	Headache	ChiSq	p
Lifestyle Behaviors				
Skip Supper 3 or more times	67.24	32.76	6.85	.0099
Skip Supper 2 or more times	65.60	34.40		
Skip Supper 1 or more times	65.89	34.11	17.27	.0001
No Water	67.00	33.39	26.88	.0000
Smoke Regularly	64.05	35.95	10.35	.0016
Binge Drink	69.23	30.77	32.95	.0000
Physical Activity			3.62	.0592
Not at all	67.69	32.31	17.88	.0000
1 or 2 times	69.29	30.71		
3 or 4 times	75.02	24.98		
5 or more times	77.59	22.41		
Illness Related Factors				
Depression	56.73	43.27	97.86	.0000
Chest Pain	43.87	56.13	81.79	.0000
Muscle Joint Pain	61.65	38.35	93.59	.0000
Insomnia	51.92	48.08	89.77	.0000
BMI- underweight	71.40	28.60	1.04	.3757
BMI- normal weight	72.52	27.48		
BMI- at risk for overweight	70.80	29.20		
BMI- obese	69.77	30.23		

Relationship between lifestyle behaviors and recurrent headache (Aim 2)

Table 8 demonstrates adolescent report of predictor variables of skipping meals, water intake, smoking, binge drinking, and physical activity. Adolescents reported skipping breakfast (51%), lunch (24%) and supper (11%) three or more times in the past week. Only 10% of adolescents did not drink water on the previous day. Of those adolescents who smoked, 20% reported doing so on a daily basis. Thirteen percent of the adolescents reported binge drinking 2 or 3 days a month or more. In the past week, 30% of the adolescents did not participate in a physical activity, 28% only 1 or 2 times, 18% 3 or 4 times and 23% participated in physical activity 5 or more times.

Using chi square (Table 9) and univariate regression analysis (Table 5), significant relationships were found for all three levels of skipping breakfast, lunch and supper with recurrent headache. Chi square analysis also demonstrated significant relationships between recurrent headache and no water ($\chi^2=10.35, p=.00$), smoke regularly ($\chi^2=32.95, p=.00$) and physical activity ($\chi^2=17.88, p=.00$). Binge drinking was not significant ($\chi^2=3.62, p=.06$), yet was considered as a predictor in the model ($p \leq .25$) during initial analysis.

Relationship between illness related factors and recurrent headache (Aim 3)

Table 8 demonstrates adolescent report of predictor variables of depression, somatic complaints, insomnia and obesity. Approximately 16% of adolescents reported depression and 8% of the adolescents reported difficulty falling asleep or staying asleep (insomnia). In regard to somatic complaints, 3% of the adolescents reported chest pain

once a week thru every day and 24% reported muscle/joint pain once a week thru every day in the past 12 months. BMI was calculated and approximately 4% of the adolescents were underweight, 69% normal weight, 15% at risk for overweight, and 13% were obese.

Chi square (Table 9) and univariate regression analysis (Table 5), using recurrent headache as the outcome variable, demonstrated significant relationships with the predictor variables except for BMI categories. Chi square significant relationships were found for depression ($\chi^2=97.86$, $p=.00$), chest pain ($\chi^2=81.79$, $p=.00$), muscle and joint pain ($\chi^2=93.59$, $p=.00$) and insomnia ($\chi^2=89.77$, $p=.00$). Overall, the relationship between adolescents who reported headache and were underweight (29%), normal weight (27%), at risk for overweight (29%) and obese (30%) did not demonstrate a significant relationship with recurrent headache ($\chi^2=1.04$, $p=.38$).

Creation of the Multivariate Model- How gender, race, Age group, lifestyle behaviors and illness related factors predict recurrent headache (Aim 4)

Main Effects

Logistic regression analysis demonstrated that a number of variables were associated with adolescent recurrent headache (Table 10). The main effects of gender (OR .36, CI .32, .42), chest pain (OR 2, CI 1.8, 2.9), depression (OR 1.87, CI 1.6, 2.2), insomnia (OR 2.03, CI 1.6, 2.5), muscle and joint pain (OR 1.9, CI 1.6, 2.1), skip breakfast 3 or more times (OR 1.2, CI 1.08, 1.33), and skip lunch one or more times (OR 1.14, CI 1.02, 1.27) were all significant. The main effect of race was significant for Hispanic (OR .59, CI .46, .75), African American (OR .62, CI .53, .72), and Asian (OR .42, CI .29, .61) when compared with Whites. Significant results were found when comparing “no sports activity” with “sports activity 5 or more times a week” (OR 1.17, CI 1.0042, 1.3714) as well as when comparing “sports activity 1 or more times a week

with “sports activity 5 or more times a week” (OR 1.28, CI 1.06, 1.56). Smoke regularly (OR 1.15, CI .97, 1.4) did not have a significant main effect with recurrent headache as the outcome variable nor did age group [lowest thru 14 (OR .89, CI .73, 1.09); 18 thru highest (OR 1.11, CI .92, 1.35)].

Table 10 Odds Ratios and Confidence Intervals*Logistic Regression Analysis: Odds Ratio and Confidence Intervals*

Independent Variables and Effects	Odds Ratio	Lower 95% Limit OR	Upper 95% Limit OR
Intercept	0.3586	0.3085	0.4169
GENDER			
Male	0.3685	0.3197	0.4247
Female	1.0000	1.0000	1.0000
RACE			
Hispanic	0.5919	0.4646	0.7541
African American	0.6167	0.5272	0.7214
Asian	0.4228	0.2931	0.6100
American Indian	1.1896	0.7356	1.9240
Other	1.0879	0.5106	2.3181
White	1.0000	1.0000	1.0000
AGE GROUP			
Lowest thru 14	0.8935	0.7319	1.0908
18 thru highest	1.1103	0.9157	1.3462
15 thru 17	1.0000	1.0000	1.0000
CHEST PAIN			
Yes	2.3239	1.8489	2.9207
No	1.0000	1.0000	1.0000
DEPRESSION			
Yes	1.8728	1.5978	2.1953
No	1.0000	1.0000	1.0000
INSOMNIA			
Yes	2.0283	1.6483	2.4958
No	1.0000	1.0000	1.0000
MUSCLE AND JOINT PAIN			
Yes	1.8519	1.6437	2.0865
No	1.0000	1.0000	1.0000
SKIP BREAKFAST Three or More Times			
Yes	1.2025	1.0807	1.3379
No	1.0000	1.0000	1.0000
SMOKE REGULARLY			
Yes	1.1597	0.9727	1.3827
No	1.0000	1.0000	1.0000
SKIP LUNCH One or More Times			
Yes	1.1438	1.0237	1.2781
No	1.0000	1.0000	1.0000
PHYSICAL ACTIVITY			
Not at all	1.1735	1.0042	1.3714
1 or 2 times per week	1.2861	1.0606	1.5596
3 or 4 times per week	1.1047	0.9232	1.3219
5 or more times per week	1.0000	1.0000	1.0000

Further evaluation of the odds ratio and demographic predictors demonstrates that the odds ratio for the MALE coefficient is .37 with a 95% confidence interval of (.32, .42). This suggests that those who are male are .36 times as likely to have recurrent headache than those who are female. The odds ratio for the HISPANIC coefficient is .59 with a 95% confidence interval of (.46, .75). This suggests that those who are Hispanic are .59 times as likely to have recurrent headache than whites. The odds ratio for the AFRICAN AMERICAN coefficient is .62 with a 95% confidence interval of (.53, .72). This suggests that those who are African American are .62 times as likely to have recurrent headache than whites. The odds ratio for the ASIAN is .42 with a 95% confidence interval of (.29, .61). This suggests that those who are Asian are .42 times as likely to have recurrent headache than whites. The odds ratio for AMERICAN INDIAN is 1.19 with a 95% confidence interval of (.74, 1.92) and the odds ratio for Other is 1.08 with a 95% confidence interval of (.51, 2.32), thus, neither has a significant main effects on recurrent headache in adolescents. The age groups of lowest thru 14 (OR .89, CI .73, 1.09) and 18 thru highest (OR 1.11, CI .92, 1.35) did not demonstrate a significant main effect.

Evaluation of the odds ratios for lifestyle behaviors demonstrates the odds ratio for the SKIPBREAKFAST3 coefficient is 1.20 with a 95% confidence interval of (1.08, 1.34). This suggests that those who skip breakfast 3 or more times in a week are 1.20 times as likely to have recurrent headache than those who do not skip breakfast 3 or more times a week. The odds ratio for the SKIPLUNCH1 coefficient is 1.14 with a 95% confidence interval of (1.02, 1.28). This suggests that those who skip lunch are 1.14 times more likely to have recurrent headache than those who do not skip lunch. The odds ratio

for the PHYSICAL ACTIVITY coefficient for “no sport” is 1.11 with a 95% confidence interval of (1.0042, 1.37). This suggests that those who do not participate in an active sport at all are 1.11 times as likely to have recurrent headache than those who exercise “5 or more times” a week. The odds ratio for the PHYSICAL ACTIVITY coefficient for “1-2 times a week” is 1.29 with a 95% confidence interval of (1.06, 1.56). This suggests that those who participate in a physical activity “1 to 2 times” are 1.11 times as likely to have recurrent headache than those exercise “5 or more times” a week. For those who exercise “3-4 times a week”, the odds ratio is 1.10 with a 95% confidence interval of (.92, 1.32) which is non-significant. Smoke regularly had an odds ratio of 1.16 with a 95% confidence interval of (.97, 1.38) demonstrating a non-significant main effect.

Further analysis of the odds ratios of illness related factors showed the odds ratio for the CHEST PAIN coefficient is 2.32 with a 95% confidence interval of (1.85, 2.92). This suggests that those who have chest pain are 2.32 times as likely to have recurrent headache than those who do not have chest pain. The odds ratio for the DEPRESSION coefficient is 1.87 with a 95% confidence interval of (1.60,2.20). This suggests that those who have depression are 1.87 times as likely to have recurrent headache than those who do not have depression. The odds ratio for the INSOMNIA coefficient is 2.03 with a 95% confidence interval of (1.65, 2.50). This suggests that those who have insomnia are 2.03 times as likely to have recurrent headache than those who do not have insomnia. The odds ratio for the MUSCLE JOINT PAIN coefficient is 1.85 with a 95% confidence interval of (1.64,2.08). This suggests that those who have muscle and joint pain are 1.85 times as likely to have recurrent headache than those who do not have muscle joint pain.

Risk- Gender and Age group

The risk of recurrent headache and the different age groups (11-14 years old, 15-17 years old, 18-19 years old) was analyzed (Table 11). A non-significant relationship was found with a risk of recurrent headache of approximately 28% for each age group. However, when looking at the interaction of age group and gender (age group*gender) significant relationships are uncovered. Those who are males and are in the 11-14 year old category had a 29% risk of having recurrent headache while those in the 15-17 year old and 18-19 year old categories had a risk of 19% and 17% respectively (Table 11). As males get older, the risk of recurrent headache decreases. In females, the opposite is found. Females in the 11-14 year old category had a 35% risk of having recurrent headache; whereas, in the 15-17 year old and 18-19 year old categories the risk is 37% and 40% respectively. As females get older, the risk of recurrent headache increases (Table 11).

Table 11 Risk*Risk of Recurrent Headache*

<u>Predicted Marginal</u>	<u>Risk</u>	<u>SE</u>	<u>T:Marg=0</u>
AGE GROUP			
11 thru 14	0.2844	0.0127	22.3039
18 thru 19	0.2828	0.0121	23.2929
15 thru 17	0.2818	0.0080	35.3174
GENDER, AGE GROUP			
Male, 11 thru 14	0.2195	0.0190	11.5656
Male, 18 thru 19	0.1685	0.0123	13.7197
Male, 15 thru 17	0.1898	0.0095	20.0017
Female, 11 thru 14	0.3480	0.0182	19.1657
Female, 18 thru 19	0.3949	0.0218	18.1410
Female, 15 thru 17	0.3720	0.0108	34.3041
RACE, SMOKE REGULARLY			
Hispanic, Yes	0.3255	0.0330	9.8616
Hispanic, No	0.2122	0.0171	12.3948
African American, Yes	0.2807	0.0421	6.6621
African American, No	0.2185	0.0111	19.6140
Asian, Yes	0.1252	0.0342	3.6624
Asian, No	0.1653	0.0230	7.1805
White, Yes	0.3306	0.0164	20.2048
<u>White, No</u>	<u>0.3019</u>	<u>0.0076</u>	<u>39.4928</u>

Interactions

One way to test for interactions in logistic regression is to start with a main-effect model, and use a forward-selection method to find interaction terms which result in a significant model (Friendly, 2005). The examples for interactions involved only the main effects of gender, race, age group, chest pain, depression, insomnia, muscle joint pain, skip breakfast, smoke regularly, skip lunch and physical activity. Tests for interactions among these factors (Appendix B, Table 16) were performed using forward selection (interactions are denoted by the terms “predictor*predictor”).

Significant interactions in the model were found and include gender*age group (Wald F 3.68, $p=.03$), race*smoke regularly (Wald F 2.51, $p=.03$) and depression*insomnia (Wald F 7.3, $p=.01$) (Table 12).

Table 12 Logistic Regression Analysis*Logistic Regression Analysis*

Independent Variables And Effects	Degrees of Freedom	Wald F	P-Value Wald F
OVERALL MODEL	27	86.8782	0.0000
MODEL MINUS INTERCEPT	26	41.1637	0.0000
CHEST PAIN	1	53.2648	0.0000
MUSCLE JOINT PAIN	1	104.5082	0.0000
SKIPBREAKFAST three or more times	1	11.6765	0.0008
SKIP LUNCH one or more times	1	5.7409	0.0180
PHYSICAL ACTIVITY	3	2.4474	0.0668
GENDER * AGE GROUP	2	3.6807	0.0279
RACE * SMOKE REGULARLY	5	2.5054	0.0336
DEPRESSION * INSOMNIA	1	7.2992	0.0078
INSOMNIA=Yes VS No:			
DEPRESSION=Yes	1	1.4342	0.2333
INSOMNIA=Yes VS No:			
DEPRESSION=No	1	45.5027	0.0000
GENDER=M VS. F: Lowest thru 14	1	21.2135	0.0000
GENDER=M VS. F: 18 thru 19	1	79.5712	0.0000
GENDER=M VS. F: 15 thru 17	1	193.8356	0.0000
SMOKE REGULARLY=Yes VS. No:			
RACE=Hispanic	1	9.6621	0.0023
SMOKE REGULARLY=Yes VS. No:			
RACE=African American	1	2.4454	0.1203
SMOKE REGULARLY=Yes VS. No:			
RACE=Asian	1	0.8297	0.3641
SMOKE REGULARLY=Yes VS. No:			
RACE=American Indian	1	1.5574	0.2143
SMOKE REGULARLY=Yes VS. No:			
RACE= Other	1	0.1974	0.6576
SMOKE REGULARLY=Yes VS. No:			
RACE= White	1	2.7794	0.0979
PHYSICAL ACTIVITY 1 VS 2*	1	1.1838	0.2786
PHYSICAL ACTIVITY 1 VS 3*	1	0.5225	0.4711
PHYSICAL ACTIVITY 1 VS 4*	1	4.1288	0.0442
PHYSICAL ACTIVITY 2 VS 3*	1	2.4829	0.1176
PHYSICAL ACTIVITY 2 VS 4*	1	6.6675	0.0109
PHYSICAL ACTIVITY 3 VS 4*	1	1.2051	0.2744

* 1= not at all, 2=1 or 2 times, 3=3 or 4 times, 4=5 or more times

*Interaction: Age group*Gender*

Logistic regression analysis demonstrated that the effect of gender (male vs female) on headache was significant for all three age groups ($p=.00$) (Table 12).

Customized odds ratios were also performed for the interaction and demonstrated the odds of recurrent headache decrease by $\frac{1}{2}$ for males versus females in the 11-14 year old age group (Table 13). Also, the odds of recurrent headache decrease by 72% for male versus female in the 18-19 year old age group and the odds of recurrent headache decrease by 63% for male versus female in the 15-17 year old age group (Table 13).

Table 13 Customized Odds Ratios*Customized Odds Ratios: Outcome Recurrent Headache*

Contrast	EXP (Contrast)	Lower 95% Limit	Upper 95% Limit
GENDER=Male VS. Female:			
AGE GROUP=11 thru 14	0.5013	0.3726	0.6744
GENDER=Male VS. Female:			
AGE GROUP=18 thru 19	0.2843	0.2151	0.3758
GENDER=Male VS. Female:			
AGE GROUP=15 thru 17	0.3685	0.3197	0.4247
SMOKE REGULARLY=Yes VS. No			
RACE=Hispanic	1.9092	1.2650	2.8817
SMOKE REGULARLY=Yes VS. No			
RACE=African American	1.4467	0.9067	2.3084
SMOKE REGULARLY=Yes VS. No			
RACE=Asian	0.7035	0.3277	1.5103
SMOKE REGULARLY=Yes VS. No			
RACE=American Indian	0.5975	0.2641	1.3519
SMOKE REGULARLY=Yes VS. No			
RACE=Other	1.4195	0.2983	6.7541
SMOKE REGULARLY=Yes VS. No			
RACE=White	1.1597	0.9727	1.3827
INSOMNIA=Yes VS No			
DEPRESSION=No	2.0283	1.6483	2.4958
INSOMNIA=Yes VS No			
DEPRESSED MOOD=Yes	1.2167	0.8799	1.6823

*Interaction: Race*Smoke regularly*

The effects of smoking regularly on headaches were significant only for Hispanics (Wald F 9.66, $p=.00$) (Table 12). Customized odds ratios for Race*Smoke regularly shows that the risk of headache doubles for Hispanics who smoke regularly versus those who do not (Table 13). All other customized odds ratios were non-significant. Risk for Race*Smoke regularly was also evaluated (Table 11). The risk of recurrent headache for Hispanics that smoke is 33% versus a 21% risk of recurrent headache in those Hispanics who do not smoke (Table 11).

*Interaction: Depression*Insomnia*

The effect of the interaction of insomnia and depression on headache was significant only when the adolescent was not depressed (Wald F 45.5, $p=.00$) (Table 12). Customized odds ratio demonstrated that the odds of recurrent headache are doubled when comparing insomnia versus no insomnia when not depressed (Table 13).

Variables retained in the final model

Table 12 presents the significance of the predictors (independent variables) in the final model showing Wald F and the P value of Wald F results. The test for the “overall model” is significant at $p=0.00$ and rejects the null hypothesis. The null hypothesis states that the independent variables have no effect on the outcome (recurrent headache).

The second test “model minus the intercept” is also significant at $p=0.00$. Thus, the null hypothesis that none of the explanatory variables are related to adolescent recurrent headache (model minus the intercept) is also rejected. Therefore, the

alternate hypothesis that the regression coefficients, except the intercept, are not all equal to 0 is accepted. At least one of the explanatory variables (predictor variables) is significantly related to recurrent headache (the outcome variable).

Table 10 presents which variables, conditional on all other variables in the model, have statistically significant effects on adolescent recurrent headache: gender, race, chest pain, depression, insomnia, muscle and joint pain, skip breakfast three or more times a week, skip lunch one or more times a week, and physical activity.

Goodness of fit for the final step of the model was assessed using the Hosmer-Lemeshow Chi-Square, Hosmer-Lemeshow Wald F, and Hosmer-Lemeshow Satterthwaite F goodness of fit statistics. When evaluating Hosmer-Lemeshow goodness of fit statistics, the researcher is testing a null hypothesis that the model is a good fit. Thus, a decision to not reject the null hypothesis is preferred (Hosmer & Lemeshow, 2000). A model is considered to have adequate fit when the p-value is greater than .05 (Brace, Kemp, & Snelgar, 2006). Hosmer-Lemeshow Chi-Square ($p=0.87$), Hosmer-Lemeshow Wald ($p=0.97$) and Hosmer-Lemeshow Satterthwaite ($p=0.97$) statistics did not demonstrate significance ($p<.05$) which is indicative of a good model fit.

Based upon the above findings the final proposed model is as follows:

Equation 2 Final Proposed Model for Adolescent Recurrent Headache

Final Proposed Model for Adolescent Recurrent Headache

Predicted Logit of (RECURRENT HEADACHE) ~ Chest Pain + Muscle and Joint Pain + Skip Breakfast 3 or More Times + Skip Lunch 1 or More Times+ Physical Activity + Gender*Age Group + Race*Smoking Regularly +Depression*Insomnia

Chapter 5

Discussion

The purpose of this research was to study adolescent health in terms of recurrent headache and explore the relationship between lifestyle behaviors, illness related factors and recurrent adolescent headache using the Add Health database. The specific aims that guided the study were as follows:

- (1) to examine the prevalence of recurrent headache in an adolescent population,
- (2) to explore the relationship between lifestyle behaviors (skipping meals, water intake, tobacco use, alcohol use and physical activity) and recurrent headache in an adolescent population,
- (3) to explore the relationship between illness related factors (depression, somatic complaints, insomnia and obesity) and recurrent headache in an adolescent population and
- (4) to create a multivariate model to demonstrate how lifestyle behaviors and illness related factors work together to predict recurrent headache in an adolescent population.

The following will discuss the findings of the study in terms of each specific aim.

Findings of the Study

Approximately 26% of the adolescents in this study experienced a headache once a week to everyday in the past year (Aim 1). Lifestyle behaviors which demonstrated a significant univariate relationship with recurrent headache included all three levels of meal skipping for breakfast, lunch and supper; no water intake on the previous day; smoking regularly; binge drinking monthly; and physical activity (Aim 2). Illness related factors which demonstrated a significant univariate relationship with recurrent headache

included depression, chest pain, muscle and joint pain, and insomnia (Aim 3). BMI was not a significant univariate predictor of recurrent headache. Finally, an overall multivariate model was developed (Aim 4) and included gender, race/ethnicity, age group, chest pain, depression, insomnia, muscle and joint pain, skipping breakfast three or more times, skipping lunch one or more times, and physical activity. Interactions between gender and age group, race and smoking regularly, as well as depression and insomnia were also included in the model. The effects of skipping supper, no water intake on the previous day, and binge drinking monthly were not included in the final model.

Headache prevalence, gender, age, race/ethnicity

This analysis of recurrent adolescent headache using the Add Health dataset reported 26% of the adolescents had a headache once a week to everyday in the past year. Similar findings were also reported in other adolescent population based studies (Zwart et al., 2004; Gordon et al., 2004). Approximately 38% of females reported recurrent headache and 19% of males reported recurrent headache. Several studies have demonstrated that females are more likely to report recurrent headache as compared with males (Scalas & Calistri, 2005; Moore & Shevell, 2004; Larsson & Sund, 2005; Rhee, 2000; Bigal et al., 2007).

Studies also report that recurrent headache increases with age (Larsson & Sund, 2005; Laurell et al., 2005). In this analysis of recurrent adolescent headache and age, no significant differences were found between age group (11 through 14, 15 through 17 and 18 through 19) and prevalence of recurrent headache. However, findings of this analysis did show that the risk of headache differs for males and females as the adolescent gets

older. In males the risk for recurrent headache decreases and for females the risk of recurrent headache increases with increasing age.

Similar findings have reported that onset and presentation of headache treatment in boys typically occurs in preadolescence; whereas, girls were not only more likely to present for headache treatment in adolescence but also report persistence of preadolescent headache into adolescence (Larsson & Sund, 2005; Bigal et al., 2007; Slater et al., 2009). Slater et al. (2009) suggested that biological or sociological factors which increase the risk of headache in pre-adolescent boys “shifts” to adolescent girls as children enter adolescence. Sociological factors may include perceived teacher unfairness or classmate support (Santinello, Vieno, & De, 2009). Biological and psychological factors have also been suggested as a reason for the effect of gender on recurrent headache in several studies (Rhee, 2000; Larsson & Sund, 2005; Santinello et al., 2009). Premenstrual syndrome, menses, use of birth control and high prolactin levels have all been linked to recurrent headache (specifically migraine) in females (Kelman, 2004; Cavestro, Rosatello, Marino, Micca, & Asteggiano, 2006; Crawford et al., 2009). However, further research, including empirical studies, are needed in identifying the biological and sociological factors associated with gender differences in adolescent recurrent headache.

When evaluating adolescent recurrent headache and the association with race/ethnicity, this analysis demonstrated a highest percentage of adolescent recurrent headache reported by American Indian adolescents followed by Other, White, Hispanic, African American and Asian adolescents. Using Wave I data from Add Health, Rhee (2000) reported American Indians had a higher rate of recurrent headache, followed by

White, African American, and Asian adolescents respectively (Hispanics were not included in her analysis).

In other studies on migraine as the recurrent headache type, the prevalence of recurrent headache in both adolescents and adults was higher in Whites than African Americans (Bigal et al., 2007; Lipton et al., 2007). In one adult study (mean age 37 years old) in which Hispanics were compared with Whites and African Americans, Whites were more likely to be diagnosed with recurrent headache (migraine) followed by Hispanics and African Americans respectively. (Morgenstern et al., 2001).

Previous studies which have evaluated race/ethnicity differences in recurrent headache have suggested that such differences may be attributed to socioeconomic status. This analysis of recurrent adolescent headache, as well as other studies, have demonstrated that White adolescents have a higher prevalence of headaches when compared with other race groups (Rhee, 2000; Lipton et al., 2007; Morgenstern et al., 2001). Rhee (2000) reported that such findings did not appear to demonstrate any relationship between socioeconomic status, race and adolescent recurrent headache. Lack of a relationship between socioeconomic status and recurrent headache was further supported in a study which evaluated several socioeconomic variables (socioeconomic status, single parent household, parent working status, financial burden, housing space) and reported no consistent association with pediatric headache and this group of socioeconomic variables (Kroner-Herwig et al., 2008). In a second study on parent self reported occupations, no relationship was found between adolescent headache and socioeconomic status (Waldie, McGee, Reeder, & Poulton, 2008). In contrast to the above studies, a recent study on household income and migraine in adolescents reported a

relationship between migraine prevalence and low income (Bigal et al., 2007). However, when “parental history of migraine” was taken into account, the relationship between low income and migraine no longer existed (Bigal et al., 2007). Thus, further studies are needed evaluating the differences in race and recurrent adolescent headache looking at the various factors associated with socioeconomic status and biological factors.

Lifestyle behaviors: skipping meals, water intake, tobacco and alcohol use, physical activity

Using chi square analysis, significant relationships were found for all three levels of meal skipping for breakfast, lunch and supper. In the logistic regression model, skipping breakfast three or more times and skipping lunch one or more times were significant and had the best model fit. Studies have demonstrated a relationship between adolescent recurrent headache and missed meals (Leviton et al., 1984; Lewis et al., 1996; Kelman, 2007). Typically, studies regarding recurrent headache and missed meals involve interviewing headache patients about factors that may trigger their headaches with “missed meals” as the response; however, studies do not look at number of times per week a meal is missed, which may be associated with recurrent adolescent headache. Adolescents are more likely to skip breakfast and lunch as opposed to dinner or supper. (Haines & Stang, 2005; Larson, Neumark-Sztainer, Hannan, & Story, 2007; Woodruff, Hanning, Lambraki, Storey, & McCargar, 2008; Pearson, Biddle, & Gorely, 2009). This analysis of recurrent adolescent headache may have found that skipping breakfast and lunch has the best model fit because adolescents skip breakfast and lunch more than dinner/supper. A correlation between missed meals and headache has been reported in the literature (Leviton et al., 1984; Lewis et al., 1996; Kelman, 2007), however, the cause

is unknown. Possible mechanisms for fasting-induced headaches include altered levels of serotonin and norepinephrine, release of stress hormones, and caffeine withdrawal (Martin & Behbehani, 2001). Further studies regarding such mechanisms would help to further substantiate the association of missed meals and headache.

Chi Square analysis demonstrated a significant relationship between no water intake on the previous day and recurrent headache, however, it failed to show a significant relationship in the logistic regression model. Several studies have addressed reports of the association of water deprivation and headaches (Blau et al., 2004; Blau, 2005; Bhatia et al., 2006; Spigt et al., 2004). Experimental studies have addressed both physiological and subjective symptoms following water deprivation and one study found an association between water deprivation and headache (Shirreffs et al., 2004) while the other study did not (Spigt et al., 2005).

In this analysis of recurrent adolescent headache and water intake, adolescents were asked to think about everything they had to drink yesterday and respond “yes” or “no” to whether or not they drank water the day prior. If an adolescent answered “yes” then they were considered to have water on the day prior. The amount of water ingested is unknown (i.e. if the adolescents did drink water the day prior, how much did they drink?). In order to determine if an adolescent had proper hydration, amount of water is important as well as drinking water on a daily basis. Response to water intake on the previous day may not be a good indicator of the true amount of water intake in this adolescent population. When evaluating adolescent headache and its association with water intake, more studies need to be done evaluating intake over periods longer than a day as well as documenting the amount of water ingested.

Recurrent headache and tobacco use demonstrated a significant relationship in both chi square ($p=.00$) and univariate analysis ($.00$). Several studies have reported an association between cigarette smoking and recurrent headache (Payne et al., 1991; Holmen et al., 2000; Jarvelaid, 2004; Aamodt et al., 2006; Waldie et al., 2008). Among adolescents, studies have shown an association between frequent headache and daily smoking (Jarvelaid, 2004; Waldie et al., 2008). One of the top three risk factors is “having ever tried cigarette smoking” (Gordon et al., 2004). This analysis of recurrent adolescent headache looked at smoking one cigarette a day for thirty days which does not take into account those who are occasional smokers or those who smoke less than 30 days.

Smoking results in nicotine binding to nicotinic acetylcholine receptors in the brain resulting in the release of neurotransmitters (dopamine, serotonin, norepinephrine, acetylcholine, gamma-amino butyric acid, and glutamate) (Quattrochi, Baird, & Yurgelun-Todd, 2000). Chronic nicotine exposure results in alteration of the receptor sites which may lead to desensitization of the sites (Quattrochi et al., 2000). Thus, headache may be a result of smoking effecting the “neurological processing of sensory information or the nutrition of peripheral tissues” (Waldie et al., 2008). What is most concerning is the effect of smoking on endothelial functioning which is a predictor of cardiovascular disease (Gordon, Lavoie, Arsenault, Ditto, & Bacon, 2008). The association of smoking with cardiovascular disease and headache is a concern due to the relationship of chronic headache (migraine) and stroke (Jousilahti, Tuomilehto, Rastenyte, & Vartiainen, 2003; Tietjen, 2005). More longitudinal studies need to be done

to assess smoking frequency as well as the risks and outcomes of those adolescents with chronic headache who smoke.

A significant univariate relationship was found between recurrent headache and binge drinking in chi square analysis ($p=.0592$) and univariate analysis (.05) but it was not included in the overall model. Adult studies report the relationship between alcohol use and recurrent headache in adults and college students (Bigal et al., 2002; Kuster et al., 2006). In a study involving adolescents, the incidence of recurrent headache was higher in alcohol users when compared to non-users (Gallelli et al., 2005). This analysis of recurrent adolescent headache looked at adolescents who drank five or more drinks in a row over the past 12 months, two or three times a month or more. Typically, binge drinking has been defined as drinking 5 or more drinks on a single occasion in the past two weeks (Flett et al., 2008). Studies evaluating the relationship between headache and alcohol, defined alcohol use at different frequencies and amounts. For example, one study looked at consumption of alcohol more than three times per week (Bigal et al., 2002) and another reported adolescent alcohol use as “yes” or “no” with no specific quantity reported (Gallelli et al., 2005). Since binge drinking is often associated with underage adolescent behaviors, it was chosen as the measurement for alcohol use in this analysis of recurrent adolescent headache (USDHHS, 2006). Inconsistencies in alcohol amount can make comparing studies difficult. Future studies may evaluate adolescent recurrent headache and alcohol use by defining alcohol intake at varying amounts of consumption consistent with adolescent intake (i.e. binge drinking).

Physical activity has been reported as a part of non-pharmacologic management of recurrent headache (Mack & Gladstein, 2008; Gunner et al., 2008). However, amount

of physical activity varies from using a treadmill at low speed for 5–10 minutes a day (Mack & Gladstein, 2008) to at least 30 minutes of enjoyable, aerobic activity 3 to 7 days a week (Gunner et al., 2008). This analysis of recurrent adolescent headache looked at how many times an active sport was played ranging from never to 5 or more times a week and a significant relationship was found between recurrent headache and physical activity. Those who did not exercise had an increased risk of 11% versus those who exercised 5 or more times a week. Those adolescents who only exercised 1 to 2 times a week had an increased risk of headache of 18% versus those who exercised 5 or more times. Intuitively, it would seem that those who exercised at least 1 or 2 times a week would have a decreased risk of recurrent headache when compared to the non-exercising counterparts. When adolescents were asked this question in this analysis of recurrent adolescent headache, Add Health responses did not include length of time spent exercising. Thus, how much difference in headache outcome is demonstrated by not exercising at all during the week versus exercising 1 time during the week (not knowing the length of actual time spent exercising) is unknown.

It has been reported that those with low activity levels were more likely to have recurrent headache when compared with those with high activity levels (Varkey et al., 2008). Physical activity as a treatment for recurrent headache has also been studied (Soderberg et al., 2006). Headache sufferers (chronic tension type headache) who began physical training, reported decreases in headache intensity and increases in headache free days (Soderberg et al., 2006). Further studies regarding physical activity (type and amount) are needed to better understand exercise as an intervention for adolescent recurrent headache.

Illness Related Factors: depression, somatic complaints, sleep and obesity

Chi square ($p=.00$) and univariate analysis ($p=.00$) both demonstrated a significant relationship between recurrent headache and depression. It is important to recognize depression in adolescents with recurrent headaches since undiagnosed psychiatric disorders increase the chronicity of the headache and the patient is less responsive to treatment (Oelkers-Ax & Resch, 2004). Several studies have been published investigating the relationship of adolescent recurrent headaches with a psychiatric co-morbidity (Pakalnis et al., 2007; Wang et al., 2007; Just et al., 2003; Fearon & Hotopf, 2001). These studies have reported that those with headaches have demonstrated higher levels of depression (based on psychological measures) when compared to those without headaches (Pakalnis et al., 2007). In another study, almost one half of the adolescents with recurrent headache had at least one psychiatric disorder with depression being the most common (Wang et al., 2007). It has also been reported that those with frequent headaches in childhood have an increased likelihood for psychiatric co-morbidity in adulthood (Fearon & Hotopf, 2001). Depressed adolescents with recurrent headache are at risk for chronic headaches. There is a need for studies to evaluate changes in adolescent recurrent headache once depression has been appropriately treated.

A significant relationship was found for both chest pain and muscle and joint pain with recurrent headache in this analysis. Both chest pain and muscle and joint pain are referred to as somatic complaints. Associations between general somatic complaints and adolescent recurrent headache have been reported in the literature (Fearon & Hotopf, 2001; Ghandour et al., 2004; Maizels & Burchette, 2004; Rhee et al., 2005a). In one

study, adolescents who reported headaches at least once a week or more also reported other frequent pains including muscle pain, back pain, and joint pain (Fichtel & Larsson, 2002). In another study, schoolchildren with headaches were more likely to report different pains including neck pain, limb pain and chest pain (Laurell et al., 2005). In the Wave I Add Health school survey analysis, simultaneous report of physical symptoms (i.e. headaches, musculoskeletal pain chest pain, etc.) in an adolescent population were analyzed and 33% of adolescents reported multiple physical symptoms including combinations inclusive of headache (Rhee et al., 2005b). Studies establishing interventions to best treat somatic complaints and analyzing the effects of such treatments on adolescent headache are needed.

This analysis of recurrent adolescent headache and insomnia found a significant association with headache and sleep difficulty. Identification and treatment of sleep disorders improves headache outcomes (Kelman & Rains, 2005). In studies evaluating sleep behaviors in adolescents with recurrent headache, significant associations were found between headache and difficulty falling asleep, staying up all night, having nightmares, and snoring (Gilman et al., 2007; Miller et al., 2003). This analysis of recurrent adolescent headache evaluated those adolescents who had trouble falling asleep or staying asleep which can be attributed to various sleep disorders. Insomnia can be associated with depression, sleep apnea or restless leg syndrome. Due to the stimulatory effects of caffeine, adolescent caffeine use has also been attributed to adolescent sleep difficulties (Orbeta, Overpeck, Ramcharran, Kogan, & Ledskey, 2006). This cross sectional analysis of recurrent adolescent headache and insomnia demonstrated that insomnia was associated with recurrent headache; however, the cause of the insomnia

could not be evaluated. Studies need to be done distinguishing the different causes of adolescent sleep problems and the association of these causes with adolescent recurrent headache. Once sleep difficulties are addressed and sleep is improved, evaluation of changes in headache occurrence needs to be reported.

In this evaluation of recurrent adolescent headache and obesity, BMI categories (underweight, normal weight, at risk for overweight, and obesity) were used to determine the relationship between obesity and recurrent adolescent headache. A significant relationship between recurrent adolescent headache and obesity was not found using chi square analysis. This is contrary to what has been published in the literature. Studies in the adult literature have reported the relationship between headache frequency and obesity (Bigal et al., 2006; Scher et al., 2003). Studies have also reported an association between obesity and adolescent headache frequency (Hershey, 2006; Pinhas-Hamiel et al., 2008; Hershey et al., 2009). In one study a significant relationship between headache frequency and obesity was found when comparing overweight females with normal weight females (Pinhas-Hamiel et al., 2008). However, a significant relationship was not found for males. In another study on weight changes and headache outcomes, Hershey et al. (2009) reported that change in BMI scores significantly positively correlated with changes in headache frequency.

Given the above findings, questions arise as to whether it is obesity or the co-morbidities associated with obesity that put adolescents at risk for recurrent headache. For example, associations have been reported between obesity and shorter sleeping hours and sleep disordered breathing in adolescents (Seicean et al., 2007; Rudnick, Walsh, Hampton, & Mitchell, 2007). Thus, could it be that sleep apnea, which is observed in

obese adolescents, is a contributor to recurrent adolescent headache (Iwasaki & Ikeda, 2007; Gilbert, 2007). Discussions have also been raised regarding the association between soft drinks and childhood obesity (Olsen & Heitmann, 2009; Murray, Frankowski, & Taras, 2005; Striegel-Moore et al., 2006). Obese adolescents are more likely to drink caffeinated soft drinks and the stimulatory effect of such beverages can lead to increased difficulty falling asleep at night (Orbeta et al., 2006; Calamaro, Mason, & Ratcliffe, 2009). Thus, the obese adolescent may experience headache.

Along with poor eating habits, decreased physical activity has been reported to result in overweight youth (Story, Nannery, & Schwartz, 2009). This analysis of recurrent adolescent headache demonstrated a significant relationship between recurrent headache and physical activity. Thus, are obese adolescents more likely to have recurrent headache due to their physical inactivity? Finally this analysis demonstrated a significant relationship between adolescent headache and depression. Studies in the adult population have reported a higher headache frequency in obese migraineurs with depression compared with normal weight migraineurs without depression (Tietjen et al., 2007). Adolescent research has reported an association between depression and adolescent obesity (Strine et al., 2008; Reeves, Postolache, & Snitker, 2008; Goossens, Braet, Van, & Mels, 2009). Again, are obese adolescents more likely to have a higher frequency of headache due to depression? It appears that obesity should be a factor taken into consideration when evaluating recurrent adolescent headache due to the co-morbidities associated with obesity (depression, sleep disordered breathing, physical inactivity) and the influences of the co-morbidities on recurrent headache. Further work exploring the

associations of BMI (obesity) with recurrent headache should address sleep disordered breathing, soft drink intake (caffeine), physical activity, and depression.

Conclusion

Summary of the Study

This analysis was based on the premise that lifestyle behaviors and illness related factors work together in order to predict adolescent recurrent headache. Major findings included development of a headache model inclusive of those behaviors and factors that are predictive of adolescent recurrent headache (Equation 2, page 102). A descriptive, exploratory study was performed using secondary data analysis from the Wave II in-home interviews of the Add Health database. The Add Health database was chosen since it represents a large and diverse population of a nationally representative sample of adolescents. Add Health addressed adolescent headache and was inclusive of all the lifestyle behaviors and illness related factors associated with this study.

Multiple studies have looked at the individual relationships of lifestyle behaviors and illness related factors with adolescent recurrent headache; however, only a few studies have looked at multiple variables (Larsson, 1988; Laurell et al., 2005; Kroner-Herwig et al., 2008). This research of recurrent adolescent headache used the Add Health dataset and logistic regression analysis demonstrated a multivariate model of lifestyle behaviors and illness related factors predictive of recurrent headache in a nationally representative US adolescent population. Approximately 26% of the adolescents experienced recurrent headache. Recurrent headache was reported by 19% of males and 26% of females. The odds of having recurrent headache were significantly associated with gender, age group, race, skipping meals (breakfast and lunch), smoking regularly,

physical activity, depression, somatic complaints (chest pain, muscle and joint pain), and insomnia . Skipping supper, water intake, binge drinking, and obesity (BMI) were not included in the overall model. Significant interactions between gender and age group; race and smoking regularly; and depression and insomnia were also found.

Limitations

Add Health is a nationally representative school-based survey of 7th through 12th grade adolescents conducted between 1994 and 1996. A limitation of this research is use of 13 year old data. However, this research was concerned only with the associations of the predictors with recurrent adolescent headache and any changes in the occurrence of predictors over time should not affect the outcome of this research study. The Add Health dataset provides a large population of a nationally representative sample of adolescents with recurrent headache. There are no large nationally representative studies of US adolescents with recurrent headaches. The number of observations used in this analysis was 13,512 (weighted count: 18,710,451). Add Health not only provided adolescent responses to recurrent headache but also provided survey data on the lifestyle behaviors and illness related factors reported in this research study. The Add Health survey data allowed for the analysis of recurrent adolescent headache using a large population based sample of children as opposed to a smaller clinical sample. Using this population based sample decreased concerns for bias that exists when using a clinical sample of adolescents who have access to and utilize the healthcare system (Kroner-Herwig et al., 2008). The model developed in this study may be used to lay the groundwork for future prospective studies on adolescent recurrent headache.

The cross sectional nature of the present analysis does not allow the results to be interpreted in regard to causality. Only significant associations can be reported. Thus, Add Health data does not provide information to evaluate effectiveness of specific interventions and it is not possible to address determinants of behavior. Add Health is a self report of adolescents; thus, risk of under- or over-reporting of behaviors may exist. Height and weight were the only data measured and reported by the researchers.

Add Health data were obtained from those youth attending school; therefore, the data are not representative of adolescents who are out of school (Brener et al., 2004). Large population based studies are helpful in obtaining an understanding of multiple health behaviors (Pronk et al., 2004) but comparison among studies is difficult due to inconsistencies in defining similar variables. Previous studies that developed models for adolescent headaches were tested and each study used different headache criteria: > once a week for more than a year (Larsson, 1988), tension type headache occurrence yes/no (Laurell et al., 2005) and frequency in the last 6 months (none, rare, weekly, monthly) (Kroner-Herwig et al., 2008). The Add Health dataset defines headache through adolescent report of headache over a 12 month period (never, just a few times, once a week, every day). Surveys that ask adolescents to recall illnesses and behaviors over a 6 to 12 month period raise concerns as to how accurately a student can report behaviors over this time period (Brener et al., 2004).

This analysis evaluated factors associated with adolescent recurrent headache. Add Health was chosen because this dataset addressed recurrent headache and each lifestyle behavior and illness related factor specific to this study. However, other factors associated with recurrent adolescent headache include analgesic overuse (Wang, Fuh, Lu,

& Juang, 2006), caffeine use (Orbeta et al., 2006; Calamaro et al., 2009) and underlying anxiety (Wang et al., 2007). These predictors were not measured in the Add Health dataset. This would be considered a limitation since the adolescent recurrent headache model was developed without taking these predictors into consideration.

An argument can be made regarding the necessity of caffeine and anxiety as predictors of adolescent recurrent headache in the model. Caffeine's stimulatory effects lead to difficulty falling asleep (Calamaro et al., 2009). One could make the case that difficulty falling asleep may be a more important predictor than the report of caffeine use. Since anxiety frequently co-occurs with depression (DSM-IV-TR, 2000), it may be argued that, although anxiety was not directly measured, those adolescents reporting depression may have also had co-morbid anxiety. Thus, inclusion of depression in the model may indirectly account for anxiety due to co-occurrence of these two illnesses.

Recommendations for Further Research

This research studied adolescent health in terms of recurrent headache and explored the relationship between lifestyle behaviors, illness related factors and recurrent headache in adolescents. Future model testing should include the lifestyle behaviors (skipping meals, water intake, tobacco use, alcohol use, and physical activity) and illness related factors (depression, somatic complaints, insomnia and obesity) used in this study as well as those predictors not measured in Add Health. Caffeine and analgesic use (lifestyle behaviors) as well as anxiety (illness related factor) are important variables that need to be included in future model testing. A well established headache model may then

serve as the basis for development and testing of an evidenced based screening tool for adolescent headache.

This analysis of recurrent headache found that those who were physically active had lower risk of recurrent headache. Intervention research studies could be designed to address physical activity in regard to type and amount of exercise beneficial for headache relief. Other studies could be designed to address interventions and headache outcomes for treatment of depression, chest pain and muscle and joint pain.

Studies regarding the association of BMI (obesity) with recurrent headache should also address sleeping difficulty, physical activity, diet and depression. Further research can establish if interventions for obesity result in improved headache outcomes. Along with BMI, other predictors did not make a significant contribution to the model (skipping lunch, no water and binge drinking). Future prospective studies could be done analyzing further if these predictors have any significant effect on adolescent headache.

Health Promotion and Recurrent Adolescent Headache

Adolescent health promotion and illness prevention literature has addressed the significance of recognizing the lifestyle behaviors and illness related factors of skipping meals, water intake, tobacco and alcohol use, physical activity, depression, somatic complaints, insomnia and obesity in the adolescent population. The findings of this research study demonstrated several lifestyle behaviors and illness related factors associated with adolescent recurrent headache. Healthy People 2010 addresses critical objectives for adolescents in terms of trends in youth risk behaviors (Towey & Fleming, 2003). Inclusive in these objectives are the following lifestyle behaviors and illness related factors as described in this study: physical activity, overweight and obesity,

adolescent tobacco use and binge drinking as well as mental health (Towey & Fleming, 2003).

Public health literature also recognizes the importance of sleep, eating regularly, and water intake in terms of adolescent health (CDC, 2009; Loughridge & Barratt, 2005; Dowdell & Santucci, 2004). Due to its association with chronic illness (headache, cardiovascular disease, obesity), sleep is now recognized as an important aspect in health promotion and illness prevention (CDC, 2009). Health promotion and illness prevention literature addresses the importance of healthful eating habits including avoidance of meal skipping (Tate & Patrick, 2000; Wilson et al., 2003; Hesketh et al., 2005). Public health efforts are also needed to encourage healthful beverage choices, decrease soda consumption, and provide cooled filtered water in schools to improve adolescent health outcomes (Striegel-Moore et al., 2006; Loughridge & Barratt, 2005).

Adolescents who practice poor lifestyle behaviors and have undiagnosed illness related factors are at risk for recurrent headache. School nurses are health care professionals who have the ability to assess students on a regular basis (Massachusetts Department of Public Health, 2007). School nurses need to understand recurrent adolescent headache and its predictors. Education of the school nurse regarding lifestyle behaviors as well recognition of illness related factors is important in order to initiate appropriate assessment, intervention and referral of students at risk for recurrent headache. School nurses can then help to reinforce factors of health promotion and illness prevention in terms of adolescent headache.

Recognition of the association between lifestyle behaviors, illness related factors and recurrent adolescent headache could further reinforce the importance of policy

changes including: providing healthy breakfast/lunch programs at schools, providing cool filtered water with limited access to caffeinated beverages, reinforcement of non-smoking and alcohol policies on school property and implementation of physical education programs in schools. Such policies may decrease recurrent adolescent headache resulting in better school performance and decreased absenteeism in those students at risk for headache.

Implications for Practice

Significant predictors of the proposed model for recurrent adolescent headache can be used as the basis for development of an assessment tool for evaluating adolescent headache. The above findings underscore the importance of obtaining a complete history in regard to lifestyle behaviors and illness related factors in adolescents with recurrent headache. Assessment of adolescents with recurrent headache needs to be broadened to include questions regarding meal schedules, tobacco and alcohol use, depression, somatic complaints, insomnia and recording BMI. Such a tool could assist health care providers in obtaining a complete history inclusive of the predictors found to be associated with recurrent adolescent headache. A thorough assessment of each predictor can alert health care providers of lifestyle behaviors in need of modification and each illness related factor that needs to be addressed. Interventions appropriate for each behavior change and co-morbidity (depression, somatic complaint, insomnia) can then be initiated. Addressing modifiable factors and co-morbidities associated with adolescent recurrent headache may result in a conservative therapy approach or even limited use of medication interventions. Once adolescents are educated about modifiable behaviors and illness related factors that

may be associated with their recurrent headache, they can then be empowered to take an active role in improving their own health outcomes.

APPENDIX A: LOGISTIC REGRESSION EQUATION

Equation 3 Logistic Regression Equation

Logistic Regression Equation

Logistic Regression Equation:

$$\log\left(\frac{P_i}{1-P_i}\right) = \alpha + \sum_{k=1}^K \beta_k X_{ik} + \varepsilon_i$$

1. $\log(P_i/1-P_i)$ is the log odds of the dependent variable (recurrent headache)
2. P_i is the conditional probability that an adolescent_i has recurrent headache ($P(Y_i)=1$)
3. $1-P_i$ is the conditional probability that an adolescent_i does not have recurrent headache
4. $(P_i/1-P_i)$ is the odds of being in one of the two outcomes of interest
5. α represents the intercept and is a parameter to be estimated
6. β_k represents the predicted odds and is a parameter to be estimated
7. X_{ik} is the k^{th} explanatory variable associated with the i^{th} adolescent in the model
8. ε_i is the random error associated with the i^{th} adolescent

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APPENDIX B: TABLES

Table 14 Correlations

Pearson Product Moment Correlations between Predictors of Adolescent Recurrent Headache										
Predictors	1	2	3	4	5	6	7	8	9	10
Recurrent Headache										
Gender	.204									
Race	.097**	-.005								
Age Group	.013	-.008	-.026**							
Chest Pain	-.121**	-.031**	.021*	-.003						
Depressed Mood	-.126**	-.042**	.089**	-.048**	.144**					
Insomnia	-.123**	-.039**	.007	-.009	.133**	.197**				
Muscle Joint Pain	-.128**	.087**	-.080**	-.025**	.122**	.098**	.136**			
Skip breakfast three or more times	-.070**	-.097**	.083**	-.049**	.040**	.121**	.082**	-.004		
Skip Lunch one or more times	-.055**	-.084**	.069**	-.034**	.026**	.129**	.064**	-.001	.223**	
Active in Sports	-.070**	-.280**	.067**	-.057**	.012	.095**	.050**	-.114*	.135**	.082**

*Correlation is significant at the 0.01 level (2-tailed)

** Correlation is significant at the 0.05 level (2-tailed)

Table 15 Tolerance and VIF*Tolerance and VIF*

Model	Collinearity Statistics	
	Tolerance	VIF
Gender	.916	1.092
Race	.955	1.047
Age Group	.982	1.018
Chest Pain	.950	1.052
Depression	.898	1.114
Insomnia	.920	1.087
Muscle and Joint Pain	.939	1.065
Skip Breakfast Three or More Times	.901	1.110
Smoke Regularly	.917	1.090
Skip Lunch One or More Times	.927	1.078
Physical Activity	.887	1.128

Dependent Variable: RECURRENT HEADACHE

Table 16 Prediction of Interaction Terms*Interaction Terms*

GENDER*RACE
 GENDER*AGE GROUP
 GENDER*CHEST PAIN
 GENDER*DEPRESSION
 GENDER*INSOMNIA
 GENDER*MUSCLE JOINT PAIN
 GENDER*SKIPBREAKFAST3
 GENDER*SMOKE REGULARLY
 GENDER*SKIPLUNCH1
 GENDER*PHYSICAL ACTIVITY

RACE*CHEST PAIN
 RACE*DEPRESSION
 RACE*INSOMNIA
 R*MUSCLE JOINT PAIN
 RACE*SKIPBREAKFAST3
 RACE*SMOKE REGULARLY
 RACE*SKIPLUNCH1
 RACE*PHYSICAL ACTIVITY

AGE GROUP*CHEST PAIN
 AGE GROUP*DEPRESSION
 AGE GROUP*INSOMNIA
 AGE GROUP*MUSCLE JOINT PAIN
 AGE GROUP*SKIPBREAKFAST
 AGE GROUP*SMOKE REGULARLY
 AGE GROUP*SKIPLUNCH1
 AGE GROUP*PHYSICAL ACTIVITY

DEPRESSION*CHEST PAIN
 DEPRESSION*INSOMNIA
 DEPRESSION*MUSCLE JOINT PAIN
 DEPRESSION*PHYSICAL ACTIVITY

SKIPBREAKFAST3*SKIPLUNCH1
 SKIPBREAKFAST3*INSOMNIA
 SKIPBREAKFAST3*DEPRESSION
 SKIPLUNCH1*INSOMNIA
 SKIPLUNCH1*PHYSICAL ACTIVITY

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