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An Analysis of Influencing Factors on Free Radicals among Women

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Abstract

The goal of this study was to obtain baseline data for detoxification by analyzing the factors influencing free radical levelsin women. Data were collected through questionnaires and urine tests between November 2014 and February 2015 from women between 20 and 65 years of age. Data were analyzed using descriptive statistics, independent t-tests, Pearson's correlation, and ANOVAusing SPSS version 21.0. Sleep satisfaction of participants was 55.4, fatigue was 61.3, and free radical was 646.9mmol/mL. Sleep satisfaction was significantly different according to economic status($F = 8.42$, $p<.001$). Fatigue was significantly different according to health($F = 5.33$, $p = .006$) and economic status($F = 8.42$, $p<.001$). Free radicals were significantly different according to age($F = 8.84$, $p<.001$), economic status($F = 10.12$, $p<.001$), level of education($F = 6.79$, $p = .001$), and occupation($F = 4.30$, $p = .006$). Age($r = .437$, $p<.001$), sleep($r = -.199$, $p = .013$), and fatigue($r = .159$, $p = .049$) were statistically significantly correlated with free radical levels. Factors influencing free radicals were age($\beta = .612$, $p<.001$), medium economic status($\beta = -.324$, $p = .007$), high economic status($\beta = -.467$, $p<.001$), high school education($\beta = .338$, $p = .004$), and college education($\beta = .338$, $p = .004$); the explanatory power of all influencing factors was 33.2%. Detoxification management for reducing free radical levels has to consider subjects who are between the ages of 40 and 60 years and who have low economic status and level of education. A comprehensive analysis that includes free radical-related variables, such as diet, exercise, living habits, and environment, needs to be carried out in the future.

Keywords: *Sleep, Fatigue, Free radicals*

1. Introduction

1.1. The Necessity of this Study

Although developments in science have made the lives of humans more convenient, it has also been accompanied by increasing toxic materials in our living environment, greatly influencing the health and lives of individuals. The accumulation of toxic materials inside the body have increased the prevalence of chronic diseases, and the concept of well-being has become a major topic of interest to people who are trying to evade the threats posed to their health [1].

The efforts made to discharge the toxins that accumulate inside the body have increased interest in detoxification. Detoxification focuses on preventing disease by discharging the toxic material and waste that accumulate inside the body [2]. Toxins are

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substances that interfere with normal physiological function and that negatively affect bodily functions when they enter the body [3]. Toxins include free radicals that are produced from metabolic activity, endotoxins produced by bacteria, chemical substances, electro-magnetic waves, radiation, contaminated food, instant food, oily food, heavy metals, endocrine-disrupting chemicals, and air pollutants. In particular, free radicals refer to oxygen molecules that are more active, less stable, and higher in energy than normal oxygen, which could make them an important indicator of toxin levels inside the body [3]. Because free radicals are unstable and have high energy, they can easily oxidize with other molecules inside the body, damaging cells and tissues in the process[4]. Free radicals that are produced in excess owing to environmental pollution, chemical substances, radiation, defects in blood circulation, and stress will cause oxidation reactions that damage cell membranes, DNA, and other cellular structures, so that the cells lose their functions or degenerate.

Many variables in relation to free radicals, such as characteristics of demographic sociology, exercise, diet, living habits, and health issues, have heretofore been discussed. Age is intimately related to free radicals and is a major explanatory variable of degenerative diseases in elderly people [5]. Sex is also a major variable that makes a difference in the manifestation of free radicals [6]. Owing to these physiological differences, the rates at which free radicals accumulate in male and female bodies vary [7]. An increase in free radicals is closely related to lifestyle conditions such as constipation [8] or coronary artery diseases [9], indicating that lifestyle is clearly associated with free radicals. Sleep is essential for antioxidant activity in the brain [10], and free radicals are related to obstructive sleep apnea [11]. Free radicals are also related to fatigue in respiratory muscles, thereby influencing respiration [12], and elimination of free radicals led to a decrease in fatigue [13]. Furthermore, antioxidants were effective in preventing neuropathy, which is a side effect of antitumor chemotherapy [14]. Environmental and psychological stress influenced the accumulation of free radicals in individuals, as was apparent in the higher levels of free radicals in astronauts compared with non-astronauts [15]. Despite the fact that free radicals are associated with diverse factors, there has been little research analyzing the relation of free radicals withvariables such as demographic characteristics, sleep, and fatigue. Therefore, this study aimed at analyzing the differences in free radicals according to general characteristics and the correlation between free radicals, age, sleep, and fatigue, while also verifying factors that influence free radical levels in individuals.

1.2. Purpose of Study

This study was intended to obtain baseline data for detoxification by analyzing the influencing factors on free radicals. The detailed objectives are as follows:

- Analyze the levels of sleep, fatigue, and free radicals of participants
- Analyze the differences in sleep, fatigue, and free radicals of participants according to their general characteristics
- Analyze the correlation between sleep, fatigue, and free radicals of participants
- Analyze factors influencing free radicals in participants

2. Methods

2.1. Research Design

This is a descriptive research study for analyzing the correlation between sleep, fatigue, and free radical levels in women and identifying the factors influencing free radicals.

2.2. Research Participants

Surveys and examinations were conducted on women who voluntarily submitted consent forms after the purpose, content, and methods of the study were explained to them. Participants with chronic diseases were excluded from the participants. Using the G*Power program and regression analysis, we calculated a moderate effect size(f^2) as 0.15, level of significance as 0.05, and the number of factors as 10.The statistical power of 155 subjects of this test was 92%.

2.3. Data Collection

Data were collected from November 2014 to February 2015 from women between 20 and 64 years of age, with approximately 30 subjects recruited to each age group(20s, 30s, 40s, 50s, 60-64). Data were collected at a women's cultural center. The participants were given explanations about the questionnaire and they filled it out themselves or were guided through questions and answers when necessary. Completing the questionnaire took approximately 10 minutes, and after it was completed, free radical levels were measured through urine tests. Completing the questionnaire and the urine test combined took between 15 and 20 minutes.

2.4. Research Tools

2.4.1. Free Radicals: Urine was used to measure free radicals. Urine was collected from individual participants in paper cups, with a dipstick that was dipped into the urine and removed within one second. Residual urine was removed using tissues, and free radicals were measured using free radical measuring instruments. The used paper cups and dipsticks were collected in medical waste bags and discarded using appropriate procedures. The free radical analyzer (BS-201 Bio Doctor; Bionics, Yongin, South Korea) used in this study measured the amount of malondialdehyde in urine, andthe higher the number obtained, the higher the level of free radicals in the body:<500 mmol/mL=fair, 501–1000mmol/mL =caution advised, 1001–3000mmol/mL =slightly high, 3001–5000mmol/mL =high, and >5001mmol/mL =very high.

2.4.2. Sleep Satisfaction: The participants were asked to respond to the question "How would you rate your sleep satisfaction?" using a visual analog scale composed of 100 points, with more points indicating higher sleep satisfaction.

2.4.3. Fatigue: The participants were asked to respond to the question "How would you rate your fatigue?" using a visual analog scale composed of 100 points, with more points indicating a higher level of fatigue.

2.5. Data Analysis

The general characteristics, sleep, fatigue, and free radical levels of participants were verified with descriptive statistics. The differences in sleep, fatigue, and free radical levels that are according to general characteristics of subjects were analyzed using the independent t-test and ANOVA. The relationships between age, sleep, fatigue, and free radical levels of subjects were analyzed using Pearson's correlation. Multiple regression was performed to examine the factors influencing free radicals in the participants.

2.6. Ethical Considerations

In consideration of the ethical aspects of the study, we explained the goals and the content of the study to the participants, as well as their right to refuse, ways to protect information, and compensation for participation. The participants who wished to

participate after sufficient explanation and who gave written consent were given self-administered questionnaires to complete. A collection box for the questionnaires was specially prepared so that participants could complete and submit questionnaires individually without any unease; as such, we placed the safety and security of participants as our top priority. The participants were given small tokens of appreciation after they submitted the data.

3. Results

3.1. Differences in Sleep, Fatigue, and Free Radicals According to General Characteristics

Sleep satisfaction of participants was rated at 55.4 (Maximum: 100), fatigue at 61.3 (Maximum: 100), and free radicals at 646.9mmol/mL. Sleep satisfaction was significantly different according to economic status; participants with medium or high economic status had higher sleep satisfaction than people with a lower economic status. Fatigue was significantly different according to health(F = 5.33, p = .006) and economic status(F = 8.42, p<.001). Fatigue levels were higher in participants who responded that they had poor health compared with those who responded that they had good health, and in participants with low economic status compared to those with medium or high economic status (Table 1).

Table 1. Differences in Sleep and Fatigue according to General Characteristics

Characteristic	Category	N (%)	Sleep		Fatigue	
			M ± SD	t or F(p)	M ± SD	t or F (p)
Age (years)	20–29	30(19.4)	58.50±16.04	.80 (.526)	60.00±17.22	1.41 (.233)
	30–39	30(19.4)	55.00±14.08		57.33±15.52	
	40–49	34(21.9)	53.82±20.60		65.29±13.54	
	50–59	32(20.6)	57.50±14.81		60.00±12.18	
	60–65	29(18.7)	52.07±13.73		63.45±15.87	
Health status	Poor[a]	20(12.9)	51.50±18.72	1.83 (.164)	68.50±14.61	5.33 (.006) a>c
	Average[b]	99(63.9)	54.70±15.10		61.92±13.90	
	Good[c]	36(23.2)	59.44±17.06		55.56±16.29	
Religion	Catholic	20(12.9)	51.00±13.72	.71 (.546)	64.50±15.72	.87 (.460)
	Protestant	62(40.0)	56.85±17.18		59.68±15.47	
	Buddhism	18(11.6)	56.67±16.80		58.89±14.91	
	No religion	55(35.5)	54.91±15.62		62.73±14.20	
Marital status	Single	94(60.6)	55.85±15.90	.20 (.658)	61.06±13.40	.05 (.816)
	Married	61(39.4)	54.67±16.63		61.64±17.24	
Economic status	Low[a]	17(11.0)	44.71±18.41	4.56 (.012) a<b,c	74.71±14.19	8.42 (.000) a>b,c
	Average[b]	99(63.9)	57.22±16.12		59.80±14.21	

	High[c]	39(25.2)	55.38±13.54		59.23±14.58	
Education	Middle school	13(8.4)	56.15±18.50	.82 (.443)	56.92±14.94	1.06 (.348)
	High school	38(24.5)	58.16±16.25		63.68±14.78	
	College	104(67.1)	54.28±15.83		60.96±15.04	
Occupation	Mental labor	55(35.5)	58.27±14.95	1.61 (.189)	59.82±17.05	2.46 (.065)
	Physical labor	21(13.5)	53.33±16.53		67.14±15.21	
	Mental &physical	24(15.5)	50.00±20.43		65.42±14.74	
	Home maker	55(35.5)	55.64±14.75		58.93±11.87	
Operation /CT	No	139(89.7)	55.00±16.19	-.88 (.381)	61.65±15.16	.892 (.374)
	Yes	16(10.3)	58.75±15.86		58.13±13.28	
Mean			55.39±16.14		61.29±14.98	

CT=Chemotherapy

Table 2. Differences in Free Radical According to General Characteristics

Characteristics	Category	N (%)	Free Radical	
			M ± SD	t or F (*p*)
Age (years)	20–29[a]	30(19.4)	476.13±305.22	8.84(.000) a,b<c, e
	30–39[b]	30(19.4)	451.03±212.46	
	40–49[c]	34(21.9)	741.71±345.80	
	50–59[d]	32(20.6)	686.25±382.95	
	60–65[e]	29(18.7)	871.83±369.30	
Health Status	Poor	20(12.9)	724.15±463.36	.78(.459)
	Average	99(63.9)	649.12±322.28	
	Good	36(23.2)	598.06±403.75	
Religion	Catholic	20(12.9)	595.85±374.79	.37(.778)
	Protestant	62(40.0)	672.94±362.76	
	Buddhism	18(11.6)	683.11±403.94	
	No religion	55(35.5)	624.38±348.38	
Marital Status	Single	94(60.6)	673.77±315.80	1.08(.283)
	Married	61(39.4)	605.61±422.74	
Economic status	Low[a]	17(11.0)	996.06±537.37	10.12(.000) a>b,c
	Average[b]	99(63.9)	593.01±270.96	
	High[c]	39(25.2)	631.67±369.86	
Education	Middle school[a]	13(8.4)	595.85±182.83	6.79(.001) b>c
	High school[b]	38(24.5)	828.16±462.27	
	College[c]	104(67.1)	587.12±314.81	

Occupation	Mentallaborer[a]	55(35.5)	520.38±278.04	4.30(.006) a<b
	Physicallabor[b]	21(13.5)	805.29±534.58	
	Mental &physical[c]	24(15.5)	711.38±438.99	
	Home maker[d]	55(35.5)	684.93±280.89	
Operation /CT	No	139(89.7)	644.78±346.81	-.218(.828)
	Yes	16(10.3)	665.69±487.48	
Mean			646.94± 361.90	

CT=Chemotherapy

Free radical levels were significantly different according to age(F = 8.84, p<.001), economic status(F = 10.12, p<.001), education level(F = 6.79, p = .001), and occupation(F = 4.30, p = .006).Free radical levels were higher in participants in their 60s or 40s compared with those in their 20s or 30s, and higher in participants with low economic status compared with participants with high economic status. Regarding education level, high school graduates had higher free radical levels than college graduates, and regarding occupation, physical laborers had higher free radical levels than mental laborers(Table 2).

3.2. Relationship between Age, Sleep, Fatigue, and Free Radicals

Age (r = .437, p<.001), sleep (r = -.199, p = .013), and fatigue (r = .159, p = .049) were statistically significantly correlated with free radicals, with age having an especially strong correlation. Although sleep was significantly correlated with fatigue(r = -.362, p<.001), age was not significantly correlated with sleep (r = -.090, p = .265) or fatigue (r = .096, p = .236) (Table 3).

Table 3. Correlations between Free Radical, Age, Fatigue and Sleep

(N=155)

	Free Radical	Age	Fatigue	Sleep
	r (p)	r (p)	r(p)	r (p)
Free Radical	1			
Age	.437 *(p<.000)*	1		
Fatigue	.159 *(p=.049)*	.096 *(p=.236)*	1	
Sleep	-.199 *(p=.013)*	-.090 *(p=265*	-.362 *(p<.001)*	1

3.3. Factors Influencing Free Radicals in Women

Nominal variables such as economic status, education level, and occupation, which showed differences in free radicals, were treated as dummy variables, and variables related to free radicals such as age, sleep, and fatigue were evaluated together in regression analysis. As a result of verifying whether the variables fulfilled the assumptions of regression analysis, the Durbin-Watson test statistic was revealed to be

1.581, which meant there was no autocorrelation. There were also no issues with multicollinearity, since the tolerance limit was .254 to .818 and the variation inflation factor was 1.223 to 3.943. The analysis revealed age(β = .612, p<.001), medium economic status (β = -.324, p = .007), high economic status(β = -.467, p<.001), high school education (β = .338, p = .004), and college education (β = .351, p = .009) to be the main factors influencing free radicals, and the total explanatory power was 33.2% (Table 4).

Table 4. Influencing Factors Influencing Free Radicals in Women

(N=155)

Variables	B	SE	β	t	p
Constant	266.53	199.98		1.33	.185
Age	12.55	2.20	.61	5.70	.000
Fatigue	-.14	1.54	-.01	-.09	.928
Sleep	-2.12	1.40	-.11	-1.51	.132
Eco1	-206.47	75.67	-.32	-2.74	.007
Eco2	-330.20	85.78	-.47	-3.85	.000
Edu1	238.72	82.33	.34	2.90	.004
Edu2	226.63	85.33	.35	2.66	.009
Job1	-144.96	81.86	-.16	-1.77	.079
Job2	-57.99	67.90	-.07	-.86	.393
Job3	-91.82	63.38	-.15	-1.45	.150

Eco1: Average economic status, Eco2: High economic status,, Edu1: High school, Edu2: College, Job1: Physical labor, Job2: Mental &Physical, Job3: Homemaking

4. Discussion

The sleep satisfaction of our participants was quite low at 55.4 (maximum: 100), and we observed that low sleep satisfaction seemed to be related to low economic status; whether this is an issue of the time or the quality of sleep is a topic for further research. The overall fatigue level was calculated to be within the medium range, and was higher for the participants who reported poor health or low economic status. This result may be explained because health is closely related to disease, and disease and weakness in turn are closely related to fatigue. People with low economic status may be exposed to a high level of stress because they find it difficult to satisfy their desires, and improper self-management leads to worsening of health, and thus, a vicious cycle may come into play. Several existing studies report that health behaviors are associated with economic status [16].

The level of free radicals at 646.99mmol/mL was high enough to require caution, and it was especially high in subjects in their 40s and 60s, those with low economic status, high school graduates, and blue-collar workers. It is thought that people in their 60s have high free radical levels due to aging and that people in their 40s have high levels because they have children attending middle and high school and have a lot of housework, situations in which they may experience a high level of stress. Low economic status increases the possibility of exposing people to toxic material from inadequate living environments or diet. The study revealed that high school graduates had higher free radical levels than college graduates, which may be because high school graduates are more likely to be working in labor-intensive occupations. Considering previous findings that physical labor induces more free radicals than intellectual labor, our study suggests that physical

overwork from manual labor could cause an increase in free radical levels. Indeed, excessive use of muscle leads to increased free radical levels [17].

Our results revealed that age was statistically significantly correlated with free radical levels and thus supports a previous report [18] that aging is closely related to the activity of free radicals. Meanwhile, age had no significant correlation with sleep or fatigue, which may be because sleep and fatigue fluctuate widely within the same age groups and are also strongly related to an individual's lifestyle, health, and economic status. It is known that elderly people frequently experience poor sleep quality, but it is thought that their subjective level of satisfaction will be different among individuals, since sleep patterns are also different among individuals. Fatigue is also a subjective experience and is influenced not only by physical health issues but also by psychological, social, and economic stress.

The factors that influenced free radicals were age, economic status, and education level, and the total explanatory power was 33.2%. It is widely known that free radicals are mainly responsible for aging. However, it is noteworthy that demographic features such as economic status and education levels were included as major factors, and lifestyle features such as sleep and fatigue were not. Although sleep and fatigue were significantly correlated with free radical levels, their exclusion as major factors when analyzed together with socio-demographic factors such as age, economic status, education level, and occupation shows that their influence fades away owing to economic and educational variables. This may be because sleep and fatigue are heavily influenced by economic status, which affects physical health [19] and also worsens mental health [20]. In conclusion, socio-demographic variables such as age, economic status, and education level should be considered when dealing with free radicals. Furthermore, there is a need in the future to increase the explanatory power of influencing factors by including variables that are predicted to influence free radical levels.

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