# Report On HRV Criterion Production

***Research period: Mar. 1, 2003 - Oct. 30, 2003***

**Research Institute: Inje University**

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# Ⅰ. Introduction

Heart beat during ordinary break time, unlike our convention that it is regular, is very irregular. Short term Heart Rate Variability, or HRV is determined by breathing, baroreceptor, chemoreceptor and variation of autonomic nerves' activity. The influence of autonomic nerves affects sinus node automatism changes every moment according to internal/outside environmental change. This is called Heart Rate Variability.

Its clinical usefulness is shown on the ongoing researches since Hon and Lee reported in 1965 that under fetal distress status, change of interval between heart rates comes ahead of heart rate change itself. Researches on relationship with a heart have been underwent, but recently the usefulness in the department of psychiatry brought up. Determining the level of activity or balance in sympathetic and parasympathetic nerves might be used as very useful information for treatment and prognosis. This possibilities led to a clinically experimental research on various diseases recently.

## 1) HRV as a stress measurement tool

With HRV's usefulness as an evaluation tool of autonomic nerves, it is widely used on stress researches. As Selye and Cannon, etc. put it, it is because stress reaction appears as biochemical physiology response in a human body through the response between HPA axis and autonomic nerves. the failure or abnormality of autonomic nerves is related to many of stress symptoms and diseases including depression, fibromyalgia, sensitive, colon syndrome, anorexia, dizziness, orthostatis low blood pressure, diabetes, low pressure, anxiety, asthma, high blood pressure, insomnia and irregular pulse, etc.
Stress consists of many types, and HRV is being widely used, in particular, for researches on chronic occupational stress. If death from overwork or Sudden Cardiac Death, or SCD taken for example, the failure of heart rhythm control is a major cause in the case of SCD and it is HRV that evaluates heart rhythm control.

The trend of existing researches on occupational stress is as follows: 1) man-made causes/mental work load: influence on HRV of experimental demand(Work Demands) 2) dynamics research on cardiovascular diseases: influence on CHD on cardiovascular control

failure 3) occupational stress - industrial and medical research: how mental and social work character influences directly or indirectly in three ways. Albeit significant results from those approaches, they failed to determine pathophysiology of mental and social causes including occupational stress on SCD, coronary artery diseases. Still, as HRV analysis methods develop, because autonomic nerves could be the evaluation of physiological mechanism to control heart functions, it aims to evaluate the influence of environmental stress employees go through(Belkic 2000, Brisson 2000).

Despite some controversies, HRV analysis, currently the most responsive and reproducible, is thought to be widely used for diseases related to autonomic nerves. Still, with characteristics HRV itself have, it seems difficult to tell inherent index to diseases except specific diseases and normality. Instead, it is reasonable to see it as a tool to measure general health of a heart and autonomic nerves. In this sense, research tasks were formulated.

## 2) Necessity and prospect of research

HRV analysis, capable of evaluating changes in autonomic nerves, is the most responsive and reproducible method. Still, with stress emerging as a serious social issue recently, evaluating stress in quantitative fashion or index for diagnosis or prognosis were much needed. In this regard, it is clear that HRV is an important method to be studied.

Yet, providing criterion data from normal persons prior to research on patients leads to tracing its significance. Even if there were a few researches on clinical significance locally, they failed to clarify comparative objects and hard to determine research significance.(Park , etc. 1994). Not much research is found abroad about HRV with an ordinary demographic group without a cardiac disorder (Tsuji , etc. 1994, May , etc. 1999). Despite the research on HRV with an ordinary demographic group, it lacks samples and has some limits. (Jeon Hyoung-jun, etc., 2001).

Since HRV can be used as a vital predictor for stress-related diseases including cardiovascular diseases, etc., much is needed to develop criterion data out of ordinary demographic group. Moreover, it is expected to greatly contribute to treating and determining preventive interruption, if vital factors of HRV is determined out of massive demographic groups and analysis dangerous causes of stress-related diseases and further comparison with patients' characters are conducted.

Research collected autonomic nerves function readings from ordinary persons through HRV. By providing the criteria of HRV with ordinary Koreans, basic data for the following research using

HRV for the years to come. Moreover, this research aims at promoting information competence, and prove that HRV measurement is a significant tool to measure stress-related diseases by comparing stress profiles including demographic, social, occupational change causes, etc. with HRV results and analysing. By analysing, in particular, employees group, possibilities were studied whether this could become a test tool to convert quantitatively for employees stress, or one of recent emerging social concerns.

## 2. Research goal

The researchers focused on research goals below.

1) This study aims at **setting criteria which will evaluate reaction to stress by age and sex** by conducting total autonomic nerves function measurement using Heart Rate Variability in around 2,000 Korean adults (including 1,000 drawn from large work places and remainders from Comprehensive check-up examinee)
2) This study is to examine whether various parameters of HRV could be biological index to evaluate the level of reaction to stress by researching stress-related demographical, social, occupational variation causes and response to stress and stress index and **relationship between stress index and HRV**.
3) This is to **develop the standardized protocol of examination** so that stress evaluation using HRV in checking employees's health is applied as a useful diagnosis and collecting basic reference used for a standardized guide in the future.

## 3. Research method

| Deciding HRV measurement method, and stress-related index |
|---|

| **Group 1 : work place employees** | setting for **research environment** | **Group 2 : Comprehensive Health check-up** |
|---|---|---|
| - oo city gas (Dr. Kim Hyun-joo, Danguk Univ.)<br>- oo automobiles (Dr. Kang Dong-muk, Busan Univ.)<br>- oo steels (Dr. Kim Jeong-il, Dong Univ.) | | - Jo Jeong-jin(Dr..Hanlim Univ.)<br>- Dr. Lee Ji-ho (Ulsan Univ.)<br>- Dr. Woo Jong-min(Inje Univ.)<br>- Dr. Kim Jeong Yeon(Ewha womans Univ.)<br>- Dr. Jeon Hyoung-jun(Gacheon |

| | |
|---|---|
| - oo Electricity, oo research center (Dr. Kim Su-young, Eulji Univ.)<br>- oo airlines (Dr. Lee Ji-ho, Ulsan Univ.) | med school) |
| Arranging work place and setting up cohort<br>Setting up material collecting system including in-house computation connection | Predicting individuals for comprehensive check-up<br>Examining material collection system |

Equipment installment and coordinating measurement method (Park Hee-jeong at Medicore)

| | | |
|---|---|---|
| HRV + SRI, sleeping habit, exam material +<br>job nature, K-JCQ | **measurement by organization** | HRV + SRI, sleeping habit, exam material |

Data input on Excel file

Interim analysis (per 1 month) -> orchestrating by age, sex

Final analysis

Producing HRV Korean criterion material

Determination of each causes of employees ' stress and its relationship

## A. Introduction

This research studied 3,483 with no previous internal or psychological disorder history. Researchers measured and identified HRV and demographic and social variances change cause - including job nature in terms of employees -and conducted Korean style Job stress questionnaires (K-JCQ), Stress Response Inventory, or SRI and sleeping questionnaires.

This, a multiple research, was analyzed comprehensively in an organization where research heads belong after collecting data from various organizations and research process is followed below(see Figure 1).

## B. Research subjects

1. Subjects were limited between those between more than 18 and less than 65 with no psychological and internal disorder history. Still, diseases which can be observed within human population such as high blood pressure, diabetes and chronic geriatric diseases were excluded. Age was limited between more than 18 and less than 65 due to the fact that age and sex could influence HRV and men were the majority.

Subjects were gathered in three ways as below(see Exhibit 1)

1) conducting collective employees check-up after installing HRV at large cooperates

2) collecting data from those during comprehensive check-up in a hospital

3) drawing those in their 20s considering shortage of subjects

2. Exclusion

1)Those who contracted with heart related disease or with previous medical history: **Coronary artery disease, or CAD, heart failure, an irregular heartbeat, etc.** (High blood pressure, diabetes were not excluded but marked down. Groups with high blood pressure, diabetes will be compared to the ordinary group)

2)Those who showing abnormality including abnormal q wave, WPW syndrome in an Electrocardiogram, or ECG

3)Those detected to have hypertrophy on the left ventricles of the heart with high blood pressure or heart hypertrophy on a chest X-ray

4)those who has less than 90% of normal RR interval 90% (excluded followed by screen through equipment)

Yet researchers measured those who under medication for other internal or psychological disorders without take-in and jotted down their medication.

## C. HRV measurement method

### 1.1.1. Guide to subjects

“No smoking and drinking within two hours prior to exam. Heart rate of five minutes is recorded using Max Pulse while sitting in a chair comfortably, and information on sex, age, smoking history and medical history were collected through questionnaires, and blood test and stressors were evaluated."

### 1.1.2. Posture

A chair people place their back against and legs are used. Caution is needed so that subjects can pose same posture with their back against around 70 degree in a same chair while being examined in a work place.

### 1.1.3. Requirements

-Test between 8 a.m. - noon
Sympathetic nerve exacerbation is expected in afternoons so
examining in mornings is desirable.
Still, work places are exception.
- No food within 2 hours prior to test
- for morning exam => no food and smoking after midnight on the test day
- for afternoon exam => no coffee(caffeine) on a test day, smoking and drug
- Explaining about a test while preparing for a test(mounting

electrodes/sensors, posture)

- Preparatory period for at least three minutes so that patients get ready (Running or walking more than staircase before entering an exam room is not permitted. In case of brisk activities, make sure that test is done after break.
- Questionnaires: Conduct ahead of time or after HRV test.
(Avoid conducting right before HRV test as possible.)

1.1.4. Setting

-Maintaining bright indoor light
-Block outside noise (No irrelevant personnel entrance or chatting)
-Maintaining appropriate indoor temperatures (±20~25 C.)

1.1.5. Notice

-Relaxed mind and posture, and breathing
-No conversation
-Examine keeping eyes open
-Keep eyes on the room wall. (no attention to monitor's change)
- Keep breathing comfortably.
- When the examinee looks nervous, stop a test and conduct for five minutes at a time he/she is fine .

6. Researcher entry

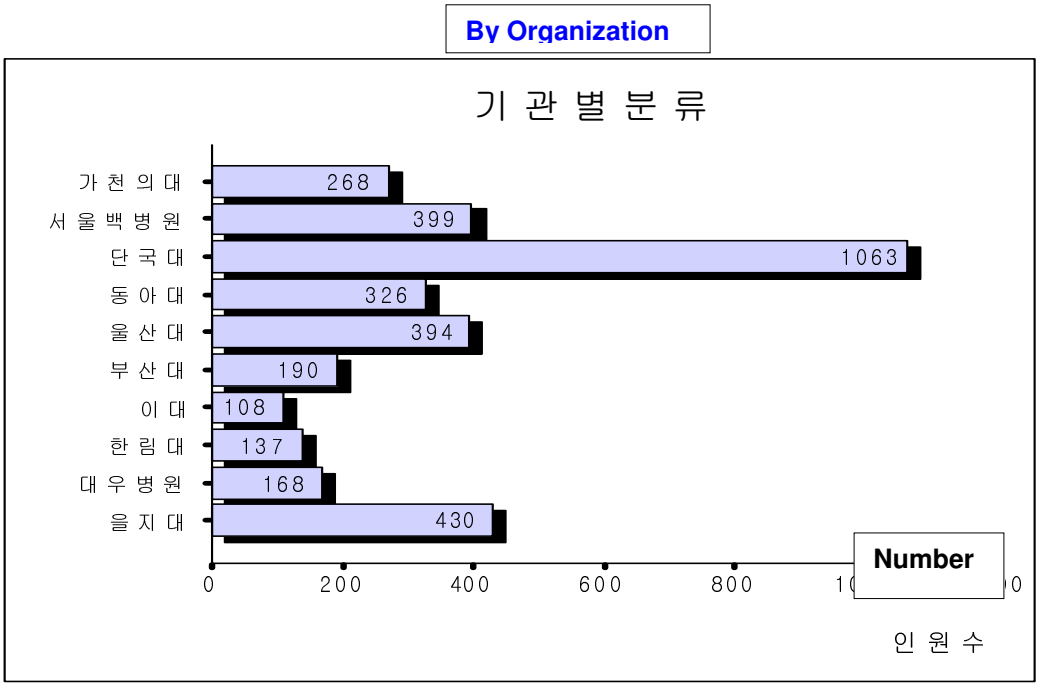
- Determine demographic change including paperweight and social security number while measuring HRV.
- Fill out questionnaires one day before or after HRV test.(Avoid right before test )

D. Test items except HRV

Major questionnaires subjects should fill out and major exam items researchers input as below.

| Questions | Additional questions for employees | Exam items |
|---|---|---|
| sex | working period | height, weight |
| age | position | blood pressure(max/min), heart rate |
| education | areas of responsibilities | CBC(RBC, Hb, MCV), blood platelet |
| religion | working hours | Glucose(before meal) |
| smoking | working pattern (shift etc,.) | cholesterol(total) |
| drinking | employment form | liver test: GOT/GPT |
| health behavior (excercise) | safety hazard | urine test: (albumen, sugar) |
| | medical history | |
| SRI | type A | gland test: T3, free T4, TSH |
| sleep questionnaire | tiredness | diagnosis of abnormality on ECG |
| | K-JCQ | diagnosis of abnormality on medical history |
| | | women - before menstrual period |

# Ⅱ. Research results




## 1. Characteristics of subjects

| Organization | Frequency | only HRV | Percent |
|---|---|---|---|
| **Gacheon Med school** | 268 | 68 | 7.7 |
| **Paik-Hospital, Seoul.** | 399 | | 11.5 |
| **Dankuk Univ.** | 1063 | 7 | 30.5 |
| **Donga Univ.** | 326 | 34 | 9.4 |
| **Ulsan Univ.** | 394 | 1 | 11.3 |
| **Busan Univ.** | 190 | 32 | 5.5 |
| **Ewha Womans Univ.** | 108 | 65 | 3.1 |
| **Hanlim Univ.** | 137 | 41 | 3.9 |

| | | | |
|---|---|---|---|
| **Daewoo Hospital** | 168 | | 4.8 |
| **Elji Hospital** | 430 | 40 | 12.3 |
| **Total** | **3,483** | **288** | **100.0** |

3,483 people gathered initially but data of only 3,442 were drawn for statistical analysis excluding 41 who showed high SDNN(over 100).

The number of subjects from a local community was 962, a corporation was 2521. 2891 responded to the questionnaires among research subjects.

Among them, 2407 corresponded to a survey for employees, who are examined in six companies including 00 city gas, 00 police office, 00 hospital, 00 Auto motors, 00 steels, 00 shipbuilding.

### 1) General nature on subjects

### (1)Age

Men accounted for 78.9%, female 21.1%, below 29 years old 10.4%, between 30-39 30.2%, between 40-49 40.8%, over 50 18.5% and people in their 40's were the most concentrated. Average age by sex for male was 42.3 years±8.32years, and female 37.8 years±10.40years, therefore male's average age was higher. The average age from all subjects was 41.3±8.99 years.

| Age | Men | Women | Total |
|---|---|---|---|
| <29 | 168(4.9) | 186(5.5) | 354(10.4) |
| 30-39 | 805(23.7) | 222(6.5) | 1027(30.2) |
| 40-49 | 1185(34.9) | 203(6.0) | 1388(40.8) |
| 50> | 523(15.4) | 106(3.1) | 629(18.5) |
| Total | **2681(78.9)** | **717(21.1)** | **3398(100.0)** |
| **Average age** | **42.3±8.32** | **37.8±10.40** | **41.3±8.99** |

Exhibit 3-1. Sex distribution by age

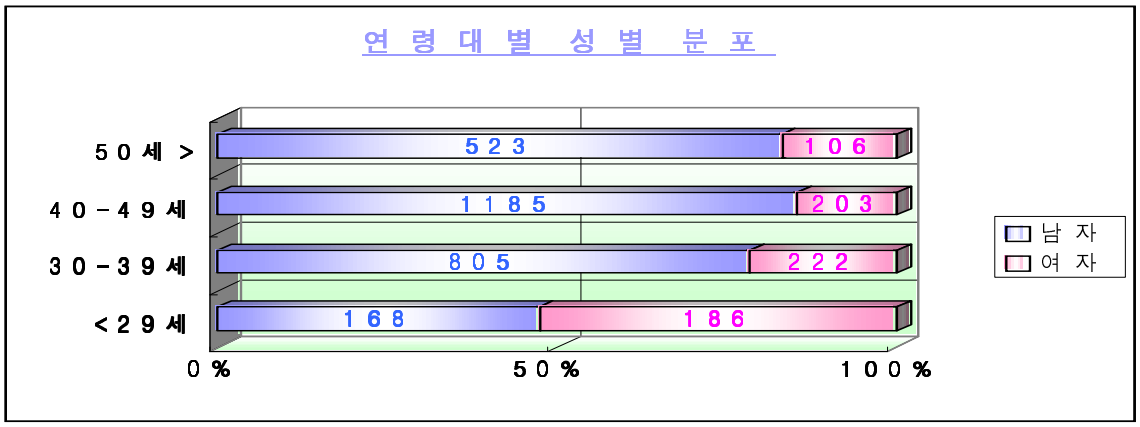



Figure 3-1. sex distribution by age

## (2) Life pattern

### A. Smoking

Questionnaires about smoking were responded by 85.3%, of which 42.5% was smokers and 37.7% non-smokers, 19.8% had a smoking history but they quit.

| Smoking | Frequency | Percentage(%) |
|---|---|---|
| smoking | 1263 | 42.5 |
| non-smoking | 1120 | 37.7 |
| smoked but quit | 589 | 19.8 |
| **total** | **2972** | **100.0** |

Exhibit 3-2 Smoking

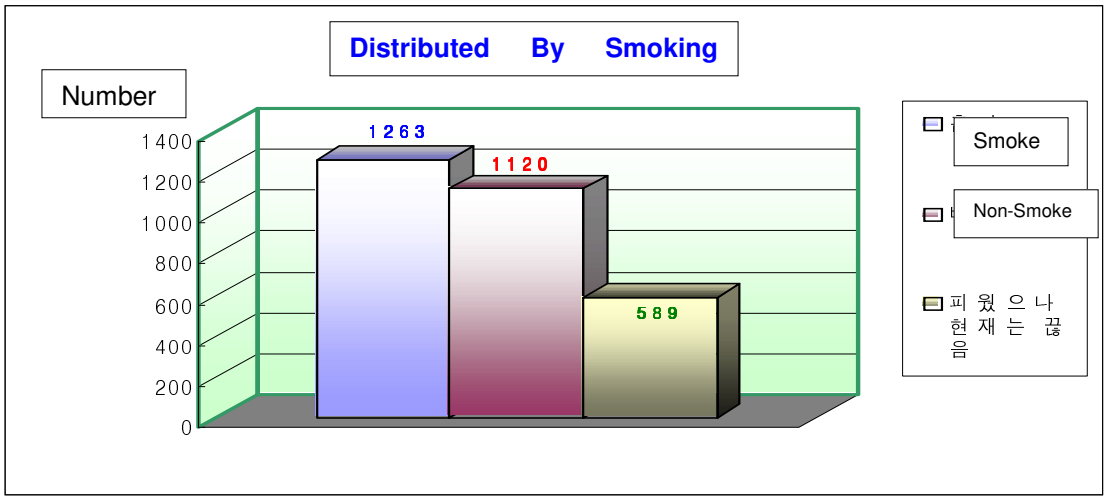



Figure 3-2. smoking/non-smoking distribution

**B. Drinking**

Questionnaires about drinking were corresponded by 2958 persons, or 84.9% out of whole, of which 1981 persons, or 67.8% were drinkers and 953 persons, or 32.2% were non-drinkers.

The survey found that persons who drink less than once a week out of drinkers accounted for 50.4%, once or twice 28.2%, three or four times 17.5%, more than five times 3.9%.

| Drinking frequency a week | Frequency | Percentage(%) |
|---|---|---|
| less than once | 983 | 50.4 |
| once or twice | 549 | 28.2 |
| three or four times | 342 | 17.5 |
| more than five times | 76 | 3.9 |
| **Total** | **1,950** | **100** |

Exhibit 3-3. Drinking frequency per week

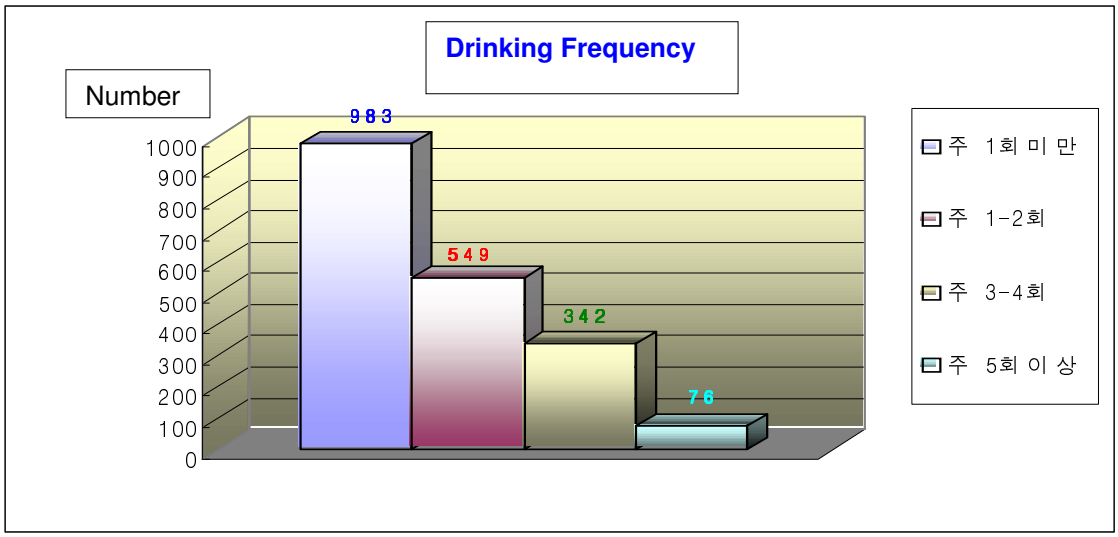



Figure 3-3. Drinking frequency per week

### C. Exercise

Questionnaires about exercise were corresponded by 2896 persons, or 83.1% out of whole subjects, of which persons who never worked out accounted for 34.9%, once or twice per week 36.2%, three or four times 19%, and more than five times 9.9%.

| Excercise frequency | Frequency | Percentage(%) |
|---|---|---|
| none | 1011 | 34.9 |
| one or twice a week | 1047 | 36.1 |
| three or four times a week | 550 | 19.1 |
| more than five times | 287 | 9.9 |
| **Total** | **2,895** | **100** |

Exhibit 3-4. Excercise frequency

Figure 3-4. Exercise frequency

### D. Religion

2849 participants or 81.8% out of total responded and 56.9% out of total respondents reported they have religion, and 43.1% no religion.

People with christianity accounted for 58.4%, Buddhism 22.5%, Catholicism 18.2%, the remainder 0. 9% out of respondents with religion.

| religion | Frequency | Percentage(%) |
|---|---|---|
| Christianity | 630 | 58.4 |
| Buddhism | 243 | 22.5 |
| Catholicism | 196 | 18.2 |
| Others | 10 | 0.9 |
| **Total** | **1,079** | **100** |

Exhibit 3-5. religion distribution

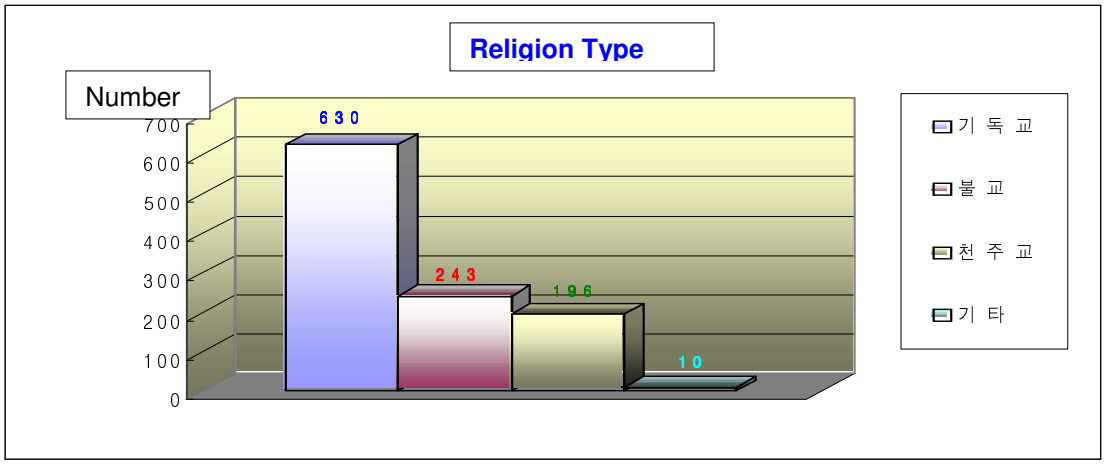



Figure 3-5. Distribution by religion

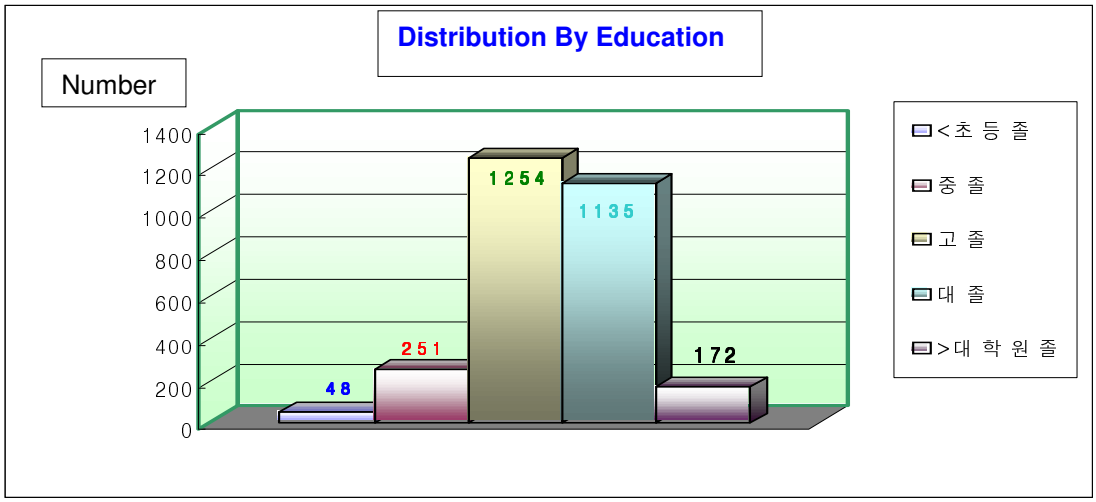
**E. Education**

2,860 or 82.1% participants out of total responded and those who have elementary or less education background accounted for 1.7%, middle school certificate 8.8%, high school certificate 43.8%, bachelor diploma 39.7%, and more than master diploma 6%.

| final education | Frequency | Percentage (%) |
|---|---|---|
| <elementary | 48 | 1.7 |
| middle school | 251 | 8.8 |
| high school | 1254 | 43.8 |

| | | |
|---|---|---|
| college | 1135 | 39.7 |
| >post graduate | 172 | 6.0 |
| **Total** | **2,860** | **100** |

Exhibit 3-6. distribution by final education




### (3)Disease

43.6% or 1501 participants out of total responded about the questionnaire whether they have diseases or not. Those who reported with no diseases accounted for 70.7%, high blood pressure 10.6%, diabetes 2.7%, hepatitis 2.7%, and others 12.5%.

| Disease | Frequency | Percentage(%) |
|---|---|---|
| **none** | 1061 | 70.7 |
| **high blood pressure** | 159 | 10.6 |
| **diabetes** | 41 | 2.7 |
| **hepatitis** | 52 | 3.5 |
| **others** | 188 | 12.5 |
| **Total** | **1501** | **100** |

Exhibit 3-7. distribution by diseases

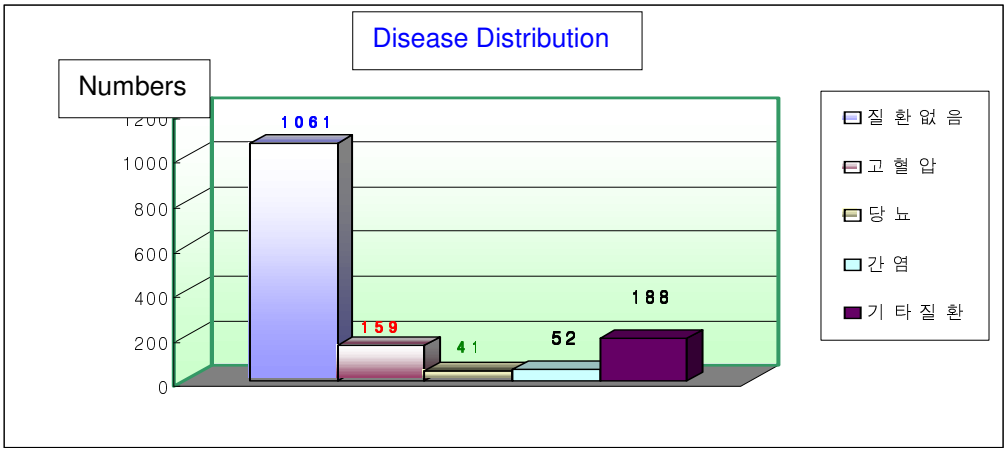



Figure 3-7. distribution by disease

## (4)Sleep

### A. Average weekly sleeping hours

2526 participants responded about average weekly sleeping hours. Those who reported under 5hours accounted for 9.9%, 5.1~6 hours 29.7%, 6.1~7 hours 37.5% , 7.1~8 hours 18.9%, and more than 8.1 hours 4.2%.

| sleeping hours(hours) | Frequency | Percentage(%) |
|---|---|---|
| <5 | 246 | 9.9 |
| 5.1~6 | 742 | 29.7 |
| 6.1~7 | 933 | 37.4 |
| 7.1~8 | 471 | 18.9 |
| >8.1 | 105 | 4.2 |
| **Total** | **2,497** | **100.1** |

Exhibit 3-8. Average sleeping hours within recent one week

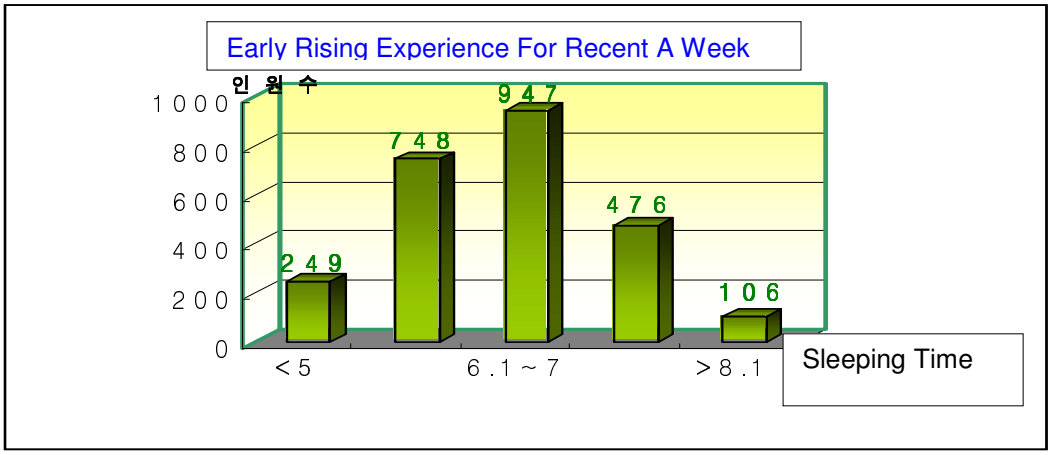



Figure 3-8. Average sleeping hours distribution

**B. Early rising**

2989 participants or 81.8% out of total responded and those who reported they had hard time due to early rising accounted for 24.4%, and who did not have those experience accounted for 75.6%.

| | Frequency | Percentage(%) |
|---|---|---|
| yes | 730 | 24.4 |
| no | 2259 | 75.6 |
| **Total** | **2,989** | **100** |

Exhibit 3-9. Early rising within recent one week

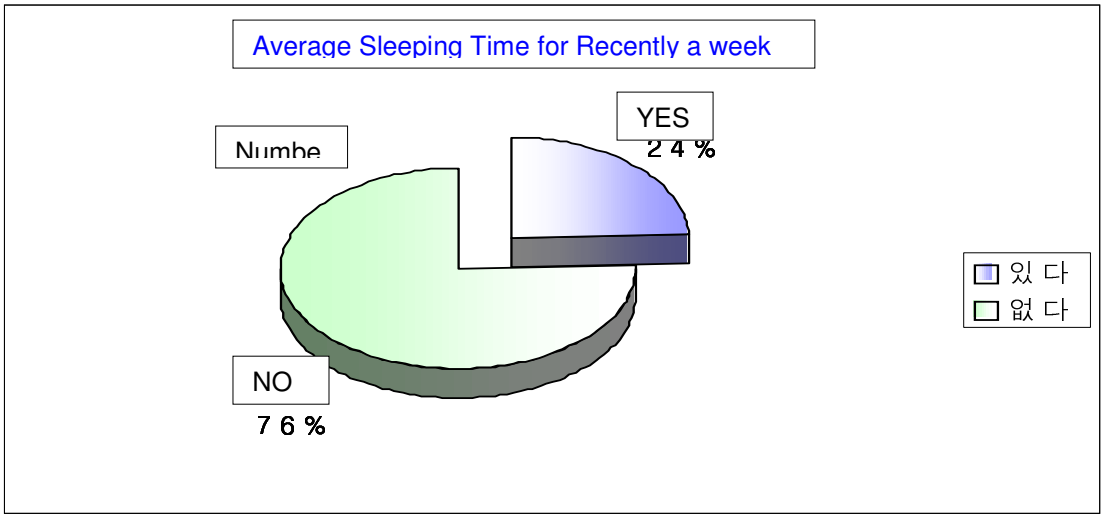


Figure 3-9. Early rising experience within recent one week

### C. Frequency of wake-up within recent one week

440 participants or 81.8% out of total responded the question about the frequency of wake-up within recent one week. Those who reported 1 time accounted for 42.5%, 2 times 33.9%, and more than 3 times 23.6%.

| The number of times | Frequency | Percentage(%) |
|---|---|---|
| 1 time | 187 | 42.5 |
| 2 times | 149 | 33.9 |
| more than 3 times | 104 | 23.6 |
| **Total** | **440** | **100** |

Exhibit 3-10. Frequency of wake-up within recent one week

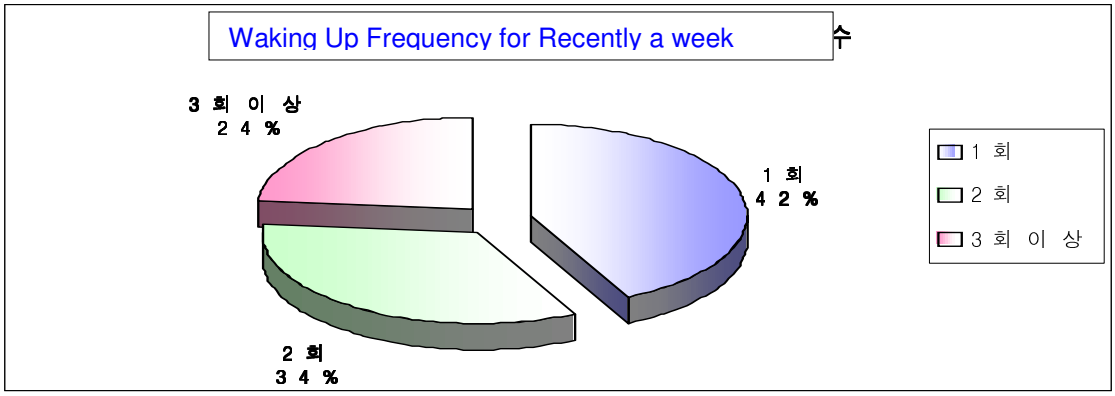



Figure 3-10. Frequency of wake-up within recent one week

### D. Snoring

Participants were asked about snoring and those who reported they do not snore accounted for 28%, they sometimes snore when tired 51.3%, two or three times a week 9.1%, and everyday for 11.6%.

| Snoring | Frequency | Percentage(%) |
|---|---|---|
| never | 835 | 28.0 |

| | | |
|---|---|---|
| sometimes after drinking or when tired | 1529 | 51.3 |
| 2-3 times a week | 270 | 9.1 |
| almost everyday | 344 | 11.6 |
| **Total** | **2,978** | **100** |

Exhibit 3-11. Snoring

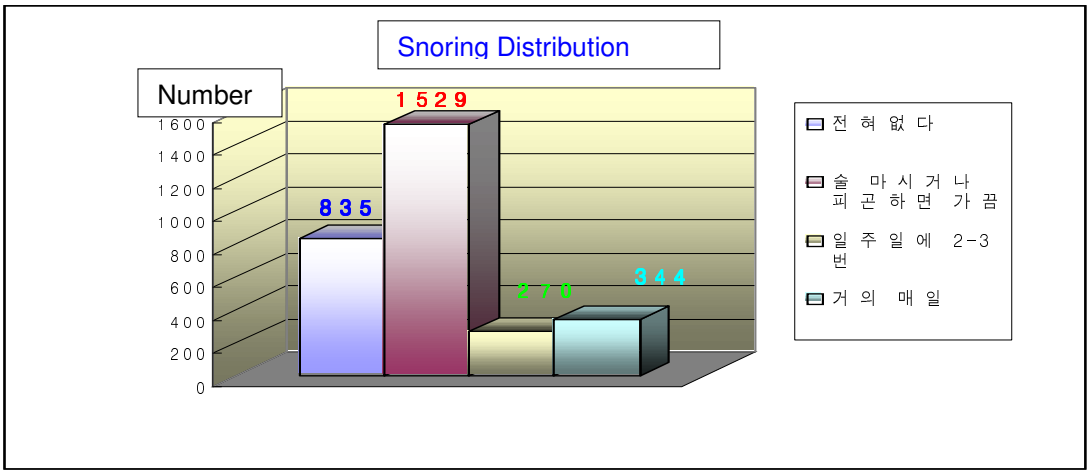



Figure 3-11. Snoring distribution

### 마. Apnea during sleeping

80.3% of participants reported they have no apnea experience, 13.5% sometimes after drinking or when feeling tired , 2.8% two or three times a week and 3.4% everyday.

| Apnea during sleeping | Frequency | Percentage(%) |
|---|---|---|
| never | 2057 | 80.3 |
| sometimes after drinking or when feeling tired | 345 | 13.5 |
| 2-3 times a week | 72 | 2.8 |
| almost everyday | 86 | 3.4 |
| **Total** | **2,560** | **100** |

Exhibit 3-12. The number of times of apnea within recent one week

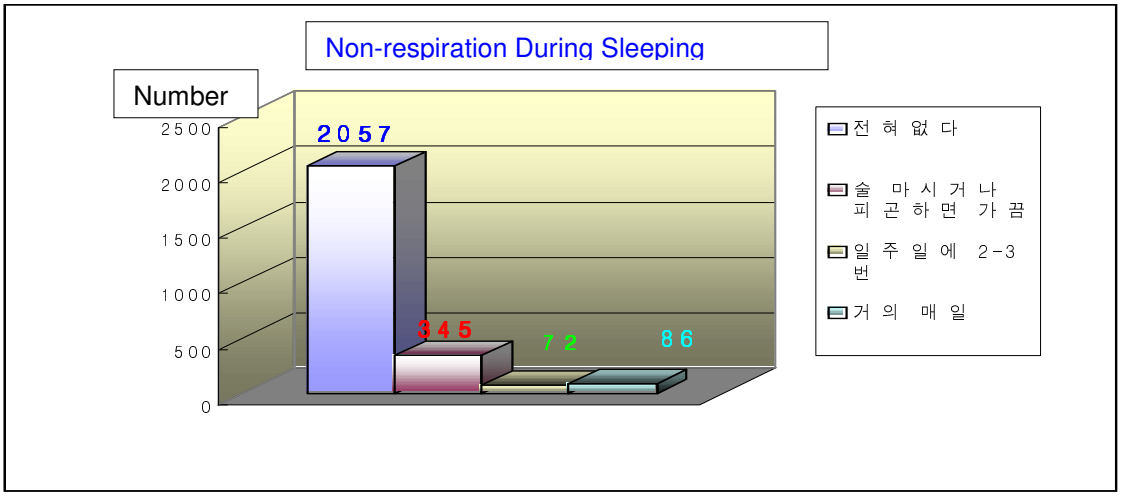



Figure 3-12. The number of times of apnea within recent one week

## 2. Analysis of HRV Variable

### (1).Mean- HRT

Average Heart rate during examination, or average Mean- HRT of total subjects found to be 71.5.

| Age | Persons | Minimum | Maximum | Average | Standard deviation | -1SD |
|---|---|---|---|---|---|---|
| below 29 | 347 | 47 | 109 | 75.8 | 11.44 | 64.36 |
| 30-39 | 1014 | 45 | 129 | 72.5 | 11.25 | 61.25 |
| 40-49 | 1365 | 44 | 112 | 70.1 | 10.65 | 59.45 |
| over 50 | 613 | 46 | 109 | 70.3 | 10.61 | 59.69 |
| **Totality** | **3,339** | **44** | **129** | **71.5** | **11.06** | **60.44** |

Exhibit 3-13. Mean- HRT

### B. SDNN

SDNN is an index showing capacity to react to stress. While Medicore set 30 as the abnormal numerical value, 30.8% of total found to be abnormal. The average of SDNN was 38.2. Below 3-14 is the average age.

| Age | Persons | Minimum | Maximum | Average | Standard deviation | -1SD |
|---|---|---|---|---|---|---|
| below 29 | 348 | 17.0 | 99.6 | 45.5 | 15.6 | 29.9 |
| 30-39 | 1014 | 12.3 | 99.6 | 41.8 | 14.2 | 27.6 |
| 40-49 | 1366 | 10.1 | 99.9 | 36.8 | 13.1 | 23.7 |
| more than 50 | 614 | 7.2 | 91.0 | 31.5 | 12.1 | 19.4 |
| **Totality** | **3,342** | **7.2** | **99.9** | **38.2** | **14.2** | **24** |

Exhibit 3-14. SDNN

**C. RMSSD**

It is the most frequently used variable for evaluating the activity of parasympathetic nerve among autonomic nerves concerning a heart. Given the fact that Medicore set under 10 abnormal, 3.3% found to be abnormal out of all subjects. Average RMSSD of total subjects found to be 28.8.

Exhibit 3-15. RMSSD distribution

| Age | Persons | Minimum | Maximum | Average | Standard deviation | -1SD |
|---|---|---|---|---|---|---|
| below 29 | 347 | 9.4 | 115.5 | 34.8 | 17.0 | 17.8 |
| 30-39 | 1014 | 5.2 | 115.2 | 31.7 | 15.3 | 16.4 |
| 40-49 | 1366 | 4.3 | 110.4 | 27.4 | 13.8 | 13.6 |
| more than 50 | 612 | 4.7 | 120.5 | 23.4 | 12.7 | 10.7 |
| **Totality** | **3,339** | **2.6** | **120.5** | **28.8** | **14.8** | **14** |

**D. LOG - LF**

It, relatively low frequency constituent, reflects activity of the total sympathetic and parasympathetic nerve simultaneously, and uses mostly the activity of sympathetic nerves. LF, related to psychological stress, could account much of many activities of sympathetic nerves concerning energy supply in a human body. LF vividly shows energy loss of a human body in a weary state by indicating low. Average LOG-LF of total participants found to be 5.48.

| Age | Persons | Minimum | Maximum | Average | Standard deviation | -1SD |
|---|---|---|---|---|---|---|
| under 29 | 270 | 3.60 | 8.30 | 5.99 | 0.80 | 5.19 |
| 30-39 | 869 | 3.10 | 8.60 | 5.78 | 0.83 | 4.95 |
| 40-49 | 1295 | 2.70 | 8.70 | 5.40 | 0.88 | 4.52 |
| more than 50 | 588 | 2.00 | 8.60 | 4.98 | 0.94 | 4.04 |
| **Totality** | **3,022** | **2.00** | **8.70** | **5.48** | **0.92** | **4.56** |

Exhibit 3-16. LOG - LF distribution

**E. LOG - HF**

HF, relatively high frequency constituent, is related to breathing activity. It activates excessively when breathing gets slow and deep. LOG-HF Average of total subjects found to be 4.96.

Exhibit 3-17. LOG - HF distribution

| Age | Persons | Minimum | Maximum | Average | Standard deviation | -1SD |
|---|---|---|---|---|---|---|
| below 29 | 270 | 2.90 | 8.40 | 5.46 | 0.99 | 4.47 |
| 30-39 | 869 | 1.20 | 8.00 | 5.23 | 0.98 | 4.25 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 40-49 | 1295 | 0.80 | 8.00 | 4.87 | 0.98 | 3.89 |
| more than 50 | 588 | 1.10 | 7.10 | 4.51 | 0.98 | 3.53 |
| **Totality** | **3,022** | **0.90** | **8.70** | **4.96** | **1.02** | **3.94** |

**F. LF/HF ratio**

It, ratio between LF and HF, reflects a sympathetic and parasym-nerve or the balance of a total autonomic nerve. It is sometimes used as the index of a sympathetic nerve. LF/HF ratio Average of total subjects founded to be 2.50.

| Age | Persons | Minimum | Maximum | Average | Standard deviation | -1SD |
|---|---|---|---|---|---|---|
| below 29 | 346 | 0.09 | 15.80 | 2.23 | 2.04 | 0.19 |
| 30-39 | 1012 | 0.10 | 24.30 | 2.56 | 2.60 | -0.04 |
| 40-49 | 1366 | 0.10 | 46.90 | 2.53 | 3.06 | -0.53 |
| more than 50 | 612 | 0.10 | 42.80 | 2.47 | 3.08 | -0.61 |
| **Totality** | **3,336** | 0.09 | **46.90** | **2.50** | **2.84** | **-0.34** |

Exhibit 3-18. LF/HF ratio 의 distribution

## 3. Relevance analysis of HRV and each index

3,483 were drawn for data collection but 3120 were analysed excluding 41, those who found to be abnormally high with SDNN and 288 who only tested HRV and did not respond to questionnaires.

### 1) Nature of electrophysiological of HRV

| Variable | Mean±SD | Percentile | | | | | | | Range |
|---|---|---|---|---|---|---|---|---|---|
| | | 2.5th | 10th | 25th | 50th | 75th | 90th | 97.5th | |
| **Age** | 41.51±11.82 | 25 | 29 | 34 | 42 | 48 | 53 | 58 | 18~66 |
| **HR** | 71.48±11.07 | 52 | 58 | 64 | 70 | 78 | 86 | 96 | 44~129 |
| **SDNN** | 38.24±14.31 | 16.3 | 22.1 | 28.1 | 36.2 | 45.9 | 57.0 | 67.3 | 7.9~99.9 |
| **RMSSD** | 28.74±14.83 | 9.21 | 13.5 | 18.8 | 25.7 | 35.5 | 46.7 | 67.3 | 4.3~120.5 |
| **PSI** | 58.77±60.44 | 10.4 | 16.8 | 25.9 | 41.7 | 68.8 | 112.9 | 218.9 | 5.2~960.8 |
| **APEN** | 1.15±0.11 | 0.89 | 1.02 | 1.09 | 1.16 | 1.22 | 1.27 | 1.32 | 0.1~1.4 |
| **SRD** | 0.99±1.28 | 0.77 | 0.84 | 0.90 | 0.96 | 1.02 | 1.09 | 1.21 | 0.4~7.48 |
| **TSRD** | 123.89±39.32 | 60.1 | 78.8 | 96.7 | 119.1 | 146.0 | 174.7 | 216.5 | 0.01~309.0 |
| **TP** | 1240.9±1120.0 | 181.6 | 346.6 | 554.3 | 924.9 | 1544.8 | 2421.7 | 4271.0 | 5.0~17475.3 |
| **VLF** | 638.5±713.2 | 72.8 | 142.4 | 240.3 | 441.3 | 790.9 | 1316.7 | 2358.5 | 15.7~17206.9 |
| **LF** | 370.6±443.2 | 34.8 | 74.5 | 131.6 | 245.8 | 441.3 | 764.4 | 1460.8 | 2.1~6109.5 |
| **HF** | 231.2±276.1 | 15.5 | 38.2 | 74.9 | 148.0 | 284.4 | 503.4 | 942.2 | 0.02~4300.9 |
| **LFnorm** | 61.2±17.7 | 25.0 | 36.5 | 48.4 | 62.5 | 75.3 | 83.6 | 90.6 | 6.9~97.9 |
| **HFnorm** | 38.8±17.7 | 9.4 | 16.3 | 24.7 | 37.5 | 51.6 | 63.5 | 75.0 | 2.1~93.1 |
| **RATIO** | 2.50±2.84 | 0.3 | 0.6 | 0.9 | 1.7 | 3.0 | 5.1 | 9.6 | 0.09~46.9 |
| **Ln_TP** | 6.82±0.78 | 5.2 | 5.9 | 6.3 | 6.8 | 7.3 | 7.8 | 8.4 | 3.4~9.8 |
| **Ln_VLF** | 6.08±0.87 | 4.3 | 5.0 | 5.5 | 6.1 | 6.7 | 7.2 | 7.8 | 2.8~9.8 |
| **Ln_LF** | 5.48±0.93 | 3.6 | 4.3 | 4.9 | 5.5 | 6.1 | 6.6 | 7.3 | 1.2~87 |
| **Ln_HF** | 4.95±1.02 | 2.8 | 3.7 | 4.3 | 5.0 | 5.7 | 6.2 | 6.9 | 0.8~8.4 |

### 2) Nature of demography and HRV

#### (1)Age

Research suggested that the more younger participants get, the higher SDNN ,RMSSD, Ln-TP, Ln-LF, Ln-HF they get and the younger, the higher PSI level gets.

| | 1. 20s (n=347) | 2. 30s (1014) | 3. 40s (1366) | more than 4. 50s (612) | F | follow-up comparison |
|---|---|---|---|---|---|---|
| **SDNN** | 45.43 (15.49) | 41.77 (14.30) | 36.81(13.18) | 31.53(14.25) | 109.62*** | 1>2>3>4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **RMSSD** | 34.83(16.98) | 31.70(15.27) | 27.43(13.80) | 23.46(12.68) | 65.79*** | 1>2>3>4 |
| **PSI** | 40.95(31.07) | 48.65(45.56) | 59.80(57.87) | 80.81(78.19) | 52.96*** | 1>2>3>4 |
| **RATIO** | 2.23(2.04) | 2.56(2.60) | 2.53(3.064) | 2.47(3.07) | 1.22 | |
| **Ln-TP** | 7.21(0.71) | 7.05(0.72) | 6.75(0.74) | 6.46(0.79) | 103.33*** | 1>2>3>4 |
| **Ln-LF** | 5.99(0.80) | 5.78(0.83) | 5.40(0.88) | 4.99(0.94) | 132.98*** | 1>2>3>4 |
| **Ln-HF** | 5.46(0.99) | 5.23(0.98) | 4.87(0.98) | 4.51(0.98) | 88.99*** | 1>2>3>4 |

Exhibit 4-1. HRV index comparison by age

* p < .05. ** p < .01. *** p < .001.

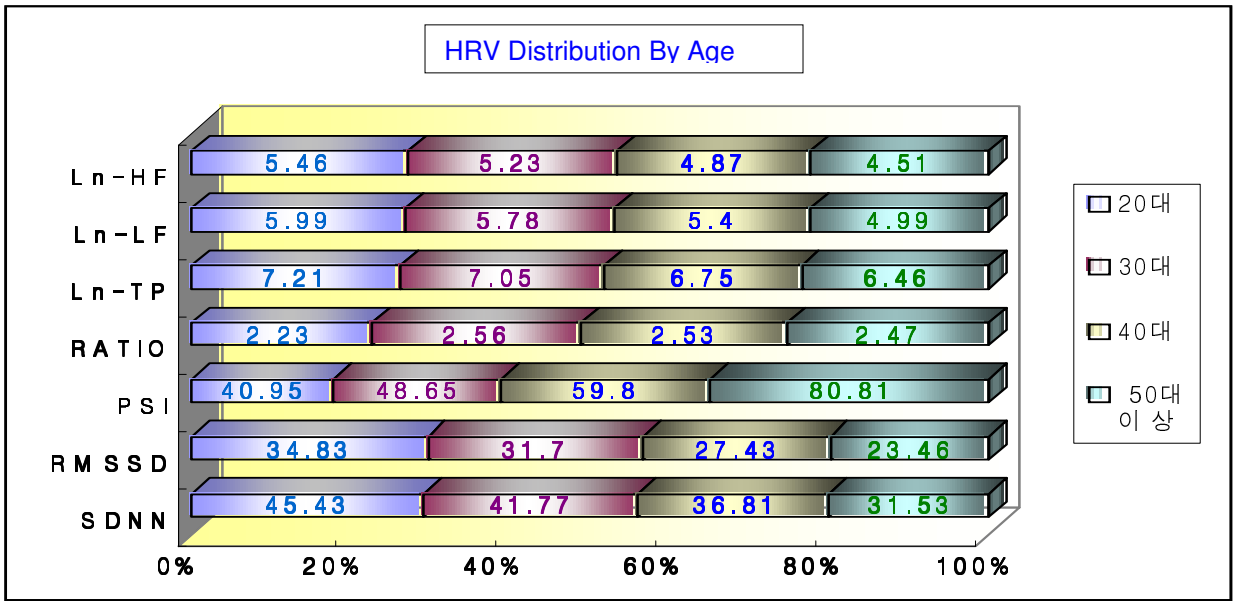



Figure 4-1. HRV by age

**(2) Sex**

Women got higher SDNN, RMSSD, Ln-HF closely and men got higher in PSI, RATIO.

Average age was 42.3±8.32 for men and 37.8±10.40 for women.

Exhibit 4-2. HRV index comparison by sex

| | **men(n=2665)** | **women(699)** | **t** |
|---|---|---|---|
| **SDNN** | 37.91(14.46) | 39.52 (13.65) | -2.66** |
| **RMSSD** | 28.09(14.80) | 31.20(14.71) | -4.95*** |
| **PSI** | 60.58(63.90) | 51.86(44.26) | 4.19*** |

| | | | |
|---|---|---|---|
| **RATIO** | 2.65(0.06) | 2.15(0.08) | 7.56*** |
| **Ln-TP** | 6.81(0.79) | 6.87(0.73) | -1.69 |
| **Ln-LF** | 5.48(0.94) | 5.45(0.89) | 0.76 |
| **Ln-HF** | 4.90(1.03) | 5.16(0.96) | -5.789*** |

* p < .05. ** p < .01. *** p < .001.

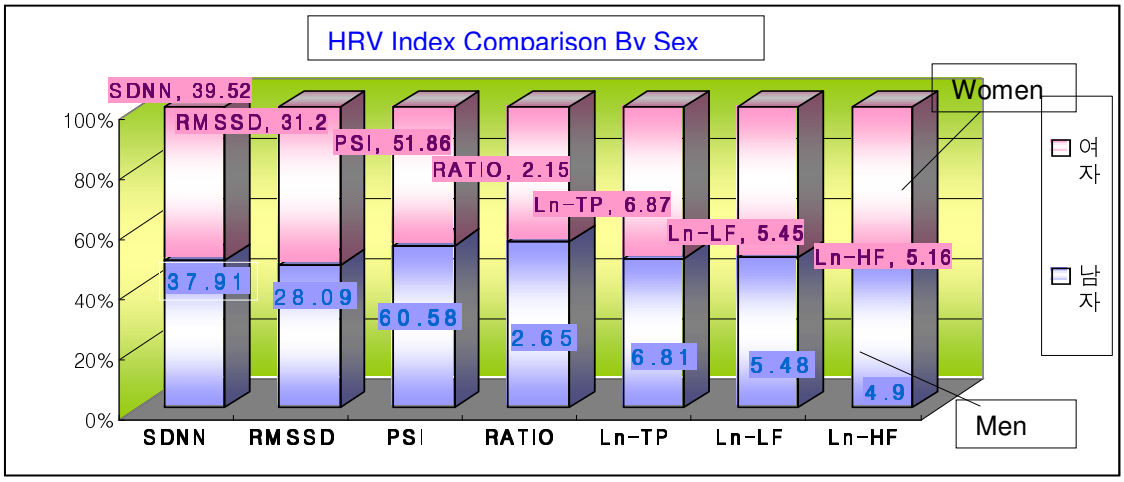



Figure 4-2. HRV index comparison by sex

### ※ HRV with control of men/women

Considering sex and age distribution is different, needed is further studies about whether sex difference should be included in a variance to influence HRV criterion. As a result of controlling age, SDNN, PSI showed no difference, but Ln-TP, Ln-LF did. In other words, RMSSD, RATIO, Ln-TP, Ln-LF, Ln-HF showed significant difference in sex.

Exhibit 4-3. HRV with control of men/women

| | **F** |
|---|---|
| **SDNN** | 1.371 |
| **RMSSD** | 4.375* |
| **PSI** | .514 |
| **RATIO** | 40.590*** |

| | |
|---|---|
| **Ln-TP** | 3.858* |
| **Ln-LF** | 27.185*** |
| **Ln-HF** | 6.784** |

## 2)Life pattern and HRV

### (1)Smoking and HRV

Smoking showed no significant influence on HRV index.

| | 1.smoking (n=1222) | 2.non-smoking (1097) | 3.quit (572) | F | following check-up |
|---|---|---|---|---|---|
| **SDNN** | 38.28 (14.35) | 37.65(14.10) | 39.27(14.42) | 2.43 | 2<3 |
| **RMSSD** | 28.94(14.58) | 28.19(16.18) | 29.34(16.18) | 1.33 | |
| **PSI** | 58.49(60.72) | 59.79(54.64) | 53.73(55.20) | 2.15 | 2>3 |
| **RATIO** | 2.48(2.85) | 2.55(2.62) | 2.54(2.87) | 0.21 | |
| **Ln-TP** | 6.80(0.79) | 6.83(0.77) | 6.89(0.77) | 2.28 | 1<3 |
| **Ln-LF** | 5.47(0.93) | 5.49(0.92) | 5.53(0.92) | 0.79 | |
| **Ln-HF** | 4.98(1.02) | 4.94(1.02) | 4.99(1.03) | 0.61 | |

Exhibit 4-4. Comparison of smoking and HRV index

* p < .05. ** p < .01. *** p < .001.

### (2)Drinking and HRV

Depending on drinking or no drinking, drinkers showed higher figures on RATIO and Ln-LF out of HRV index.

| | no drinking(n=932) | drinking(1945) | t |
|---|---|---|---|
| **SDNN** | 37.66(13.29) | 38.53(14.71) | -1.59 |
| **RMSSD** | 28.85(14.18) | 28.67(14.98) | 0.31 |
| **PSI** | 56.65(48.79) | 58.35(60.72) | 0.81 |

| | | | |
|---|---|---|---|
| **RATIO** | 2.35(2.59) | 2.65(2.82) | -2.25* |
| **Ln-TP** | 6.82(0.74) | 6.84(0.79) | -0.65 |
| **Ln-LF** | 5.44(0.91) | 5.52(0.93) | -2.07* |
| **Ln-HF** | 4.99(0.99) | 4.95(1.04) | 0.73 |

Exhibit 4-5. Comparison of smoking and HRV index

* p < .05. ** p < .01. *** p < .001.

**(3) Coffee and HRV**

SDNN ,Ln-TP, Ln-LF Ln-HF showed significant difference and appeared higher among drinkers.

| | **not drinking(n=655)** | **drinking(2333)** | **t** |
|---|---|---|---|
| **SDNN** | 37.14(14.14) | 38.38(14.24) | -1.96* |
| **RMSSD** | 27.54(13.94) | 28.77(14.71) | -1.90 |
| **PSI** | 62.34(66.53) | 57.61(57.29) | 1.80 |
| **RATIO** | 2.60(3.03) | 2.48(2.69) | 0.99 |
| **Ln-TP** | 6.75(0.80) | 6.84(0.77) | -2.61** |
| **Ln-LF** | 5.41(0.97) | 5.50(0.91) | -2.14* |
| **Ln-HF** | 4.87(1.04) | 4.97(1.01) | -2.18* |

Exhibit 4-6. Comparison of drinking coffee and HRV index

* p < .05. ** p < .01. *** p < .001.

**(4) Excercise and HRV**

The higher SDNN ,RMSSD, Ln-TP, Ln-LF , Ln-HF get, the more participants exercise. The higher PSI gets, the less exercise was done.

| | 1.none (n=980) | 2.1-2 a wk (1024) | 3.3-4 a wk (531) | 4. 5-7a wk (281) | F | Multiple comparison |
|---|---|---|---|---|---|---|
| **SDNN** | 36.63(13.40) | 38.20(13.94) | 40.47(15.38) | 39.81(15.29) | 9.73*** | 1<3 |
| **RMSSD** | 27.20(14.00) | 28.20(13.19) | 31.34(16.51) | 32.28(17.46) | 16.04*** | 1,2<3,4 |
| **PSI** | 62.06(55.18) | 59.46(65.63) | 51.41(46.38) | 50.33(48.97) | 5.90** | 3,4<1,2 |
| **RATIO** | 2.47(2.61) | 2.60(2.95) | 2.45(2.85) | 2.38(2.56) | 0.65 | |
| **Ln-TP** | 6.77(0.76) | 6.83(0.79) | 6.92(0.77) | 6.87(0.80) | 3.92* | 1<3 |
| **Ln-LF** | 5.41(0.91) | 5.52(0.92) | 5.57(0.92) | 5.54(0.99) | 3.97* | 1<3,4 |
| **Ln-HF** | 4.89(1.05) | 4.95(0.98) | 5.08(1.04) | 5.10(1.03) | 5.18** | 1,2<3,4 |

Exhibit 4-7. Comparison of excercise and HRV index

* p < .05. ** p < .01. *** p < .001.

## 3) Disease status, medical examination and HRV

**(1) Disease type and HRV**

Those with geriatric diseases including high blood pressure, and diabetes showed significant decline in SDNN, RMSSD,Ln-TP, Ln-HF, Ln-LF and surge in PSI . This is a vital view in the fact that HRV can be used as a predictor of cardiac disorder and diabetes autonomic neuropathy in endocrine and metabolic diseases.

Exhibit 4-8. Comparison of smoking and HRV index

| | 1.none (n=1024) | 2.high blood pressure (156) | 3.diabetes (41) | 4.hepatitis (52) | 5.others (186) | F | Multiple comparison |
|---|---|---|---|---|---|---|---|
| **SDNN** | 39.13 | 33.19 | 36.53 | 36.27 | 36.36 | 7.45*** | 1>2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | (14.11) | (11.86) | (16.33) | (14.96) | (12.31) | | |
| **RMSSD** | 29.28 (14.89) | 24.47 (13.62) | 27.71 (18.97) | 28.00 (13.89) | 26.65 (13.15) | 5.90*** | 1>2 |
| **PSI** | 52.25 (45.62) | 74.29 (68.27) | 82.44 (97.85) | 68.00 (90.52) | 64.23 (62.80) | 9.20*** | 1<2<3 |
| **RATIO** | 2.48 (2.87) | 2.53 (2.93) | 2.51 (1.99) | 3.01 (2.85) | 2.40 (1.87) | 0.53 | |
| **Ln-TP** | 6.90 (0.74) | 6.57 (0.75) | 6.62 (0.86) | 6.82 (0.91) | 6.75 (0.78) | 7.04*** | 1>2 |
| **Ln-LF** | 5.53 (0.92) | 5.14 (0.93) | 5.40 (0.82) | 5.43 (1.10) | 5.40 (0.92) | 5.61*** | 1>2 |
| **Ln-HF** | 5.08 (0.97) | 4.59 (0.98) | 4.70 (1.07) | 4.81 (1.38) | 4.83 (1.09) | 9.21*** | 1>2 |

* p < .05. ** p < .01. *** p < .001.

**(2) Cholesterol and HRV**

SDNN, RMSSD, Ln-TP, Ln-LF, Ln-HF showed significant decline with the group with Cholesterol increase of 240mg/dl compared to those in their 20s and PSI showed significant increase.

Exhibit 4-9. Comparison of cholesterol and HRV index

| | **less than 1.240mg/dl (n=1910)** | **2. more than 240mg/dl (1097)** | **t** |
|---|---|---|---|
| **SDNN** | 38.94 (14.52) | 34.28(12.07) | 4.957*** |
| **RMSSD** | 29.33(14.85) | 25.72(12.47) | 3.723*** |
| **PSI** | 57.83(57.21) | 70.66(68.01) | -2.501* |
| **RATIO** | 2.54(2.91) | 2.30(2.42) | 1.108 |
| **Ln-TP** | 6.87(0.78) | 6.59(0.75) | 4.318*** |
| **Ln-LF** | 5.54(0.93) | 5.16(0.92) | 5.018*** |
| **Ln-HF** | 5.00(1.01) | 4.72(1.01) | 3.058*** |

* p < .05. ** p < .01. *** p < .001.

**(3) Comparison of Systolic blood pressure and HRV index**

SDNN, RMSSD, Ln-TP, Ln-LF, Ln-HF showed significant decline with the group whose systolic blood pressure increased over 140mmHg and PSI showed significant increase..

Exhibit 4-10. Comparison of Systolic blood pressure and HRV index

| | 1.less than1.140mmHg (n=2186) | 2.more than140mmHg (185) | t |
|---|---|---|---|
| **SDNN** | 38.56 (14.37) | 34.26(13.22) | 3.938*** |
| **RMSSD** | 28.80(12.89) | 24.39(12.89) | 3.997*** |
| **PSI** | 58.06(59.09) | 79.63(76.74) | -3.731*** |
| **RATIO** | 2.55(3.00) | 2.59(2.75) | -2.11 |
| **Ln-TP** | 6.84(0.78) | 6.60(0.81) | 3.678*** |
| **Ln-LF** | 5.49(0.92) | 5.25(1.04) | 2.838** |
| **Ln-HF** | 4.96(1.01) | 4.66(1.08) | 3.584*** |

* p < .05. ** p < .01. *** p < .001.

## 4) Stress -SRI

2,700 responded and symptoms of stress based on SRI were tension, aggressive tendency, physical action, rage, depression, tiredness, frustration. After grading symptoms by case and general symptoms, an ordinary group fell under 50%, a low risk group 51-70%, and high risk group over 71%.

Exhibit 4-11.Risk classification and its standard out of Stress

| classification | tension | aggress-ive tendency | physical action | rage | depress-ion | tired-ness | frustra-tion | total |
|---|---|---|---|---|---|---|---|---|
| **ordinary** | 1607 | 1644 | 1802 | 1449 | 1516 | 1693 | 1657 | 1378 |
| **(below average)** | (56.3) | (62.6) | (62.4) | (50.7) | (53.2) | (58.9) | (58.0) | (51.0) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **low risk group** | 530 (18.6) | 483 (18.4) | 361 (12.5) | 757 (26.5) | 632 (22.2) | 331 (11.5) | 413 (14.4) | 541 (20.0) |
| **high risk group** | 719 (25.2) | 498 (19.0) | 723 (25.1) | 651 (22.8) | 703 (24.7) | 848 (29.5) | 789 (27.6) | 781 (28.9) |

### 5) Regression analysis

**Multiple Regression analysis was conducted to identify the most convincing variable.**

■ **General character - M-HRT, AGE, BMI. SBP**

SDNN, TP, PSI, RMSSD changed according to M-HRT and AGE change with both men and women, which shows explicitly that M-HRT and AGE explains HRV.

**(1)Men**

**A. SDNN**

| Dependent variable | Independent variable | R | R Square | $R^2$ change | Beta | F change |
|---|---|---|---|---|---|---|
| **SDNN** | **M-HRT** | 0.469 | .220 | .003 | -.435*** | 5.585* |
| | **AGE** | | | | -.245*** | |
| | **BMI** | | | | -.057* | |

**B. PSI**

| Dependent variable | Independent variable | R | R Square | $R^2$ change | Beta | F change |
|---|---|---|---|---|---|---|
| **PSI** | **M-HRT** | .602 | .362 | .003 | -.572*** | 5.532* |
| | **AGE** | | | | -.245*** | |
| | **SBP** | | | | -.052* | |

**C.TP**

| Dependent variable | Independent variable | R | R Square | $R^2$ change | Beta | F change |
|---|---|---|---|---|---|---|
| TP | M-HRT | .318 | .101 | .021 | -.303*** | 30.549*** |
| | AGE | | | | -.145*** | |

**D. RMSSD**

| Dependent variable | Independent variable | R | R Square | $R^2$ change | Beta | F change |
|---|---|---|---|---|---|---|
| RMSSD | M-HRT | .502 | .252 | .003 | -.476*** | 5.297* |
| | AGE | | | | -.179*** | |
| | SBP | | | | -.063** | |
| | BMI | | | | -.055* | |

**(2)Women**

**A.SDNN**

| Dependent variable | Independent variable | R | R Square | $R^2$ change | Beta | F change |
|---|---|---|---|---|---|---|
| SDNN | M-HRT | .313 | .118 | .010 | -.329*** | 5.112* |
| | AGE | | | | -.251*** | |
| | SBP | | | | .101* | |

**B.PSI**

| Dependent variable | Independent variable | R | R Square | $R^2$ change | Beta | F change |
|---|---|---|---|---|---|---|
| PSI | M-HRT | .481 | .232 | .103 | 10.865*** | 63.647*** |
| | AGE | | | | 7.978*** | |

**C.TP**

| Dependent variable | Independent variable | R | R Square | $R^2$ change | Beta | F change |
|---|---|---|---|---|---|---|
| TP | M-HRT | .209 | .044 | .011 | -.197** | 5.485* |
| | SBP | | | | .121* | |
| | AGE | | | | -.114* | |

**D.RMSSD**

| Dependent variable | Independent variable | R | R Square | $R^2$ change | Beta | F change |
|---|---|---|---|---|---|---|
| RMSSD | M-HRT | .460 | .212 | .032 | -.479*** | 19.450*** |
| | AGE | | | | -.188*** | |

## 4) Correlation analysis with age control

Attachment 2 is the result of correlation analysis with control of age, the most influential factor to HRV result.

.

# 4.Result of adaptation

### 1) Character

**(1)Occupational types**

1322 out of 2521among workplace exam subjects responded the questionnaires about occupational types. Manufacturing workers accounted for 61.4%, office workers 38.6%.

| Occupational types | Frequency | Percentage(%) |
|---|---|---|
| Manufacturing workers | 812 | 61.4 |

| | | |
|---|---|---|
| office workers | 510 | 38.6 |
| **Total** | **1,322** | **100** |

Exhibit 5-1. distribution by occupational types

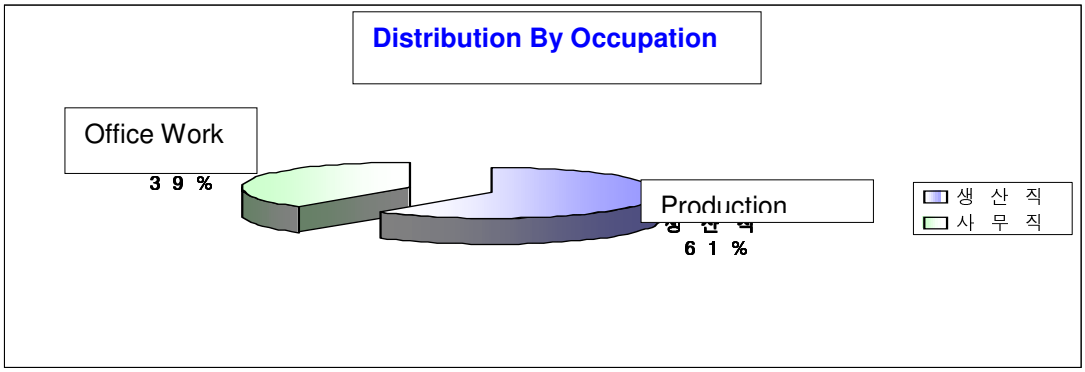



Exhibit 5-1. Distribution by occupational types of business

**(2) Employment type**

1270 responded questions about employment type. Full timers accounted for 96.1%, outsourcing workers 0.6%, contractual workers 2.1%, and the remainder 1.3%.

| employment type | Frequency | Percentage(%) |
|---|---|---|
| Full time | 1220 | 96.1 |
| outsourcing | 7 | 0.6 |
| contract | 27 | 2.1 |
| other | 16 | 1.3 |
| **Total** | **1,270** | **100.1** |

Exhibit 5-2. Distribution by employment type

**(3) Job type**

Out of 1962 who responded, those with no shift accounted for 64.1%, and shift 35.1% . 360 responded questions about shift type among those 35.1%. Those are from 00 police office ,00 nurse ,00 steels, etc.

| shift type | Frequency | Percentage(%) |
|---|---|---|
| 3 shift | 283 | 78.6 |
| 2 shift | 58 | 16.1 |
| shift followed by 24-hour duty | 3 | 0.8 |
| others | 16 | 4.5 |
| **Total** | **360** | **100** |

Exhibit 5-3. Distribution of shift type

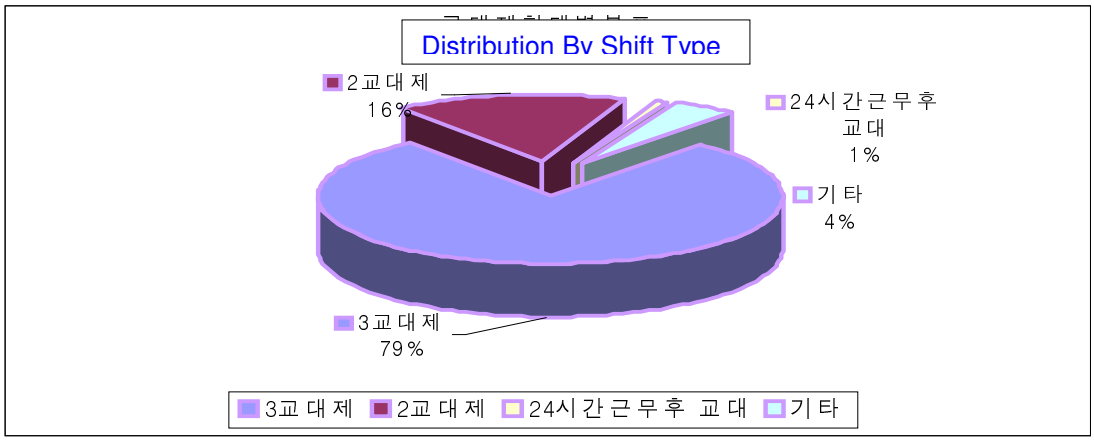



Figure 5-2. Distribution by shift type

**(4) Working hours**

1,179 responded out of 2521. Among them, those who works more than 40 hours weekly accounted for 9.5%, 41~44hours 29.9%, 45~48hours 14.2%, 49~56hours 29.6%, and more than 57hours 16.9%.

| Average weekly working hours | Frequency | Percentage(%) |
|---|---|---|
| <40hours | 112 | 9.5 |
| 41-44hours | 352 | 29.9 |
| 45-48hours | 167 | 14.2 |
| 49-56hours | 349 | 29.6 |
| >57hours | 199 | 16.9 |
| **Total** | **1179** | **100.0** |

Exhibit 5-4. Distribution by average weekly working hours

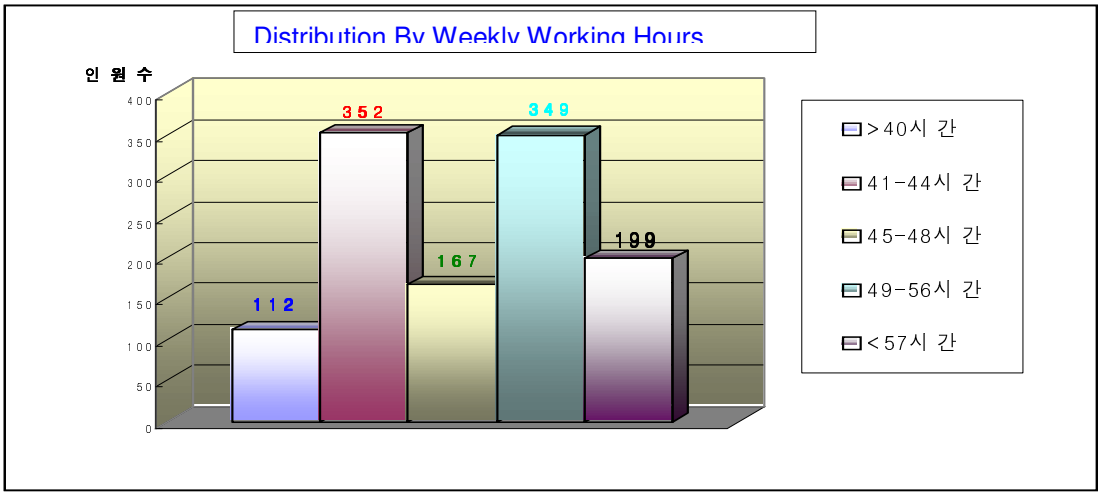



Figure 5-3. Distribution by weekly working hours

**(5)Monthly paycheck**

32.2% or 1,127 out of all subjects responded.

| Monthly paycheck (unit:10,000KRW) | Frequency | Percentage(%) |
|---|---|---|
| <monthly 100 | 98 | 8.7 |
| monthly 101~200 | 286 | 25.4 |
| monthly 201~300 | 356 | 31.6 |

| | | |
|---|---|---|
| 301~400 | 270 | 24.0 |
| >401 | 117 | 10.3 |
| **Total** | **1,127** | **100** |

Exhibit 5-5. Distribution by monthly paycheck

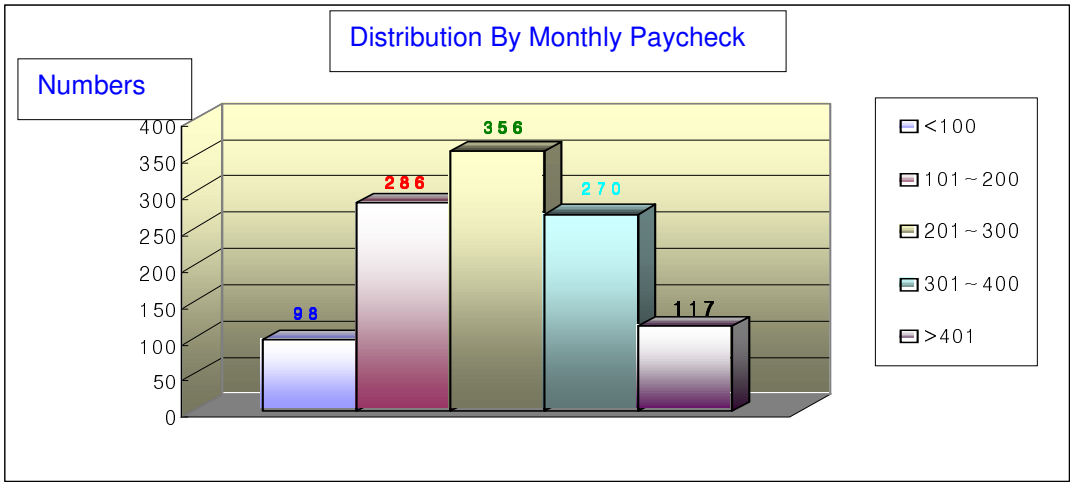



Figure 5-4. Distribution by monthly paycheck

**(6) JCQ**

In Job strain based on Karasek, 708 responded among employees. .

| | Detail | Frequency | Percent |
|---|---|---|---|
| **low strain group** | high competence low demand | 108 | 15.3 |
| **participative** | high competence high demand | 192 | 27.1 |
| **passive** | low competence low demand | 250 | 35.3 |
| **high strain group** | low competence high demand | 158 | 22.3 |
| **Total** | | **708** | **100** |

Exhibit 5-6. JCQ

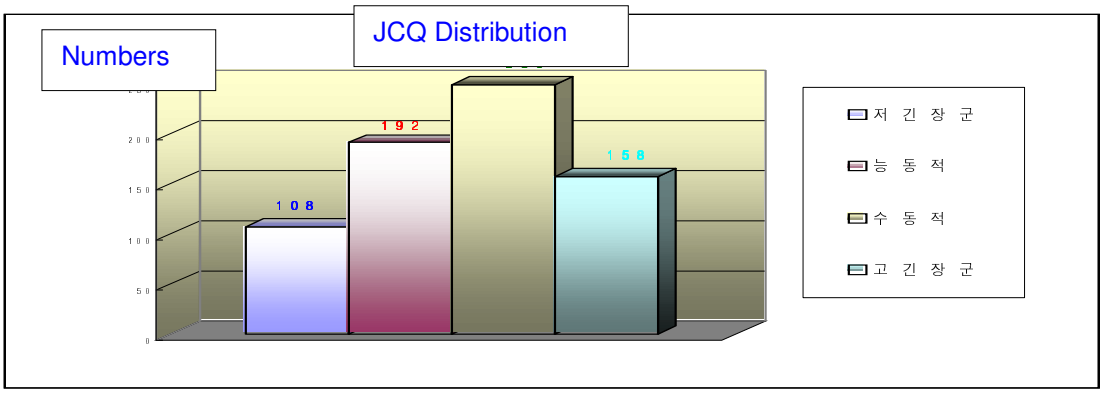



Figure 5-5. JCQ Distribution

## 2) Regression analysis

### ■ JCQ - Job requirement, Autonomy, Superiors support, Co-workers support

#### (1) Male

SDNN, TP, RMSSD showed no change in terms of JCQ change for man but investigation suggested that only PSI could change depending on Job competence.

**A. PSI**

| Dependent variable | Independent variable | R | R Square | $R^2$ change | Beta | F change |
|---|---|---|---|---|---|---|
| **PSI** | **Job competence** | .087 | .008 | .008 | -.087* | 4.942* |

#### (2)Female

Hierarchical regression analysis for women uncovered that only SDNN, PSI, TP, RMSSD out of JCQ changed depending on job competence.

| Dependent variable | Independent variable | R | R Square | $R^2$ change | Beta | F change |
|---|---|---|---|---|---|---|
| **SDNN** | **Job** | .636 | .405 | .405 | -.636** | 10.212** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **competence** | | | | | |

**A. SDNN**

**B. PSI**

| **Dependent variable** | **Independent variable** | **R** | **R Square** | **R² change** | **Beta** | **F change** |
|---|---|---|---|---|---|---|
| **PSI** | **Job competence** | .526 | .277 | .277 | .526* | 5.742* |

**C. TP**

| **Dependent variable** | **Independent variable** | **R** | **R Square** | **R² change** | **Beta** | **F change** |
|---|---|---|---|---|---|---|
| **TP** | **Job competence** | .506 | .256 | .256 | -.506* | 5.164* |

**D.RMSSD**

| **Dependent variable** | **Independent variable** | **R** | **R Square** | **R² change** | **Beta** | **F change** |
|---|---|---|---|---|---|---|
| **RMSSD** | **Job competence** | .595 | .354 | .311 | -.595 | 8.232 |

**■ Behavior pattern - TYPE-A & CHARACTER**

**(1) Men**

**A. SDNN**

| **Dependent variable** | **Independent variable** | **R** | **R Square** | **R² change** | **Beta** | **F change** |
|---|---|---|---|---|---|---|
| **SDNN** | **total** | .173 | .030 | .005 | -.174 | 4.789* |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **character** | | | | | |
| | **character 5** | | | | .075 | |

**B. PSI**

| Dependent variable | Independent variable | R | R Square | R² change | Beta | F change |
|---|---|---|---|---|---|---|
| **PSI** | **total character** | .082 | .007 | .007 | .082 | 5.905 |

**C. TP**

| Dependent variable | Independent variable | R | R Square | R² change | Beta | F change |
|---|---|---|---|---|---|---|
| **TP** | **total character** | .179 | .032 | .006 | -.188 | 5.279 |
| | **total for Type A** | | | | -.081 | |

**D. RMSSD**

| Dependent variable | Independent variable | R | R Square | R² change | Beta | F change |
|---|---|---|---|---|---|---|
| **RMSSD** | **total character** | .173 | .030 | .005 | -.253 | 4.789* |
| | **total for Type 5** | | | | -.085 | |

## Conclusion

● The research chose key factors for Korean standard regulation of HRV measurement.

● Standard by sex difference and age of each HRV index.

● HRV measurement suggested the relevance to health behavior, fatal causes of geriatric diseases, geriatric diseases. Therefore, employing HRV measurement seems to be viable to evaluate objective stress and health danger cause in Health care organization.

● Strong relevance to sleep-related causes.

● It suggested relavance to job stress, subjective stress, and tiredness but further studies are needed.

■ **Attachment** : Questionnaire protocol

**Page 1: General items**

◆ Sex, age, social security number - for screening by items on HRV measurement equipment. Fill out a name and sex on a survey to compare to identification on it after input into equipment when measuring.

◆ Drinking - When drinking, fill out average tolerance as Soju 2 hop as a standard. (example) Soju 0.5 bottle / times

◆ Coffee - vending machine coffee (caffeine 80g) standard

◆ Exercise -Excercise with sweating standard

▷Additional questionnaires for employees.

◆ Work type (shift work)

| | |
|---|---|
| | 2 for shift, 1 for non-shift |
| shift work | |

| | |
|---|---|
| time to work | marking check-in by 24 hours |
| time to home | marking check-out by 24 hours |
| shift type | marking numbers |

**Page 2: Stress Response Inventory (39 questionnaires)**

reference: Psychosom Med 2001 Jul-Aug;63(4):668-78 Development of the stress response inventory and its application in clinical practice. Koh KB, Park JK, Kim CH, Cho

**Page 3 : Questionnaire for sleep**

- ◆ How to fight stress
- ◆ Pittsburgh Sleep Questionnaire

| cause | comments |
|---|---|
| bed time | at the time of going to a bed<br>marking in 24 hours |
| get-up time | at the time of getting up, not the waking time. marking in 24 hours |
| sleep hour | actual sleeping hours |
| sleep minute | actual sleeping hours |
| sleep latency | the period of sleeping after going to a bed.<br>(by minutes) |
| total waking | waking-up frequency during sleep |
| | waking up to urinate |

| | |
|---|---|
| nocturia | |
| non-nocturia | waking up except for urinating |
| resleep latency | period to go back to sleep after wake-up (by minutes) |
| hypnotic | Mark 1 if you take a sleeping pill, Mark 2 if you do not take a sleeping pill |
| hypnotic frequency | actual taking frequency |
| early waking | Mark 1 if you wake up early, Mark 2 if you do not wake up early. |
| early wake frequency | numbers of waking up early |

◆ Epworth Sleepness Scale

| | |
|---|---|
| reading sleep | marking numbers |
| reading sleep | |
| TV sleep | marking numbers |
| Tv sleep | |
| Movie sleep | marking numbers |
| movie sleep | |
| car sleep | marking numbers |
| car sleep | |
| rest sleep | marking numbers |
| rest sleep | |
| talk sleep | marking numbers |
| talk sleep | |
| lunch sleep | marking numbers |
| lunch sleep | |

| | |
|---|---|
| driving sleep | marking numbers |
| driving sleep | |

◆ Apnea

| | |
|---|---|
| snoring | marking numbers |
| snoring | |
| snoring period | period with snoring(year) |
| snoring period | |
| apnea | marking numbers |
| apnea | |
| apnea period | period with apnea(year) |
| apnea period | |

**Page 4 : Questionnaires for tiredness (19 questions)**

Multidimensional Fatigue Scale)(Jang Se-jin 2000) by modifying Fatigue Assessment Instrument (FAI) (Schwartz JE et al. The measurement of fatigue : A new instrument. Journal of Psychosomatic Research. 1993;37(7):753-762

▷complementary three questions

**Page 5 : Survey on job and social support behavior pattern(additional questionnaires for employees)**

◆ JCQ-Job requirement : item no. 1-5, Job autonomy item No. 6-14 ) (JCQ developed by Karasek(1979 )

◆ Socia support - Superiors : item no. 1-4, Co-workers : item No. 5-8) ( JCQ developed by Karasek (1979)

◆ Type A Behavior pattern (personal traits) : item no.11-15 ) (Framingham Type A Behavior Pattern. Haynes SG et al, The relationship of psychosocial factors to coronary heart disease in the Framingham study. American Journal of Epidemiology 1978;107(5):362-383

◆ Type A Behavior pattern ( item no. 1-5) (source : Framingham Type A Behavior Pattern)