

## 정서경험과 생체노화

백서채, 김종성

충남대학교병원 가정의학과

## The Effect of Emotional Experiences on Biological Aging

Seo Chae Paik, Jong Sung Kim

Department of Family Medicine, Chungnam National University Hospital, Daejeon, Korea

**Background:** This study was designed to investigate the effects of usual negative emotional experiences on biological aging progression of human.

**Methods:** A total of 237 subjects who visited the Health Promotion Center at Chungnam National University Hospital from May 2013 through September 2013 was enrolled. Each subject had been drawn up a structured questionnaire about usual experiences of depression, anxiety, anger, and anger expression. The degree of biological aging progression of each subject was computed by a specific formula which consisted of chronological age and biological age reflecting obesity and aging of main organs.

**Results:** Trait anger and low education level showed the significant correlations with biological aging ( $r=0.160$ ,  $P=0.014$ , and  $r=-0.189$ ,  $P=0.024$ , respectively). Trait anger and low education level solely displayed the significant  $R^2$ 's for biological aging in consequence of multivariate analyses;  $R^2=0.044$ ,  $P=0.020$ , and  $R^2=0.022$ ,  $P=0.038$ , respectively.

**Conclusions:** This study suggests that the significant relationship between usual anger experience (i.e., trait anger) and biological aging would be present. In addition, lower education level may be related with biological aging.

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**Keywords:** Aging, Anger, Education

### Introduction

The fight-or-flight response (also called 'hyperarousal' or 'the acute stress response') is a physiological reaction that occurs in response to a harmful event, attack, or threat to survival.<sup>1)</sup> Nowadays, level of individual social stress are gradually increased, thus the fight-or-flight responses are increased altogether. It signifies that humans are more likely to experience anger, anxiety, or depression. These negative

emotional experiences considerably affects the physiologic human system. Along with secretion of various hormones including adrenaline, sympathetic nervous system is activated and blood vessels are contracted. Consequently, both blood pressure and blood glucose level rise, thereby increasing circulating blood volume to muscles and decreasing to guts.<sup>2)</sup> Repeated these experiences could accelerate biological aging.

Previous studies reported adverse effects of anger on the human organism. Anger increases risks of coronary calcification, myocardial infarction, subclinical atherosclerosis, and coronary artery disease.<sup>3)</sup> Anger and hostility are significantly correlated with metabolic syndrome.<sup>4)</sup> Depression also negatively affects the human body. There is a significant association between depression and Parkinson's disease<sup>5)</sup> and a high

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■ Corresponding author : **Jong Sung Kim, MD, PhD**

Department of Family Medicine, Chungnam National University

Hospital, 282 Munhwa-ro, Jung-gu, Daejeon 35015, Korea

Tel: +82-42-280-7548, Fax: +82-42-280-7879

E-mail: jskim@cnuh.co.kr

prevalence of major depression disorder in cancer patients is reported.<sup>6)</sup> There are plenty of researches that anxiety has a biologically negative impact. The strong relationship between anxiety and metabolic syndrome<sup>7)</sup> and the increased risk of cardiovascular disease by anxiety disorders and panic disorder<sup>8)</sup> are reported.

However, above-mentioned studies are almost similar focusing the relationship between negative emotional experiences and particular diseases or medical findings only. Because the physiological impacts of negative emotional experiences may be connected with biological aging progression of human, association with the degree of biological aging progression of the human body and negative emotional experiences should be investigated.

Moreover, previous studies mostly used the Beck Depression Inventory (BDI),<sup>9)</sup> Beck Anxiety Inventory (BAI),<sup>10)</sup> Zung Self-Rating Depression Scale,<sup>11)</sup> Zung Self-Rating Anxiety Scale,<sup>12)</sup> Hamilton Depression Rating Scale,<sup>13)</sup> or Hamilton Anxiety Rating Scale<sup>14)</sup> for assessing the degree of depression or anxiety. Since these tools are used for screening or diagnosing depression or anxiety, these measures cannot fully reflect usual emotional experiences. Thus, the present study to investigate the relationship between negative emotional experiences and biological aging using structured questionnaire about usual experiences of depression, anxiety, anger, and anger expression.

## Methods

### 1. Study participants and period

This study is a cross-sectional study to investigate the relationship between biological aging and emotional experience of anxiety, depression, anger, and anger expression. A total of 300 subjects who visited the Health Promotion Center at the Chungnam National University Hospital in Daejeon from May 2013 through September 2013. The study was approved by the Chungnam National University Hospital Institute Review Board, and written informed consent was obtained from all participants or their legal guardians. All clinical investigations were conducted according to the principles of the Declaration of Helsinki.

All participants had been drawn up respective structured questionnaires: 63 subjects who missed more than one item or question of questionnaires were excluded from analyses and finally 237 subjects were enrolled in this study.

### 2. Instruments

The questionnaire contains measurements to assess each emotional experiences.

#### 1) Questionnaire for demographics and faith

Socio-biological demographic variables of subjects were sex, age, body mass index (BMI), education level, monthly household gross income, weekly alcohol use, faith level, weekly exercise, smoking, and family function index by adaptability, partnership, growth, affection, and resolve (APGAR) score. Faith level of each subject was categorized by scoring 'no or little' as zero point, 'a little' one point, 'moderate' two points, and 'a lot' three points (Supplementary questionnaire 1). Comprehensive health screening records were also included in the questionnaire.

#### 2) Trait depression inventory

The State-Trait Depression Inventory was developed in 1999 for the purpose of assessing the degree of usual depression by Spielberger and Reheiser.<sup>15)</sup> The Trait Depression Inventory was applied in the current survey, separated from the Korean adaptation of State-Trait Depression Inventory (STDI-K) developed by Lee et al.<sup>16)</sup> This tool consists of twenty questions which describe emotions and physiological and psychological symptoms. Each question is composed of four-point scale from 'not at all' (one point) to 'very yes' (four points). The reliability coefficient (Cronbach's alpha [ $\alpha$ ]) was 0.822 in this study and it was reported as 0.90 by Lee et al.<sup>16)</sup> (Supplementary questionnaire 2).

#### 3) Trait anxiety inventory

The State-Trait Anxiety Inventory was developed in 1970 for estimating the degree of usual anxiety by Spielberger et al.<sup>17)</sup> The Trait Anxiety Inventory was used in the present study, exacted from the Korean adjustment of State-Trait Anxiety Inventory application developed by Kim.<sup>18)</sup> This tool consists of twenty questions and each question is composed of four-point scale from 'not at all' (one point) to 'very yes' (four points). Lee et al. applied this adjusted inventory to their study and reported that the Cronbach's  $\alpha$  was 0.884.<sup>18,19)</sup> In this research, the reliability coefficient was 0.800 (Supplementary questionnaire 3).

#### 4) Trait anger inventory

The State-Trait Anger Expression Inventory (STAXI) was developed in 1988 for evaluating the degree of usual anger by Spielberger and Sydeman.<sup>20)</sup> The Trait Anger Inventory was utilized in this paper, selected from the Korean adaptation of State-Trait Anger Expression Inventory (STAXI-K) adapted by Hahn et al.<sup>21)</sup> This tool is made up of two categories which are angry temperament and angry reaction. The former involves a tendency to experience anger in general, while the latter contains when angry is provoked. Five questions make up each category. Each question is composed of four-point scale from 'not at all' (one point) to 'very yes' (four points). In the present research, the Cronbach's  $\alpha$ 's were 0.713 in angry temperament and 0.805 in angry reaction (the calculated Cronbach's  $\alpha$ 's were 0.79 and 0.75 respectively, reported by Hahn et al.<sup>21)</sup>) (Supplementary questionnaire 4).

#### 5) Anger expression inventory

Anger Expression Inventory in the STAXI, the tool to assess the pattern and frequency of anger expression, consists of the three items of anger-in, anger-out, and anger-control. Each item has eight questions and each question is composed of four-point scale from 'not at all' (one point) to 'very yes' (four points). The sum of responses of these three items, a total of 24 questions, is the frequency of anger expression. The Anger Expression Inventory was used in the current survey, parted from the STAXI-K likewise. In this paper, the Cronbach's  $\alpha$ 's were 0.676 in anger-in, 0.716 in anger-out, and 0.709 in anger-control (the computed Cronbach's  $\alpha$ 's were 0.73, 0.74, and 0.81 respectively, reported by Hahn et al.<sup>21)</sup>) (Supplementary questionnaire 5).

#### 6) Biological aging

Biological aging was calculated by means of a conversion formula as the below-described.

$$\text{Biological aging (\%)} = \frac{(\text{biological age} - \text{chronological age})}{\text{chronological age}} \times 100$$

The factor 'biological age' was developed in Mediage Inc. (Seongnam, Korea) and listed in an international journal in the Science Citation Index class, which reflects obesity and aging of the main organs-heart, lungs, liver, pancreas, and kidneys.<sup>22,23)</sup>

The formula to compute biological age consists of the be-

low-mentioned variables: BMI, body fat (%), body muscle (%), waist circumference, waist-hip ratio (WHR), systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse pressure, forced expiratory volume in one second (FEV1), forced vital capacity (FVC), total protein, albumin, albumin-globulin ratio (AGR), total bilirubin, direct bilirubin, alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase, gamma-glutamyl transpeptidase, total cholesterol, triglyceride, high-density lipoprotein, low-density lipoprotein, homocysteine, lactate dehydrogenase, serum creatine phosphokinase, fasting blood sugar level, glycated haemoglobin, amylase, blood urea nitrogen, serum creatinine, and creatinine clearance.

### 3. Statistics

Chi-square or Fisher's exact tests were used to compare for categorical variables, *t*-tests for normal distribution, and Kruskal-Wallis tests for non-normal distribution of continuous variables to compare the demographic variables. One-way analysis of variance (ANOVA) and correlation analyses were used to compute the relationships among general characteristics (age, sex, BMI, education level, monthly household gross income, faith level, smoking, weekly exercise, weekly alcohol use, and family function index), emotional experiences, and biological aging. Stepwise multiple regression analyses were performed to estimate the coefficients of determination of general characteristics and emotional experiences for biological aging. The SPSS version 18.0 (SPSS Inc., Chicago, IL, USA) was used for all statistical analyses. The statistical significance level was less than 0.05.

## Results

### 1. General characteristics and emotional experiences

The mean age of subjects was 52.8±10.8 years old, and the middle-aged were the most common group in this study (Table 1). Men was slightly more than women in number and the ratio of male to female was 53.2:46.8. The mean BMI was 24.0±3.3 kg/m<sup>2</sup>. The mean weekly exercise 92.9±138.4 minutes. The mean family function index was 6.4±2.4. In faith level, 'no or little' was 37.1%, 'a little' 30.4%, 'moderate' 10.5%, and 'a lot' 10.1%. More than a

half of subjects answered 'no or little' or 'a little'. In education level, 'under elementary school graduation' was 1.3%, 'elementary school graduation' 11.0%, 'middle school graduation' 15.2%, 'high school graduation' 24.5%, and 'college or university graduation' 48.1%. Most subjects of this study were well-educated.

In monthly household gross income (won), 'under  $1 \times 10^6$ ' was 11.4%, 'more than  $1 \times 10^6$  and less than  $3 \times 10^6$ ' 26.6%, 'more than  $3 \times 10^6$  and less than  $5 \times 10^6$ ' 29.1%, and 'more than

$5 \times 10^6$ ' 32.9%. Subjects were generally evenly distributed. In smoking, 'non-smoker' was 61.6%, 'past (not present) smoker' 19.4%, and 'present smoker' 19.0%, implying non-smoker group was majority. The mean weekly alcohol use (standard drink) of subjects was  $5.3 \pm 11.0$  standard drinks (1 standard drink was considered as alcohol 14 g). The means of trait depression, trait anxiety, trait anger, and anger expression were  $20.7 \pm 5.2$ ,  $41.3 \pm 9.5$ ,  $19.9 \pm 5.3$ , and  $48.1 \pm 7.1$ , respectively (Table 1).

**Table 1.** General characteristics and emotional experiences

Characteristic	Value
Sex	
Male	126 (53.2)
Female	111 (46.8)
Age, y	$52.8 \pm 10.8$
BMI	$24.0 \pm 3.3$
Education level	
<Elementary school	3 (1.3)
Elementary school	26 (11.0)
Middle school	36 (15.2)
High school	58 (24.5)
$\geq$ College or university	114 (48.1)
Monthly household gross income ( $10^6$ won)	
<1	27 (11.4)
$1 \leq N < 3$	63 (26.6)
$3 \leq N < 5$	69 (29.1)
$\geq 5$	78 (32.9)
Faith level	
No or little	88 (37.1)
A little	72 (30.4)
Moderate	25 (10.5)
A lot	24 (10.1)
Smoking	
Non-smoker	146 (61.6)
Past smoker	46 (19.4)
Present smoker	45 (19.0)
Weekly exercise, min	$92.9 \pm 138.4$
Weekly alcohol use (standard drink <sup>a</sup> )	$5.3 \pm 11.0$
Family function index	$6.4 \pm 2.4$
Trait depression	$20.7 \pm 5.2$
Trait anxiety	$41.3 \pm 9.5$
Trait anger	$19.9 \pm 5.3$
Anger expression	$48.1 \pm 7.1$

Abbreviation: BMI, body mass index.

Values are presented as number (%) or mean  $\pm$  standard deviation.

<sup>a</sup>A standard drink=alcohol 14 g.

## 2. The relationships among general characteristics, emotional experiences and biological aging

Education level showed significantly negative correlation with biological aging ( $r = -0.189$ ,  $P = 0.024$ ), and trait anger showed significantly positive correlation with biological aging ( $r = 0.160$ ,  $P = 0.014$ ) (Table 2). In subgroup analysis of sex, there were no significant correlations between education level and biological aging in male ( $r = -0.152$ ,  $P = 0.101$ ) and female ( $r = -0.143$ ,  $P = 0.120$ ) (Table 3). In addition, there were no significant correlations between trait anger and biological aging in male ( $r = 0.152$ ,  $P = 0.101$ ) and female ( $r = 0.133$ ,  $P = 0.146$ ). With age stratification, a significant correlation between education level and biological aging only in 50's was observed ( $r = -0.290$ ,  $P = 0.010$ ) but the others did not show. Age group of 30's showed a significant correlation between trait anger and biological aging ( $r = 0.383$ ,  $P = 0.018$ )

**Table 2.** The relationships among general characteristics, emotional experiences, and biological aging<sup>a</sup>

Variable	<i>r</i>	<i>P</i>
Age	-0.054	0.404
Education level <sup>b</sup>	-0.189	0.024
Monthly household gross income <sup>b</sup>	-0.123	0.424
Faith level <sup>b</sup>	0.018	0.612
Weekly exercise	-0.110	0.066
Weekly alcohol use	-0.005	0.944
Family function index	0.024	0.711
Trait depression	-0.026	0.689
Trait anxiety	0.053	0.414
Trait anger	0.160	0.014
Anger expression	0.015	0.816

All variables were calculated by Pearson correlation analyses.

<sup>a</sup>Biological aging (%) =  $\{(\text{biological age} - \text{chronological age}) / \text{chronological age}\} \times 100$ .

<sup>b</sup>Converted into dummy variables.

but the other groups did not show. However, other variables of sex, monthly household gross income, faith level, age, smoking, weekly alcohol use, weekly exercise, family function index, trait depression, trait anxiety, and anger expression did not showed significant correlation with biological aging (Table 2).

**Table 3.** Subgroup analysis on relationships among general characteristics, emotional experiences and biological aging<sup>a</sup>

Variable	<i>r</i>	<i>P</i>
Education level <sup>b</sup>	-0.189	0.024
Sex		
Male	-0.152	0.101
Female	-0.143	0.120
Age		0.072
30's	-0.121	0.470
40's	0.014	0.929
50's	-0.290	0.010
60's	0.089	0.468
70's	-	-
Trait anger <sup>b</sup>	0.160	0.014
Sex		
Male	0.152	0.101
Female	0.133	0.146
Age		
30's	0.383	0.018
40's	0.128	0.409
50's	0.174	0.130
60's	-0.067	0.583
70's	0.404	0.281

<sup>a</sup>Biological aging (%)=((biological age-chronological age)/chronological age)×100.

<sup>b</sup>Calculated by Pearson correlation analyses.

### 3. Coefficients of determination of general characteristics and emotional experiences for biological aging

Simple linear regression analysis was performed. Trait anger and education level only showed the significant coefficients of determination ( $R^2$ s) for biological aging (Table 4). The  $R^2$ s of trait anger and education level were 0.044 and 0.022 respectively. However, sex, monthly household gross income, faith level, smoking, weekly alcohol use, and weekly exercise had no significant  $R^2$  for biological aging. Multiple stepwise linear regression analysis was performed adjusting age, sex, body mass index, monthly household gross income, faith level, smoking, weekly exercise, and weekly alcohol use. This model was suitable to show relationship between emotional experiences and biological aging ( $R^2=0.206$ ,  $P=0.027$ ). In this analysis, education level significantly and negatively affected the biological aging ( $\beta=-0.588$ ,  $P=0.038$ ). However, trait anger showed the positive influence on biological aging ( $\beta=0.168$ ,  $P=0.020$ ).

## Discussion

The present study was designed to investigate the association between usual emotional experiences and biological aging. This study demonstrated that education level showed significantly negative correlation with biological aging and trait anger showed significantly positive correlation with biological aging.

Trait anger means the tendency of anger which a person experiences continuously regardless of a certain situation or time period. The finding of significant positive correlation between trait anger and biological aging in this study is in line with previous studies that elevated trait anger negatively affected physical health.<sup>24)</sup> The human system aging in the level of organ-system is generally explained as follows. The

**Table 4.** Coefficients of determination of general characteristics and emotional experiences for the biological aging<sup>a</sup>

Predictor	$R^2$	$\Delta R^2$	Adjusted $R^2$	$\beta$	Standard error	Beta	<i>P</i>
Model <sup>b</sup>	0.206 <sup>c</sup>	0.043 <sup>c</sup>	0.034 <sup>c</sup>				
Trait anger	0.044 <sup>d</sup>	- <sup>d</sup>	0.017 <sup>d</sup>	0.168 <sup>e</sup>	0.075 <sup>e</sup>	0.198 <sup>e</sup>	0.020 <sup>e</sup>
Education level	0.066 <sup>d</sup>	0.022 <sup>d</sup>	0.028 <sup>d</sup>	-0.588 <sup>e</sup>	0.277 <sup>e</sup>	-0.164 <sup>e</sup>	0.038 <sup>e</sup>

<sup>a</sup>Biological aging (%)=((biological age-chronological age)/chronological age)×100.

<sup>b</sup>Model was adjusted for age, sex, body mass index, monthly household gross income, faith level, smoking, weekly exercise, and weekly alcohol use.

<sup>c</sup> $R^2$ ,  $\Delta R^2$ , and adjusted  $R^2$  were calculated using multiple stepwise linear regression analysis.

<sup>d</sup> $R^2$ ,  $\Delta R^2$ , and adjusted  $R^2$  were calculated using simple linear regression analysis.

<sup>e</sup>Data were calculated using multiple stepwise linear regression analysis.

system homeostasis is regulated by the signals of nerves and hormones. When the body's ability to maintain the homeostasis decreases, the system often fails to adapt oneself. Accordingly, the system aging is progressed and possibly causes some diseases including cancer in this condition.<sup>25)</sup> Furthermore, the 'fight-or-flight response' theory describes a physiological responses to the stress. When a man/woman feels himself/herself placed in a stressful situation, his/her sympathetic nervous system comes to be activated and catecholamines secreted from adrenal medulla in his/her body.<sup>26)</sup> Unhealthy reactions are caused consequently that heart rate and respiratory rate are increased, gastrointestinal function is suppressed, most vessels in the system except muscles are contracted, and glycogen and fatty acids are released. Hence, the current study that higher trait anger was correlated with more biological aging consists substantially with the 'fight-or-flight response' theory as well as the explanation of aging in the level of organ-system. In addition, our study agrees with the previous study that psychological stress weakened humoral and cellular immune reactions.<sup>27)</sup>

On the other side, trait depression and trait anxiety did not show significant relationships with the biological aging in this study. These results were inconsistent with the previous studies. It was reported that serum tumor necrosis factor alpha (TNF- $\alpha$ ) level was more elevated in normal persons than in patients with depression.<sup>28)</sup> Emotional stress response of anxiety significantly increased arterial stiffness even after adjusting confounding factors of age, mean arterial pressure, gender, BMI, smoking, education, and income.<sup>29)</sup>

There are a few reasons why these inconsistencies occurred in this study.

Firstly, dependent variables used for aging of human body were different. Although our study reported emotional stress on biologic aging process by biologic age, previous studies used TNF- $\alpha$  and arterial stiffness. TNF- $\alpha$  is a cytokine to regulate immune cells and its dysregulation implicate a variety of human diseases. Arterial stiffness reflects the severity of atherosclerosis. In contrast to these factors, biological aging is a value computed by a specific formula which consists of chronological age and biological age. As stated above, biological age is calculated with BMI, body fat, body muscle, waist circumference, WHR, SBP, DBP, pulse pressure, FEV1, FVC, and other blood test results. Because biological age is a complex parameter reflecting various conditions, relation-

ship between emotional stress and biological age would be more precise in this study than in previous studies.

Secondly, there might be some discordances among inventories to estimate the degree of depression and anxiety. BDI in the previous study was utilized to appraise depression. On the one hand, the Trait Depression Inventory was employed in this survey, separated from STDI-K.<sup>16)</sup> The State-Trait Anxiety Inventory in the old survey was employed to evaluate anxiety, developed by Spielberger et al.<sup>17)</sup> On the other hand, the Trait Anxiety Inventory exacted from the Korean adjustment of State-Trait Anxiety Inventory application done by Kim<sup>18)</sup> in the current study. For those reasons, adjusted questionnaires for Korean would reflect anxiety and depression better than previous tools. These differences could induce inconsistent results.

Finally, there is another possibility that stress hormones are less secreted in circumstances with depression or trait anxiety than with trait anger.

The significant negative correlation between education level and biological aging was found in this study. It did not seem to be significantly affected by sex when performing subgroup analysis. Generally, the higher education level, the less biological aging. People who have a higher formal schooling generally aware the importance of health maintenance and disease prevention. It coincides with the previous result that people who was less educated poorly execute the preventive strategies for cardiovascular diseases.<sup>30)</sup> In age stratification, significant relationship was found in the generation of 50's. In other generations, there were no significant impacts. The reasons for these differences might be originated from different numbers of each generations. The most patients were enrolled in the generation of 50's (n=77 [32.5%]) in this study. Meanwhile, the relationship between trait anger and biological aging was not affected by sex. The significant relationship between trait anger and biological aging was observed only in the generation of 30's during age stratification. This could mean that trait anger more powerfully aggravated biological aging in generation of 30's. Because the other groups did not show significant the relationships, whether the relationship was applied in general population or only in specific group will be needed to investigate.

There are several limitations in this study. Since this study was a cross-sectional study using questionnaire, detailed medical history of depression or anxiety could not be figured out. In addition, calculation formula of biological aging

included the patient's chronological age, reflecting the possibility of influence of patient's own age. It implied that factors such as educational status could be affected by biological aging itself. However, analysis using Pearson's correlation and subgroup analysis with one-way ANOVA showed that the chronological age did not affect the biological aging. We also adjusted the chronological age when analysis the impact of general characteristics and emotional experiences on biological aging. Nonetheless, causal relationships between usual emotional experiences and biological aging needed further investigations because this study was a cross-sectional study. Furthermore, the number of subjects in this study was small and they lived mostly in the Daejeon-Chungcheong province. Finally, the  $R^2$ 's of trait anger and education level for biological aging ( $R^2=0.044$  and  $0.022$ , respectively) showed low absolute values in the current study. It implies that many other factors could affect the human body aging.

This study suggests that the significant relationship between usual anger experience (i.e., trait anger) and biological aging would be present. In addition, lower education level may be related with biological aging. Until now, there has been no studies investigating adverse effects of usual negative emotional experiences on the human body system by biological aging progression, in our knowledge. Further studies for causal relationship between emotional stress and biological aging would be needed.

## 요 약

연구배경: 본 연구는 인간이 평소에 부정적인 정서들을 경험하는 것과 생물학적 노화 사이의 연관성을 알아보기 위하여 고안되었다.

방법: 2013년 5월부터 9월까지 충남대학교병원 건강증진 센터를 내원한 237명을 대상으로 연구하였다. 피험자들 개개인에게 구조화된 설문지를 주어 응답하도록 하였다. 피험자들이 '평소에 느끼는 우울, 불안, 분노 그리고 분노표현' (이하 '정서경험들')은 특성우울척도([the Korean adaptation of] State-Trait Depression Inventory에서 분리함), 특성불안척도(한국형 상태-특성불안척도[State-Trait Anxiety Inventory]에서 분리함) 그리고 특성분노척도와 분노표현척도([the Korean adaptation of] State-Trait Anger Expression Inventory에서 분리함)로 사정하였다. 피험자들 각각이 '생물학적으로 노화가 진행되는 정도' (이하 '생체노화')는 생체 연령(비만과 주요 장기들의 노화를 반영)과 실제 나이로 이루어진 특수한

공식으로 계산하였다. 독립  $t$ -검정, 일원분산분석, 상관분석을 시행하여 피험자들의 일반적 특성들(정서경험들을 포함)과 생체노화들 간의 연관성들을 평가하였다. 단계적 회귀분석을 사용하여 피험자들의 일반적 특성들과 생체노화들 간의 설명력( $R^2$ )들을 산출하였다.

결과: 일변량분석에서 오직 특성분노와 교육수준만이 생체노화와 유의한 상관관계를 보였다; 전자의 경우는  $r=0.160$ ,  $P=0.014$ , 후자는  $r=-0.189$ ,  $P=0.024$ . 다변량분석에서는 특성분노와 낮은 교육수준만이 생체노화와 유의한 설명력을 나타냈다; 전자의 경우는  $R^2=0.044$ ,  $P=0.020$ , 후자는  $R^2=0.022$ ,  $P=0.038$ .

결론: 본 연구는 평소에 경험하는 분노(즉 특성분노)와 낮은 교육수준이 인체의 생물학적 노화를 촉진시키는 주목할 만한 요인들임을 시사한다.

중심 단어: 노화, 분노, 교육

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**Supplementary questionnaire 1. Questionnaire for demographics and faith**

다음 설문 문항들을 읽고 본인이 해당된다고 생각하는 답가지(①, ②, ③, ④, ⑤) 중 하나에만 O표를 하세요.

1. 어떤 종교를 갖고 계십니까?

- ① 없다
- ② 기독교
- ③ 천주교
- ④ 불교
- ⑤ 기타

2. 종교가 있다면, 신앙에 얼마나 의지하십니까? (종교가 있는 분만 답하세요)

- ① 거의 의지하지 않음
- ② 조금 의지함
- ③ 대체로 의지함
- ④ 많이 의지함

3. 여가활동 또는 취미생활을 하고 계십니까?

- ① 안 한다.
- ② 가끔 한다.
- ③ 정기적으로 하고 있다.

4. 최종학력을 표시해주세요.

- ① 무학
- ② 초졸
- ③ 중졸
- ④ 고졸
- ⑤ 대졸 이상

5. 결혼을 하셨습니까?

- ① 기혼
- ② 미혼
- ③ 기타(이혼, 별거, 배우자 사별 등)

6. 평소 가족과 같이 생활하고 계십니까?

- ① 가족과 같이 지낸다.
- ② 가족과 떨어져서 지낸다.

7. 본인의 경제적 수입은 어느 정도입니까?

- ① 월 100만 원 미만
- ② 월 100~300만 원
- ③ 월 300~500만 원
- ④ 월 500만 원 이상

8. 가계의 총 경제적 수입은 어느 정도입니까?

(가정의 경제적 수입원이 본인 혼자인 경우, 7번과 똑같이 답하세요)

- ① 월 100만 원 미만
- ② 월 100~300만 원
- ③ 월 300~500만 원
- ④ 월 500만 원 이상

9. 나에게 괴롭거나 어려운 일이 생기면 나의 가족에게 도움을 청할 수 있다.

- ① 항상 그렇다.
- ② 때때로 그렇다.
- ③ 아니다.

10. 문제 해결을 위한 대화나 어려움을 서로 나누어 갖기 위해 현재 우리 가족이 취하고 있는 방법들이 좋다고 생각한다.

- ① 항상 그렇다.
- ② 때때로 그렇다.
- ③ 아니다.

11. 내가 새로운 일을 하거나 새로운 제안을 할 때 나의 가족은 이를 따라주고 도와준다.

- ① 항상 그렇다.
- ② 때때로 그렇다.
- ③ 아니다.

12. 분노, 슬픔, 사랑 등 나의 감정에 대응하는 나의 가족의 반응에 만족한다.

- ① 항상 그렇다.
- ② 때때로 그렇다.
- ③ 아니다.

13. 가족과 함께 여가를 보내는 방법 중 현재 우리 가족이 취하는 방법들이 좋다고 생각한다.

- ① 항상 그렇다.
- ② 때때로 그렇다.
- ③ 아니다.

**Supplementary questionnaire 2. Trait depression inventory**

각 문장을 잘 읽으시고 각 문장의 오른쪽에 있는 답가지들(①, ②, ③, ④) 중에서 ‘평소에 내가 일상생활에서 느끼는 바’를 가장 잘 나타낸다고 생각되는 것 하나에 O표를 하십시오.

평소에 일상생활에서 느끼는 바로는	답가지			
	전혀 아니다	조금 그렇다	상당히 그렇다	매우 그렇다
나는 행복하다 <sup>a</sup>	①	②	③	④
나는 침울하다	①	②	③	④
나는 완전하다 <sup>a</sup>	①	②	③	④
나는 슬프다	①	②	③	④
나는 평온하다 <sup>a</sup>	①	②	③	④
나는 기분이 초조하다	①	②	③	④
나는 우울하다	①	②	③	④
나는 안도감을 느낀다	①	②	③	④
나는 희망이 없다	①	②	③	④
나는 생활이 즐겁다 <sup>a</sup>	①	②	③	④
나는 기분이 좋다 <sup>a</sup>	①	②	③	④
나는 쉽게 피로해진다	①	②	③	④
나는 울고 싶은 심정이다	①	②	③	④
나는 다른 사람들처럼 행복했으면 좋겠다	①	②	③	④
나는 마음을 빨리 정하지 못해서 실패를 한다	①	②	③	④
나는 마음이 놓인다 <sup>a</sup>	①	②	③	④

<sup>a</sup>: 역산 문항

**Supplementary questionnaire 3. Trait anxiety inventory**

나는 마음이 차분하고 침착하다 <sup>a</sup>	①	②	③	④
나는 너무 많은 어려운 문제가 밀려 닥쳐서 극복할 수 없을 것 같다	①	②	③	④
나는 하찮은 일에 너무 걱정을 많이 한다	①	②	③	④
나는 행복하다 <sup>a</sup>	①	②	③	④
나는 무슨 일이건 힘들게 생각한다	①	②	③	④
나는 자신감이 부족하다	①	②	③	④
나는 마음이 든든하다 <sup>a</sup>	①	②	③	④
나는 위기나 어려움을 피하려고 애쓴다	①	②	③	④
나는 울적하다	①	②	③	④
나는 만족스럽다 <sup>a</sup>	①	②	③	④
사소한 생각이 나를 괴롭힌다	①	②	③	④
나는 실망을 지나치게 예민하게 받아들이기 때문에 머릿속에서 지워버릴 수가 없다	①	②	③	④
나는 착실한 사람이다 <sup>a</sup>	①	②	③	④
나는 요즈음의 걱정거리나 관심거리를 생각만 하면 긴장되거나 어찌할 바를 모른다	①	②	③	④

<sup>a</sup>: 역산 문항

**Supplementary questionnaire 4. Trait anger inventory**

평소에 일상생활에서 느끼는 바로는	답가지			
	전혀 아니다	때때로 그렇다	자주 그렇다	거의 언제나 그렇다
나는 성미가 급하다	①	②	③	④
나는 불같은 성질을 지녔다	①	②	③	④
나는 격해지기 쉬운 사람이다	①	②	③	④
나는 다른 사람이 잘못해서 내 일이 늦어지게 되면 화가 난다	①	②	③	④
나는 일을 잘하고도 다른 사람으로부터 인정받지 못하면 분통이 터진다	①	②	③	④
나는 쉽게 화를 낸다	①	②	③	④
나는 화가 나면 욕을 한다	①	②	③	④
나는 다른 사람 앞에서 비판을 받게 되면 격분한다	①	②	③	④
나는 내 일이 막히면, 누군가를 때려주고 싶다	①	②	③	④
나는 일을 잘 했는데도 나쁜 평가를 받으면 격분한다	①	②	③	④

**Supplementary questionnaire 5. Anger expression inventory**

화가 나거나 분노를 느낄 때	답가지			
	전혀 아니다	때때로 그렇다	자주 그렇다	거의 언제나 그렇다
나는 화를 참는다 <sup>a</sup>	①	②	③	④
나는 화가 난 감정을 표현한다	①	②	③	④
나는 말을 하지 않는다	①	②	③	④
나는 사람들에게 인내심을 가지고 대한다 <sup>a</sup>	①	②	③	④
나는 똥해지거나 토라진다	①	②	③	④
나는 사람을 피한다	①	②	③	④
나는 소리를 지른다	①	②	③	④
나는 냉정을 유지한다 <sup>a</sup>	①	②	③	④
나는 문을 쾅 닫아버리는 식의 행동을 한다	①	②	③	④
나는 상대의 시선을 피한다	①	②	③	④
나는 행동을 자제한다 <sup>a</sup>	①	②	③	④
나는 사람들과 말다툼을 한다	①	②	③	④
나는 아무에게도 말하지 않으나, 안으로 앙심을 품는 경향이 있다	①	②	③	④
나는 목소리를 높인다	①	②	③	④
나는 화가 나더라도 침착하게 자제할 수 있다 <sup>a</sup>	①	②	③	④
나는 속으로 다른 사람을 비판한다	①	②	③	④
나는 나 자신이 인정하고 싶은 것보다 화가 더 나 있다	①	②	③	④
나는 대부분의 사람들보다 빨리 진정된다 <sup>a</sup>	①	②	③	④
나는 욕을 한다	①	②	③	④
나는 참고 이해하려고 노력한다 <sup>a</sup>	①	②	③	④
나는 다른 사람이 알고 있는 것보다 분통이 더 나 있다	①	②	③	④
나는 자제심을 잃고 화를 낸다	①	②	③	④
나는 화난 표정을 짓는다	①	②	③	④
나는 화난 감정을 자제한다 <sup>a</sup>	①	②	③	④

<sup>a</sup>: 역산 문항