PSYCHOBEHAVIORAL FACTORS, ARTERIAL STIFFNESS, AND BLOOD PRESSURE IN KOREAN AMERICANS

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ABSTRACT

JEONGOK G. LOGAN: Psychobehavioral Factors, Arterial Stiffness, and Blood Pressure in Korean Americans

(Under the direction of Debra J. Barksdale)

High levels of psychological stress and a high prevalence of hypertension (HTN) have been reported in Korean Americans (KAs). Immigration may be one source of stress which contributes to HTN in KAs. Arterial stiffness is another cardiovascular condition which is also related to both stress and hypertension. Traditionally, arterial stiffness was viewed as the result of HTN, but longitudinal studies have shown that arterial stiffness may itself predict progression of HTN in non-hypertensive people. Thus, this study explored the associations among stressors (acculturation and time in the U.S.), psychobehavioral responses (psychological stress, chronic active coping, and stress emotions of anger, anxiety, and depression), and physiological responses (blood pressure and arterial stiffness) in KAs.

In this study, a convenient sample of 102 KAs (aged 21-60 years, 60% women) was recruited. Subjects were asked to complete the seven psychobehavioral scales and a demographic questionnaire. Physiological data including weight, height, blood pressure (BP), and arterial stiffness were also measured. The collected data were analyzed using SAS (version 9.2). Descriptive analysis, Pearson correlation, and multiple regressions were used to analyze the data.

Age and mean arterial pressure (MAP) were the major determinants of arterial stiffness as measured by carotid-femoral pulse wave velocity (cfPWV) and augmentation index adjusted at heart rate 75 (AI_75). When age and MAP were controlled, state anger and state & trait anxiety significantly and independently predicted levels of cfPWV. Women had a significantly higher AI_75 than men. Perceived stress significantly predicted AI_75 after controlling age, MAP, and gender. Anger, anxiety, and perceived stress were related to arterial stiffness but not BP. Age was an independent predictor of cfPWV but not of BP; thus, age-associated increases in BP reported in previous studies may actually be the effect of age-associated increases and related effects of PWV on BP. More studies are needed to compare psychobehavioral factors and arterial stiffness in KAs and other racial groups, and to explore specific mechanisms by which psychobehavioral factors are implicated in the pathological process of arterial stiffness.

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I can do all this through Him who gives me strength (Philippians 4:13).

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[1] Spielberger's State-Trait Anger Expression Inventory 2 (STAXI-2) and Spielberger State-Trait Anxiety Inventory (STAI) are not presented due to copyright.

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CHAPTER I

INTRODUCTION

Significance of the Problem

Cardiovascular disease (CVD) is a major health problem and the leading cause of death in the United States. An estimated 81,100,000 American adults (more than 1 in 3) have one or more types of CVD. In 2006 alone, 831,272 people died of CVD, which was 34.3% of all deaths or one of every 2.9 deaths in the U.S. (Lloyd-Jones et al., 2010). Considering that 569,490 deaths from all kinds of cancer are projected to occur in the U.S. in 2010 (Jemal, Siegel, Xu, & Ward, 2010), the severity of the problem posed by CVD is easily recognized.

Among CVD, high blood pressure (HBP) is the most prevalent condition. An estimated 74,500,000 people (33.6% of U.S. adults ≥20 years of age) have HBP defined as systolic pressure 140 mm Hg or greater and/or diastolic pressure 90 mm Hg or greater (Lloyd-Jones et al., 2010). From previous studies, it has been well established that HBP is an independent and strong predictor for other CVD (Gu, Dillon, Burt, & Gillum, 2010). Hypertension is important not only due to its high prevalence but also because it is a major modifiable risk factor for CVD and kidney disease (Jackson, Lawes, Bennett, Milne, & Rodgers, 2005). Although progress has been made in prevention and treatment, hypertension still remains an important public health challenge.

Traditionally, it was believed that arterial stiffness was attributable to elevated blood pressure (BP) or hypertension (Franklin, 2005; Risler, Cruzado, & Miatello, 2005). However, population-based longitudinal studies have shown that arterial stiffness may itself predict progression to hypertension in nonhypertensive subjects (Dernellis & Panaretou, 2005; Liao et al., 1999). Arterial stiffness is characterized by decreased elastin and increased collagen fibers in arteries (Levy, Pappano, & Berne, 2007). The change of elastic properties in arteries causes disorders in arterial function. For example, left ventricular ejection initiates an arterial pressure wave, and the pulse wave is reflected back toward the ascending aorta when it meets arterial walls. However, stiffened arterial walls cause a fast reflection of the pulse wave, boosting pressure during systole and therefore, increasing the left ventricular load (Barksdale & Logan, 2009; Hamilton, Lockhart, Quinn, & McVeigh, 2007). In this regard, it is not surprising that arterial stiffness has also been identified as an independent marker of cardiovascular morbidity and mortality (Cohn, Duprez, & Grandits, 2005; Laurent et al., 2006). Indeed, arterial stiffness is recognized as an independent predictor of hypertension (Dernellis & Panaretou, 2005) as well as a marker for increased CVD risk (Cernes, Zimlichman, & Shargorodsky, 2008; Laurent & Boutouyrie, 2007), including myocardial infarction (Matsuoka et al., 2005), heart failure (Gradman & Alfayoumi, 2006), cognitive impairment (Scuteri, Brancati, Gianni, Assisi, & Volpe, 2005) and renal diseases (Taal, Sigrist, Fakis, Fluck, & McIntyre, 2007).

Since arterial stiffness may precede hypertension, the factors which have been identified as risk factors for hypertension may contribute to arterial stiffness, before hypertension develops (Liao et al., 1999). Among many other risk factors, psychobehavioral factors have long been of interest as risk factors for hypertension. Literature has been accumulating on the relationship of psychological stress, stress emotions, and coping to hypertension.

Psychological Stress. When an external stressor is appraised as harmful, challenging, or threatening (Lazarus & Folkman, 1984), this perceived psychological stress is thought to contribute to elevated BP. If the condition persists, the psychological stress may contribute to the development of hypertension (Larkin, 2005) and other CVD (McCarron, Smith, Okasha, & McEwen, 2000).

Stress Emotions. The stress model of Lazarus and Folkman (1984) indicates that appraisal and coping lead to short term outcomes including emotional responses; thus, emotions should be evaluated to better understand a person's response to perceived stress. Among stress emotions defined by Lazarus (1999), anger, anxiety, and depression have been frequently investigated as risk factors for CVD (Bleil, Gianaros, Jennings, Flory, & Manuck, 2008; Rozanski, Blumenthal, & Kaplan, 1999; Suls & Bunde, 2005). Population-based longitudinal studies have shown that trait anger has been associated with increased risk of progressing to hypertension, incident coronary heart disease (Player, King, Mainous, & Geesey, 2007) and total mortality (Eaker, Sullivan, Kelly-Hayes, D'Agostino, & Benjamin, 2004; Player et al., 2007). A large number of studies report that anxiety poses a strong risk for coronary artery disease (CAD) (Vural, Satiroglu, Akbas, Goksel, & Karabay, 2007) and myocardial infarction (MI) or death among patients with CAD (Shen et al., 2008; Shibeshi, Young-Xu, & Blatt, 2007), but one population-based longitudinal study demonstrated that anxiety predicted lower BP 11 years later (Hildrum, Mykletun, Holmen, & Dahl, 2008). Evidence has been increasing that depression is linked to high prevalence of coronary heart disease (CHD) and hypertension (Artinian, Washington, Flack, Hockman, & Jen, 2006; Herbst, Pietrzak, Wagner, White, & Petry, 2007). However, there is some evidence that depression is negatively associated with BP (Lenoir et al., 2008; Licht et al., 2009). Therefore, there are conflicting results on the role of stress emotions including anxiety and depression in the development of hypertension.

Coping. The association between perceived stress and disease can be modified by the coping characteristics of the individual and by social support from family and friends (Folkman & Moskowitz, 2004). Chronic active coping, which is defined as a strong predisposition to confront daily psychosocial stressors in an active and effortful manner (James, Hartnett, & Kalsbeek, 1983), has been associated with high BP and increased heart rate responses (Smith, Ruiz, & Uchino, 2000). In particular, when chronic active coping is combined with limited psychosocial and socioeconomic resources (e.g. education and income), it may result in a greater risk for hypertension and CVD (Merritt, Bennett, Williams, Sollers, & Thayer, 2004).

Although psychobehavioral factors including stress, emotions, and coping have long been implicated in the development of hypertension, the exact pathways by which psychobehavioral factors contribute to the development of hypertension are still not clear. Therefore, the investigation of the association between these psychobehavioral factors and arterial stiffness may provide important information to elucidate these inconsistent links.

Investigators are just beginning to explore risk factors for increased arterial stiffness, and few have examined the relationship between psychobehavioral factors and arterial stiffness. No studies have examined these relationships in Korean Americans, the fifth largest Asian populations in the U.S. (Reeves & Bennett, 2004).

Studies on the health of Korean Americans are limited. Nevertheless, a study among 761 Korean Americans aged 18 to 89 years revealed a high prevalence of hypertension (32%) (Kim, Kim, Juon, & Hill, 2000), higher than the prevalence of hypertension in Koreans in Korea (21.8% for all ages, and 26.1% in those aged 30 and older [KNSO, 2001]). Factors that contribute to the increased prevalence of hypertension in Korean Americans have not been systematically examined. However, international immigration, which is considered one of the most significant stressful life events (Shen & Takeuchi, 2001), may be a source of psychological stress that increases the risk of hypertension. Actually, several studies have reported that Korean Americans may experience high levels of emotional distress from adapting to the social, cultural, and economic norms of American society (Chun, Knight, & Youn, 2007; Kim, Han, Shin, Kim, & Lee, 2005; Koh, 1998; Kuo, 1984; Saint Arnault & Kim, 2008; Shin, 1993). In addition, psychological problems related to anger and depression are reported to be common in elderly Korean immigrants (Han, Kim, Lee, Pistulka, & Kim, 2007; Jang, Kim, & Chiriboga, 2005; Lin et al., 1992). Thus, Korean Americans are a vulnerable population at high risk for psychological problems, arterial stiffness and hypertension.

Therefore, this study is intended to explore the relationships among the psychobehavioral factors, arterial stiffness and blood pressure in Korean Americans who have immigrated to the United States.

Purpose of the Study

The purpose of the study was to investigate the associations among stressors (acculturation and time in the U.S.), psychobehavioral responses (psychological stress – perceived stress and acculturative stress, chronic active coping, and stress emotions - anger, anxiety, and depression), and physiological responses (BP and arterial stiffness) in Korean Americans.

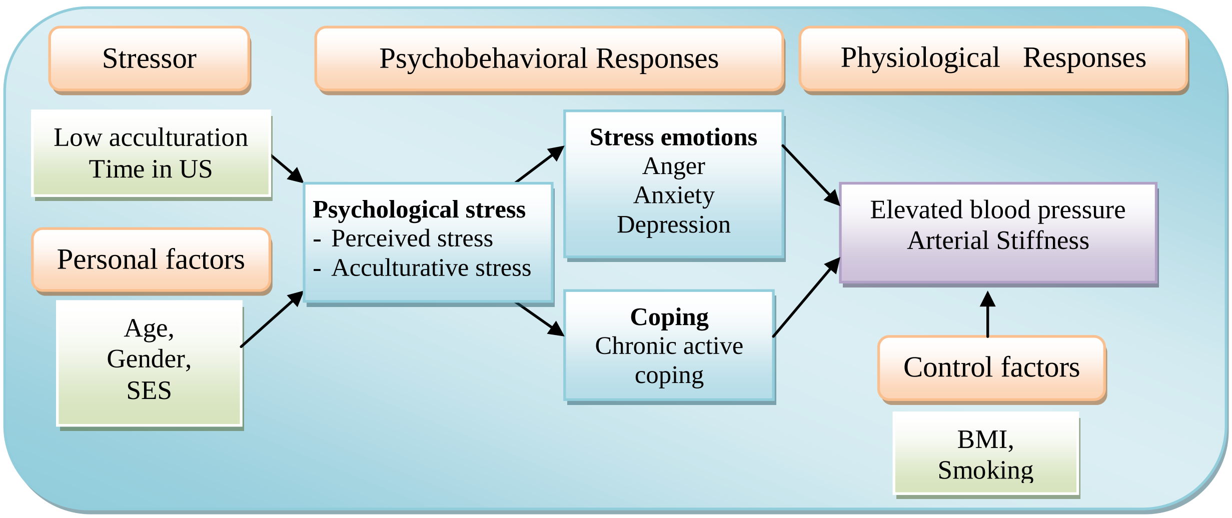


Figure 1. Conceptual Framework

Overview of Conceptual Model and Variables

The conceptual model for this study consists of five parts: stressors, personal factors, psychobehavioral responses, physiological responses, and control factors (See Figure 1).

Stressors were defined by low acculturation which is considered a very significant stressor for immigrants (Claassen, Ascoli, Berhe, & Priebe, 2005; Fazel, Wheeler, & Danesh, 2005) and time in the U.S. A shorter time in the U.S. is considered a stronger stressor (Steffen, Smith, Larson, & Butler, 2006). The response to stressors can be influenced by many personal factors. This study included the personal factors age, gender, and socio-economic status (SES). These are believed to influence psychobehavioral and physiological responses to stressors.

Once an individual appraises or perceives an experience as stressful, psychobehavioral responses and physiological responses are initiated. Psychobehavioral responses can be divided into cognitive, emotional, and behavioral responses to stressors. Psychological stress can be considered as a cognitive component of stress response because it is usually measured by individual appraisal or perception of the significance of stressful events (Lazarus & Folkman, 1984). In this study, psychological stress was operationalized by perceived stress and acculturative stress. Studies show that psychological stress is correlated with stress emotions measured by trait anger, trait anxiety, and trait depression (Peters, 2006), and greater tendency to use coping strategies (Tull, Sheu, Butler, & Cornelious, 2005). In this study, the stress emotions of anger, anxiety, and depression, which are correlated with the higher incidence of CVD, will be examined as an emotional component of psychobehavioral responses. Chronic active coping, one of the coping strategies related to the development of hypertension, will be examined as a behavioral component of psychobehavioral responses.

Physiological responses will include elevated BP and arterial stiffness which may lead individuals to develop hypertension. Smoking and body mass index (BMI), well known independent CVD risk factors, are control factors.

Research Questions

In Korean Americans who were born in Korea and have been in the U.S. at least one year;

Question 1. How does acculturation relate to time in the U.S.?

Question 2. What are the associations among the psychobehavioral responses of psychological stress (perceived stress and acculturative stress), emotions (anger, anxiety, or depression), and chronic active coping?

Question 3. What is the relationship between blood pressure and arterial stiffness?

Question 4. How much of the variance in arterial stiffness is explained by stressors (acculturation and time in the U.S.), psychological stress (perceived stress and acculturative stress), chronic active coping, and stress emotions (anger, anxiety, or depression), controlling for BP, age, gender, SES, BMI, and smoking?

Question 5. How much of the variance in blood pressure is explained by stressors (acculturation and time in the U.S.), psychological stress (perceived stress and acculturative stress), chronic active coping, and stress emotions (anger, anxiety, or depression), controlling for arterial stiffness, age, gender, SES, BMI, and smoking?

CHAPTER II

LITERATURE REVIEW

Psychological Stressors

Low acculturation as a significant psychological stressor.

Life involves numerous events which require adaptation. According to life span theories, both normative and nonnormative events are encountered in one's life (Baltes, Staudinger, & Lindenberger, 1999). While normative events are predictable and often connected with a biological change of life (e.g., puberty, parenthood, or death of spouse), nonnormative events are less predictable and less prevalent (Laosa, 1997). Immigration is often considered a profound nonnormative life event and requires extensive adaptation (Claassen et al., 2005; Fazel et al., 2005). Immigration usually entails many stressors including loss of intimate relationship with family or friends, language barriers, discrimination, financial strain, different physical environment, unfamiliar culture in social relationship, or non availability of familiar food. The extent to which immigrants adjust or adapt to a different culture is explained by acculturation. Specifically, acculturation is an adaptation process by which one cultural group adopt the beliefs and behaviors of a host culture (Mills & Henretta, 2001). Low acculturation in which one has difficulties adjusting to the new culture can be a source of great psychological stress. Research on acculturation and health have reported that less acculturated immigrants have poorer psychological health condition (Gonzalez, Haan, & Hinton, 2001; Mui &

Kang, 2006). It was also reported that less time of residence in the U.S. related to more life stresses (Mills & Henretta, 2001)

The experience of acculturation can be different in its extent and impact among various racial/ethnic groups. For example, European immigrants who have lived in a society where people are encouraged to express their own goals and desires may have less difficulty with acculturating to the American society than Asian immigrants who have lived in a culture where familial or societal goals are prioritized over an individual's goal. The more new or unfamiliar environments one encounters, the more difficult their acculturation process would be; thus, more adaptation efforts may be required. Actually, many studies show ethnic differences in psychological stress, emotional and biological responses. Kim (2008) investigated cultural differences in the psychological and biological effects of verbalization of thoughts. In that study, a visual pattern discrimination game was given as a task. When a difficult task was given, verbalization of thoughts impaired East Asians or East Asian Americans' performance of the task. However, verbalization of thoughts had a neutral or positive effect on performance in European Americans. Furthermore, verbalization decreased the cortisol response to the task in European Americans but not in East Asian Americans. This study demonstrated that the same task could lead to different psychological and biological responses in people from different cultures (Kim, 2008). Lee et al. (2006) compared 45 Asian Americans and 38 European Americans in social anxiety with self-report diary measures. Asian Americans and European Americans had a similar number of events which caused anxiety in social situations, but Asian Americans reported higher level of social anxiety than European Americans (Lee, Ohazaki, & Yoo, 2006). Another study examined social anxiety, self-construals, and depression in 348 college students (183 White American and 165 Asian Americans) and reported that Asian Americans had significantly higher social anxiety and depression than White Americans (Okazaki, 1997). Despite increasing evidence that Asian Americans have difficulties with acculturation, few studies have been conducted to explore acculturation in Korean Americans.

Given the literatures showing cultural difference in psychological stress and stress responses, it is important to study how low acculturation, a significant life stressor, plays a role in psychological and physiological health in Asian minority populations who seem to be more vulnerable to the life event of immigration to the U.S.

Immigration and hypertension.

The effect of immigration to a foreign country on blood pressure (BP) has been investigated by researchers. One meta-analytic study investigated the association between stress from immigration and BP in 125 relevant research manuscripts (Steffen et al., 2006). The authors reported that the overall strength of the relationships (effect size) between stress and BP was 0.28 for systolic BP and 0.30 for diastolic BP, with increasing stress related to higher BP. These large effect sizes are similar to those of other well known risk factors such as diet and physical activity. A more interesting finding is that the change in BP caused by immigration was not related to body mass index (BMI) or cholesterol, but instead, it was related to the length of residence in the new country. The largest effect sizes were observed during the initial entry period and then decreased rapidly within the first few years. Another study followed 53 male Ethiopians (on average 21 years old) who immigrated from Ethiopia to Israel, and showed that their BP significantly increased over 2 years (on average, systolic BP rose 11mmHg and diastolic

BP rose 9 mmHg), without any change in BMI and triceps' skinfold (Bursztyn & Raz, 1995).

Immigration is also associated with other CVD risk factors including hyperlipidemia, BMI, sedentary life style, smoking (Patel et al., 2006), and intima-media thickness of the carotid artery (Lear, Humphries, Hage-Moussa, Chockalingam, & Mancini, 2009). Whereas BP may be most increased within the first few years, other CVD risk factors seem to continuously increase over time since immigration. For example, the 2002 National Health Interview Survey (NHIS) of 5,230 immigrant adults found that a longer length of residence in the U.S. was associated with increased incidence of multiple CVD risk factors, including obesity, hyperlipidemia, and cigarette smoking even after adjusting for relevant confounding factors (Koya & Egede, 2007). Lear et al. (2009) investigated sub-clinical atherosclerosis measured by intima-media thickness in a total of 460 immigrants and 158 non-immigrants of Chinese, European, and South Asian without pre-diagnosed CVD. This study revealed that time since immigration was significantly associated with intima-media thickness after adjustment for age, sex, ethnicity, income, education, family history of CVD, diabetes, smoking, physical activity, BMI, visceral adipose tissue, lipids, insulin, glucose and BP. There was a 2% increase in intima-media thickness for every ten years after immigration in addition to the 7% increase in intima-media thickness for every 10 years of age (Lear et al., 2009).

Hypertension is a chronic condition that has various stages, thus, diverse CVD risk factors may play different roles in different stages. Some may contribute to elevating BP and others may support maintaining elevated BP. Psychological stress related to cultural change may contribute to elevated BP. More studies should be conducted to examine the relationship of time in the U.S. and BP in understudied immigrants such as Korean Americans.

Psychobehavioral Stress Responses

For this study, the psychobehavioral responses to stressors selected as possible risk factors for arterial stiffness and elevated BP are psychological stress, coping, and stress emotions (anger, anxiety, or depression). These psychobehavioral factors are also main components of the stress and coping model of Lazarus and Folkman (1984) and his extended work on stress and emotion (Lazarus, 1999). Studies that will be discussed indicated that these cognitive, behavioral and emotional stress responses predict (or are associated with) the development of hypertension and other cardiovascular diseases.

Psychological stress.

In studies on the effects of stress on health, the term ‘stress’ has varying definitions. Lazarus (1984) defined stress as “a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being” (Lazarus & Folkman, 1984, p. 19). This definition has a great emphasis on the individual’s perception and evaluation (appraisal) of the potential harm posed by objective environmental events or experiences (Cohen et al., 1997). When it is considered that persons actively interact with their environments and that stress responses occur when a situation is appraised as potentially harmful, threatening or challenging in regard of available coping resources (Lazarus, 1999), perceived stress can be viewed as a better measure of the experienced level of stress than the objective event itself. Perceived stress is also sensitive to chronic stressor caused by ongoing life circumstances and to stress concerning expected future events (Cohen, Kamarck, & Mermelstein, 1983).

A large number of studies have supported that psychological stress may have an important role in the etiology and progression of hypertension. One systematic review of cohort and case control studies reported that 5 out of 7 studies found a significant and positive association between measures of chronic stress and hypertension with risk ratio ranging from 0.8 to 11.1 (Sparrenberger et al., 2009). Recently population-based longitudinal studies revealed that the incident of hypertension was significantly related to perceived stress from racism (Cozier et al., 2006), life stress such as fire accident (Dorn, Yzermans, Guijt, & van der Zee, 2007), and stress from financial strain (Steptoe, Brydon, & Kunz-Ebrecht, 2005).

It is becoming more apparent that many systems, organs, and mechanisms are responsible in the link between stress and elevated BP. Physiological responses to stress may start in the brain and influence the autonomic nervous system, the neuroendocrine system, immune system, rennin-angiotensin-aldosterone system, volume regulation mechanism, vascular remodeling, and baroreceptor reflex mechanisms (Larkin, 2005). Since several regulators are involved, the relationship between psychological stress and hypertension is not direct, but involves many intervening factors (Larkin, 2005). More studies are needed to further explore how psychological stress is associated with cardiovascular stress response, such as arterial stiffness, which may play a causal role in the development of hypertension.

Stress emotions; anger, anxiety, and depression.

According to Lazarus and Folkman (1984), appraisal of stressful life events and coping result in immediate effects including emotional and physiological changes. Some researchers who focus on the physiological response of stress have challenged the notion that the appraisal mechanism results in emotional reactions. Zautra (2003) reasoned that emotions occur too quickly to require appraisals (Zautra, 2003). Zajonc (1980) also asserted that emotions have meaning and purpose, which are independent of, or unrelated to what we think. However, Clore et al. (2001) suggest that the relationship between appraisal and everyday emotion may be similar to that between the rules of syntax and everyday speech. When people speak very fast, sometimes speech is outside the rules of syntax but still based on the rules. The emotion of fear is often mentioned as the example of how quickly individuals react to fear-producing stimuli before they are aware that they are afraid. Fear, which is necessary to protect individuals from various harm in their lives, is considered to be formulated through the process of appraisal in daily experiences, and also be retrieved through the same process either consciously or unconsciously. In this regard, emotions are thought to require either a conscious or unconscious appraisal process, regardless of the time it takes.

Emotion affects all aspects of health through physiological responses (Lazarus, 1999). Therefore, exploring the relationships of emotion with physiological responses may provide helpful information to understand the effect of stressors on the development of hypertension. Emotions have both a state and a trait component. State emotions fluctuate from time to time, while trait emotion represents stable individual predispositions to certain states (Diener & Emmons, 1984). Since substantial differences exist among people in the frequency and the intensity with which emotions are experienced, trait emotion is a critical element in stress responses along with state emotion, and both state and trait emotion should be included in measures of psychological stress (Spielberger, 1985).

Stress emotions, defined by Lazarus (1999), include anger, envy, jealousy, anxiety, fright, guilt, shame, and sadness. Among these stress emotions, anger, anxiety, and depression which is often described as prolonged sadness have been most frequently investigated as risk factors for hypertension and other CVD (Bleil et al., 2008; Rozanski et al., 1999; Suls & Bunde, 2005) and are included in this study.

Anger.

Anger is defined as a strong feeling of displeasure or hostility (Houghton Mifflin Company, 2002). Anger is an unpleasant emotion which may range from irritation to rage in its intensity (Smith, 1992). One meta-analysis showed that anger experience was correlated with elevated BP. In this study, the overall relationship across all studies was quite small but statistically significant (Suls, Wan, & Costa, 1995). Schum et al. (2003) also conducted a meta-analysis on the association between trait anger and ambulatory BP. In this study, trait anger was significantly and positively associated with systolic blood pressure (Schum, Jorgensen, Verhaeghen, Sauro, & Thibodeau, 2003). Trait anger has also been associated with other cardiovascular diseases. Chida and Steptoe (2009) conducted a meta-analysis with 25 studies in healthy population and 19 studies in population with existing coronary heart diseases (CHD). They reported that in healthy subjects and patients with CHD, anger measured by trait anger, anger expression, and hostility was associated with coronary outcomes including CHD incidence, cardiac arrest, and mortality (Chida & Steptoe, 2009). The Framingham offspring study with 3873 subjects monitored the incidence of CHD, arterial fibrillation, and total mortality for 10 years (Eaker et al., 2004). In that study, anger measured by trait anger, symptoms of anger, hostility, and anger expression significantly predicted the development of arterial fibrillation. Given the strong evidence that anger is related to risk for hypertension and CVD, more studies should be conducted to further explore specific mechanisms by which anger is implicated in pathological processes of chronically increased blood pressure, hypertension.

Anxiety.

Anxiety is another emotion that has long been of interest as a risk factor of CVD. Anxiety is described as a vague, diffuse, continuing, and anticipatory state of uneasiness (Lazarus, 1999). The emotion of anxiety is also considered synonymous with apprehension, unease, concern, and worry (Lazarus, 1999). In studies on anxiety and hypertension, anxiety appears to cause the “white coat effect” during clinic visit, producing temporary BP elevations (Ogedegbe et al., 2008; Spruill et al., 2007). Studies have also shown that anxiety scores or symptoms are higher in hypertension patients (Han et al., 2008; Vural et al., 2007), and diabetes mellitus and coronary artery disease patients compared with their referents (Vural et al., 2007).

Several population-based longitudinal studies also demonstrated the negative effect of trait anxiety on hypertension or CVD. A study on 735 older men with an average age of 60 years revealed that anxiety independently predicted the onset of myocardial infarction (MI) over an average of 12.4 years (Shen et al., 2008). The data from a national survey of 4351 adults in South Africa showed that being diagnosed with both hypertension and another chronic physical condition were associated with anxiety disorders that were assessed during the previous 12-months (Grimsrud, Stein, Seedat, Williams, & Myer, 2009). In a study with a 10-20 year supervision period of 2,149 middle-age Russian men, the relative risk of CVD development within five years in men with high level of anxiety compared with men with average level of anxiety was 6.0 times higher for arterial hypertension (AH), 2.5 times higher for myocardial infarction (MI), and 6.4 times higher for stroke. Within 10 and 15 years, relative risk for MI and stroke continuously increased, while within 20 years, relative risk decreased. This longitudinal study demonstrated that high levels of anxiety may predict higher cardiovascular risk in middle-age men (Gafarov, Gromova, Gagulin, Ekimova, & Santrapinskiy, 2007).

On the other hand, one study with 36,530 men and women aged 20-70 years indicated that symptoms of anxiety predicted lower blood pressure 11 years later (Hildrum et al., 2008).

The results of long-term anxiety are not always consistent. Further examination is needed to see how trait anxiety is related to elevated blood pressure (Tjugen, Flaa, & Kjeldsen, 2009) and arterial stiffness which may contribute to the development of hypertension.

Depression.

Depression is described as a sense of hopelessness about restoring an irrevocable loss (Lazarus, 1999). Sadness is often mentioned as an emotion of experiencing an irrevocable loss. Therefore, depression can be considered a prolonged state of sadness and hopelessness. Depression has been linked to general mortality (Wulsin, Vaillant, & Wells, 1999) and a variety of CVD including CHD, MI, and angina in several population-based studies (Herbst et al., 2007; Jones & West, 1996; Linden, Stossel, & Maurice, 1996; Siegrist, Peter, Junge, Cremer, & Seidel, 1990). Many investigators have reported the association between depression and hypertension. In one study with 245 African-American women, those with higher levels of depression had higher diastolic BP (Artinian et al., 2006). In that study, depression mediated the relationship between stress and higher diastolic BP. A cross-sectional study with 1017 participants aged 12 to 62 years presented evidence for the indirect effect of depression symptoms and hypertension which was mediated through higher level of BMI in both whites and African Americans (Kabir, Whelton, Khan, Gustat, & Chen, 2006).

While a large body of evidence supports the link between depression and CVD, several population-based studies reported conflicting results on the associations between depression and hypertension. The Norwegian Nord-Trϕndelag Health Study with 60,799 men and women aged 20-89 years presented epidemiological evidence showing depression was associated with low BP (Hildrum et al., 2007). However, in that study, depression was measured with different instruments at baseline and follow-up (The Anxiety and Depression Symptom Index at basement and The Hospital Anxiety and Depression Scale at follow-up). In addition, different methods were used to measure blood pressure at baseline and follow-up (measured using calibrated mercury manometers with standard cuff size at basement and at follow-up, BP was measured with a Dinamap 845XT based on oscillometry and cuff size was adjusted after measuring the arm circumference. Two different measurements used in that study may greatly reduce the reliability of study results. Another Netherlands study with 2,981 participants showed that depression was associated with low systolic BP and less hypertension, but the use of certain antidepressants was related to high systolic and diastolic BP (Licht et al., 2009). In a cross-sectional community-based study in 9294 participants aged 65 years and over, depressed individuals had lower BP (Lenoir et al., 2008). Furthermore, one study that examined the relationship between depressive symptom and cardiovascular reactions to psychological stress in 1608 adults reported that depression scores were negatively associated with systolic BP and heart rate reactions (Carroll, Phillips, Hunt, & Der, 2007). This result is opposite to the expectation that cardiovascular and sympathetic nervous system responses may be exaggerated in depressive subjects. For example, a study with 60 healthy women aged 18-49 reported that the depressive symptom group exhibited higher systolic and diastolic BP, shorter pre-ejection period (as a marker of increased cardiac sympathetic activity), and lower heart rate variability (Light, Kothandapani, & Allen, 1998). In this study, the depressive symptom group also showed greater increases in plasma norepinephrine and higher cardiac output responses with faster heart rate than the control group during a speech task. The association between depression and hypertension can be multifaceted and bidirectional (Artinian et al., 2006). Investigating the association between depression and arterial stiffness may provide important information which can be helpful in disentangling their link.

John Henryism chronic active coping.

Coping is defined as thoughts and behaviors that people use to manage the internal and external demands of situations that are appraised as stressful (Lazarus & Folkman, 1984). The association between stress and disease can be modified by coping characteristics of the individual (Coker, Sanderson, Ellison, & Fadden, 2006). In the 2-year longitudinal study by Twisk et al. (1999), the positive relationship between stress (measured as daily hassles) and coronary heart disease risk factors (measured as lipoprotein levels, daily physical activity, and smoking behavior) was mediated by a rigid coping style characterized by strict use of either emotion or problem-focused coping (Twisk, Snel, Kemper, & van Mechelen, 1999).

One coping style related to hypertension, John Henryism active coping is defined as a strong behavioral predisposition to cope with psychosocial environmental stressors in an active, determined, and hard-working manner (James et al., 1983; James, Strogatz, Wing, & Ramsey, 1987). The construct of John Henryism is coined from the story of the American folk-legend of John Henry who worked himself to death to beat a steam engine. He was known for his incredible physical strength and endurance (James et al., 1987). Individuals who are high in John Henryism coping are considered to believe that they can manage daily stressors and accomplish goals through hard work and determination (Wright, Treiber, Davis, & Strong, 1996).

A growing number of studies are supporting the hypothesis that individuals with chronic active coping style are more likely to exhibit higher BP levels in the face of low socioeconomic resources than those with greater socioeconomic resources (Fernander, Duran, Saab, & Schneiderman, 2004; Merritt et al., 2004) The study by Merritt et al., (2004) with 58 normotensive, healthy Black men aged 23 to 47 years showed that high John Henryism and low education level were associated with higher BP, heart rate, and rate pressure product during the final recovery period after experimental tasks, compared with those who had high education level. This suggests that John Henryism may increase the risk of CVD among people with low education by increased cardiovascular reactivity (Merritt et al., 2004). Wright et al. (1996) examined the relationship of John Henryism to cardiovascular functioning in 173 normotensive 10-17 year old people and found that high John Henry scores were associated with higher BP and higher total peripheral resistance. This relationship was more pronounced in those with low socioeconomic status (Wright et al., 1996).

While several studies have identified negative effects of chronic active coping (John Henryism) on the development of hypertension in African Americans with low socio-economic resources (Duijkers, Drijver, Kromhout, & James, 1988; James et al., 1987; Wiist & Flack, 1992), some studies have shown that chronic active coping is adaptive and health promoting (Bonham, Sellers, & Neighbors, 2004; Derogatis, Abeloff, & Melisaratos, 1979; Haritatos, Mahalingam, & James, 2007). For example, one exercise participation study showed that exercise participation was significantly associated with higher levels of John Henryism active coping in 922 low-income pregnant Black women (Orr, James, Garry, Prince, & Newton, 2006). Although studies conducted on minority groups other than African Americans are very limited, one study examined how John Henryism was associated with self-reported physical health among high socio-economic status Asian immigrants (318 Chinese and Indian immigrants aged 18-73) and found that higher John Henryism significantly predicted better self-rated health, physical functioning (measured by the physical health subscale of the Health Survery Short Form-36) and few somatic symptoms (Haritatos et al., 2007). Although these studies showed chronic active coping may promote health behaviors or self-reported health, it is not clear whether or not chronic active coping also has positive effect on their actual health condition. In order to explore the effect of chronic active coping on physiological health, studies are recommended to include valid measure such as BP to assess physiological health condition of subjects. In addition, given the emphasis on the relationship of John Henryism and CVD risk in low socioeconomic group, further studies should be conducted to examine health implications of John Henryism among different socioeconomic groups of racial/ethnic minorities.

Physiological Stress Response

Arterial Stiffness, hypertension, and cardiovascular disease.

About 73 million adults (33.6%) in the United States have hypertension, a leading cause of cardiovascular morbidity and mortality. The causes of 90-95% of cases of hypertension are unknown (Rosamond et al., 2008; Stergiou & Salgami, 2004). Increasing evidence suggests that arterial stiffness may precede the development of hypertension (Franklin, 2005). A 4-year longitudinal study with 2,512 nonhypertensive subjects, defined as having systolic BP less than 140 mmHg or diastolic BP less than 90 mmHg, showed that aortic stiffness was an independent predictor of progression to hypertension (Dernellis & Panaretou, 2005). A 3.3 year longitudinal study conducted on 6,992 nonhypertensive participants, defined as systolic BP < 160 mmHg or diastolic BP < 95 mmHg, showed that higher arterial stiffness was associated with greater risk of hypertension, and the relationship was independent of well known risk factors for hypertension and baseline BP (Liao et al., 1999).

Arterial stiffness has been identified not only as an independent predictor of hypertension but also as an important clinical marker of CVD (Cernes et al., 2008). In a 9-year study of 1,678 Danes, the carotid-femoral pulse wave velocity (PWV) predicted a composite of cardiovascular outcomes (coronary heart disease, stroke, and cardiovascular mortality) beyond traditional cardiovascular risk factors, including 24 hour mean arterial pressure (MAP), HDL serum cholesterol, and diabetes (Willum-Hansen et al., 2006). In another longitudinal study, 1,715 hypertensive patients with no overt cardiovascular disease or symptoms were followed for 7.9 years: Aortic stiffness, measured by carotid-femoral PWV, was an independent predictor of fatal stroke even after adjusting for classic CVD risk factors including age, cholesterol, diabetes, smoking, BP, and pulse pressure (PP) (Laurent et al., 2003). A correlation between arterial stiffness and atherosclerotic plaques was also observed in several studies, including the ARIC study and the Rotterdam study (Qureshi et al., 2007; Riley, Evans, Sharrett, Burke, & Barnes, 1997; van Popele et al., 2001).

Arterial stiffness, measured by pulse wave velocity (PWV) and augmentation index (Alx), is an independent and consistent predictor of left ventricular hypertrophy and the development of left ventricle failure (Tsai, Lin, Huang, Chen, & Chen, 2007). Increased arterial stiffness has been associated with deteriorating glucose tolerance status (Henry et al., 2003), the metabolic syndrome (Saijo, Yoshioka, Fukui, Kawaharada, & Kishi, 2006), end-stage renal disease (Taal et al., 2007), cognitive impairment (Mitchell, 2008; Poels et al., 2007), and retinal arteriolar narrowing (Cheung et al., 2007). Alterations of the microcirculation in brain, kidney, and retina have been associated with hypertension. However, recent studies on older adults have found that the exposure of small arterioles to high pulsatile pressure caused by arterial stiffness better explains the microvascular damage that leads to renal insufficiency and intellectual deterioration than does mean arterial pressure (MAP) (Fukuhara et al., 2006; Hanon et al., 2005; O'Rourke & Safar, 2005; Safar & Lacolley, 2007; Scuteri et al., 2007).

In order to identify patients with higher CVD risk at an early stage and to intervene to reduce morbidity and mortality, further studies are required to explore independent risk factors for arterial stiffness.

Arterial stiffness and altered wave reflection.

The arterial wall has three layers: the intima, media, and adventia. The media contains elastin, collagen, and smooth muscle cells (O'Rourke & Franklin, 2006). Arterial stiffness (hardening of arterial wall) is caused mainly by medial degeneration involving decreased elastin and increased collagen fibers (Levy et al., 2007). The arteries have two functions: to act as a conduit of blood from the heart to arterioles, and to act as a cushion transforming pulsatile flow at the ascending aorta into steady flow through the arterioles (O'Rourke, 1967). The elastic properties of large arteries affect the arteries' ability to function as a cushion. When blood is ejected into the aorta, a pressure wave is generated (incident wave) and transmitted throughout the body; the wave is reflected backward when it meets the arterial walls of arterial branch points (reflected wave) (Payne & Webb, 2006). The incident wave is summed with the reflected wave. In optimal arterial function, the reflected wave is apparent as a secondary wave in diastole; it does not add to left ventricular pressure load but enhances the capacity for flow through the coronary system (O'Rourke, 1967). However, when the walls of the arteries lose their elastic properties and become stiff, their cushioning capacity is decreased and the forward wave of the blood coming from the heart to the tissues reflects faster toward the heart when the blood hits stiffer arteries (Safar, Levy, & Struijker-Boudier, 2003). In this case, the reflected wave is apparent as a secondary wave in late systole, resulting in an increase in systolic BP, left ventricular load, and pulse pressure (PP), and a reduction of pressure throughout diastole (Safar et al., 2003). Thus, measuring the timing and intensity of wave reflections from pulse waveforms provides information on the cushioning capacity of arteries, offering a sensitive measure of cardiovascular hemodynamics and early signs of hypertension (O'Rourke, 1999).

Determining pulse wave velocity (PWV) is generally accepted as the most simple, noninvasive, robust and reproducible method to measure arterial stiffness (Mackenzie, Wilkinson, & Cockcroft, 2002). PWV can be determined by the distance the pulse travels between two arterial sites divided by pulse transit time, PWV=D(meters)/Δt(seconds) (Laurent et al., 2006). The wave reflects faster in peripheral arteries, because peripheral arteries are less elastic than proximal arteries, and reflection sites associated with arterial branching are closer (Nichols, McDonald, & O'Rourke, 2005). Carotid-femoral PWV is considered the 'gold-standard' measurement of arterial stiffness because it is measured along the aortic and aorto-iliac pathway (Laurent et al., 2006), and the thoracic and abdominal aorta make the largest contribution to the arterial buffering function (Laurent et al., 1994).

Pulse wave analysis (PWA) is also widely used to assess arterial stiffness. As noted previously, the pulse pressure waveform is a composite of the forward pressure wave (incident wave) and a reversed wave (reflected wave). In elastic vessels, because PWV is low, the reflected wave tends to arrive back at the aortic root during diastole. In stiff vessels, PWV is high and the reflected wave arrives back at the central arteries earlier, augmenting the systolic pressure. This augmented pressure (AP) is calibrated by pulse wave analysis (PWA) (Figure 2) (O'Rourke, 1967). The augmentation index (AI) is defined as augmented pressure (AP)

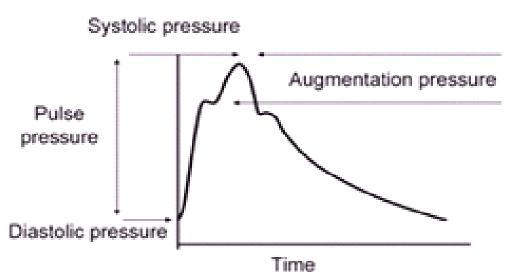


Figure 2. Carotid Pressure Waveform recorded by Applanation Tonometry (Laurent et al., 2006)

which is expressed as a percentage of pulse pressure (PP). Pulse wave analysis (PWA) is a noninvasive method to generate the ascending aorta pressure wave from the arterial pressure pulse measured in the radial artery by mathematical transformation, using Fourier analysis (Chen et al., 1997). The widely used approach is to apply applanation tonometry containing a high-fidelity micromanometer on the radial arterial site to electronically capture the shape of a peripheral arterial pulse (Pauca, O'Rourke, & Kon, 2001). This is the approach that will be used in the proposed study.

The Relations among Psychobehavioral and Physiological Stress Responses

Perceived stress and arterial stiffness.

Perceived stress, which involves neural activation of the brain, is believed to contribute to the development of hypertension and other CVD. The mechanisms by which perceived stress contribute to the development of hypertension may include its effect on the sympathetic nervous system, rennin-angiotensin system, inflammation, cortisol levels, and unhealthy behaviors (Ghiadoni et al., 2000; Rozanski, Blumenthal, Davidson, Saab, & Kubzansky, 2005; Rozanski et al., 1999; Steptoe, Melville, & Ross, 1982). Given the evidence that arterial stiffness may precede hypertension, psychological stress may contribute to arterial stiffness, before hypertension develops. A few studies have examined the relationship between psychological stress and arterial stiffness. For example, Lipman et al. (2002) investigated the relationships among mental stress responses, arterial stiffness, and baroreflex sensitivity in 24 healthy individuals, aged 51 to 86 years. As participants completed mentally stressful tasks, their heart rate, mean arterial pressure, and carotid stiffness increased, while their baroreflex sensitivity decreased (Lipman, Grossman, Bridges, Hamner, & Taylor, 2002). Baroreflex, a homeostatic mechanism for maintaining BP, is associated with arterial stiffness (Eveson et al., 2005). Normally, when BP rises, the carotid and aortic sinuses are distended and baroreceptors are activated; this inhibits the sympathetic system, reducing BP (Drew, Bell, & White, 2008). However, low distensibility resulting from stiffened arterial vessels causes a blunted baroreflex so BP remains elevated (Chesterton, Sigrist, Bennett, Taal, & McIntyre, 2005; Pinter, Laszlo, Mersich, Kadar, & Kollai, 2007; Poels et al., 2007). Lipman et al. (2002) suggested that augmented hemodynamic reactions to mental stress may be one example of reduced baroreflex function caused by arterial stiffness. Vlachopoulos et al. (2006), who assessed the effect of acute mental stress on arterial stiffness in young healthy subjects, found that increased arterial stiffness, induced by a 3-minute mental stress test, was sustained for 60 minutes, even after adjusting for changes in mean arterial pressure (Vlachopoulos et al., 2006).

While the studies of Lipman et al. (2002) and Vlachopoulos et al. (2006) demonstrate a positive association between acute mental stress and arterial stiffness, studies that have explored the relationship between chronic psychological stress and arterial stiffness have shown conflicting results. Nomura et al. (2005) examined the relationship between work-related psychological stress and arterial stiffness in 396 Japanese, aged 24-39 years, and reported that job strain was negatively associated with arterial stiffness even after controlling for significant CVD risk factors such as age, heart rate, and serum noradrenaline levels (Nomura, Nakao, Karita, Nishikitani, & Yano, 2005). On the other hand, a study of 352 Japanese male factory workers between the ages of 24.9 to 55.8 years reported that after controlling for potential confounders, high job strain was associated with increased arterial stiffness (Michikawa et al., 2008). The study by

Utsugi et al. (2009) also showed that in 4266 local government employees (3,412 men and 854 women) aged 35 years and over, high occupational stress indicated by high demands and low control was associated with increased arterial stiffness only in women, suggesting that job stress associated with a high risk of arterial stiffness may differ by gender (Utsugi et al., 2009). Given the evidence of a positive association between psychological stress and hypertension and the paucity of data on the relationship of psychological stress and arterial stiffness, it is important to further investigate the relationship between psychological stress and arterial stiffness.

Stress emotions and arterial stiffness.

Considering the recent evidence of the deleterious effects of anxiety, depression, and anger emotions on cardiovascular functioning, further studies are needed to examine the role of stress emotions in arterial stiffness. Although research is limited to date, increasing interest is focused on the association of stress emotions (anxiety, depression, and anger) and arterial stiffness.

In the Atherosclerosis Risk in Communities Study (ARIC), arterial stiffness was measured in 10,285 Black and White men and women, 48-67 years of age, using pulsatile arterial diameter change derived from echo-tracking ultrasound methods; investigators found that trait anger was significantly associated with arterial stiffness independent of established CVD risk factors (Williams, Din-Dzietham, & Szklo, 2006). Investigators studying 200 healthy adults older than 50 years reported that high anger-in was a significant independent determinant of carotid artery stiffness (Anderson, Metter, Hougaku, & Najjar, 2006). Yeragani et al. (2006) compared 23 patients with anxiety disorders and age- and sex- matched 25 normal controls, and found that patients with anxiety had significantly higher arterial stiffness measured by brachial-ankle PWV (BaPWV) (Yeragani, Tancer, Seema, Josyula, & Desai, 2006). Midei and Mattews (2009) also reported that 160 Black and White adolescents with higher anxiety had greater arterial stiffness measured by PWV (Midei & Matthews, 2009). One population-based cross-sectional study with 3704 subjects revealed that increased arterial stiffness was significantly related to depressive symptoms and this association was stronger for participants with depressive disorders even after controlling for atherosclerosis risk as measured by presence of plaques in the carotid artery (Tiemeier, Breteler, van Popele, Hofman, & Witteman, 2003). On the other hand, one study on 382 Japanese males aged 24 to 39 years failed to find any significant relations among arterial stiffness and stress emotions including anger, anxiety, and depression (Nakao, Nomura, Karita, Nishikitani, & Yano, 2004).

Further studies to investigate the negative effect of stress emotions such as anxiety, anger, and depression on arterial stiffness may provide important information to clarify the pathophysiological pathway by which stress emotions are associated with increased risks for CVD.

Chronic active coping and arterial stiffness.

In order to explore the negative effect of chronic active coping in the development of hypertension, closer investigations of the relationship between chronic active coping and specific physiological parameters are required. Since no study reported in the literature has examined how chronic active coping as measured by John Henryism is related to arterial stiffness, a possible precursor of hypertension, additional studies are needed to identify this relationship. Studies on chronic active coping and arterial stiffness in relatively understudied population such as immigrants may contribute to better understanding and improving health in racial minorities.

Psychological Problems and Hypertension in Korean Americans

Korean Americans, who are the fifth largest Asian population in the U.S. (Reeves & Bennett, 2004), have the highest uninsured rate (52%) of all ethnicities in the U.S. (Hughes, 2002). Studies on their physiological and psychological health are very limited. Nevertheless, one study revealed a high prevalence of hypertension (32%) in 761 Korean Americans aged 18-89 years (Kim et al., 2000) which is higher than the prevalence of hypertension in Koreans in Korea (21.8% for all ages, and 26.1% in those aged 30 and older) (KNSO, 2001).

The high prevalence of hypertension in Koreans who have immigrated to the United States may be attributed to psychological stress from language inadequacy, loss of ties to family and friends in their home country, discrimination, and lack of social and financial resources (Mui & Kang, 2006). Psychological stress may increase their susceptibility to illness and contribute to the high prevalence of hypertension seen in this group (Heilemann, Frutos, Lee, & Kury, 2004).

A higher incidence of psychological problems has been observed in various immigrant populations as compared to dominant cultural groups (Cuellar, Bastida, & Braccio, 2004). A few studies have reported that Korean Americans have high levels of psychological stress (Chun et al., 2007; Shin, 1993). One study found that Korean Americans had significantly higher scores on perceived stress, anxiety, depression and somatic symptoms than Koreans in Korea (Koh, 1998). Also, a study of 499 Asian Americans found that Korean Americans had higher levels of depression than Chinese, Filipinos, or Japanese Americans (Kuo, 1984). Saint-Arnault and Kim (2008), who compared Japanese and Korean undergraduate students in the U.S., reported that Korean students had significantly higher somatic symptoms from emotional distress than Japanese students (Saint Arnault & Kim, 2008). One study of 472 older Korean Americans (average age of 69.9) reported that 34% of the sample was considered depressed when measured with the Center for Epidemiologic Studies Depression Scale (CES-D) and about 8.5% of the sample had thought about committing suicide at some point in their lives (Jang, Kim, Hansen, & Chiriboga, 2007). This prevalence of depression is considered very high when compared with another study with 447 Korean elderly people, in which 18.1 % of subjects were considered depressed when measured with CES-D (Cho, Hahm, Jhoo, Bae, & Kwon, 1998).

Culturally formed and shared belief systems or coping patterns may affect people's perception of stress and responses to it (Ellsworth, 1994). For example, there is an old Korean proverb that repressing anger is more virtuous than expressing anger. "Hwabyeong," literally "anger illness" in Korean, is a Korean culture-bound syndrome in response to emotional disturbance (Somers, 1998). This refers to a condition characterized by passive suffering, and sufferers report such symptoms as palpitation, heavy feeling in the chest, dyspnea, and in severe cases, a feeling of impending death (Lin, 1983). The Diagnostic and Statistical Manual of Mental Disorders (DSM) IV listed Hwabyeong among its culture-bound illnesses (Kwon, Min, & Kim, 2006). Pang (1999) explains that Hwabyeong occurs when distressed emotions are managed in the specifically Korean way of perceiving and reacting to intolerable life situations. She also reported that Korean elderly immigrants have a broad range of symptoms associated with Hwabyeong.

Although Korean Americans seem to be exposed to various sources that may produce a greater risk for hypertension, less is known about what personal factors may produce the higher rates of psychological symptoms, how Korean Americans manage high levels of stress, and how their coping patterns are related to hypertension. More research on psychological stress, coping, and stress emotions in this Korean American population may provide valuable information to better understand their higher prevalence of psychological problems and risk for hypertension.

A few studies have found racial differences in arterial stiffness. Din et al. (2006) compared 20 healthy young South Asian men to 20 age-matched healthy European Caucasian men, and reported that the South Asian men had markedly greater levels of arterial stiffness than the European Caucasians (Din et al., 2006). The Multi-Ethnic Study of Atherosclerosis (MESA) explored aortic distensibility in four ethnic groups (Non-Hispanic white, African American, Hispanic, and Chinese) and reported that African Americans had the least aortic distensibility (greater arterial stiffness), but the researchers did not report on aortic distensibility for the Chinese subjects (Malayeri et al., 2008).

After an extensive review of the literature, no study has been found that examined arterial stiffness in Korean Americans. In addition, no study was found that explored chronic active coping in Korean Americans and how it is related to psychological stress, stress emotions, and hypertension. Studies on arterial stiffness, hypertension, and psychobehavioral factors are needed for understudied racial minorities such as Korean immigrants.

CHAPTER III

METHODS

Research Design

This was a descriptive, correlational, and cross-sectional study of psychobehavioral factors for hypertension and arterial stiffness in a sample of Korean Americans.

Subjects and Setting

A total of 102 male and female Korean Americans 21-60 years of age were recruited for the study from the Triangle area (Durham, Orange and Wake Counties) of North Carolina (NC). NC saw a 30.71% growth in its Asian population from 2000 to 2006, and Koreans are one of the fastest growing groups of Asian immigrants in the U.S. (U.S. Census Bureau, 2006). For this study, Korean Americans were defined as people who were born in Korea and have lived in the U.S. for at least 1 year. Because the consent form and questionnaires were administered in Korean, only subjects who were able to speak and read Korean were recruited. The ability to use Korean language was important because those who cannot speak and read Korean may have been already acculturated to America. Since language and culture are not separate, but are acquired together (Mitchell and Myles, 2004), people who use only the English language may have different psychobehavioral stress responses than Korean Americans who can use the Korean language. Only adults were recruited because stressor and stress responses differ in adults and children and little is known about chronic psychological stress in Korean American children. Further, the parameters for arterial stiffness have not been standardized in children and the relationship between arterial stiffness and hypertension in children is unknown. Arterial stiffness progressively increases with age and isolated systolic hypertension affects 50% of people over age 60 (McEniery et al., 2008). Therefore, in order to limit arterial stiffness that may be aggravated by age, only adults 21 to 60 years of age were recruited.

Antihypertensive medications may cause muscular artery dilatation that results in decreased pulse wave velocity (O'Rourke & Adji, 2005). Therefore, people who take antihypertensive medications or other medications known to affect BP (e.g., β-blockers, thyroid hormones, or steroids) were excluded from the study. Since the device measuring arterial stiffness (SphygmoCor) requires a regularly occurring pulse wave and normal electrocardiogram (ECG) to derive its measures, people who have irregular cardiac rhythm (e.g., frequent premature atrial contractions or premature ventricular contractions) were also excluded. Those with known cardiac conditions (e.g., pace maker, heart failure, coronary artery disease, myocardial infarction, left ventricular dysfunction, or valvular heart diseases), who have known vascular conditions (e.g., peripheral vascular diseases), or who are currently taking medications for a major mental disorder (e.g., schizophrenia or bipolar disorder) that may affect the measures of perceived stress were also excluded (See Table 1).

Table 1

Subject Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
- Age 21-60 - Born in Korea - Lived in the US at least 1 year - Able to speak and read Korean	- Taking antihypertensive medication or other medications known to affect BP (e.g., β-blockers, thyroid hormones, or steroids) - Having irregular cardiac rhythm - Having known cardiac conditions (e.g., pace maker, heart failure, coronary artery disease, myocardial infarction, left ventricular dysfunction, or valvular heart diseases) - Having known vascular conditions (e.g., peripheral vascular disease or diabetes) - Taking medications for a major mental disorder such as schizophrenia, depression, or bipolar disorder

Measures

The study measured stressors (acculturation and time in the U.S.), personal factors (age, gender, SES measured by education and household income), psychobehavioral responses (psychological stress operationalized by perceived stress and acculturative stress, chronic active coping, and stress emotions including anger, anxiety, depression), physiological responses (arterial stiffness and BP), and control factors (BMI and smoking) (See Table 2). Measures of arterial stiffness are known to have a circadian pattern and to be maximal in the morning (Bonnemeier et al., 2003; Papaioannou et al., 2006), therefore, all data were collected in the morning between 7 and 11am.

Korean versions of the 10-item Perceived Stress Scale (PSS), the John Henryism Active Coping Scale(JHAC), the Spielberger's State-Trait Anger Expression Inventory 2 (STAXI-2), and the Spielberger State-Trait Anxiety Inventory (STAI) were not available.

Permission to translate PSS into languages other than English was provided through the website of the author of the instrument (Dr. Sheldon Cohen). The investigator received permission for translation of JHAC, STAXI-2 and STAI. She is sensitive to Korean subjects' cultural nuances and translated them into Korean. A bilingual native Korean speaker who speaks both Korean and English very fluently reviewed the initially translated version and translated it back into English. A native English speaker who has a major in English and is not familiar with the scales compared the original scales with the back translated English version of the scales. Based on the results of this comparison, the investigator refined the initially translated Korean version of the scales. These processes were repeated until the original scales were judged equivalent to the back translated English version of the scales by the American professor, who is familiar with the American version of the scales.

Psychological concepts are time and situation dependent. Therefore, the temporal stability of psychometric instruments was examined by test-retest reliability test with a 2 week interval. To assess the test-retest reliability of the Korean version of the scales, these instruments were mailed to subjects' home 2 weeks after the first data collection date with a postage-paid return envelope addressed to the investigator. Participants were asked to complete and return these scales within 10 days. Among 102 participants, 74 participants (72.6%) returned their scales in a timely manner and these responses were included in the analysis for test-retest reliability.

Table 2

Variables and Measurements

	Variables	Scale or Index
Stressors	Acculturation Time in the U.S.	Bidimentional acculturation scale (American subscale) In years
Personal Factor	Age Gender Social Economic Status (SES)	In years Male or Female Education and Household Income
Psychobehavioral Responses	Psychological stress Chronic active coping Stress emotions Anger Anxiety Depression	Perceived stress scale (PSS) -10 items Revised social, attitudinal, familial, and environmental (R-SAFE) acculturative stress scale – 24 items John Henryism Active Coping Scale (JHAC12) – 12 items Spielberger's State-Trait Anger Expression Inventory 2 (STAXI-2) – 57 items Spielberger State-Trait Anxiety Inventory (STAI) – 40 items Center for Epidemiological Studies Depression Scale (CES-D) – 20 items
Physiological Responses	Blood Pressure (BP) Arterial Stiffness	Average of two measures of brachial BP Augmentation Index (AI) Pulse Wave Velocity (PWV)
Control factors	Body mass index (BMI) Smoking	Weight (kg) / squared height (m^2) 4 items in the demographic form

Stressors.

Acculturation.

Acculturation was measured using the American orientation subscale of Bidimentional Acculturation Scale. This scale was developed by Jang and her colleagues

(2007) to measure acculturation status for Asian or Korean American older adults who immigrated to the U.S. Although this scale was originally developed for older adults, it includes major aspects of acculturation that are common regardless of age. The subscale of American orientation contains 12 items on English proficiency, frequency of English use, consumption of audiovisual media (e.g., TV or videos), consumption of printed media (e.g., newspaper or magazine), consumption of American food at home, consumption of American food outside the home, ethnicity of friends, social gathering, sense of belonging, getting along with Americans, familiarity to American culture and custom, and celebration of American holidays. A 4-point Likert scale ranging from 0 (low acculturation) to 3 (high acculturation) is used and total scores were derived from the sum of each item score, with lower scores indicating less adherence or acculturation to the American culture. Internal consistency for this scale was Cronbach's alpha .77 in Jang's study (2007) and .87 in the present study. In this study, the test-retest reliability of this scale was .93 which is very high.

Time in the U.S.

Time in the U.S. was measured in years. Less time was considered a greater stressor.

Psychobehavioral Responses.

Psychological stress.

Psychological stress was operationalized by perceived stress and acculturative stress.

Perceived stress was measured with the Perceived Stress Scale (PSS), a widely used instrument for measuring the degree to which situations in one's life are appraised as stressful (Cohen et al., 1983) (see Appendix 1). The scale is a global measure of perceived stress that assesses the amount of stress in one's life rather than response to a specific stressor, and the items are designed to assess how unpredictable, uncontrollable, and overloaded respondents find their lives (Cohen et al., 1983). A 5-point Likert scale ranging from 0="never" to 4="very often" is used and scores are derived from the sum of the item scores, with higher scores indicating greater stress. Possible scores range from 0 to 40. Among the 4, 10, and 14-item versions of the scale, the 10-item version used in this study has shown maximum reliability (Monroe and Kelley, 1995; Cohen, Kessler, & Gordon, 1995). The 10-item Perceived Stress Scale (PSS) has good internal consistency (Cronbach's alpha=0.85), test - retest reliability (r=.85) (Cohen et al., 1983), construct validity and predictive validity (Cohen, Tyrrell, & Smith, 1993). In this study, internal consistency was Cronbach's alpha 0.83 and test – retest reliability was .79.

Acculturative stress was measured with the modified short version of the original 60 item SAFE scale (Padilla, Wagatsuma, & Lindholm, 1985). This 24-item version of the Revised SAFE scale (R-SAFE) comprises 17 items which measure acculturative stress in Social, Attitudinal, Familial, and Environmental contexts (Padilla et al., 1985) and 7 items that measure "perceived discrimination or majority group stereotypes toward immigrant populations" (Mena, Padilla, & Maldonado, 1987). R-SAFE scale has been used in 4, 5, or 6-point Likert scales in different studies. In this study, 4-point Likert scale ranging from 0= "not stressful" to 3= "extremely stressful" was used and scores were derived from the sum of the item scores with higher scores indicating greater stress. The R-SAFE has good construct validity (Mena et al., 1987) and convergent and discriminant validity (Joiner & Walker, 2002). Possible scores range from 0 to 72. Studies reported that the R-SAFE is also reliable for Asian American (Cronbach's alpha .89) (Kim, Ahn, Chon, Bowen, & Khan, 2005). In the present study, this scale showed good internal consistency (Cronbach's alpha .88) and good test – retest reliability (r=.73).

Stress emotions.

Anger. Anger was measured with the 57-item Spielberger's State-Trait Anger Expression Inventory 2 (STAXI-2). This 4-point Likert-type scale was developed to assess the intensity of state anger and trait anger and measure the way these two components contribute to pathologic conditions such as hypertension, coronary heart disease, and cancer. The STAXI-2 includes 2 subscales to measure state anger and trait anger. Possible scores for the state anger subscale range from 15 to 60 and possible scores for the subscale of trait anger range from 10 to 40 (Spielberger et al., 1983a). In both subscales, higher scores indicate greater anger. Several recent studies, which have adopted STAXI-2 to examine the relationship between anger and cardiovascular responses, reported that STAXI-2 has good internal consistency reliability with Cronbach's α ranging from .73 to .95 for the total scale scores and from .73 to .93 for the sub-scales (Burns, Quartana, & Bruehl, 2007; Caska et al., 2009; Narita et al., 2007). In this study, the STAXI-2 showed good internal consistency (Cronbach's α .95 for the subscale of state anger and .85 for the subscale of trait anger). Its test – retest reliability was .69 for state anger and .66 for trait anger. Although it is odd that state anger has higher test-retest reliability than trait anger, both reliabilities are considered still accepted (Kerlinger & Lee, 2000).

Anxiety. Anxiety was measured by the Spielberger State-Trait Anxiety Inventory (STAI). The 40 item 4-point Likert scale has been developed to measure anxiety in adults. The first subscale measures state anxiety, and the second subscales measures trait anxiety

(Spielberger et al., 1983b). Total scores obtained from the tool range from 20 to 80 with higher scores indicating greater anxiety. When used as an interval scale, a score between 1 and 20 is evaluated as no anxiety, 21 to 40 as a mild level of anxiety, 41 to 60 as a moderate level of anxiety, and 61 and higher as a severe level of anxiety. This scale has been used extensively in practice demonstrating good construct and divergent validity and test– retest reliability (Spielberger et al., 1983b; Oner and Le Comple, 1985). In this study, the internal consistency of STAI was very good (Cronbach's α .93 for the state anxiety and .93 for the trait anxiety).

Depression. Depression was assessed with the Center for Epidemiological Studies Depression Scale (CES-D) (Radloff, 1977). This 20-item self-report instrument was developed to assess mood, somatic symptoms, and interpersonal relationships within the last week (Radloff, 1977). This 4-point scale measures the frequency of occurrence, ranging from 0 (rarely or none of the time) to 3 (most or all of the time). The total sum score ranges from 0 to 60 with higher scores indicating greater depressive symptoms (Radloff, 1977). This scale is extremely useful for screening depressed persons, demonstrating its validity (Myers & Weissman, 1980). One study showed that the reliability coefficients (Cronbach's α) for the CES-D scores at 18 months, 3, 6, and 10 years were 0.89, 0.90, 0.89, and 0.91, respectively (Seto, Cornelius, Goldschmidt, Morimoto, & Day, 2005). In this study, the internal consistency of the CES-D was Cronbach's $\alpha = .93$. and the test – retest reliability was $r = .68$.

Chronic active coping.

Chronic active coping was measured by the John Henryism Active Coping Scale (JHAC12) (James et al., 1983). This 12-item scale measures the behavioral predisposition to cope actively and persistently with difficult psychosocial stressors and barriers. According to James et al. (1987), the scale consists of three themes: a commitment to hard work, a determination to achieve one's goals, and efficacious mental and physical tenacity. The 5-point Likert scale ranges from 1 = completely false to 5 = completely true, and the total John Henryism score is derived by summing the numerical values for all 12 items; thus, possible scores range from 12 to 60 with higher scores indicating greater active coping. The Cronbach's alpha of .76, and .73 have been reported by Haritatos et al. (2007) and Fernander, et al. (2005), respectively. Several authors stated there is no published study that has reported test-retest reliability of this scale (Fernander et al., 2005; Haritatos et al., 2007). In this study, the internal consistency of JHAC12 was Cronbach's alpha of .79 and the test – retest reliability was r = .61.

Physiological Responses.

Arterial stiffness.

Arterial stiffness was measured by carotid-femoral pulse wave velocity (C-F PWV) and augmentation index (AI) from pulse wave analysis (PWA). C-F PWV was obtained noninvasively using the commercially available SphygmoCor system (AtCor medical). Carotid and femoral waveforms were acquired by applying a pressure sensitive transducer (tonometer) on carotid and femoral sites. The transit time of the pulse from the left ventricle (The peak of R wave in electrocardiogram [ECG]) to the carotid artery ***(t1)*** and the transit time of the pulse from the left ventricle to the femoral artery ***(t2)*** were calculated by the system software on the basis of ECG, using the foot-to-foot method. The distance from the suprasternal notch to the carotid artery site (***d-carotid***) and the distance from the suprasternal notch to the femoral artery site ***(d-femoral)*** were measured on the body using a tape measure. PWV is the difference in the distances from suprasternal notch to two arterial sites ***(dpwv)*** divided by the mean time difference **(Δ*t*)** in ***t1*** from ***t2*** (Millasseau, Stewart, Patel, Redwood, & Chowienczyk, 2005) (Figure 3).

Figure 3

Pulse Wave Velocity (PWV) Using SphygmoCor

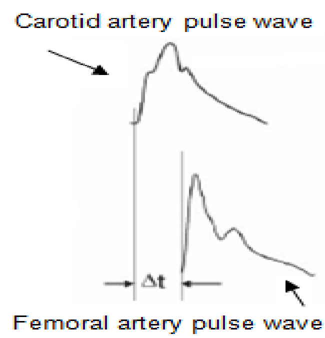
t1: The time difference between the R wave of ECG and the foot of carotid artery wave form (A)

t2: The time difference between the R wave of ECG and the foot of radial artery wave form (B)

Δ*t*: The mean difference in time between A and B, taking the difference in *t1* from *t2*

dpwv: The difference between ***d-* femoral** and ***d- carotid***

$$PWV = \frac{d_{PWV}}{\Delta t} \quad (m/s)$$

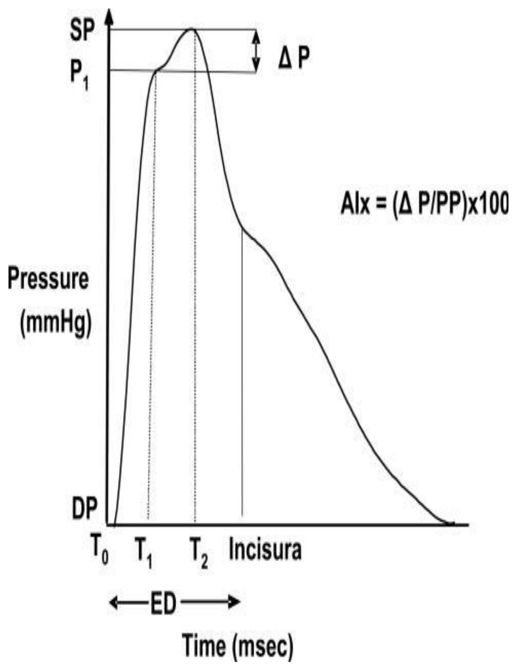


The augmentation index (AI) is a commonly used measure of arterial stiffness obtained from pulse wave analysis (PWA) (Oliver & Webb, 2003). PWA was performed with the SphygmoCor system (AtCor Medical), by applying a tonometer on the radial arterial site. AI indicates the size of the increase or decrease in the pulse height as a result of the reflected wave (O'Rourke & Mancia, 1999) (Wilkinson, Cockcroft, & Webb, 1998). If the reflected peak is greater than the primary peak, AI is positive; if the reflected peak is less than the primary peak, AI is negative. Figure 4 shows how AI is derived from pulse wave forms on the radial artery site. While pulse wave velocity (PWV) is a direct measure of arterial stiffness (O'Rourke & Pauca, 2004), the augmentation index (AI) can be affected by multiple factors including LV ejection, PWV, timing of reflection, arterial tone, structure at the peripheral reflecting sites, BP, heart rate (Hamilton et al., 2007).

Therefore, the augmentation index (AI) was adjusted to a heart rate of 75 beats per minutes and was used only to support pulse wave velocity data.

Figure 4

Pulse Wave Analysis (PWA) Using SphygmoCor (Williams et al., 2006)



T0 : The time at the start of the waveform
T1 : Duration from start of the waveform to the first peak/shoulder (outgoing pressure wave)
T2 : Duration from start of the waveform to the second peak/shoulder (reflected pressure wave)
ED: (ejection duration): duration from start of the waveform to closure of the aortic valve (incisura)
SP: Central aortic systolic pressure
DP: Central aortic diastolic pressure
P1 : Height difference between the minimum pressure and the pressure at the first peak/shoulder (T1)
∆P : Augmentation, difference between Maximal pressure (central aortic systolic pressure) and pressure at the fist peak/shoulder (P1 height)
PP: Pulse pressure
AI: Augmentation index

Blood Pressure.

Blood pressure (BP) is a measure of the force applied to the walls of the arteries as the heart pumps blood through the body. BP is determined by both the force and amount of blood pumped, as well as the size and flexibility of the arteries. Brachial BP was measured using WelchAllyn Vital Signs Monitor 300 Series. Since incorrect cuff size causes error in BP measurement (Pickering et al., 2005), the mid-section circumference of the dominant upper arm was measured with a tape, and the proper sized cuff was selected according to the upper arm circumference. The bladder of the cuff should encircle at least 80% of the arm. The cuff was placed over the bare arm to maximize reliability of the measures. The artery marker on the cuff was placed over the brachial artery and the cuff was applied snuggly allowing no more than two fingers underneath. The arm was kept at the level of the heart without movement and the patient was not spoken to and asked not to speak during the BP measurement (Umana, Ahmed, Fraley, & Alpert, 2006). Using the automated BP monitoring device, BP was measured in the dominant arm twice with 2 minutes rest between measures (Pickering et al., 2005). The mean of the 2 BP measurements served as baseline BP and was entered into SphygmoCor software.

Stressors, Personal Factors, and Control Factors.

Time in the U.S., age, gender, social economic status (SES), and smoking.

Time in the U.S. (in years), age, Gender, SES (income and education), and smoking were self-reported. Income and education were measured in ordinary levels. To calculate *BMI*, height was measured in centimeter with a portable stadiometer manufactured by Accu-Hite, and weight was measured in kilogram with an electronic scale manufactured by Pen Scale. BMI is weight (kg) divided by squared height (m^2).

Procedures

A total of 102 male and female Korean Americans aged 21 to 60 years were recruited for the study. Subjects were informed about the study by 1) notices posted in public places such as Korean grocery stores, beauty salons, and churches; 2) word of mouth; and 3) subject recruitment letters posted on Korean web sites including the Korean Association of Students and Scholars (KASS), Korean Business Student Association (KBSA), and the North Carolina Korean Nurses Association (NCKNA). The posted flyers contained the phone number of the investigator so that potential subjects could call for more information. Over the phone, the investigator briefly explained the study and checked all of the eligibility criteria with the potential subject, using a form written in Korean. If the potential subject met all study criteria, the investigator explained the study purpose and procedures in more detail. Individuals who were willing to participate were enrolled in the study. The subject and investigator arranged a convenient date (between Monday to Saturday) and time (between 7 and 11 a.m.) for data collection.

Data were collected in the homes of the subjects since convenient parking was not available near the School of Nursing and some Korean Americans did not have reliable transportation. Equipment needed for data collection (SphygmoCor system, computer, vital signs monitor, scale, and stadimeter) were all portable. All subjects were asked to refrain from consuming coffee, smoking, and eating for at least 3 hours before data collection and from drinking alcohol for 10 hours before data collection (Laurent et al., 2006).

After explaining the study purpose, procedures, and potential benefits and risks in greater detail, the Korean version of the informed consent form was provided to subjects. After the subject had signed the consent form and provided demographic information, the subject completed the five psychobehavioral scales in Korean. To minimize distractions and family interruptions, the subjects completed the scales in a quiet room. This portion of data collection (including fully explaining the study and answering questions) took about 50 minutes.

After completing the questionnaires, height was measured with a portable stadiometer manufactured by Accu-Hite, and weight was measured with a portable electronic scale manufactured by Pen Scale. Subjects then rested at least 10 minutes in the recumbent position, and BP was measured twice with 2 minutes of rest between measures. This portion of data collection took about 20 minutes.

After measuring BP, electrodes were attached on the subject's chest. Pulse wave velocity (PWV) was obtained at the carotid and femoral arterial sites. The investigator, who is female, obtained the femoral pulse wave measures from female subjects, and a trained male research assistant obtained the femoral pulse wave measures from male subjects. All subjects were in the supine position and kept their underwear on during the measurements. To ensure privacy, the investigator brought a clean blanket to cover the groin site so that only a small area of the femoral region was exposed for the tonometer placement. The groin area remained covered at all times. Then the augmentation index (AI) was measured from the radial artery. This portion of data collection took about 20 minutes. Study procedures complied with the European Society of Cardiology's recommendation to standardize subject conditions when measuring arterial stiffness (Laurent et al., 2006).

Data analysis

All analyses were performed with SAS (version 9.1 for Windows). Descriptive analysis was completed for all of the variables. Normality of distribution of the continuous variables was assessed by checking mean, mode, median, standard deviations, skewness, kurtosis, and extreme outliers of all variables. Normal distribution was considered when skewness and excess kurtosis (kortosis-3) were between -1.0 and +1.0 and no severe outliers existed in the data (Maxwell & Delaney, 2004). Gender differences in physiological responses were examined by independent samples t-test. To examine the internal consistency and test-retest reliability of the Korean version of the scales, Cronbach's alpha and correlation coefficients were analyzed.

Research Question (RQ 1) was analyzed by Pearson correlations to examine how acculturation status relates to time in the U.S. The associations among the psychobehavioral responses (RQ 2) were analyzed by Pearson correlations and principle factor analysis. Pearson correlation was also used to examine how arterial stiffness and blood pressure are related to each other (RQ 3). Plots between all the variables reported for bivariate correlations were generated and examined for any non-linearity in relations.

Multiple regression was used to examine RQ 4 and RQ 5. Before conducting multiple regression, only variables that were significantly correlated with dependent variables at α level of .1 or lower in bivariate correlation were selected. In multiple regression, independent variables that had a significant association at α level of .1 or lower were included in further multiple regression to reexamine their effect on dependent variables. Some of the independent variables were highly correlated to each other and thus multicollinearity was a concern. For example, state anxiety was highly correlated to trait anxiety, so one factor (anxiety) was created by principle component analysis and used as one independent variable in multiple regression. Systolic and diastolic blood pressures were also highly correlated to each other. Therefore, mean arterial pressure (MAP) was used in multiple regression. In order to examine the multicollinearity of independent variables in multiple regression, tolerance, variance inflation factor (VIF), and conditional index were examined. If the independent variable has low tolerance and high VIF, conditional indices were assessed to examine the collinearity among independent variables. Independent variables that have collinearity with other variables were separately examined in further multiple regressions.

For tests of association using Pearson correlations, a moderate correlation (*r* = .40) between variables was considered meaningful (Cohen, 2003). To detect a moderate correlation, a sample of 102 subjects would provide 94% power to discover whether the correlation significantly differs from zero at the 0.05 significance level. By convention, effect sizes of 0.02, 0.15, and 0.35 are considered small, medium, and large, respectively in multiple regressions (Cohen, 1988). Thus, 102 subjects would provide about 72% power to detect a moderate effect of ten predictors and 93% power to detect a moderate effect of three predictors at a significance level of 0.05. Since the study was cross-sectional, a causal relationship between psychological stress and arterial stiffness could not be determined. However, the study provides foundational data for building future studies with larger, more representative samples.

CHAPTER IV

RESULTS

Descriptive Results of Variables

For all the variables, descriptive statistics such as the mean, standard deviation, minimum, maximum, range of score, frequency, and percent were analyzed (see Table 3, 4, and 5). The age in the full sample ranged from 21 to 60, with a mean of 39.64 (SD 9.9) years; the mean age of the women was 38.96 (SD 9.71) and the mean age of the men was 39.76 (SD 10.44). Women comprised 61% of the sample. As for education, 67.6% of the sample had university or higher education. More than half (65.7%) reported household income less than $49,999 per year. According to a population-based study with 1,344,267 Korean Americans, 49.8% of participants had a bachelor's or higher degree and the median household income of that population was $53, 887 (Palaniappan et al., 2010). Therefore, more of the Korean Americans in this study had higher educational levels but low household income compared with the national data. Most (71.6%) of the sample lived with their spouse and 34.31% had a professional occupation. The BMI of the sample ranged from 16.4 to 31.6, with a mean of 23.6 (SD 3.2). Only 6% of the sample was currently smoking.

The stressors and psychobehavioral responses are summarized in Table 4. The mean time in the U.S. of this study sample was 10.07 years. The mean of acculturation was 17.78 which is lower than the middle score in the scale range. For psychobehavioral responses, the means of perceived stress and acculturative stress was 16.59 and 16.98, respectively. State and trait anger had means of 17.33 and 18.75. The means of state and trait anxiety were 36.06 and 39.62. Depression ranged from 0 to 38 with a mean of 11.29. The mean of chronic active coping was 42.04, which is much higher score than the middle score of the scale range.

The physiological variables are shown in Table 5. All physiological variables were normally distributed. The means of systolic and diastolic blood pressure of the full sample were 119.7 and 71.9 mmHg, respectively. The systolic blood pressures (SBP) of men were significantly higher than that of women and the mean difference of SBP was 10.23 mmHg. Men's diastolic blood pressure was also significantly higher than that of women and the mean difference of DBP was 6.53 mmHg. Augmentation index adjusted at heart rate 75 (AI_75) had a mean of 18.59 for the total sample. Women had significantly higher AI_75 than men and the mean difference was 7.86. The mean of pulse wave velocity (PWV) for the total sample was 6.99 m/s and there was no significant difference in PWV by gender.

Table 3

Descriptive Statistics for Personal Factors (n=102)

Variable		Frequency	Percent
Gender	Men	41	40.20
	Women	61	59.80
Education	Elementary	1	.98
	Middle	1	.98
	High grad	22	21.57
	College grad	9	8.82
	University grad	35	34.31
	Graduate	34	33.33
Household income	Not reported	4	3.92
	Less than $4,999	13	12.75
	From $5,000 to $9,999	9	8.82
	From $10,000 to $ 24,999	14	13.73
	From $ 25,000 to 49,999	27	26.47
	From $50,000 to $74,999	13	12.75
	From $75,000 to $99,999	11	10.78
	More than $100,000	11	10.78
Marriage	Single,widowed (within 2years)	2	1.96
	Separated or divorced	5	4.90
	Single, living alone	7	6.86
	Single, living with someone	15	14.71
	Married, living with spouse	73	71.57
Occupation	Not reported	1	0.98
	Business owner	9	8.82
	Cashier	4	3.92
	Home maker	17	16.67
	Laborer	15	14.7
	Minister	6	5.88
	None	10	9.80
	Professional	35	34.31
	Student	5	4.90

Table 4

Descriptive Statistics for Stressors and Psychobehavioral Responses

Variable	N	Mean	Sd	Min	Max	Possible Range
Stressors						
Time in the U.S.	102	10.07	7.40	1.0	34.0	≥1
Acculturation	102	17.78	5.83	6.0	33.0	0-36
Psychobehavioral responses						
Perceived stress	101	16.59	4.54	6.0	29.0	0-40
Acculturative stress	100	16.98	9.14	1.0	40.0	0-72
State anger	102	17.33	5.15	15.0	49.0	15-60
Trait anger	102	18.75	4.56	10.0	34.0	10-40
State anxiety	102	36.06	9.07	20.0	68.0	20-80
Trait anxiety	102	39.62	9.97	21.0	72.0	20-80
Depressive symptoms	101	11.29	7.76	0	38.0	0-60
Chronic active coping	102	42.04	5.68	21.0	54.0	12-60

Table 5

Descriptive Statistics for Physiological Responses (BP and Arterial Stiffness)

Variable (N=102)	All (N=102)	Male (N=41)	Female (N=61)	P Value
Blood Pressure				
Systolic blood pressure	119.70 ± 14.91	125.82 ±12.74	115.59 ± 14.95	<.001
Diastolic blood pressure	71.92 ± 9.27	75.82 ± 8.19	69.29 ± 9.09	<.001
Arterial Stiffness				
Augmentation index (%)	24.67 ± 12.27	20.42 ± 12.85	27.53 ± 11.07	.005
Augmentation index adjusted at HR75 (%)	18.59 ± 12.24	13.92 ± 11.95	21.78 ± 11.48	0.001
Pulse wave velocity (m/s)	6.99 ± 1.13	7.11 ± 0.96	6.91 ± 1.23	0.371

Values are mean ± SD

Research Questions

In Korean Americans who were born in Korea and have been in the U.S. at least one year;

Question 1. How does acculturation relate to time in the U.S.?

Question 2. What are the associations among the psychobehavioral responses of psychological stress (perceived stress and acculturative stress), stress emotions (anger, anxiety, or depression), and chronic active coping?

Question 3. What is the relationship between blood pressure and arterial stiffness?

Question 4. How much of the variance in arterial stiffness is explained by stressors (acculturation and time in the U.S.), psychological stress (perceived stress and acculturative stress), chronic active coping, and stress emotions (anger, anxiety, or depression), controlling for BP, age, gender, SES, BMI, and smoking?

Question 5. How much of the variance in blood pressure is explained by stressors (acculturation and time in the U.S.), psychological stress (perceived stress and acculturative stress), chronic active coping, and stress emotions (anger, anxiety, or depression), controlling for arterial stiffness, age, gender, SES, BMI, and smoking?

Acculturation and time in the U.S.

Question 1 was “How is acculturation related to time in the U.S?” Acculturation was positively correlated to time in U.S. ($r=.10$) but was not statistically significant ($p=.297$). Plots between acculturation and time in the U.S. showed no evident non-linearity in their relationship.

The associations among psychobehavioral responses.

Question 2 was “What are the associations among the psychobehavioral responses examined?” Perceived stress, acculturative stress, state anger, state anxiety, trait anxiety, and depression were all significantly and positively correlated with one another (Table 6). The one exception was trait anger as it was significantly and positively correlated only with state and trait anxiety. Chronic active coping was significantly and negatively correlated with perceived stress, acculturative stress, state anger, state anxiety, trait anxiety, and depression but not with trait anger. In the bivariate plots between variables, none of the pairs appeared to have a non-linear relationship.

Psychological stress and Emotions.

Perceived stress was positively related to state anger; the more perceived stress participants had, the more state anger they had (r=.39). Although perceived stress was significantly related to state anger, it was not significantly related to trait anger (r=.13). Perceived stress was also significantly related to state anxiety (r=.49), trait anxiety (r=.49), and depression (r=.55), showing that the more perceived stress participants had, the more state anxiety, trait anxiety, and depression they had.

Acculturative stress was positively related to perceived stress (r=.39). It was also significantly related to state anger; therefore, the more acculturative stress participants had, the more state anger they had (r=.32). However, acculturative stress was not significantly related to trait anger (r=.19). Acculturative stress was also significantly related to state anxiety (r=.40), trait anxiety (r=.44), and depression (r=.35), indicating that the more acculturative stress subjects had, the more state and trait anxiety and depression they had.

Table 6

Correlations among Stressors and Psychobehavioral Stress Responses (n=102)

		Acculturation	Time in the U.S.	Perceived stress	Acculturative stress	State anger	Trait anger	State anxiety	Trait anxiety	Depression	Chronic active coping
Acculturation	r	1	0.10	-0.39	-0.36	-0.22	-0.08	-0.33	-0.29	-0.27	0.30
	p		0.297	<.001	<.001	0.027	0.408	0.001	0.002	0.006	0.002
Time in the U.S.	r		1	-0.01	0.07	0.11	-0.05	0.09	0.08	0.03	-0.11
	p			0.944	0.513	0.278	0.625	0.395	0.417	0.731	0.289
Perceived stress	r			1	0.39	0.39	0.13	0.49	0.49	0.55	-0.38
	p				<.001	<.001	0.199	<.001	<.001	<.001	<.001
Acculturative stress	r				1	0.32	0.19	0.40	0.44	0.35	-0.29
	p					0.001	0.066	<.001	<.001	0.004	0.003
State anger	r					1	0.09	0.64	0.51	0.58	-0.28
	p						0.385	<.001	<.001	<.001	0.004
Trait anger	r						1	0.31	0.34	0.18	-0.08
	p							0.002	<.001	0.065	0.439
Sate anxiety	r							1	0.82	0.62	-0.35
	p								<.001	<.001	<.001
Trait anxiety	r								1	0.69	-0.38
	p									<.001	<.001
Depression	r									1	-0.28
	p										0.005
Chronic active coping	r										1

Psychological stress and chronic active coping.

Chronic active coping was significantly and negatively related to perceived stress (r= -.38) and acculturative stress (r= -.29). Therefore, the more chronic active coping subjects reported, the less perceived stress and acculturative stress they had.

Emotion and Chronic active coping.

Chronic active coping had significant negative relationships with stress emotion variables. For example, chronic active coping was significantly negatively related to state anger (r= -.28), state anxiety (r= -.35), trait anxiety (r=-.38), and depression (r= -28). Therefore, the more chronic active coping people used, the less state anger, state anxiety, trait anxiety, and depression they had. Only trait anger was not significantly associated with chronic active coping in this sample (r=-.08).

Principle factor analysis results.

In order to better visualize the relationships of psychological stress, stress emotions, and chronic active coping, a principle axis factor analysis was conducted. Prior communalities were estimated by the squared multiple correlation coefficient [SMC]. As expected from the correlation results, trait anxiety and state anxiety had the highest prior communalities, suggesting these two variables were most related to the underlying factor. Consistent with the correlation results, acculturative stress, trait anger, and chronic active coping had low prior communality with other variables (see Table 7).

Table 7

Principal Factor Analysis of Psychobehavioral Responses and Squared Multiple Correlations

Trait anxiety	*State anxiety*	*Depre-ssion*	*State anger*	*Perceived stress*	*Accultua-tive stress*	*Trait anger*	*Chronic active coping*
0.77	0.75	0.61	0.50	0.41	0.24	0.15	0.21

Table 8 presents the first three eigen values of the psychobehavioral responses. Eigen values indicate the total variance that can be explained by each factor; thus, a high eigen value means that the factor explains the variables well. An eigenvalue is used in factor analysis to determine how many underlying factors can be extracted from a data set and conventionally, factors which have more than 1 eigen value are retained (StatSoft, 2010). In this sample, only a single factor was retained by that criterion which suggests that there is only one empirically significant shared source of variation among the variables.

Table 8

Eigenvalue Results

	Eigenvalue	*Proportion*	*Cumulative*
1	3.480	0.957	0.957
2	0.305	0.084	1.041
3	0.198	0.0545	1.096
…	…	…	…

Table 9 shows which variables are involved with which factor and to what degree. All psychobehavioral variables are correlated with Factor 1; trait anger has the least correlation and chronic active coping has a negative relationship to Factor1. The variances for each variable that can be explained by Factor1 are presented in Table 10.

Table 9

Factor Loading Matrix

Variables	*Factor1*
Trait anxiety	.87
State anxiety	.86
Depression	.78
State anger	.67
Perceived stress	.63
Acculturative stress	.50
Trait anger	.29
Chronic active coping	-.43

Table 10

Final Communality Estimates

Trait anxiety	*State anxiety*	*Depre-ssion*	*State anger*	*Perceived stress*	*Acccultua-tive stress*	*Trait anger*	*Chronic active coping*
0.76	0.75	0.61	0.45	0.39	0.25	0.08	0.19

Therefore, the results by principle factor analysis were basically the same as the simple correlations. While trait anxiety, state anxiety, and depression shared a large amount of variance with the others as a group, acculturative stress, trait anger, and chronic active coping shared less variance with the others in a group.

The associations among physiological responses.

Question 3 explored the relationship between blood pressure and arterial stiffness in the sample. Bivariate Pearson correlations were calculated to answer this question (table 11). Systolic blood pressure was highly significantly related to diastolic blood pressure (r=.81) and to pulse wave velocity (r=.45). However, systolic blood pressure was not significantly related to augmentation index adjusted at HR 75 (AI_75). Diastolic blood pressure was significantly related to pulse wave velocity (r=.56) and to AI_75 (r=.33). The two arterial stiffness variables, pulse wave velocity and AI_75 were significantly related (r=.49).

Table 11

Correlation among Physiological Variables (n=102)

		SBP	*DBP*	*MAP*	*PWV*	*AI_75*
SBP	r	1.00	0.81	0.94	0.45	0.18
	p		<.001	<.001	<.001	0.065
DBP	r		1.00	0.96	0.56	0.33
	p			<.001	<.001	<.001
MAP	r			1.00	0.54	0.28
	p				<.001	0.005
PWV	r				1.00	0.49
	p					<.001
AI_75	r					1.00
	p					

Factors associated with arterial stiffness.

Question 4 was “How much of the variance in arterial stiffness is explained by stressors (acculturation and time in the U.S.), psychological stress (perceived stress and acculturative stress), chronic active coping, and stress emotions (anger, anxiety, or depression), controlling for BP, age, gender, SES, BMI, and smoking?” The correlations of arterial stiffness and blood pressure with the other variables are shown in Table 12. Only variables that were significantly correlated with dependent variables at α level of .1 or lower in bivariate analysis were used for multiple regression. Because arterial stiffness was measured by two variables (pulse wave velocity [PWV] and augmentation index adjusted at heart rate 75 [AI_75]), this question had two parts: **question 4-A with PWV** as the dependent variable and **question 4-B with AI_75** as the dependent variable.

Table 12

Correlation of Arterial Stiffness and Blood Pressure with All Other Variables (n=102)

	PWV *r(p)*	*AI_75* *r(p)*	*SBP* *r(p)*	*DBP* *r(p)*
Age	0.61 (<.001)	0.64 (<.001)	0.25 (0.013)	0.39 (<.001)
Gender	-0.09 (0.371)	0.32 (0.001)	-0.34 (<.001)	-0.35 (<.001)
Education	-0.34 (<.001)	-0.39 (<.001)	-0.31 (0.002)	-0.31 (0.001)
Income	0.19 (0.058)	0.19 (0.050)	0.20 (0.046)	0.23 (0.024)
BMI	0.28 (0.005)	0.08 (0.436)	0.29 (0.002)	0.24 (0.014)
Smoking	0.14 (0.158)	0.1 (0.307)	0.02 (0.814)	0.15 (0.135)
Acculturation	-0.12 (0.214)	-0.29 (0.003)	0.05 (0.633)	0.01 (0.915)
Time in U.S.	0.43 (<.001)	0.34 (<0.001)	0.35 (<0.001)	0.33 (<0.001)
Perceived stress	0.06 (0.536)	0.19 (0.064)	-0.02 (0.821)	0.03 (0.763)
Acculturative stress	0.19 (0.046)	0.28 (0.005)	0.20 (0.045)	0.13 (0.204)
State anger	0.29 (0.003)	0.19 (0.054)	0.16 (0.098)	0.14 (0.159)
Trait anger	0.12 (0.220)	0.01 (0.933)	0.07 (0.513)	0.06 (0.538)
State anxiety	0.30 (0.002)	0.18 (0.071)	0.20 (0.044)	0.18 (0.074)
Trait anxiety	0.21 (0.030)	0.16 (0.115)	0.09 (0.367)	0.06 (0.566)
Depression	0.12 (0.237)	0.09 (0.333)	-0.02 (0.854)	0.03 (0.790)
Chronic active coping	-0.14 (0.173)	-0.19 (0.050)	-0.06 (0.551)	-0.09 (0.359)

Question 4-A.

Based on the conceptual framework, the basic model (model 1) with only controlling variables was run first:

Model 1: PWV = age + education + income + BMI + MAP

Table 13

Multiple Regression Results for model 1 Predicting PWV

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
Age	0.05	0.009	<.001	0.824	1.213
Education	-0.08	0.074	0.282	0.832	1.202
Income	-.011	0.048	0.818	0.893	1.119
BMI	0.03	0.027	0.227	0.891	1.122
MAP	0.04	0.009	<.001	0.789	1.266

R-Square 0.513 (F=19.36, P<.001)

Model 1 was significant (p<.0001), rejecting the null hypothesis F_0 ($\beta_1 = \beta_2 = \ldots = \beta_k = 0$). In this model, R-Square is .51, showing the independent variables explain about 51% of variance of pulse wave velocity (PWV). Although education, income, and BMI were significantly related to PWV in bivariate correlations, they did not remain significant in the multiple regression. Only age and MAP significantly predicted PWV.

In order to see how much variance was explained by age and MAP, the multiple regression was run with only age and MAP as the independent variables (Table 14). About 49% of the variance in PWV was explained by age and MAP. When age increased 1 year, PWV increased .06 m/s (β=.06, p<.001) after controlling MAP. When MAP increased 1 mmHg, PWV increased .04 m/s (β=.04, p<.001) after controlling age.

Table 14

Multiple Regression Results for Simplified Model 1 Predicting PWV

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
Age	0.06	0.009	<.001	0.882	1.134
MAP	0.04	0.008	<.001	0.882	1.134

R-Square = .492 (F=47.99, p<.001)

As the next step, the following model was run with significant controlling factors (age and MAP) and psychobehavioral factors that were significantly related to PWV in bivariate correlation (see Table 12).

Model 2: PWV = age + MAP **+ time in U.S. + acculturative stress + *state anger* + anxiety (*state anxiety* + *trait anxiety)***

Table 15

Multiple Regression Results for Model 2 Predicting PWV

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
Age	0.05	0.009	<.001	0.714	1.400
MAP	0.03	0.008	<.001	0.827	1.209
Time in U.S.	0.02	0.012	0.213	0.778	1.286
Acculturative stress	-0.01	0.010	0.222	0.724	1.381
State anger	0.02	0.019	0.274	0.624	1.603
State & Trait Anxiety	0.17	0.104	0.115	0.565	1.771

R-square = .528 (F=17.32, p<.001)

In model 2, time in U.S., acculturative stress, state anger, and state & trait anxiety did not remain significant predictors of PWV. However, the results of tolerance, VIF, and conditional index (see appendix H) showed that the association between state anger and state & trait anxiety caused multicollinearity. Therefore, the models were separately run with either state anger (model 3) or anxiety (model 4).

Model 3: PWV = age + MAP **+ time in U.S. + acculturative stress + *state anger***

Table 16

Multiple Regression Results for Model 3 Predicting PWV

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
Age	0.05	0.009	<.001	0.722	1.386
MAP	0.03	0.008	<.001	0.828	1.208
Time in U.S.	0.02	0.012	0.195	0.779	1.284
Acculturative stress	-0.01	0.009	0.468	0.818	1.222
State anger	0.04	0.016	0.023	0.879	1.137

R-Square = .515 (F=19.96, p<.001)

The results for model 3 showed that time in the U.S. and acculturative stress did not predict PWV, while state anger significantly predicted PWV.

In order to see how much variance was explained only by the significant variables in model 3, the multiple regression was run with only age, MAP and state anger as the independent variables (Table 17). About 52% of variance in PWV was explained by age, MAP, and state anger. After controlling age and MAP, when state anger increased one unit, PWV increased .03 m/s (β=.03, p=.037). Compared with Table 14, state anger explained about 2% of the variance in PWV (.515 [R-Square for simplified model 2] - .492 [R-Square for simplified model 1] = .023).

Table 17

Multiple Regression Results for Simplified Model 3 Predicting PWV

Variable	*B*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
Age	0.05	0.009	<.001	0.865	1.157
MAP	0.04	0.008	<.001	0.872	1.146
State anger	0.03	0.016	0.037	0.956	1.047

R-Square = .515 (F=34.62, p<.001)

Model 4: PWV = age + MAP **+ time in U.S. + acculturative stress + anxiety**

Table 18

Multiple Regression Results for Model 4 Predicting PWV

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
Age	0.05	0.009	<.001	0.719	1.389
MAP	0.03	0.008	0.001	0.829	1.206
Time in U.S.	0.02	0.012	0.205	0.778	1.285
Acculturative stress	-0.01	0.010	0.238	0.725	1.379
State and Trait anxiety	0.23	0.088	0.011	0.796	1.256

R-Square = .522 (F=20.50, P<.001)

The results for model 4 showed that acculturative stress and time in the U.S. did not predict PWV, while state and trait anxiety predicted PWV significantly.

In order to see how much variance was explained by the significant variables, the multiple regression was run with only age, MAP and anxiety as the independent variables (Table 19). About 52% of variance in PWV was explained by age, MAP, and anxiety. After controlling age and MAP, when anxiety increased one unit of measure, PWV increased .19 m/s (β=.19, p=.025). Compared with Table 14, anxiety explained about 3% of variance in PWV (.518 [R-Square for simplified model 3]-.492 [R-Square for simplified model 1] = .026).

Table 19

Multiple Regression Results for Simplified Model 4 Predicting PWV

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
Age	0.05	0.009	<.001	0.876	1.142
MAP	0.04	0.008	<.001	0.872	1.147
State & Trait Anxiety	0.19	0.081	0.025	0.973	1.028

R-Square=.518 (F=35.10, p<.001)

In summary, pulse wave velocity (PWV) was significantly predicted by age, mean arterial pressure (MAP), state anger, and state & trait anxiety. To compare the strength of the relationship between these significant predictors and the dependent variable (PWV), effect size was calculated. Cohen's f^2 is used to measure effect sizes in multiple regression and is defined as $f^2 = \frac{R^2}{1 - R^2}$ (R^2 = Squared multiple correlation). By convention, f^2 effect sizes of 0.02, 0.15, 0.35 are considered small, medium, and large, respectively (Cohen, 1988). The effect size of both age and MAP on PWV was .97 which is very large. The effect size of state anger and anxiety on PWV was .02 and .03, respectively, which are relatively small.

Question 4-B.

Based on the conceptual framework, the basic model (model 1) with only controlling variables was as follows:

Model 1: AI_75 = age + gender + education + income + MAP

Table 20

Multiple Regression Results for Model 1 Predicting AI_75

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
Age	0.69	0.092	<.001	0.816	1.226
Gender	10.19	1.879	<.001	0.797	1.254
Education	-0.34	0.785	0.662	0.756	1.322
Income	0.22	0.472	0.640	0.915	1.093
MAP	0.23	0.094	0.015	0.669	1.494

R-Square = .569 (F=24.05, p<.001)

Although education and income were significantly related to augmentation index adjusted at heart rate 75 (AI_75) in bivariate correlation, they did not remain significant in the multiple regression when other variables were included. Only age, gender, and MAP significantly predicted AI_75.

In order to see how much variance of AI_75 was explained by the significant variables in model 1, the multiple regression was run with only age, gender, and MAP as the independent variables (Table 21). About 57% of the variance in AI_75 was explained by age, gender, and MAP. When age increased 1 year, AI_75 increased .72 (β =.72, p=<.001) after controlling gender and MAP. Women had 10.66 higher AI_75 than men after controlling age and MAP (β = 10.66, p<.001). When MAP increased 1 mmHg, AI_75 increased .27 (β =.27, p=.002) after controlling age and gender.

Table 21

Multiple Regression Results for Simplified Model 1 Predicting AI_75

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
Age	0.72	0.089	<.001	0.884	1.131
Gender	10.66	1.776	<.001	0.869	1.151
MAP	0.27	0.088	0.002	0.774	1.291

R-Square = .569 (F=42.63, p<.001)

As the next step, the following model was run with significant controlling factors (age and MAP) and psychobehavioral factors that were related to PWV at the α level of .1 or lower in the bivariate correlation.

Model 2: AI_75 = age + gender + MAP + **acculturation + time in U.S. + perceived stress + acculturative stress + chronic active coping** + ***state anger*** + ***state anxiety***

Table 22

Multiple Regression Results for Model 2 Predicting AI_75

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
Age	0.67	0.117	<.001	0.552	1.810
Gender	11.26	1.926	<.001	0.791	1.265
MAP	0.29	0.099	0.005	0.649	1.541
Acculturation	-0.06	0.190	0.738	0.569	1.756
Time in U.S.	0.06	0.137	0.674	0.694	1.441
Perceived stress	0.45	0.237	0.063	0.602	1.662
Acculturative stress	0.01	0.109	0.919	0.704	1.421
Chronic active coping	-0.002	0.171	0.989	0.762	1.312
State anger	-0.18	0.219	0.423	0.548	1.824
State anxiety	0.02	0.133	0.895	0.473	2.113

R-Square = .588 (F=12.44, p <.001)

The results for model 2 showed that acculturation, time in the U.S., acculturative stress, chronic active coping, state anger, and anxiety did not significantly predict AI_75. Since the results of collinearity diagnostics (see appendix H) showed that association between age and acculturation and the association between state anger and state & trait anxiety caused multicollinearity in this model, further multiple regressions were run to examine the effect of acculturation, state anger, and state anxiety on AI_75 in separate models; none of these were identified as significant predictors of AI_75.

The effect of perceived stress on AI_75 was significant at α level = .10 (β=.45, p=.063). In order to examine the possible effect of perceived stress on AI_75, multiple regression was run with age, gender, MAP, and perceived stress as the independent variables (Table 23). About 59% of variance in AI_75 was explained by age, gender, MAP, and perceived stress. When perceived stress increased one unit, AI_75 increased .42 m/s (β=.42, p=.022) after controlling age, gender, and MAP. Compared with Table 22, perceived stress explained about 2% of the variance in AI_75 (.591 [R-Square for simplified model 2] - .569 [R-Square for simplified model 1] = .022).

Table 23

Multiple Regression Results for Simplified Model 2 Predicting AI_75

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
Age	0.69	0.090	<.001	0.851	1.175
Gender	11.13	1.781	<.001	0.846	1.181
MAP	0.29	0.087	0.001	0.752	1.329
Perceived stress	0.42	0.179	0.022	0.968	1.033

R-Square = .591 (F=34.36, p<.001)

In summary, augmentation index adjusted at heart rate 75 (AI_75) was significantly predicted by age, gender, mean arterial pressure (MAP), and perceived stress. The effect size of age, gender, and MAP on AI_75 was 1.32 all together which is very large. The effect size of perceived stress on AI_75 was 0.02 which is small.

Finally, question 4 was “How much of the variance in arterial stiffness is explained by stressors (acculturation, time in the U.S.), psychological stress (perceived stress and acculturative stress), chronic active coping, and stress emotion (state/trait anger, state/trait anxiety or depression), controlling for BP, age, gender, SES (education and income), BMI, and smoking?” The major predictors of arterial stiffness were age and BP for both PWV and AI_75, and gender for AI_75. In addition, state anger, state & trait anxiety and perceived stress were small but significant predictors of arterial stiffness independent of age, BP, and gender. While state anger and state & trait anxiety were independent predictors of PWV, perceived stress was an independent predictor of AI_75.

Factors associated with blood pressure.

Question 5 was "How much of the variance in blood pressure is explained by stressors (acculturation and time in the U.S.), psychological stress (perceived stress and acculturative stress), chronic active coping, and stress emotions (anger, anxiety, or depression), controlling for arterial stiffness, age, gender, SES, BMI, and smoking?" Because blood pressure has two components (systolic blood pressure [SBP] and diastolic blood pressure [DBP]), this question had two parts: **question 5-A** with SBP as the dependent variable and **question 5-B** with DBP as the dependent variable.

Question 5.

Question 5-A (SBP).

Based on the conceptual framework, the basic model (model 1) with only controlling variables was as follows:

Model 1: SBP = PWV + age + gender + education + income + BMI

Table 24

Multiple Regression Results for Model 1 Predicting SBP

Variable	*B*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
PWV	5.26	1.452	<.001	0.575	1.739
Age	-0.18	0.161	0.255	0.605	1.653
Gender	-10.51	2.655	<.001	0.916	1.092
Education	-2.59	1.138	0.025	0.812	1.232
Income	0.67	0.721	0.353	0.903	1.108
BMI	0.36	0.412	0.390	0.844	1.184

R-Square = .377 (F=9.18, p<.001)

Although age, income, and BMI were significantly related to SBP in bivariate correlation, they did not remain significant in the multiple regression when other variables were included. Only PWV, gender, and education significantly predicted SBP. Since the VIFs for PWV and age were increased by the correlation between PWV and age, the additional model was run only with age, gender, education, income, and BMI. The result showed that age was not a significant predictor of SBP.

In order to see how much variance of SBP was explained by PWV, gender, education, the multiple regression was run with only PWV, gender, and education as the independent variables (Table 25). About 34% of variance in SBP was explained by PWV, gender, and education. When PWV increased 1 m/s, SBP increased 4.41 mmHg after controlling gender and education (β =4.41, p=<.001). Women had 10.35 mmHg lower SBP than men after controlling PWV and education (β= -10.35, p<.001). When education increased 1 unit in the scale, SBP decreased 2.97 mmHg (β = -2.97, p=.008) after controlling PWV and gender.

Table 25

Multiple Regression Results for Simplified Model 1 Predicting SBP

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
PWV	4.41	1.159	<.001	0.862	1.160
Gender	-10.35	2.535	<.001	0.959	1.043
Education	-2.97	1.089	0.008	0.852	1.174

R-Square = .341 (F=16.93, p<.001)

In order to calculate the variance of SBP that was explained by education alone, an additional multiple regression analysis was run with PWV and gender (Table 26). About 5% of variance in SBP was explained by education only (.341 [R-Square for simplified model 1] - .292 [R-Square for more simplified model 1] = .049).

Table 26

Multiple Regression Results for More Simplified Model 1 Predicting SBP

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
PWV	5.55	1.116	<.001	0.992	1.008
Gender	-9.09	2.572	<.001	0.992	1.008

R-Square = .292 (F=20.37, p<.001)

As the next step, the following model was run with only the significant controlling factors and the psychobehavioral factors that were significantly correlated with SBP.

Model 2: SBP = PWV + gender + education + **time in U.S. + acculturative stress +** ***state anger*** + ***state anxiety***

Table 27

Multiple Regression Results for Model 2 Predicting SBP

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
PWV	3.44	1.314	0.010	0.729	1.372
Gender	-10.27	2.604	<.001	0.938	1.066
Education	-2.18	1.253	0.085	0.677	1.477
Time in U.S.	0.28	0.206	0.184	0.674	1.484
Acculturative stress	0.20	0.150	0.179	0.824	1.214
State anger	0.07	0.319	0.837	0.565	1.768
State anxiety	-0.04	0.189	0.845	0.516	1.937

R-Square=.349 (F=7.07, p<.001)

The significant relationships of SBP with time in U.S., acculturative stress, state anger and state anxiety in bivariate correlation did not remain significant in the multivariate analysis. In this model, the apparent effect of education on SBP was reduced due to the relationship between education and time in the U.S. (r= -.51). The association between state anger and state anxiety also caused multicollinearity in this model. Further analyses were conducted to examine the effect of each time in U.S., state anger, and state anxiety on SBP in separated models. Time in U.S., state anger, and state anxiety had no significant effect on SBP after controlling PWV and gender. As seen in the table 25, only education was a significant predictor of SBP after controlling PWV and gender.

In summary, systolic blood pressure (SBP) was best predicted by pulse wave velocity (PWV), gender, and education. The effect size of PWV and gender was 0.41 which is considered large. The effect size of education alone was .05 which is relatively small.

Question 5-B (DBP).

Based on the conceptual framework, the following model 1 was run first only with controlling factors.

Model 1: DBP = PWV + age + gender + education + income + BMI

Table 28

Multiple Regression Results for Model 1 Predicting DBP

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
PWV	3.72	0.843	<.001	0.575	1.739
Age	0.01	0.093	0.921	0.605	1.653
Gender	-6.73	1.542	<.001	0.916	1.092
Education	-1.27	0.661	0.059	0.812	1.232
Income	0.52	0.419	0.220	0.903	1.108
BMI	-0.05	0.239	0.844	0.844	1.184

R-Square = .454 (F=12.59, p<.001)

The results for the model 1 showed that PWV and gender significantly predicted DBP. The effect of education on DBP was significant at $p<.10$, so it was included in subsequent analyses.

In order to examine how much of variance in DBP was explained by PWV, gender, and education, the multiple regression was run with these three variables as the independent variables (Table 29). About 44% of the variance in DBP was explained by PWV, gender, and education. When PWV increased 1 m/s, DBP increased 3.75 mmHg after controlling gender and education ($\beta = 3.75$, $p<.001$). Women had 6.29 lower DBP than men ($\beta = -6.29$, $p<.001$) after controlling PWV and education. When education increased 1 unit of the scale, DBP decreased 1.54 mmHg after controlling PWV and gender ($\beta = -1.54$, $p = .016$).

Table 29

Multiple Regression Results for Simplified Model 1 Predicting DBP

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
PWV	3.75	0.668	<.001	0.862	1.160
Gender	-6.29	1.460	<.001	0.959	1.043
Education	-1.54	0.628	0.016	0.852	1.174

R-Square = .435 (F=25.15, p<.001)

In order to calculate the variance of DBP which was explained by education alone, additional multiple regression was run with PWV and gender (Table 30). About 4% of variance in DBP was explained by education only (.435 [R-Square for simplified model 1] - .4003 [R-Square for more simplified model 1] = .035).

Table 30

Multiple Regression Results for More Simplified Model 1 Predicting DBP

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
PWV	4.34	0.638	<.001	0.992	1.008
Gender	-5.64	1.472	<.001	0.992	1.008

R-Square = .4003 (F=33.04, p<.001)

As a next step, the model was extended to include significant controlling factors and psychobehavioral factors that were significantly correlated with DBP.

Model 2: DBP = PWV + gender + education + **time in U.S.** + ***state anxiety***

Table 31

Multiple Regression Results for Model 2 Predicting DBP

Variable	*β*	*SE*	*P value*	*Tolerance*	*Variance Inflation*
PWV	3.71	0.732	<.001	0.730	1.369
Gender	-6.31	1.475	<.001	0.955	1.047
Education	-1.46	0.716	0.044	0.665	1.504
Time in U.S.	0.05	0.117	0.663	0.662	1.510
State anxiety	-0.03	0.085	0.707	0.852	1.174

R-Square = .437 (F=14.92, p<.001)

The significant relationship of DBP with time in the U.S. and state anxiety did not remain significant after controlling PWV, gender and education. Only PWV, gender, and education were significant predictors of DBP in this sample.

In summary, diastolic blood pressure (DBP) was best predicted by pulse wave velocity (PWV), gender, and education. The effect size of PWV and gender was .67 which is considered large and the effect size of education alone on DBP was .04 which is relatively small.

Question 5 asked “How much of the variance in blood pressure is explained by stressors (acculturation and time in the U.S.), psychological stress (perceived stress and acculturative stress), chronic active coping, and stress emotion (state/trait anger, state/trait anxiety or depression), controlling for arterial stiffness, age, gender, SES (education and income), BMI, and smoking?” None of the stressors or psychobehavioral responses were significant predictors of SBP and DBP. Only PWV and gender were major independent predictors of SBP and DBP; in addition, education was a small but significant predictor of SBP and DBP.

CHAPTER V

DISCUSSION

Introduction

This study examined the associations among stressors (acculturation and time in the U.S.), psychobehavioral responses (psychological stress [perceived stress and acculturative stress], chronic active coping, and stress emotions [anger, anxiety, and depression]), and physiological responses (BP and arterial stiffness) in Korean Americans.

Acculturation and Time in the U.S.

In this study, it was hypothesized that acculturation would be positively related to time in the U.S. because as time passes, immigrants may adapt to the dominant culture. There was a positive relationship between acculturation and time in the U.S. but it was not statistically significant. This result was not consistent with previously reported findings that acculturation was significantly and positively related to length of residence (Madianos, Gonidakis, Ploubidis, Papadopoulou, & Rogakou, 2008; Zea, Asner-Self, Birman, & Buki, 2003).

The nonsignificant relationship between acculturation and time in the U.S. may suggest that Korean Americans in this sample have not acculturated to the dominant culture over time. In bivariate correlations, acculturation was significantly and negatively related to perceived stress (r= -.39), acculturative stress (r= -.36), state anger (r= -.22), state and trait anxiety (r= -.33, r= -.29), depressive symptoms (r= -.27). Thus, those who scored low in acculturation also indicated more perceived stress, acculturative stress, state anger, anxiety, and depressive symptoms. This result might indicate that low acculturation can serve as stressor in these immigrants and should be further studied. None of these psychological responses had significant relationships with time of residence in the U.S.

There are several possible explanations for nonsignificant relationship between acculturation and time in the U.S. Koreans are often described as a highly homogeneous ethnic group since Korean culture is based on shared history and one language (Hangul). Koreans have also developed a sense of a “unitary nation” (Danil minjok) that shares ancestry. Therefore, Koreans are considered racially distinctive (Shin, 2006). The acculturation process may be more stressful for some ethnic groups than others (Berry, 1997). Koreans tend to maintain their traditional culture, and distinctive differences between Korean and western cultures may hinder the acculturation process. Language can be a possible obstacle to acculturation in Korean Americans. Language influences our thought processes and is described as a critical component of culture (Stevens, 1985; (Lee, Kim, & Chen, 2010). Language issues may decrease interactions with the dominant culture and lead to feelings of isolation and lack of belonging. In particular, Korean Americans in this sample were all first-generation immigrants who were born in Korea and their average time in the U.S was 10 years; thus, most of them immigrated to the U.S when they were adults who had already mastered their native language, Korean. The uniqueness of the Korean language in sentence structure, morphology (word structure) and phonology may make it harder for Koreans to learn English than for other immigrant groups such as Mexicans. Furthermore, individual characteristics such as personality, family support, or reasons for immigration may also make acculturation process various in different groups.

This study demonstrated that higher acculturation was related to lower psychological stress and stress emotions. Considering that high psychological stress and stress emotions may result in adverse psychological and physical health condition (Black, 2002; Rutledge & Hogan, 2002), there is a need for studies that explore the association between health, acculturation, and time in the U.S. in Korean Americans. In addition, longitudinal studies may greatly contribute to the understanding of acculturation process over length of residence in the U.S. in this population.

Psychobehavioral Responses

Higher incidence of psychological problems have been observed in immigrant populations compared to dominant cultural groups (Claassen et al., 2005; Cuellar et al., 2004; Fazel et al., 2005). Several studies previously reported high levels of psychological stress, anxiety, and depression in Korean Americans (Chun et al., 2007; Koh, 1998; Kuo, 1984).

This sample of Korean Americans had higher perceived stress (16.59) than the reference levels for Whites (12.8), Hispanics (14.0), and Blacks (14.7), and for all other minority groups combined (14.1) (Cohen et al., 1983; 1988).

On the other hand, this study's participants had lower acculturative stress than 114 Mexican immigrants using English as a second language (Hovey, 2000) and 609 Arab Americans residing in the U. S. in the post September 11 era (Amer, 2005). Considering that perceived stress was positively related to acculturative stress ($r=.39$) and that Korean Americans have higher perceived stress than other racial groups, it is intriguing that Korean Americans from this study had lower acculturative stress than other groups. Perhaps Korean Americans in this sample do not interact with Americans as much as other immigrant groups do and tend to socialize mainly with other Korean people in their communities or churches. Individuals who do not get involved in the acculturation process and interact primarily in their own ethnic community may not report high acculturative stress although they may have low acculturation status.

Anger emotion seems to be higher in Korean Americans than Americans. In this study, trait anger was higher than what was reported in a sample of 10,285 Black and White Americans aged 48 to 67 years. State anger was also slightly higher than what was reported for American women living in the U.S. (Chen, Booth-LaForce, Park, & Wang, 2010). Since anger slowly decreases with age and men are reported to score higher in anger than women, the high anger levels found may be attributable to differences in the samples' age and gender distribution.

The level of state anxiety of this sample was consistently lower and the level of trait anxiety was very similar to that found in studies of 853 Greeks, 121 Americans living in the U.S. and 101 Taiwaneses living in Taiwan, (Chen et al., 2010; Yannakoulia et al., 2008).

The scores for depressive symptoms in this sample were higher than that of 1173 obese participants and similar to 117 breast cancer patients (average age 53.7 years) (Hann, Winter, & Jacobsen, 1999). It is striking that the depressive symptoms score in these healthy Korean Americans was higher than the obese participants in Hann et al.'study who tended to be depressed, but closer to those with serious medical conditions.

Chronic active coping reflects a determination to succeed even in the face of overwhelming obstacles. Chronic active coping from this sample was consistently lower than what was reported for a community sample of 319 self-identified Chinese and Indian immigrants (Haritatos et al., 2007) and 306 European Americans and 213 African Americans (Wang, Trivedi, Treiber, & Snieder, 2005). In this sample, chronic active coping was significantly related to acculturation (r=.30), showing those who scored high in chronic active coping had higher levels of acculturation. The level of chronic active coping was also significantly and negatively related to perceived stress (r= -.38), acculturative stress (r= -.29), state anger (r= -.28), state anxiety (r= -.35), trait anxiety (r= -.38), and depression (r= -.28). These findings suggest that chronic active coping may be a useful strategy to alleviate psychological stress and stress emotions in Korean Americans.

In summary, the Korean Americans in this study had high levels of perceived stress, anger, and depressive symptoms. These findings are similar to previous investigations with samples of immigrants (Chun et al., 2007; Koh, 1998; Kuo, 1984; Shin, 1993). Future studies should examine what factors contribute to perceived stress, anger, and depressive symptoms in this population. Intervention studies are recommended to prevent or reduce psychological stress, anger, and depressive symptoms in Korean American immigrants. Since this study was the first to examine chronic active coping in Korean Americans, it would be interesting to further explore what individual characteristics predict chronic active coping and to explore different coping styles in this population.

Physiological Responses

Systolic & diastolic blood pressure.

Although the means of systolic blood pressure (SBP) and diastolic blood pressure (DBP) in all participants of this sample were in the normal range, the mean systolic blood pressure (SBP) for the Korean American men was slightly higher than women and was in the prehypertensive stage (125.8 mmHg). The mean SBP for the Koran American women (115.6 mmHg) was in the normal range. According to the 2001 Korea National Health and Nutrition Examination survey of the Korea National Statistical Office (2001), the mean SBP of 2009 Korean men aged 20-59 was 123.9 mmHg and the mean SBP of 2674 women aged 20-59 was 115.0 mmHg. That study's sample included hypertensive men (24.89%) and women (19.4%). Since the present study did not include any hypertensive subjects, it is possible that the SBP of Korean Americans from this study was higher than that of Koreans who live in Korea. According to the same Korean National Survey (2001), the mean DBP of Korean men was 80.37 mmHg and the mean DBP for women was 73.56 mmHg (KOSIS, 2001). The mean DBP for men (75.8 mmHg) and for women (69.3 mmHg) in the present study was less than that of Koreans living in Korea.

Carotid-femoral pulse wave velocity.

The values of carotid and femoral pulse wave velocity (cfPWV) for this sample were 6.1, 6.5, 7.4, and 8.3 m/s for age<30, 30-39, 40-49, and 50-59 respectively. These values are compatible with the reference values reported in a population based study in which cfPWV values were 6.2, 6.5, 7.2, and 8.3 m/s for the same age ranges in 1455 subjects (mostly Caucasians). However, according to a study on 998 healthy individuals (mostly Caucasian), 40 year old men and women are expected to have cfPWV values of

6.41 m/s and 6.12 m/s, respectively.(McEniery et al., 2005). The cfPWV of 7.11 m/s for Korean American men and 6.91m/s for Korean American women in the current study were somewhat higher than in the McEniery et al.'s study. Furthermore, Libhaber et al (2008) assessed cfPWV using the SphygmoCor in 305 South Africans of African ancestry (mean age 39 ± 17) who had prevalent cardiovascular risk factors (24% of the sample was hypertensive and 17% had diabetes mellitus). They reported that the mean cfPWV was 6.5 m/s (SD 3.2) for men (n=107, mean age 40 ± 18) and 6.0 m/s (SD 2.1) for women (n=146, mean age 38 ± 16). Considering that Korean Americans in the present study were free from known cardiovascular diseases including hypertension and diabetes, they seem to have higher cfPWV than South Africans of African ancestry from Libhaber et al.'s study.

Many studies have reported levels of arterial stiffness in different racial groups. However, several different algorithms were used to calculate PWV, and pulse wave velocity was measured in different arterial sites (e.g., brachial artery or tibial artery). Reference values of arterial stiffness will vary among different measures. For example, the values of brachial-ankle pulse wave velocity (baPWV) will be higher than carotid-femoral pulse wave velocity (cfPWV) because there is increasing arterial stiffness moving from the heart to the peripheral (Ito et al., 2006). Therefore, caution should be used when directly comparing levels of arterial stiffness among different studies. The levels of arterial stiffness for this Korean American sample seemed to be higher than what was reported in other studies that used the same method to measure arterial stiffness. Nevertheless, since studies were conducted in different circumstances and by different measurers, whether or not Korean Americans have more arterial stiffness than other racial groups should be examined in further studies.

Augmentation index adjusted at heart rate 75.

Mean Augmentation index (AI) values from this study (20.42% for men and 27.53% for women) were higher than the estimated values from the equation model reported by McEniery et al.'s study, 15.46% for men and 25.53% for women (McEniery et al., 2005). This study sample also had higher AI than 105 subjects (41 males and 64 females) aged 19-71 years in UK (8.59% for men and 22.04% for women). There could be a real difference in arterial stiffness measured by AI between this sample and other groups. However, the difference of AI between different racial groups may be attributable to height differences. The inverse correlation between AI and height has been reported in previous studies, suggesting that the taller people are, the lower AI they have (G. London et al., 1992; London, Guerin, Pannier, Marchais, & Metivier, 1992; Marchais et al., 1993). Since Koreans are relatively shorter than Europeans, further studies controlling for height are recommended to compare AI in different racial groups.

Systolic & diastolic blood pressure and arterial stiffness.

The results from this study showed that arterial stiffness measured by carotid-femoral pulse wave velocity (cfPWV) was significantly related to SBP (r=.45) and DBP (r=.56). This result is consistent with a large amount of literature (O'Rourke & Adji, 2005; Safar et al., 2003). Conventionally, it was believed that arterial stiffness was the result of hypertension. However, increasing evidence by longitudinal studies suggests that arterial stiffness may precede the development of hypertension (Dernellis & Panaretou, 2005; Liao et al., 1999). Large-artery stiffness is an age-related process characterized by fissuring of the elastin protein, collagen proliferation, and calcium deposition (Nichols et al., 2005). As arterial blood pressure increases, acute stiffening of large arteries occurs and this stiffening is immediately reversible. However, over time elevated blood pressure can lead to vascular remodeling, hypertrophy, and hyperplasia that induce intrinsic arterial stiffening (Franklin, 2005; Risler et al., 2005). Arterial stiffness as a preexisting condition may induce high blood pressure, and hypertension can accelerate increased arterial stiffness; thus, the relationship between arterial stiffness and hypertension may be bi-directional (Franklin, 2005).

Factors for Carotid-Femoral Pulse Wave Velocity

Only age, SBP, DBP, state anger, and state & trait anxiety were significant predictors of arterial stiffness as measured by carotid-femoral pulse wave velocity (cfPWV).

Age as a predictor of cfPWV.

Age has been identified as a major determinant of arterial stiffness in previous studies (EHJ, 2010a; Koivistoinen et al., 2007). As age increases, changes such as thinning and fragmentation of elastin and increase of collagen occur in the media of arterial walls, causing stiffness of large elastic arteries (Levy et al., 2007). These changes are independent of atherosclerosis as measured by intima-media thickness (Wykretowicz et al., 2009). According to the finding in this study, the correlation coefficient (r) of age and cfPWV was .61 and the regression coefficient of age on cfPWV (β) was .06; thus, for every increase of age by 1 year, cfPWV increases by .06 m/s after controlling MAP.

Shiburi et al (2006) measured arterial stiffness in 185 healthy South Africans of African ancestry (mean age 33.5 years) with the SphygmorCor system, demonstrating a linear relationship between age and cfPWV. In their study, the correlation coefficient (r) of age and cfPWV was .61 and the regression coefficient of age on cfPWV (β) was .07. (Shiburi et al., 2006). In another study of 24 volunteers (mean age 54), Rogers et al (2001) reported a similar correlation coefficient (r=.62) between age and cfPWV, but their regression coefficient was higher (β=.097) (Rogers et al., 2001). The level of interdependence between age and cfPWV (correlation coefficients) of the present study was very similar to those reported in these previous studies, but the amount of increase in cfPWV for every year (regression coefficient) were lower in the current study. Age-associated changes in cfPWV were reported to be non-linear with greater increase in individuals over 50 years of age (McEniery et al., 2005; Mitchell et al., 2004). The regression coefficient of .097 reported by Rogers et al. (2001) is higher than the regression coefficient of .054 in this study. However, the mean age in Rogers' study was 54 years, while the mean age in the present study was 40 years. This may indicate that cfPWV increases more for every increase of year in older subjects. Longitudinal research is needed to confirm such a curvilinear relationship.

MAP as a predictor of cfPWV.

This study showed that both SBP and DBP were significantly related to cfPWV in bivariate correlations (r= .45 and r=.56, respectively). Since SBP and DBP were very strongly correlated (r = .81), mean arterial pressure (MAP) was used to explore the effect of BP on cfPWV. MAP was significant but weakly correlated with age. Almost half the portion of the total variance in cfPWV was explained by age and MAP, showing the critical effect of age and MAP on arterial stiffness. For an increase of MAP by 1 mmHg, cfPWV increased by 0.04 m/s after controlling age.

Previous studies demonstrated that both SBP and DBP are positively correlated with cfPWV in subjects who are less than 60 years of age, as in this study (Izzo, 2004; Safar et al., 2003). Although some longitudinal studies demonstrated that arterial stiffness may precede the development of hypertension (Dernellis & Panaretou, 2005; Liao et al., 1999), there is still the effect of BP on acute and reversible arterial stiffness (Izzo, 2004). Therefore, it is important to control blood pressure when comparing arterial stiffness in different groups.

Anger as a predictor of cfPWV.

Several meta-analysis studies have reported a weak but significant influence of anger on elevated BP (Schum et al., 2003; Suls et al., 1995). In effort to explore pathways by which anger contributes to the development of elevated BP, it is important to explore how anger is related to arterial stiffness. In this study, the relationship between state anger and cfPWV remained significant even after controlling age and MAP which are powerful determinants of cfPWV. For an increase of state anger by one unit, cfPWV increased .03 m/s, after controlling age and MAP; thus, those with more state anger had stiffer arteries.

Four other studies have so far reported inconsistent results on this relationship. The Atherosclerosis Risk in Communities (ARIC) study defined arterial stiffness as “the diminished ability of the vessel to expand and contract in response to pulsatile pressure during the cardiac cycle” and measured pulsatile arterial diameter change in the left common carotid artery using a B-mode ultrasound system. Their study with 10,285 Black and white men and women aged 48-67 years, demonstrated that trait anger as measured by the Spielberger Trait anger scale was significantly related to pulsatile arterial diameter change in men, independent of age, height, race, education, smoking, and pulse pressure (Williams et al., 2006). On the other hand, the Baltimore Longitudinal Study of Aging with 200 participants showed that trait anger was not related to arterial stiffness (calculated by the log of systolic over diastolic blood pressure as a function of carotid distensibility) in bivariate correlation (Anderson et al., 2006). Another study with 156 Black and White Americans also showed that trait anger was not associated with cfPWV. However, in that study, hostility measured by the Cook-Medley Hostility Scale predicted higher cfPWV (Midei & Matthews, 2009) and hostility can be defined as extreme anger. Lastly, in a study conducted on 382 Japanese males aged 24 to 39 years, anger and hostility were measured by the Profile of Mood States (POMS), and arterial stiffness by brachial-ankle PWV. The study showed that neither anger nor hostility was related to arterial stiffness in their sample (Nakao et al., 2004). Only one of the four previous studies reported the significant relationship between anger and arterial stiffness in men and that was a very large study with a high amount of power (Williams et al., 2006). Since there may be differences between men and women in the experience of anger, it is possible that there is gender difference in this relationship. An interesting finding of this study is that neither state anger nor trait anger was associated with BP, suggesting that perhaps the association of anger and BP in previous studies may be mediated by increased arterial stiffness. Further studies are recommended to better understand the relationship between anger and arterial stiffness.

Anxiety as a predictor of cfPWV.

The present study found that both state and trait anxiety significantly predicted arterial stiffness, independent of age and MAP. The regression model showed that for an increase of state & trait anxiety by one unit, cfPWV increased .19 m/s, after controlling age and MAP. The effect size of state & trait anxiety on cfPWV was small but significant.

Previous studies reported inconsistent results on the relationship between anxiety and arterial stiffness. For example, one study that compared brachial and ankle PWV (baPWV) in 25 patients with anxiety and 23 age- and sex matched controls reported that arterial stiffness measured by baPWV was significantly higher in the anxiety patient group (Yeragani et al., 2006). Another study with 156 Black and White Americans also showed that trait anxiety was associated with cfPWV. Interestingly, this relationship was significant only in Blacks, showing the interaction between the effects of anxiety and race on cfPWV(Midei & Matthews, 2009). On the other hand, the Health, Aging, and Body Composition Study with 2,488 older adults (60 % White and 40% Black) reported that anxiety symptoms measured by the Hopkins Symptom Checklist were not related to cfPWV (Lewis et al., 2010). In another study conducted on 382 Japanese males aged 24 to 39 years, tension and anxiety were measured by the Profile of Mood States (POMS), and arterial stiffness by brachial-ankle PWV. Their study showed that neither tension nor anxiety was related to arterial stiffness (Nakao et al., 2004). Possible reasons for inconsistent results include different measures of anxiety and arterial stiffness and racial difference in vascular response on stress emotion. In addition, since the effect size of anxiety on arterial stiffness is small, it may be difficult to detect in some studies.

In this study, trait anxiety was not significantly related to BP and state anxiety was marginally positively associated with SBP. Therefore, arterial stiffness may be a mechanism to explain the connection between anxiety and HTN risk. The relationship between anxiety and arterial stiffness may be mediated by autonomic function (Watkins, Grossman, Krishnan, & Sherwood, 1998; Yeragani et al., 2006). Anxiety may induce an increase of sympathetic and vasoconstrictive component, and a decrease of parasympathetic and vasodilator component, which may contribute to increased arterial stiffness (Thayer, Friedman, & Borkovec, 1996; Williams et al., 2006; Yeragani et al., 2006). Additional studies are suggested to better understand the connection between anxiety and arterial stiffness and the potential role of decreased cardiac vagal activities to mediate anxiety and arterial stiffness.

Factors for Augmentation Index adjusted at Heart Rate 75

Among many independent variables, only gender, age, MAP, and perceived stress were significant predictors of augmentation index adjusted at heart rate 75 (AI_75).

Gender as a predictor of AI_75.

While gender was not related to cfPWV, gender was a significant predictor of augmentation index adjusted at heart rate 75 (AI_75). Women had 10.66 higher AI_5 than men after controlling age and MAP. This result is consistent with the previous studies which reported that women have higher augmentation index (AI) than men of similar age (Gatzka et al., 2001; Hayward & Kelly, 1997). AI in Korean women seems to be even higher than what was reported in other studies. Libhaber et al (2008) measured AI with SphygmoCor Software on 305 South Africans of African ancestry with prevalent cardiovascular risk (24% hypertensive, 63% overweight/obese, and 17% abnormal blood glucose control). They reported that the mean AI was 26 % (SD 14) for all participants (n=305, age 39 ± 17), 24% (SD 14) for men (n=117, age 40 ± 18) and 26% (SD 14) for women (n=188, age 38 ± 16) (Libhaber et al., 2008). Although the present study had lower mean AI for all participants including men, the mean AI in Korean women was higher than in the Libhaber's study which included women with high cardiovascular risk. As mentioned previously, a greater AI may be because of the shorter stature of women which results in a shorter distance for the wave to travel. Korean women tend to be shorter and short stature has been independently associated with a shorter pulse travel time and increased arterial wave reflections (G. M. London et al., 1992; Marchais et al., 1993). However one recent study reported that earlier wave reflection in girls was independent of height and carotid artery diameter (Ayer, Harmer, Marks, Avolio, & Celermajer, 2010). More studies are required to explore whether or not higher AI_75 in Korean women is due to their body height.

A higher AI in women than in men may explain why hypertensive women have more left ventricular hypertrophy than hypertensive men (Liebson et al., 1993). Since central pressure augmentation increases ventricular afterload, increased augmentation promotes ventricular hypertrophy. AI, which is the ratio of central pressure augmentation to central PP, has been related to left ventricular hypertrophy independently (Marchais et al., 1993). More studies are recommended to examine cardiovascular risk in Korean women who seem to have higher AI.

Age as a predictor of AI_75.

This study showed that for an increase of age by 1 year, AI_75 increased .72 controlling gender and MAP, demonstrating the important effect of age on AI_75. Several previous studies also reported that age is one of the most powerful predictors of AI in the general population (Kelly, Hayward, Avolio, & O'Rourke, 1989). Furthermore, age-associated increase of AI seems to be nonlinear with a greater increase before age 50. For example, one population based study, which measured AI using SphygmoCor software in 4001 healthy, normotensive individuals aged 18 to 90 years (of whom 92% were Caucasian), produced the regression equations in quadric terms with great age-related increase in younger individuals (<50years) and less increase in older individuals (>50years) (McEniery et al., 2005). Another study with a relatively older population (mean age 57) also reported non-linear increases in AI over years (Mitchell et al., 2004). While AI has greater age-associated change in individuals under 50 years of age, cfPWV was reported to have more prominent changes in those over 50 years of age (McEniery et al., 2005). Therefore, it was suggested that AI might be a more sensitive marker of arterial stiffening and risk in younger individuals but PWV might be a better measure for older individuals (McEniery et al., 2005).

MAP as a predictor of AI_75.

This study showed that for an increase of MAP by 1 mmHg, AI_75 increased by .27, after controlling gender and age. Since SBP was not significantly related to AI_75 in bivariate analysis, this may reflect the relationship between DBP and AI_75. The positive and weak correlation between DBP and AI_75 has been reported in a previous study (Yasmin & Brown, 1999). This result can be explained by peripheral pressure pulse amplification in which systolic pressure rises and the diastolic pressure decreases as blood flows from the aorta to distal arteries (Karamanoglu, O'Rourke, Avolio, & Kelly, 1993). One study conducted in 185 healthy South Africans reported a mean difference of 9.69 mmHg between peripheral SBP and central SBP, while the mean difference of peripheral DBP and central DBP was only 1.38 mmHg (Shiburi et al., 2006). Another study on 534 participants (mean age 34.9 years) also showed that the difference between peripheral SBP and central SBP was 14 mmHg, whereas the difference between peripheral DBP and central DBP was only 0.1 mmHg (Wojciechowska et al., 2006). Since AI is calculated from central pressure waves, AI would be well correlated with peripheral DBP which has less change from central DBP.

Perceived stress as a predictor of AI_75.

Perceived stress has long been considered a risk factor of hypertension and CVD. In this study, perceived stress was identified as a significant predictor of augmentation index adjusted at heart rate 75 (AI_75). For an increase of perceived stress by one unit, AI_75 increased by .42, after controlling age, gender, and MAP, and its effect size was small but significant. Although perceived stress was related to neither SBP nor DBP, the effect of perceived stress on AI_75 was significant even after controlling age, gender, and MAP which were important predictors of AI_75. This result suggests that amplified wave reflection may help explain how perceived stress is connected to CVD risk.

While several studies demonstrated that acute mental stress induced in labs increases augmentation index (Vlachopoulos et al., 2006; Vlachopoulos et al., 2009) (Ahlund, Pettersson, & Lind, 2008), one study has so far reported that high job strain has a significantly increased odds ratio for an elevated augmentation index, even after controlling age, BP, lipid profile, plasma glucose levels, white blood cell count, smoking status, and other related lifestyle factors for CVD in 808 working men (mean age 47 years) (Otsuka, Kawada, Ibuki, & Kusama, 2009). Their study demonstrated the significant effect of psychological stress in real life on augmentation index, supporting the result of the current study.

Although perceived stress was identified as a significant predictor of AI_75, it was not related to carotid-femoral pulse wave velocity (cfPWV) in this study. On the other hand, stress emotions of anger and anxiety were significant predictors of cfPWV, but not AI_75. It is not clear why different measures of arterial stiffness have different psychological predictors. Perceived stress can be considered a cognitive process which engages cortical regions of the brain (Gazzaniga, Ivry, & Mangun, 2008), whereas emotions are often linked to subcortical areas such as the amygdale (Whalen et al., 1998). Thus, cognition and emotion may have different cardiovascular responses.

This study showed that perceived stress is a significant predictor of AI_75 independent of age, gender, and MAP. This result needs to be confirmed so that interventions can be developed to reduce cardiovascular risk in this immigrant population who appeared to have high perceived stress and high AI_75.

Factors for Systolic Blood Pressure and Diastolic Blood Pressure

Among many independent variables, only PWV, gender, and education were significant predictors of SBP and DBP.

PWV as a predictor of SBP and DBP.

In this study, for every increase of PWV by 1 m/s, SBP increased 5.26 mmHg, after adjusting for age, gender, education, income and BMI. Separate analysis showed that with an increase of PWV by 1 m/s, DBP increases 3.72 mmHg, independent of age, gender, education, income and BMI, in this Korean American sample aged 60 years or less. Although a causal relationship between PWV and BP is not supported in this cross sectional study, there are three population-based longitudinal studies that provide evidence that arterial stiffness may precede the development of hypertension. In those studies, arterial stiffness, which was measured by various methods including aortic stain, distensibility, and β stiffness index (Dernellis & Panaretou, 2005), adjusted arterial diameter change, Peterson's elastic modulus, Young's elastic modulus, and β stiffness index (Liao et al., 1999), and cfPWV (EHJ, 2010), predicted the development of hypertension, independent of well-known CVD risk factors including age, BMI, and baseline blood pressure.

Age has been identified as an important determinant of SBP in previous studies (Franklin et al., 1997; Ko, Chan, & Cockram, 1999). DBP has been reported to continuously increase by age up to 60 years and to decrease after 60 years of age (Franklin et al., 1997); (Burt et al., 1995). The present study with participants 60 years old or less showed that age was significantly positively related to SBP and DBP in the bivariate analysis. However, the relationship of age with SBP and DBP did not remain significant when PWV was controlled. The impact of age on SBP and DBP reported in the previous studies may disguise the impact of PWV on SBP and DBP because age is an important determinant of PWV. Since the present study was cross-sectional, longitudinal studies should be conducted to clarify and compare the age-associated increase of SBP and DBP and the PWV-associated increase of SBP and DBP.

Gender as a predictor of SBP and DBP.

In this Korean American sample, Men had 10.51 mmHg higher SBP and 6.73 mmHg higher DBP than women, after controlling age, PWV, education, income and BMI. Similar gender differences in SBP and DBP have been documented in previous studies in other populations (Burt et al., 1995); (Perez-Lloret, Toblli, Cardinali, & Milei, 2010).

Although SBP and DBP are higher in men during early adulthood, this gender difference seems to decrease in older ages because the age-associated changes of SBP and DBP are steeper in women than in men (Wiinberg et al., 1995); (Franklin et al., 1997); (Jervase, Barnabas, Emeka, & Osondu, 2009). While the difference in SBP between men and women gradually decreased and eventually reversed beyond age 60, DBP remained lower in women after age 60 (Franklin et al., 1997), showing more early wave reflection and arterial stiffness in older women than older men.

Increased cardiovascular risk in older women compared with older men was often explained by high SBP and low DBP in older women. However this may also be explained by gender difference in age-related increase of PWV. Other studies as well as this one showed no gender differences in PWV (McEniery et al., 2005; Vermeersch et al., 2008). Nevertheless, age-related increase of PWV was reported to be higher in women than in men (Mitchell et al., 2004). When considering that age was no longer a significant predictor of SBP when PWV was controlled in this study, higher age- related increase of PWV in women may be more persuasive to explain high cardiovascular risk in older women.

Education as a predictor of SBP and DBP.

In this study, education was a significant predictor of SBP and DBP, independent of age, PWV, gender, income, and BMI. For each increase in education from one level (as measured) to the other, SBP decreased by 2.59 mmHg and DBP decreased by 1.27 mmHg.

The significant effect of education on BP was consistent with previous studies reporting that lower socioeconomic status (SES) predicted increase of both SBP and DBP (Conen, Glynn, Ridker, Buring, & Albert, 2009; Liu et al., 2011; Winkleby, Jatulis, Frank, & Fortmann, 1992). In the present study, socioeconomic status (SES) of participants was measured by education and income. However, education and income were significantly and negatively correlated (r= -.21), showing that participants with more education had less income. Some participants who had more education were either student or pursuing job opportunity, whereas some Korean Americans who owned their own business (e.g., grocery store or hair salon) did not have higher levels of education. Income was also significantly and positively correlated with all the physiological measures in bivariate analyses (SBP, DBP, cfPWV, and AI_75), suggesting that the more income participants had, the more cardiovascular risk they had. However, these bivariate relationships did not reach significance levels. On the other hand, education was significantly and negatively related to all the physiological measures and the favorable effect of education on SBP and DBP remained significant after controlling important risk factors of SBP and DBP such as PWV and gender. Education was significantly and negatively correlated with age, thus those with higher levels of education were more likely to be younger. However the effect of education on SBP and DBP was significant after controlling age. A 9.8 year longitudinal study also demonstrated that education, not income, significantly predicted increase of BP and incident hypertension (Conen et al., 2009).

Limitations in the Current Study

This study has several limitations that should be noted. First, the study participants were recruited from a small geographical region (three contiguous counties) of North Carolina (NC). Therefore, it is not appropriate to generalize the study findings from this sample to Korean Americans who live in urban or other areas of the country. For example, people who live in urban communities were reported to have more psychological issues than people living in rural areas (Romans, Cohen, & Forte, 2010).

Secondly, the study sample is relatively small and homogeneous. Most of the study participants were recruited from churches, and some were ministers, family members of ministers, or students who attend a divinity school. The levels of their stress, emotion, and coping may be different from other people. Because of the homogeneity of the sample in terms of subjects' jobs and specialties, these findings may not be generalizable to other Korean Americans. Further studies with a larger number of subjects who are heterogeneous in their characteristics are essential.

Thirdly, all psychological variables were self reported. As with all self-reported questionnaires, the accuracy and honesty of subject responses cannot be guaranteed. Responses may be based on what is perceived as socially desirable (Horwitz, Prados-Torres, Singer, & Bruce, 1997). In the Korean culture especially, people may be reluctant to share their personal information with researchers. The investigator tried to minimize this issue by establishing rapport with subjects and ensuring confidentiality for all information obtained from subjects. Nevertheless, the income data indicates that subjects may have had some reluctance to report real income levels. In future studies, investigators should explore various ways to improve accuracy of sensitive self-report data such as income. For example, investigators may bring a ballot box so that participants drop their self reported questionnaires in the box directly. Furthermore, qualitative research approaches may also be helpful to clarify this issue.

Fourthly, the design of this study was cross-sectional. In order to confirm directionality of relationships between identified risk factors and physiological variables, longitudinal studies should be conducted.

Fifthly, there are many other factors that influence blood pressure and arterial stiffness. For example, exercise and diet are very important risk factors of cardiovascular diseases; however, this study did not include those variables. In order to examine independent effects of identified predictors on blood pressure and arterial stiffness, further studies are recommended to include other important factors and control them in multivariate analysis.

Conclusion

This study explored the associations among stressors (acculturation and time in the U.S.), psychobehavioral responses (psychological stress, chronic active coping, stress emotions - anger, anxiety, and depression), and physiological responses (BP and arterial stiffness) in 102 Korean Americans.

Acculturation was not related to time in the U.S. in this Korean American sample. Korean Americans may have higher perceived stress, anger, and depression than other racial groups. Korean Americans in this sample also had low chronic active coping when compared with other Asian groups and European and African Americans.

This was the first study to evaluate arterial stiffness in Korean Americans. AI_75 was significantly and positively associated with cfPWV and DBP but not with SBP, suggesting that cfPWV and peripheral DBP reflect central hemodynamic activities better than peripheral SBP. Korean Americans may have similar or slightly higher arterial stiffness measured by cfPWV and AI_75 than other racial groups.

Findings confirmed that age and mean arterial pressure (MAP) were the major determinants of arterial stiffness as measured by cfPWV and AI_75. As age increases, arteries lose elastic properties and become stiffer. Nevertheless, when these two important variables (age and MAP) are controlled, state anger and state & trait anxiety significantly and independently predicted levels of cfPWV. Since anger and anxiety were not related to increased BP, arterial stiffness may be the pathway by which anger and anxiety contribute to development of hypertension and CVD. Gender was a significant and independent predictor of AI_75, showing that women had about a 10% higher AI_75 than men. After controlling age, MAP, and gender, perceived stress significantly predicted AI_75.

Finally, age was no longer a significant predictor of SBP and DBP when cfPWV was controlled. Since age is an independent predictor of cfPWV, age-associated increase of BP reported in previous studies may actually be the effect of age-associated increase of PWV on BP. When cfPWV and gender were controlled, education level significantly predicted SBP and DBP.

In summary, this study showed that Korean Americans in this study had high perceived stress, anger, and depression and they may have higher arterial stiffness measured by cfPWV and AI_75 than other racial groups. This study also demonstrated that perceived stress, state anger, and state & trait anxiety are significant and independent predictors of arterial stiffness, after adjusting age, MAP, and gender.

Implication for Clinical Practice

The study findings revealed that those who had low acculturation status had high psychological stress, anger, anxiety, and depressive symptoms. The study also showed that this sample of Korean Americans had high perceived stress, anger and depression. These findings suggest that health providers may need to assess immigrants for psychological health condition. Patients who have high levels of psychological stress or stress emotions should be referred to mental health care providers or community health service. Since many immigrants have a language barrier and difficulties in using health service, it is recommended that health facilities either hire interpreters or seek volunteers who will work as interpreters.

It is also important to identify people with CVD risk and intervene to reduce those risks at an early stage. Patients who have high psychological stress and stress emotions may have high risk for CVD. This study supports the need of regular assessment of arterial stiffness, especially for vulnerable population such as immigrants. Because of the predictive value of arterial stiffness for hypertension and CVD morbidity and mortality, clinicians should consider arterial stiffness as a measure of CVD risk in clinical practice (Barksdale & Logan, 2009; Crilly, Coch, Bruce, Clark, & Williams, 2007; Van Bortel, 2006).

Directions for Future Research

The lack of a relationship between acculturation and time in the U.S. indicate that Korean Americans in this sample may have difficulty in acculturation to American culture. Since low acculturation was significantly related to psychological stress and stress emotions, further studies are needed to explore cultural factors and individual characteristics that may hinder the acculturation process in Korean Americans. Studies to develop culturally sensitive interventions are also recommended to reduce psychological stress, anger, anxiety, and depression in Korean American immigrants.

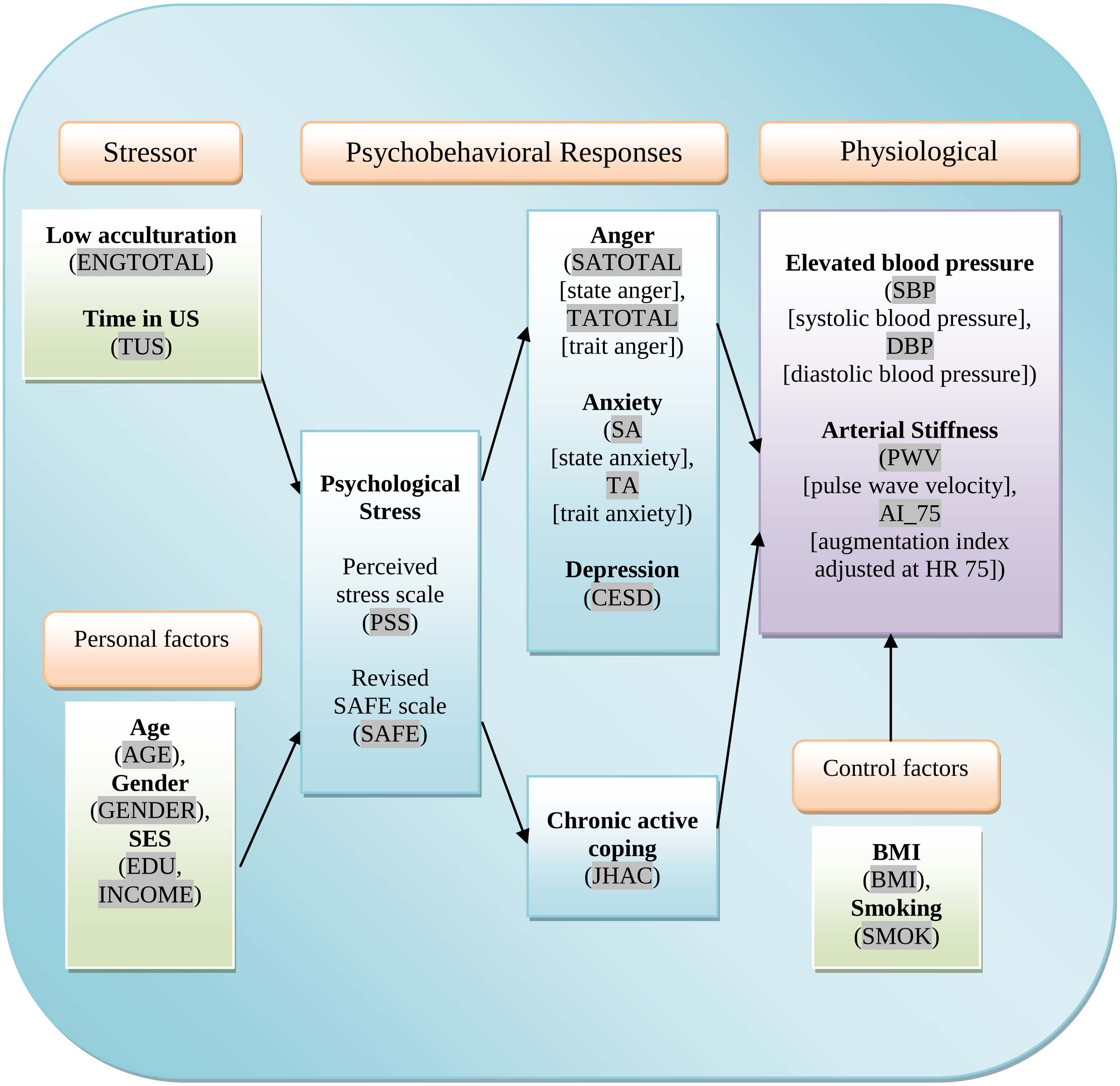
Direct comparisons between levels of arterial stiffness in this and previous studies were difficult because several different methods were used to measure arterial stiffness across studies. Studies are recommended to compare arterial stiffness in Korean

Americans and different racial groups. Including different racial groups in one study will allow researchers to control confounding factors such as BP and height in comparing arterial stiffness.

Since anger and anxiety were not directly related to an increase of BP in this study, perhaps arterial stiffness may be the pathway by which anger and anxiety contribute to the development of hypertension. Longitudinal studies are required to clarify these relationships. Furthermore, future investigators are encouraged to examine specific mechanisms by which psychological stress and stress emotions are implicated in the pathological process of arterial stiffness.

Studies conducted to explore psychological factors and arterial stiffness for Korean Americans, an understudied group, will not only provide information on psychological and physiological health of this population, but also increase knowledge of the links among psychological factors and arterial stiffness. Furthermore, these studies will benefit public health by informing future intervention studies for stress relief and early detection and/or reduction of arterial stiffness to prevent hypertension and CVD.

Appendix A: Conceptual Framework with Variable IDs



Appendix B: Demographic Information Form

DIF
ID # ______________
Date ______________

1. Date of birth : ______/_______/_______ (day/month/year)

2. Sex : ______ Male / _____ Female

3. How many years have you been in the United States? _______ Years

4. The highest level of education that you have completed

_____No education
_____Elementary School
_____Middle School
_____High School
_____College (less than 4years)
_____ University (4years)
_____Graduate School

5. Marital status:

_____ married, living with spouse
_____ married, separated
_____ single, living alone
_____ single, living with someone
_____ single, recently widowed (2 years)

6. Occupation : ________________

7. How many family members do you have? __________

8. What is the total combined income of your household for the year?

_____Less than $4,999
_____$5,000 through $9,999
_____$10,000 through $24,999
_____$25,000 through $49,999
_____$50,000 through $74,999
_____$75,000 through $99,999
_____$100,000 and greater

9. Are you smoking currently? Yes ___(go to 10) / No__(skip 10 and 11, then go to 12)

10. How many years have you smoked? _______ Years

11. On average, how much do you smoke?
    1) less than one pack (i.e. 20 cigarettes) per week
    2) 1 or more but less than 4 packs per week
    3) 4 or more but less than 7 packs per week
    4) 7 or more packs per week

12. Have you smoked in the past? Yes_____ (go to 13)
No_____ (You have finished this questionnaire)

13. How many years had you smoked? _______ Years

14. On average, how much did you smoke?
    1) less than one pack (i.e. 20 cigarettes) per week
    2) 1 or more but less than 4 packs per week
    3) 4 or more but less than 7 packs per week
    4) 7 or more packs per week

Demographic Information Form (Korean)

DIF
ID # ______________
Date ______________

1. 생년월일 : ______/_______/_______ (일/달/년)

2. 성별 : ______ 남자 / _____ 여자

3. 몇 년간 미국에 사셨습니까? _______ 년

4. 학력이 어떻게 되십니까?

_____교육을 받은 적이 없다

_____초등학교

_____중학교

_____고등학교

_____전문대학

_____ 4년제 대학

_____대학원

5. 결혼 상태는 어떻게 되십니까?

____ 결혼 했고 배우자와 함께 살고 있다

____ 결혼 했었지만 지금은 따로 살거나, 별거중이거나 이혼을 한 상태이다

____ 미혼이고 혼자 살고 있다

____ 미혼이고 친척이나 룸메이트와 함께 살고 있다

____ 결혼 했었지만 사별한지 2 년 이하이다

6. 직장이 무엇입니까? _______________

7. 가족이 몇명이나 되십니까? _______________ 명

8. 가계의 일년 수입이 어떻게 되십니까 (가족들의 수입의 총합)?

_____ $4,999 이하
_____$5,000 에서 $9,999
_____$10,000 에서 $24,999
_____$25,000 에서 $49,999
_____$50,000 에서 $74,999
_____$75,000 에서 $99,999
_____$100,000 이상

9. 현재 담배를 피십니까? 예 ____ (10 번으로 가십시오)
아니오 ___ (10, 11 번을 건너뛰고, 12 번으로 가십시오)

10. 몇 년동안 담배를 피신 상태입니까? ______ 년

11. 평균 얼마나 담배를 피십니까?
1) 일주일에 1 팩 (20 개피) 이하
2) 일주일에 1 팩에서 4 팩
3) 일주일에 4 팩에서 7 팩
4) 일주일에 7 팩 이상

12. 과거에 담배를 피신적이 있으십니까? 예___ (13 번으로 가십시오)
아니오___ (본 설문지를 마치셨습니다)

13. 과거에 몇 년동안 담배를 피셨습니까? ______ 년

14. 평균 얼마나 담배를 피셨습니까?
1) 일주일에 1 팩 (20 개피) 이하
2) 일주일에 1 팩에서 4 팩
3) 일주일에 4 팩에서 7 팩
4) 일주일에 7 팩 이상

Appendix C: Bidimentional Acculturation Scale

BAS
ID # _____________
Date _____________

1. How well do you speak English?

   Very well ___ Well ___ Not well ___ Not at all ___

2. How often do you use English?

   Always ___ Often ___ sometimes ___ Not at all ___

3. Among the TV programs or Videos you watch, how many of them are spoken in English?

   Almost ___ More than half ___ A little ___ Not at all ___

4. Among the newspapers or magazines you read, how many of them are written in English?

   Almost ___ More than half ___ A little ___ Not at all ___

5. Among the food you eat at home, how much is not Korean food?

   Almost ___ More than half ___ A little ___ Not at all ___

6. Among the food you eat out of home, how much is not Korean food?

   Almost ___ More than half ___ A little ___ Not at all ___

7. Among the people you get along with, how many of them are not Korean?

   Almost ___ More than half ___ A little ___ Not at all ___

8. How often do you attend meetings or parties with are not Korean?

Almost ___ More than half ___ A little ___ Not at all ___

9. Do you feel homogeneity with Americans?

Very much ___ Maybe ___ Maybe not ___ Not at all ___

10. Do you become intimate with Americans?

Very much ___ Maybe ___ Maybe not ___ Not at all ___

11. How familiar are you with American heritage?

Very much ___ Maybe ___ Maybe not ___ Not at all ___

12. How often do you celebrate American holidays such as Independent Day or Thanksgiving?

Always ___ Often ___ Sometimes ___ Not at all ___

Bidimentional Acculturation Scale

BAS
ID # ____________
Date ____________

아래에 적혀 있는 문항을 잘 읽으신 후, 자신의 상태를
가장 잘 나타낸다고 생각되는 대답에 V표 하시기 바랍니다.

1. 영어를 얼마나 잘 하십니까?

☐ 매우 잘 한다 ☐ 잘 하는 편이다 ☐ 별로 잘 하지 못한다 ☐ 전혀 못한다

2. 영어를 얼마나 자주 쓰십니까?

☐ 항상 쓴다 ☐ 자주 쓴다 ☐ 가끔 쓴다 ☐ 전혀 쓰지 않는다

3. 보시는 텔레비젼 프로나 비디오 중 영어로 된 것들이 얼마나 됩니까?

☐ 대부분 ☐ 절반 이상 ☐ 약간 ☐ 전혀 없다

4. 보시는 신문이나 잡지 중 영어로 된 것들이 얼마나 됩니까?

☐ 대부분 ☐ 절반 이상 ☐ 약간 ☐ 전혀 없다

5. 집에서 드시는 음식 중 한국 음식이 아닌 다른 나라 음식이 얼마나 됩니까?

☐ 대부분 ☐ 절반 이상 ☐ 약간 ☐ 전혀 없다

6. 집 밖에서 드시는 음식 중 한국 음식이 아닌 다른 나라 음식이 얼마나 됩니까?

☐ 대부분 ☐ 절반 이상 ☐ 약간 ☐ 전혀 없다

7. 어울려 지내는 이들 중 외국 사람이 얼마나 됩니까?

☐ 대부분 ☐ 절반 이상 ☐ 약간 ☐ 전혀 없다

8. 외국 사람들과 어울리는 모임이나 잔치에 자주 참여하시는지요?

☐ 매우 자주 ☐ 자주 ☐ 가끔 ☐ 전혀 참여하지 않는다

9. 미국 사람들과 동질감을 느끼십니까?

☐ 매우 그렇다 ☐ 그런 편이다 ☐ 별로 그렇지 않다 ☐ 전혀 그렇지 않다

10. 미국 사람들과 잘 통하십니까?

☐ 매우 그렇다 ☐ 그런 편이다 ☐ 별로 그렇지 않다 ☐ 전혀 그렇지 않다

11. 미국 문화와 전통에 얼마나 친숙하십니까?

☐ 매우 그렇다 ☐ 그런 편이다 ☐ 별로 그렇지 않다 ☐ 전혀 그렇지 않다

12. 땡스기빙이나 독립 기념일과 같은 미국 명절이나 기념일을 자주 지내십니까?

☐ 항상 ☐자주 ☐가끔 ☐전혀 지내지 않는다

Appendix D: Perceived Stress Scale

PSS
ID # _____________
Date _____________

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, please indicate with a check how often you felt or thought a certain way.

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

1. In the last month, how often have you been upset because of something that happened unexpectedly?

2. In the last month, how often have you felt that you were unable to control the important things in your life?

3. In the last month, how often have you felt nervous and "stressed"?

4. In the last month, how often have you felt confident about your ability to handle your personal problems?

5. In the last month, how often have you felt that things were going your way?

6. In the last month, how often have you found that you could not cope with all the things that you had to do?

7. In the last month, how often have you been able to control irritations in your life?

8. In the last month, how often have you felt that you were on top of things?

9. In the last month, how often have you been angered because of things that were outside of your control?

10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

Perceived Stress Scale (Korean)

PSS
ID # ______________
Date ______________

아래에 적혀 있는 문항을 잘 읽으신 후, 지난 달 당신께서 느끼시고 행동하신 것을 가장 잘 나타낸다고 생각되는 숫자에 O 표 하시기 바랍니다.

	나는 지난 달…	결코 그런 적이 없다	거의 그런 적이 없다	때때로 그랬다	자주 그랬다	매우 자주 그랬다
1	예견치 못한 일들이 일어나는 바람에 좀 화가 났었다.					
2	나의 인생에서 중요한 일들을 통제할 수 없다고 느꼈다.					
3	신경이 곤두서고 스트레스를 받았다.					
4	나의 개인적인 일들을 잘 다룰 수 있을 것 같다는 자신감을 느꼈다.					
5	일들이 잘 진행되는 것처럼 느꼈다.					
6	해야 할 일들에 잘 대처할 수 없다고 느꼈다.					
7	나의 인생에서 귀찮은 일들을 잘 통제할 수 있다고 느꼈다.					
8	나의 일들을 미루지 않고 아주 잘 해나가고 있다고 느꼈다 .					
9	내가 통제할 수 없는 일들 때문에 화가 났었다.					
10	내가 극복할 수 없을 정도로 어려운 일들이 싸인다고 느꼈다.					

Appendix E: Acculturative Stress scale

ASS
ID # ____________
Date ____________

0= have not experienced/ not at all stressful…
1= a little stressful…
2= moderately stressful…
3= very stressful…

1) I feel uncomfortable when others make jokes about or put down people of my ethnic background.

2) I have more barriers to overcome than most people.

3) It bothers me that family members I am close to do not understand my new values.

4) Close family members have different expectations about my future than I do.

5) It is hard to express to my friends how I really feel.

6) My family does not want me to move away but I would like to.

7) It bothers me to think that so many people use drugs.

8) It bothers me that I cannot be with my family.

9) In looking for a good job, I sometimes feel that my ethnicity is a limitation.

10) I don't have any close friends.

11) Many people have stereotypes about my culture or ethnic group and treat me as if they are true.

12) I don't feel at home.

13) People think I am unsociable when in fact I have trouble communicating in English.

14) I often feel that people actively try to stop me from advancing.

15) It bothers me when people pressure me to become part of the main culture.

16) I often feel ignored by people who are supposed to assist me.

17) Because I am different I do not get enough credit for the work I do.

18) It bothers me that I have an accent.

19) Loosening the ties with my country (or family ethnic background) is difficult.

20) I often think about my cultural background.

21) Because of my ethnic background, I feel that others often exclude me from participating in their activities.

22) It is difficult for me to "show off" my family.

23) People look down upon me if I practice customs of my culture.

24) I have trouble understanding others when they speak.

Acculturative Stress scale (Korean)

ASS
ID # ____________
Date ____________

다음의 문장을 읽고 그것이 자기에게
얼마만큼의 스트레스를 주는 지에 대해 해당하는 칸에 V표시를 하세요.

	경험한 적이 없거나 전혀 스트레스를 주지 않는다	조금 스트레스를 준다.	스트레스를 준다.	매우 스트레스를 준다.
1. 다른 사람이 한국 문화를 가진 사람들에 대해 농담하거나 무시할때 나는 마음이 불편하다.				
2. 나는 대부분의 사람들보다 극복해야할 장애물들을 더 많이 가지고 있다.				
3. 내가 가까이 지내는 가족들이 내가 새롭게 배우고 있는 미국 문화의 가치를 이해하지 못할때 나는 짜증이 난다.				
4. 가까운 가족들은 내 미래에 대해서 내가 가지고 있는 것과 다른 기대를 가지고 있다.				
5. 내가 정말 어떻게 느끼는지를 내 친구들에게 표현하는 것은 힘든 일이다.				
6. 내 가족들은 내가 멀리 떨어져 사는 것을 원하지 않지만 나는 그렇게 하고 싶다.				
7. 많은 사람들이 불법적인 약을 사용한다는 것을 생각하면 괴롭다.				

	경험한 적이 없거나 전혀 스트레스를 주지 않는다	조금 스트레스를 준다.	스트레스를 준다.	매우 스트레스를 준다.
8. 가족들과 함께 있지 못하는 것이 나를 힘들게 한다.				
9. 좋은 직장을 찾으려 할 때, 나는 종종 내가 한국인이라는것이 한계라고 느낀다.				
10. 나는 절친한 친구들이 아무도 없다.				
11. 많은 사람들이 한국 문화에 대한 전형적인 편견을 가지고 자기가 생각하는 것이 맞는 것처럼 나를 대한다.				
12. 나는 내 집에 있는 것처럼 느껴지지 않는다.				
13. 사람들은 내가 사교성이 없다고 하지만 사실은 내가 영어로 대화하는것에 어려움을 가지고 있기 때문이다.				
14. 나는 종종 사람들이 내가 발전해 나가는 것을 막으려고 하는 것 같다.				
15. 사람들이 나보고 미국 문화에 속해야 한다고 나를 다그치면 나는 짜증이 난다.				
16. 나는 종종 나를 도와주도록 되어 있는 사람들이 나를 무시하고 있다고 느낀다.				
17. 내가 다른 사람들과 틀리기 때문에 나는 내가 하는 일에 대해 충분한 신용이나 신뢰를 받지 않는다.				

	경험한 적이 없거나 전혀 스트레스를 주지 않는다	조금 스트레스를 준다.	스트레스를 준다.	매우 스트레스를 준다.
18. 내가 한국어 억양으로 영어를 하는 것 때문에 괴롭다.				
19. 내가 내 나라, 가족의 문화적 배경으로부터 벗어나는 것은 힘든일이다.				
20. 나는 나의 문화적 배경에 대해 종종 생각한다.				
21. 나는 나의 민족적 배경 때문에 다른 사람들이 종종 나를 자신들의 활동에 참여하는 것으로부터 배제시킨다고 느낀다.				
22. 나의 가족들을 사람들에게 보이고 자랑하는 것은 내게 어려운 일이다.				
23. 내가 내 문화적 관습을 행할 때 사람들은 나를 깔본다.				
24. 다른 사람들이 영어로 얘기할 때 그들이 말하는 것을 이해하는 것에 어려움을 가진다.				

Appendix F: John Henryism Active Coping Scale

JHAC 12
ID # _____________
Date _____________

The questions below concern how you see yourself, Today, as a person living and doing things in the real world. Read each QUESTION CAREFULLY and then write the number of the response which best describes how you feel on the line next to the item number for each question. Each person is different, so there are no “RIGHT” or “WRONG” answers. We would simply like an honest appraisal of how you generally see yourself.

For each of the following statements, please select one of these responses:

1 = completely false   2 = somewhat false   3 = neutral
4 = somewhat true   5 = completely true

_____ 1. I’ve always felt that I could make of my life pretty much what I wanted to make of it

_____ 2. Once I make up my mind to do something, I stay with it until the job is completely done

_____ 3. I like doing things that other people thought could not be done

_____4. When things don’t go the way I want them to, that makes me work even harder.

_____5. Sometimes I feel if anything is going to be done right, I have to do it myself.

_____6. It’s not always easy, but I manage to find a way to do the things I really need to get done

_____7. Very seldom have I been disappointed with the results of my work.

_____8. I feel that I am the kind of individual who stands up for what she believes in, regardless of the consequences.

_____9. In the past, even when things got really tough, I never lost sight of my goals

_____10. It’s important for me to be able to do things in the way I want to do them rather than the way other people want me to do them

_____11. I don’t let my personal feelings get in the way of doing a job.

_____12. Hard work has really helped me to get ahead in life.

John Henryism Active Coping Scale (Korean)

JHAC 12
ID # ______________
Date ______________

아래에 적혀 있는 문항을 잘 읽으신 후, 평소 때 당신이 느끼시는 것을 가장 잘 나타낸다고 생각되는 칸에 O 표 해 주세요.
옳고 그른 답은 없으니 그냥 본인께서 느끼시는 대로 솔직하게 답해 주세요.

		전혀 그렇지 않다	거의 그렇지 않다	보통 이다	좀 그런 편이다	정말 그렇다
1	내 인생은 거의 내가 마음 먹은 대로 되어진다고 느낀다.					
2	나는 어떤 것을 하기로 한번 마음을 먹으면 그 일이 끝날 때까지 그것을 한다.					
3	나는 다른 사람들이 생각하기에는 좀 힘들겠지 생각하는 것들을 하는 것을 좋아한다.					
4	일이 내가 생각했던 것처럼 잘 안 풀리면 나는 더 열심히 그 일을 해결하려고 한다.					
5	때때로 나는 "일이 제대로 되려면 나 혼자서 하는 것이 낫다"라고 생각한다.					
6	때때로 힘들기도 하지만, 일이 되어야 하는 것은 결국 그 방법을 찾아 낸다.					
7	내 일의 결과에 대해서는 대부분의 경우 만족스럽다.					
8	나는 대체로 결과에 상관없이 내가 맞다고 생각하는 것을 지키고, 그 입장을 고수하는 편이다.					
9	과거에, 일들이 어렵게 진행되었어도 나는 언제나 내 목표를 잃지 않았다.					
10	나는 일을 할 때 다른 사람들이 원하는 방식보다 내가 원하는 방식으로 일을 할 수 있는 것이 중요하다.					
11	나는 일을 할 때 내 개인적인 감정으로 인해 내 일이 방해받도록 하지 않는다.					
12	힘든 일들은 나로 하여금 내가 인생에서 앞으로 나아가는 것에 정말 도움을 주었다.					

Appendix G: Center for Epidemiological Studies Depression Scale

CES-D
ID # _____________
Date _____________

The 20 items below refer to how you have felt and behaved during the last week. Please write the number of the response which best describes how often you felt on the line next to the item number for each question.

- **0 = Rarely or none of the time (<1 day)**
- **1 = Some or a little of the time (1-2 days)**
- **2 = Occasionally or a moderate amount of the time (3-4 days)**
- **3 = Most or all of the time (5-7 days)**

_____1. I was bothered by things that don't usually bother me.

_____2. I did not feel like eating; my appetite was poor.

_____3. I felt that I could not shake off the blues even with the help of my family or friends.

_____4. I felt that I was just as good as other people.

_____5. I had trouble keeping my mind on what I was doing.

_____6. I felt depressed.

_____7. I felt everything I did was an effort.

_____8. I felt hopeful about the future.

_____9. I thought my life had been a failure.

_____10. I felt fearful.

_____11. My sleep was restless.

_____12. I was happy.

_____13. I talked less than usual.

_____14. I felt lonely.

_____15. People were unfriendly.

_____16. I enjoyed life.

_____17. I had crying spells.

_____18. I felt sad.

_____19. I felt that people disliked me.

_____20. I could not get "going".

Center for Epidemiological Studies Depression Scale (Korean)

CES-D
ID # _____________
Date _____________

아래에 적혀 있는 문항을 잘 읽으신 후, 지난 1주 동안 당신께서 느끼시고 행동하신 것을 가장 잘 나타낸다고 생각되는 숫자에 O 표 하시기 바랍니다.

	나는 지난 1 주 동안…	극히 드물게 (1 일 이하)	가끔 (1-2 일)	자주 (3-4 일)	거의 언제나 (5-7 일)
1	평소에는 아무렇지도 않던 일들이 귀찮게 느껴졌다.				
2	먹고 싶지 않았다; 입맛이 없었다.				
3	가족이나 친구가 도와주더라도 울적한 기분을 떨쳐 버릴 수 없었다.				
4	다른 사람들만큼의 능력이 있다고 느꼈다.				
5	무슨 일을 하든 정신을 집중하기가 힘들었다.				
6	우울했다.				
7	하는 일마다 힘들게 느껴졌다.				
8	미래에 대하여 희망적으로 느꼈다.				
9	내 인생은 실패작이라는 생각이 들었다.				
10	두려움을 느꼈다.				
11	잠을 설쳤다; 잠을 잘 이루지 못했다.				
12	행복했다.				
13	평소보다 말을 적게 했다; 말수가 줄었다.				
14	세상에 홀로 있는 듯한 외로움을 느꼈다.				
15	사람들이 나에게 차갑게 대하는 것 같았다.				
16	생활이 즐거웠다.				
17	갑자기 울음이 나왔다.				
18	슬픔을 느꼈다.				
19	사람들이 나를 싫어하는 것 같았다.				
20	도무지 무엇을 시작할 기운이 나지 않았다.				

Appendix H: Collinearity Diagnostics Results

Collinearity Diagnostics (intercept adjusted) – Dependent variable : PWV

Number	*Eigenvalue*	*Condition Index*	*Proportion of Variation*					
			Age	*MAP*	*Time in U.S.*	*Acculturative stress*	*State anger*	*State and trait anxiety*
1	2.28724	1.00000	0.05208	0.04514	0.03427	0.05977	0.05657	0.05220
2	1.37986	1.28747	0.08425	0.09667	0.15946	0.02740	0.06191	0.08346
3	0.77717	1.71553	0.16521	0.05946	0.10017	0.42442	0.13037	0.03369
4	0.68200	1.83132	0.07902	0.79740	0.25785	0.01939	0.02000	0.00083945
5	0.51629	2.10480	0.47275	0.00133	0.41182	0.24453	0.20712	0.04190
6	0.35745	2.52957	0.14669	0.00000137	0.03643	0.22448	0.52403	0.78791

Collinearity Diagnostics (intercept adjusted) – Dependent variable : AI_75

Number	*Eigenvalue*	*Condition Index*	*Proportion of Variation*									
			Age	*Gender*	*MAP*	*Acculturation*	*Time in U.S.*	*Perceived stress*	*Acculturative stress*	*Chronic active coping*	*State anger*	*State anxiety*
1	3.15166	1.00000	0.01550	0.00040218	0.00657	0.02133	0.00383	0.02845	0.03164	0.02635	0.02725	0.02799
2	1.64601	1.38374	0.04300	0.05178	0.13817	0.01506	0.11498	0.02078	0.00065106	0.01274	0.00085345	0.00259
3	1.16173	1.64709	0.07129	0.36113	0.03035	0.00523	0.09132	0.02774	0.00146	0.00661	0.00054274	0.01406
4	1.02149	1.75652	0.08788	0.05205	0.00118	0.18837	0.05207	0.00007949	0.02059	0.00839	0.11129	0.04878
5	0.74811	2.05252	0.01139	0.02957	0.00042	0.00132	0.05329	0.03090	0.06008	0.64876	0.07833	0.03235
6	0.63748	2.22349	0.03891	0.00829	0.00617	0.11429	0.00025241	0.00355	0.77336	0.00309	0.06983	0.01926
7	0.57880	2.33348	0.00050757	0.03094	0.20548	0.00508	0.27259	0.38810	0.00263	0.22086	0.01673	0.00012068
8	0.40069	2.80458	0.02909	0.46231	0.57708	0.01701	0.02232	0.31518	0.07842	0.04899	0.11362	0.00005690
9	0.37510	2.89866	0.19831	0.000535	0.00205	0.19765	0.18971	0.18115	0.00500	0.00595	0.27086	0.41312
10	0.27894	3.36137	0.50414	0.00299	0.03252	0.43467	0.19964	0.00409	0.02616	0.01827	0.31069	0.44167

Collinearity Diagnostics (intercept adjusted) - Dependent variable : SBP									
Number	*Eigenvalue*	*Condition Index*	*Proportion of Variation*						
			PWV	*Gender*	*Education*	*Time in U.S.*	*Acculturative stress*	*State anger*	*State anxiety*
1	2.45237	1.00000	0.05252	0.00011417	0.04330	0.03009	0.03793	0.04997	0.04780
2	1.34665	1.34948	0.02933	0.00392	0.09166	0.17793	0.08757	0.04656	0.05682
3	1.07259	1.51208	0.05841	0.73621	0.03040	0.00589	0.00002777	0.00763	0.00000477
4	0.72677	1.83693	0.00401	0.01946	0.01229	0.02629	0.79320	0.12629	0.05491
5	0.61776	1.99244	0.65019	0.17066	0.29360	0.01163	0.03316	0.00926	0.01930
6	0.45554	2.32023	0.20485	0.00150	0.39972	0.64553	0.00065386	0.19587	0.00875
7	0.32833	2.73301	0.00068772	0.06814	0.12903	0.10263	0.04746	0.56442	0.81241

Collinearity Diagnostics (intercept adjusted) - Dependent variable : DBP							
Number	*Eigenvalue*	*Condition Index*	*Proportion of Variation*				
			PWV	*Gender*	*Education*	*Time in U.S.*	*Sate anxiety*
1	1.99626	1.00000	0.10196	0.00016352	0.10197	0.09456	0.05534
2	1.08339	1.35743	0.03904	0.67214	0.04355	0.01105	0.07111
3	0.90675	1.48376	0.00403	0.11423	0.00008430	0.17778	0.60395
4	0.59792	1.82720	0.68848	0.18686	0.32305	0.01249	0.02499
5	0.41568	2.19142	0.16650	0.02661	0.53134	0.70412	0.24461

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