

Pilot Study of Application Status for the Improvement of Weather Information in the Korean Peninsula: Focus on Extreme Heat Watch and Warnings

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ABSTRACT

The extreme heat watch and warnings (EHWW) which is constructed as a part of the climate change adaptation took effect in the summer of 2008, but active response actions failed to be taken because of low perception among citizens. Therefore, a survey investigation targeting citizens residing in Busan and the Gyeongnam province was conducted in order to know the perception regarding EHWW issued by the Korea Meteorological Administration, to identify the main media through which information is acquired, and to propose an improvement measures which may enhance the usefulness and the degree of satisfaction of weather information. The results are as follows; The perception regarding EHWW was not very high as it remained at 59.8% in terms of percentile. Although the statistical significance was not fulfilled in the categories of gender or occupation, significant differences did exist among age groups. The main medium through which citizens acquired information regarding EHWW was the television, which was followed in order by the internet, acquaintances, short message service (SMS), radio, newspapers, the 131 weather hotline, and other media. The usefulness of EHWW was somewhat high (67.2%), and female students were found to utilize the information to a higher degree than male students. The statistics on the level of satisfaction regarding the weather information (65.4%) revealed that most respondents were satisfied. Housewives, professional, and the elder age groups exhibited great satisfaction, leading to the conclusions that the level of perception and interest regarding to the special weather reports (SWR) have an impact on satisfaction of SWR.

Key words: Climate change adaptation, Extreme heat watch and warnings, Weather information, Perception, Special weather reports

1. INTRODUCTION

According to the 4th IPCC Report (2007), hot days and hot nights will occur with greater frequency, and heat waves (or extreme heats) are predicted to not only increase in frequency but also in their intensity (NIMR, 2009; Park *et al.*, 2008a; Hardy, 2003). Such extreme heat not only has an indirect impact on cardiovascular disease and cerebrovascular disease, but also causes the heat-related illnesses (heat strokes, heat exhaustion, heat syncope, sunstroke). They also have an impact on ozone concentration and may cause allergic diseases or respiratory diseases arising from nitric oxides, the substance generated by the secondary chemical reaction between ultraviolet rays and air pollutants (Park *et al.*, 2008a, b; Kim, 2007a; NIMR, 2007; KMA, 2006; Park and Lee, 2006). Because of the impact of heat waves on health, the necessity to research preparations of response measures protecting against heat waves has been raised.

Recently, interest in research related to climate change adaptation has been rising continually (Gyeong *et al.*, 2009), and in particular, there have been an increase in research seeking to construct a system of responses to heat wave disasters (Song, 2007) and to prepare the systematic measures (Kim, 2007b). Moreover, on the national level, the Korea Meteorological Administration (KMA) is currently implementing special protective measures for vulnerable groups such as

elderly individuals, etc. and the extreme heat watch and warnings (EHWW). The extreme heat watch are issued in cases where the daily maximum temperature is predicted to remain at 33°C or higher for two or more consecutive days, and the extreme heat warning are issued in cases where the daily maximum temperature is forecasted to remain at 35°C or higher for two or more consecutive days (Jung *et al.*, 2009; Park *et al.*, 2009).

Such preparations of response measures to protect against heat waves are properly being administered based on research and through the public notices issued by KMA. However, in order to reduce the damage and frequency of disasters, what is required is the active utilization and application by individuals aware of this information and putting it into practice, but there has hitherto been a complete absence of research emphasizing individual awareness and utilization of weather information, while there have been partial accomplishments in research seeking to quantitatively identify the impact of meteorological disasters on industries or on society in general (Yang *et al.*, 2004; Nichols, 1966). In actuality, Korea suffered from around 6.1 trillion Korean won of losses in 2002 which were the extensive damages caused by typhoon Rusa, and at the socio-economic benefits gained from the utilization of weather information was valued at around 7.1 trillion won, constituting 1% or more of the country's entire GDP (Yang *et al.*, 2004).

The EHWW issued by KMA were developed as a part of the program to adapt to the climate change and have been implemented since the summer of 2008, but the level of awareness among citizens has remained so low that events such as marathon competitions or walking tours of the national territory by university students, etc. have been scheduled on dates on which the EHWW have been issued, and there have even been reports of consequent casualties (Daegu Shinmun, 2008; Sheridan, 2007). This demonstrates that the impact of meteorological phenomena on society varies greatly depending on how the individual is made aware of the meteorological phenomena (Meze-Hausken, 2007).

When natural disasters arise due to the climate change in the future, it will be necessary to minimize damages to human lives and properties and to provide speedy and accurate information to the citizens, and simultaneously preemptive preparations need to be made by means of disaster education and the active implementation of preventive programs before such disasters occurs (Park *et al.*, 2006). In particular, meteorological disasters such as heat waves can result in losses due to the lack of advance preparation of caution on the part of individuals even in cases where the system has been

successfully developed. Hence, individuals themselves need to acquire the attitude of "actively" accessing special weather reports (SWR) regarding heat waves, etc. and other relevant information while there also needs to be changes in the media to enable the speedy delivery of this information. From this perspective, therefore, it is predicted that concomitant research regarding the level of utilization of weather information such as EHWW and the degree of user's satisfaction must be conducted to assist individuals in taking the initiative in reducing the damages incurred due to the natural disasters.

The objective of the present research is to analyze the current status of utilization of weather information regarding EHWW by ordinary citizens (including university students) residing in Busan and the Gyeongnam province, with analyses of the results according to the respondent's occupation, age, and gender. Simultaneously, this study will identify the degree of awareness among ordinary citizens regarding EHWW, categorize the media through which they acquire the information about the risks of extreme heat conditions, examine the features of response measures implemented after confirming SWR, and research the level of satisfaction these users experience toward the weather information provided by KMA, and then propose methods for future improvement.

2. DATA AND METHODOLOGY

2.1 Research Targets and Data

The present study is a descriptive investigative research which seeks to analyze the usefulness of weather information such as EHWW among the residents in Busan and Gimhae city, Gyeongnam province (near Busan) for the purpose of identifying the level of awareness existing regarding EHWW currently implemented by KMA. Four districts in the provinces were conveniently selected as by considering their various regional characteristics, which include urban, agricultural, coastal and other areas. To minimize sampling error, this study selected 1,000 samples where the number of sample correspond to 0.05% of 2.26 million adults aged over 18 in this area and included various occupations, such as housewives, employees, self-employed, farmers, fishermen, students and so forth.

The data was collected over a period of two months from June 1 to July 31, 2009. Approval for the study was obtained from the Institutional Review Board at Inje University, Busan Paik Hospital, Korea. In determining the appropriate sample size, using 95% confidence level and error tolerance 0.033, 881 samples were the minimum required (Kim *et al.*, 2009). There-

Table 1. A statistical chart of respondents for application status of the weather information.

Group		An object number	Men	Women
Job	Student	426	173	253
	Professional	319	189	130
	Housewife	161	4	157
	Etc	12	11	1
Age	10-19	125	51	74
	20-29	401	160	241
	30-39	136	65	71
	40-49	109	44	65
	50-59	83	31	52
	60-69	64	26	38
Total		918	377	541

fore, a total of 1,000 questionnaires were distributed in consideration of loss, 968 questionnaires were returned (return rate 96.8%). From among surveys returned by the respondents who demonstrated sufficient understanding of the objective of the research and voluntarily agreed to participate, those with missing or inadequate responses regarding inquired items such as gender, age (ages 16-69), level of education, occupation were excluded, leaving a final data pool of 918 individuals to conduct the analysis. These respondents were grouped by occupation and age to implement analysis and teenagers are adults older than 16 who can express their opinion exactly.

As shown in Table 1, the data used for analysis were categorized by grouping the respondents into students, professionals, housewives, and others, and they were also distinguished by gender into males and females. The latter distinction was made because prior studies which investigated the level of perception among university students (Park *et al.*, 2010; Oh and park, 2009) have revealed that women are more active than men in responding to weather information and exhibited a higher degree of utilization and this research sought to examine this difference. Also, the respondents were also grouped into 6 stages by age, from teenagers to people in their sixties, in order to examine the characteristics of levels of perception regarding EHWW by age.

2.2 Survey Tools

Similar to the preceding studies (Oh and Park, 2009; Kim and Ji, 2003), the survey questions used to conduct this research were composed of questions addressing four different areas including the degree of perception of EHWW issued by KMA, the medium of information acquisition, the level of utilization of weather information, and the degree of satisfaction.

First, the level of perception regarding EHWW which

are currently in operation was investigated through a survey consisting of eight questions, and the response to each question was measured by a Likert scale with the responses 'I am very well aware (4)', 'I am aware (3)', 'I do not know well (2)' and 'I do not know at all (1)' and the reliability coefficient Cronbach's α for the survey tool was found to be 0.83.

Next, the respondents were required to indicate the media through which they acquire weather information such as EHWW by ranking the top five media used, and six questions were used to investigate the degree of utilization of weather information such as EHWW. The responses to each question were measured on a four point Likert scale ranging from 'Very true (4)' to 'Not true at all (1)', and the reliability coefficient Cronbach's α for the tool identified as 0.81. Lastly, the questions regarding the level of satisfaction toward weather information including EHWW currently provided by KMA measured the responses by applying a five point Likert scale ranging from 'I am very satisfied (5)' to 'I am very dissatisfied (1)'.

2.3 Method of Analysis

The collected data was analyzed using the SPSS 17.0 statistics program. Descriptive statistics consisting of averages, standard deviations ($M \pm SD$) and percentiles were utilized for the responses to each question, and the t-test was used as the method to analyze the differences in the results according to gender. The t-test is able to verify the difference in the average value between two groups through the method of analyzing whether the difference in two groups which constitute the independent variables result in differences in the values of the dependent variables. The ANOVA methodology was applied to analyze the results by group and by age. When seeking to compare two or more groups, ANOVA is able to identify the difference between groups using the F-distribution obtained through a comparison of the dispersion among groups. For the post-hoc test, the Scheffé test was used to analyze the differences among groups distinguished by detailed categorization. The Scheffé test is a method applied when there is a difference in the number of groups, and this method is characterized by a higher degree of sensitivity compared to other methods. In particular, when analyzing the medium of information regarding EHWW which respondents were required to identify by ranking, first the result for the first ranking medium was presented as a percentile, and the total frequency of responses, the response percentage and the case percentage were derived. The response percentage is the percentage occupied by the case response out of the total number of responses, and the case percentage can be considered the percentage occupied by the number

of case responses out of the total number of respondents.

3. RESULTS AND DISCUSSION

3.1 Degree of Perception Regarding EHWW

Among SWR issued on a regular basis currently by KMA (gale, heavy rain, cold wave, dryness, surge, wind and wave, typhoon, heavy snow, Asian dust, extreme heat), extreme heat is increasing in frequency of occurrence due to the recent climate change, and hence an analysis was conducted regarding the degree of awareness among citizens regarding EHWW which has been implemented since May 2008, including

awareness of its significance and the risks indicated by the system, etc. and the relevant information. The results according to gender and occupation are presented in Table 2, and the results regarding level of awareness by age group are in Table 3.

As indicated in Table 2, the point total was 19.15 ± 3.91 (percentile=59.8), demonstrating that the degree of awareness among citizens regarding EHWW was not very high, and the results were similar in the case where the targeted respondents were university students (Park *et al.*, 2010). Although the results distinguished by gender or occupation did not satisfy the criteria of statistical significance, there did exist a significant difference among the age groups compared (F=4.383, p =0.080), with respondents in their fifties exhibiting

Table 2. Perception of EHWW according to gender and job group.

Items	Total (n=918)		Male (n=377)	Female (n=541)	t, p	Student (n=426)	Professional (n=319)	Housewife (n=161)	etc (n=12)	F, p Scheffe
	M ± SD	%	M ± SD			M ± SD				
1-1	2.79 ± .66	69.8	2.81 ± .70	2.77 ± .63	1.068	2.75 ± .76	2.80 ± .61	2.84 ± .59	2.83 ± .40	.910
1-2	2.56 ± .70	64.0	2.62 ± .76	2.52 ± .66	2.170*	2.53 ± .70	2.57 ± .72	2.61 ± .62	2.67 ± .65	.608
1-3	2.41 ± .74	60.3	2.41 ± .78	2.40 ± .72	.180	2.37 ± .77	2.37 ± .75	2.57 ± .67	2.58 ± .52	3.486* a < c
1-4	1.96 ± .76	49.0	1.99 ± .79	1.95 ± .74	.846	1.90 ± .75	1.96 ± .77	2.15 ± .74	2.00 ± .74	4.317** a < c
1-5	2.70 ± .71	67.5	2.74 ± .73	2.35 ± .75	1.350	2.73 ± .74	2.67 ± .71	2.73 ± .64	2.50 ± .67	.853
1-6	2.30 ± .72	57.5	2.35 ± .75	2.27 ± .70	1.733	2.30 ± .73	2.27 ± .72	2.37 ± .70	2.25 ± .75	.752
1-7	1.96 ± .72	49.0	1.95 ± .73	1.96 ± .71	-.054	1.94 ± .76	1.93 ± .68	2.06 ± .66	2.00 ± .60	1.288
1-8	2.47 ± .80	61.8	2.44 ± .83	2.48 ± .79	-.814	2.42 ± .82	2.50 ± .80	2.50 ± .75	2.92 ± .67	2.106
Total	19.15 ± 3.91	59.8	19.33 ± 4.12	19.02 ± 3.76	1.169	18.93 ± 4.12	19.07 ± 3.79	19.84 ± 3.58	19.75 ± 3.17	2.257

*p < 0.05, **p < 0.01

a: Student, b: Professional, c: Housewife, d: Etc

Table 3. Same as Table 2, except for an age group.

Items	Total (n=918)		10-19 (n=125)	20-29 (n=401)	30-39 (n=136)	40-49 (n=109)	50-59 (n=83)	60-69 (n=64)	F, p Scheffe
	M ± SD	%	M ± SD						
1-1	2.79 ± .66	69.8	2.73 ± .69	2.74 ± .71	2.81 ± .60	2.87 ± .56	2.86 ± .59	2.89 ± .62	1.443
1-2	2.56 ± .70	64.0	2.47 ± .73	2.55 ± .71	2.54 ± .72	2.56 ± .70	2.77 ± .61	2.56 ± .77	1.938
1-3	2.41 ± .74	60.3	2.33 ± .78	2.37 ± .76	2.28 ± .74	2.55 ± .65	2.67 ± .68	2.50 ± .71	4.551** c < e, b < e 5.169**
1-4	1.96 ± .76	49.0	1.86 ± .75	1.90 ± .74	1.88 ± .76	2.12 ± .74	2.23 ± .75	2.14 ± .81	b < e, a < e, c < e
1-5	2.70 ± .71	67.5	2.73 ± .70	2.71 ± .74	2.63 ± .74	2.74 ± .63	2.80 ± .62	2.64 ± .74	0.805
1-6	2.30 ± .72	57.5	2.27 ± .73	2.29 ± .72	2.20 ± .71	2.39 ± .65	2.45 ± .72	2.31 ± .79	1.650
1-7	1.96 ± .72	49.0	1.90 ± .77	1.95 ± .75	1.82 ± .65	2.05 ± .67	2.08 ± .67	2.09 ± .68	2.540*
1-8	2.47 ± .81	61.8	2.30 ± .81	2.45 ± .82	2.43 ± .77	2.52 ± .80	2.67 ± .77	2.63 ± .81	2.878*
Total	19.15 ± 3.91	59.8	18.59 ± 4.06	18.59 ± 4.05	18.57 ± 3.79	19.81 ± 3.06	20.53 ± 3.55	19.77 ± 4.23	4.383** a < e, b < e, c < e

*p < .05, **p < .01

a: Teenage, b: Twenties, c: Thirties, d: Forties, e: Fifties, f: Sixties

the highest points (20.53 ± 3.55), followed by those in their forties (19.81 ± 3.06) and their sixties (19.77 ± 4.23). The group in their fifties exhibited the highest results out of all the age groups, and it is conjectured that this is because individuals in the fifties constitute the generation which is most concerned about one's own health out of all the age groups, and hence they respond sensitively to external shocks such as changes in the climate.

Question 1-1 elicited results to the survey inquiry asking whether "I know the meaning of EHWW issued by KMA last year", and the average was found to be 2.79 ± 0.66 (percentile=69.8), which leads to the conclusion that in general the respondents properly perceived the meaning of EHWW, and the differences derived by gender, occupation or age group did not fulfill the level of statistical significance.

Question 1-2 was expressed with greater specificity than Question 1-1, asking whether "I am able to explain what EHWW". The average of the results was 2.56 ± 0.70 (percentile=64.0), indicating that respondents in general were capable of explaining. However, the number of positive respondents was less than the number of those who knew the significance of EHWW, demonstrating that there is a need for much promotional and educational effort regarding EHWW issued by KMA. These results were the same in the case of the survey targeting university students (Park *et al.*, 2010). There was a statistically significant difference among gender ($t=2.170$, $p=0.030$), with males (2.62 ± 0.70) earning higher points than females (2.52 ± 0.66), but there were no significant differences in terms of occupation or age group.

Question 1-3 inquired whether "I know the difference between an extreme heat watch and an extreme heat warnings". and the resulting responses had an average of 2.41 ± 0.74 (percentile=60.3), demonstrating that on average the respondents were not informed of the distinction, and even university students exhibited similar results (Park *et al.*, 2010). There was no statistically significant difference between gender, but there was a significant difference in terms of occupation ($F=3.486$, $p=0.015$). The results of the post-hoc test revealed that housewives (2.57 ± 0.67) earned higher points than students (2.37 ± 0.77), which appeared to indicate that housewives exhibited higher interest in the warnings out of concern for the health of their families. There was also significant differences among the age groups ($F=4.551$, $p=0.000$), and the results of the Scheffe test were higher for respondents in their fifties (2.67 ± 0.68) compared to those in their twenties (2.37 ± 0.76) or thirties (2.28 ± 0.74). As discussed above this is judged to be due to the fact that respondents in their fifties have a higher interest due to concern about their

own health and a sense of responsibility toward their families.

Question 1-4 surveyed whether respondents were "aware that the EHWW are based on excess mortality rates" and the results had an average of 1.96 ± 0.76 (percentile=49.0), showing that more than half of the respondents were not aware of this fact. There was no statistically significant difference between gender, and in the case where the survey targeted university students, male students (2.07 ± 0.79) exhibited a significant difference from female students (1.81 ± 0.70) (Park *et al.*, 2010), but because the points scores were low, it should not be regarded as having a large meaning. Also, there existed significant differences among the occupational groups ($F=4.317$, $p=0.005$), with housewives (2.15 ± 0.74) scoring somewhat higher than students (1.90 ± 0.75). The groups distinguished by age also exhibited significant differences ($F=5.169$, $p=0.000$), and the results of the Scheffe test showed respondents in their fifties (2.23 ± 0.75) scoring higher than those in their twenties (1.90 ± 0.74), thirties (1.88 ± 0.76), or teens (1.86 ± 0.75) with significant difference, and among those in their thirties or younger, more than half were ignorant of the basis of EHWW.

Question 1-5, asking whether respondents "were aware of the risks of extreme heat" garnered an average score of 2.70 ± 0.71 (percentile=67.5), showing that in general respondents were informed of the dangers of extreme heat, and there were no statistically significant differences among gender, occupational groups or age groups.

Since extreme heat has a great impact on the human body, Question 1-6 was intended to identify whether respondents were knowledgeable about response measures or safety procedures, and asked whether a respondent "knows safety procedures or the cautions to be taken when EHWW are issued". The responses had an average of 2.30 ± 0.72 (percentile=57.5) demonstrating that a large number of the respondents were not properly informed, and the differences among gender, occupational groups or age groups did not reach statistically significant levels. Although this was similar to the results of preceding studies which conducted surveys targeting university students (Park *et al.*, 2010), students who had received education related to the climate obtained relatively higher points, pointing to the urgent need for promotional and educational programs regarding climate change and extreme heat conditions.

Following upon the question above, Question 1-7 sought to find out how much interest respondents had in EHWW by presenting the statement "I am aware of the regions in which EHWW were issued in the past year". The average score was 1.96 ± 0.72 (percentile=49.0), indicating that the majority of respondents did

not know the answer. While there were no significant differences between gender or among occupational groups, the differences among age groups were statistically significant ($F=2.540$, $p=0.027$), and the older the age, the higher was the level of interest.

Lastly, Question 1-8 surveyed whether respondents “believe that due to the severity of the extreme heat problem arising from climate change, EHWW should be issued regardless of the region of issuance and the frequency”. The average was 2.47 ± 0.80 (percentile = 61.8) points, as nearly half of the respondents answered that they were aware of the severity of extreme heat and accordingly were convinced of the necessity of EHWW issuances. The survey of university students showed similar results, and as in the case of Question 1-6, students who have received education pertaining to climate change demonstrated higher levels of awareness, and hence it is judged that there is an urgent need to implement education and promotions related to climate change targeting ordinary citizens. The differences among age groups were statistically significant ($F=2.878$, $p=0.014$), with respondents in their fifties and sixties earning relatively higher points and those in their thirties or younger had low scores, indicating that the level of awareness regarding EHWW was higher among older age groups.

As examined above, the examination of the level of awareness regarding EHWW among citizens revealed that respondents understood the general significance of EHWW but did not know their precise meanings or their basis, and although they were aware of the dangers of extreme heat and showed a somewhat positive response to the statement that EHWW should be issued regardless of the location of the extreme heat occurrence of the frequency of warning issuances, they were not very knowledgeable about safety procedures or response measures. While the number of extreme heat occurrences in the middle latitude regions is predicted to increase each year due to climate change, the level of awareness about EHWW among citizens is rather

low, indicating the need for active promotion and education. By developing and distributing programs regarding safety procedures or response measures, it will be possible to reduce public health disasters arising from climate change.

3.2 Informational Media for Obtaining EHWW

Speedy transmission of information is required to inform not only the groups vulnerable to extreme weather events such as extreme heat but also ordinary citizens about the danger of extreme heat to enable them to take initiatives in protective measures. Hence, for the purpose of identifying which informational media are used by citizens to obtain EHWW and to emphasize the function of informational media, the survey asked respondents which media they used to obtain information about EHWW, requiring them to list the top five rankings. The results are presented in Table 4.

As shown in Table 4, among the 918 respondents the informational medium chosen most frequently as the first ranking was TV (television, 75.4%), which was followed in order of ranking by the internet (11.3%), acquaintances (3.9%), SMS (short message service, 3.1%), radio (2.4%), newspapers (1.6%), the 131 weather information phone line (1.2%), and others (1.1%). This demonstrates that citizens usually obtain weather information through TV or the internet, and that these are an important informational media. Even across all occupational and age groups, the most frequently selected informational medium was TV (refer to Figs. 1, 2), and among the occupational groups, the percentages were respective 85.7% among housewives, 80.3% among professionals, and 67.6% among students. The percentage was also high among respondents in occupations categorized as ‘other’. In terms of age, the percentages in order of magnitude were 90.4% in the fifties, 85.9% in the sixties, 85.3% in the forties, 78.7% in the thirties, 69.3% in the twenties, and 67.2% in the teens, revealing that dependency on TV was higher among older respondents and highlighting the impor-

Table 4. Informational media of EHWW.

Media	First answer n (%)	Frequency of response	Response%	Case%
Television	692 (75.4)	862	28.3	93.9
Internet	104 (11.3)	544	17.9	59.3
Acquaintance	36 (3.9)	462	15.2	50.3
Short message service	28 (3.1)	272	8.9	29.6
Radio	22 (2.4)	334	11.0	36.4
Newspaper	15 (1.6)	461	15.1	50.2
Telephone 131	11 (1.2)	93	3.1	10.1
Etc.	10 (1.1)	15	0.5	1.6
Total	918 (100.0)	3,043	100.0	331.4

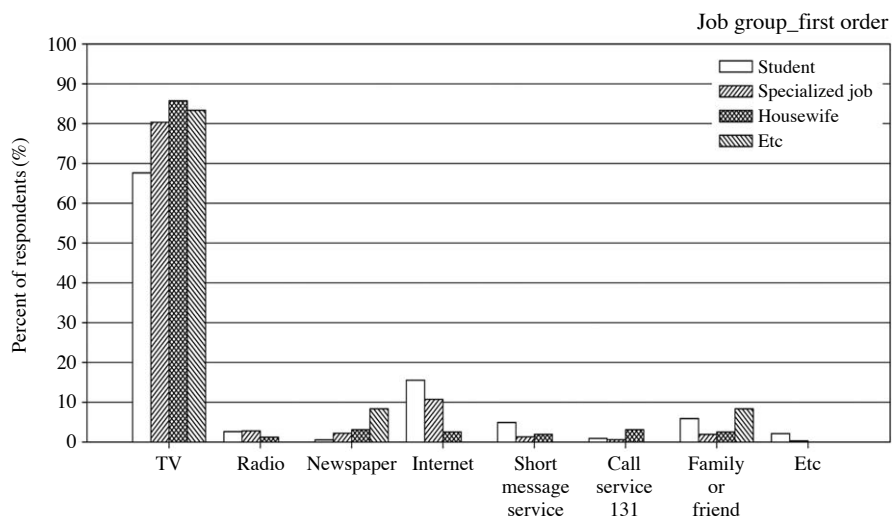


Fig. 1. The distribution of the source of information that the respondents used to first become aware of EHWW according to a job group.

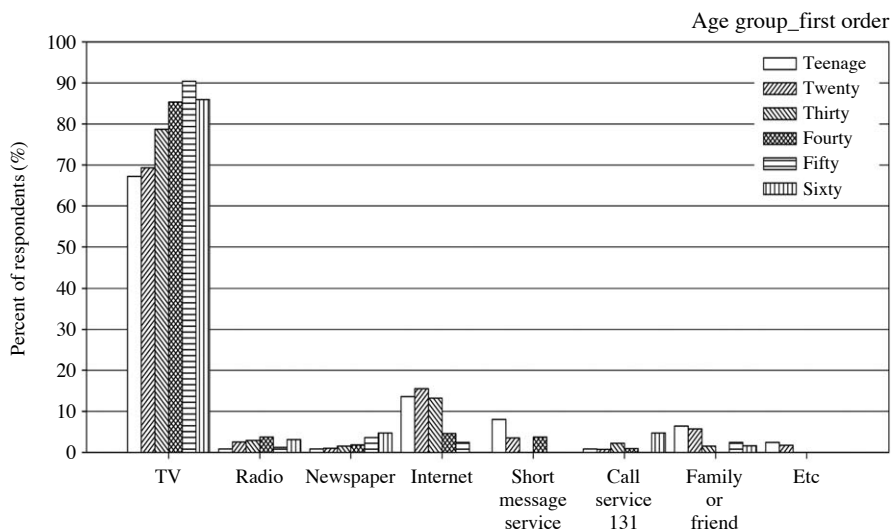


Fig. 2. Same as Fig. 1, except for an age group.

tance of TV.

In particular, TV acquired the highest response percentage (28.3%) and the highest case percentage (93.9%), establishing it as the most frequently used informational medium. Since it has been found that the desire to obtain information increases among a large number of people in cases where critical situations such as disasters or emergencies occur, and that in such cases the degree of dependency on press media such as TV, radio and newspapers also increases (Shin, 2007; Kim and Ji, 2003), broadcasting stations must uphold a sense of their responsibility to communicate weather information with speed and accuracy.

The second most frequently selected informational medium was the internet, which also had a high response percentage (17.9%) and high case percentage (59.3%) (Table 4), and the internet was also the secondly most frequently cited informational medium in the survey targeting university students in Korea and overseas (Park *et al.*, 2010; Belobraydich and Biddle, 2007). However, there were some differences according to occupation and age (refer to Fig. 3 and Fig. 4): a high percentage of students (32.7%) and professionals (22.9%) selected the internet while many housewives (47.6%) selected newspapers in their responses. There were also distinguishing features among the age groups, with

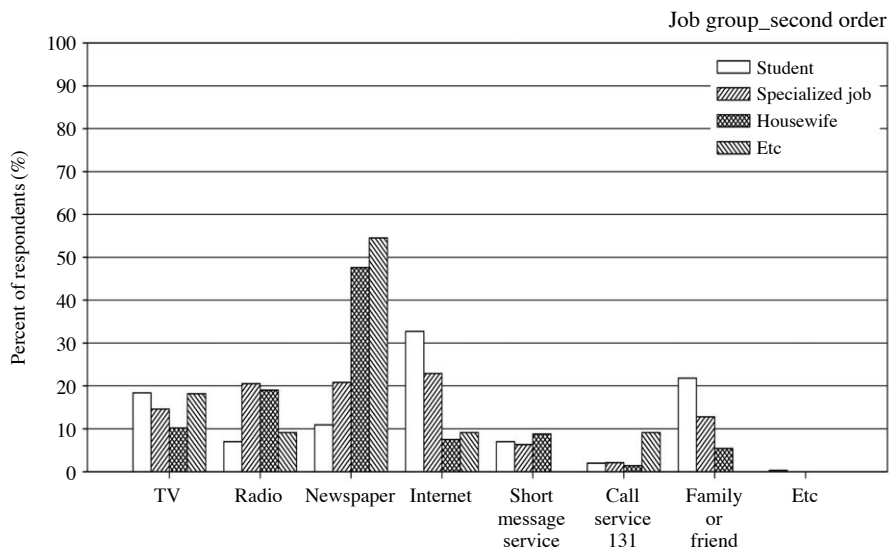


Fig. 3. The distribution of the source of information that the respondents used to second become aware of EHWW according to a job group.

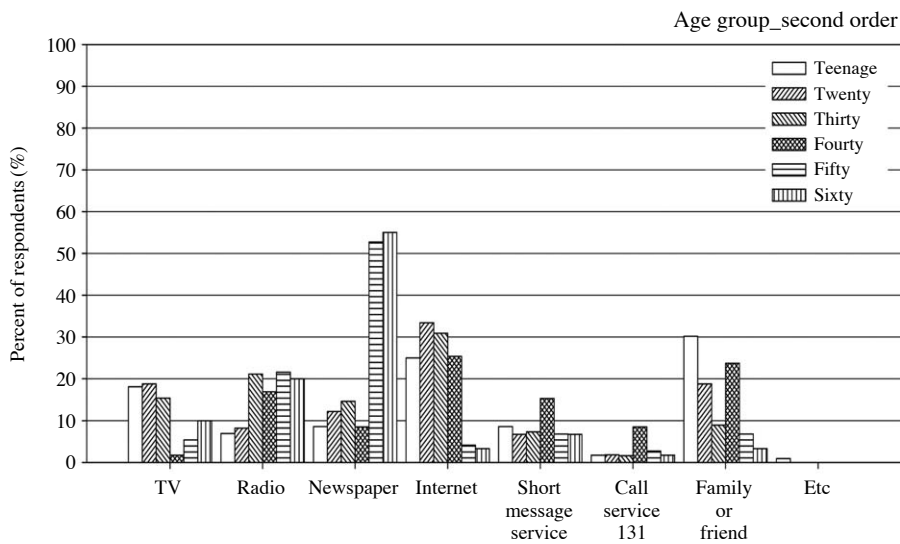


Fig. 4. Same as Fig. 3, except for an age group.

teens (30.2%) relying highly on acquaintances such as family members or friends and those in their twenties (33.4%) or thirties (30.9%) relying highly on the internet while those in their forties (34.3%), fifties (52.7%) and sixties (55.0%) tended to seek out information in the newspapers far more frequently than on the internet, as was the case among housewives. Hence, the second ranking informational medium differed somewhat across occupational and age groups.

Weather related reports transmitted through on-line media are perceived by citizens as the most important

topic (Kim and Ji, 2003), and according to the investigation conducted by the Pew Research Center, users frequently visit the weather section of on-line news sites to download or find information related to the weather (Noack, 2000). This demonstrates that the transmission of weather information through the internet is growing in importance, and has a large impact on the public. In particular, students and respondents in their twenties had a higher ratio of responses compared to other groups stating that they use the internet to acquire information related to the dangers of extre-

me heat, pointing to the increased necessity for transmitting speedy and accurate weather information via internet in the future. However, usage of media predicated on ‘active’ initiative on the part of the users such as the internet, SMS, fax, phone, etc. do not yet reach the power of distribution exercised by ‘passive’ mass media (TV, radio, newspapers) (Shin, 2007), and hence it is necessary to enhance the speed and accuracy of the ‘active’ media.

The third most frequently cited informational medium was the word of acquaintances such as family members or friends (response%=15.2, case%=50.3), revealing that weather information such as EHWW are not exclusively spread through media such as the press but also through oral communication. With the exception of professionals (14.6%), students (27.3%), housewives (26.3%) and other groups (33.3%) showed a high response percentage, and in terms of age, only those in their sixties exhibited a high ratio (34.1%) while other groups opted for the internet, newspapers, or SMS.

Newspapers were the sixth medium chosen by respondents as their first ranking medium and its response percentage (15.1%) and case percentage (50.2%) ranked fourth, indicating that a lot of weather information is acquired through the newspapers. As mentioned above, this is because housewives and older age groups prefer newspapers over the internet which is generally used by young people. Also, the 131 phone line operated by KMA for information transmission was the 7th ranking informational medium chosen for the first selection by the respondents, showing the lowest rate of utilization. The research by Oh and Park (2009) also revealed that there were extremely few respondents who know this number accurately or who utilize the number, and hence it will be necessary to induce improvements in this area and to seek more active means of communicating information.

As shown above, the informational medium with the highest preference among ordinary citizens regardless of occupation or age was TV, and the internet was the medium preferred by all age groups excluding individuals in their fifties and sixties, as well as by students and by professionals. Hence, it may be worthwhile to create a TV channel devoted exclusively to constant updates on weather information including EHWW rather than relying on the 131 phone line which exhibits markedly low utilization rates. While pre-existing TV broadcasters are hampered by the disadvantage that they are unable to provide up-to-date weather information except in special cases, an exclusive TV channel will have the advantage of providing a constant stream of information. Also, the internet is capable of transmitting information speedily through the iPhone or Twitter, and hence demands active scrutiny.

3.3 Response Measures after Receiving SWR

The SWR which perform a critical function in the prevention of natural disasters provide information which benefit daily living conditions of individuals as well as reducing losses to human lives and property (Kim and Ji, 2003), and in particular, individuals with illnesses affected by weather conditions are at the risk of health problems caused by extreme weather events such as extreme heat and hence must pay attention to the contents of such SWR (Oh and Park, 2009).

This study examined whether there were differences among categorized groups of respondents when they are confronted with issued SWR such as EHWW to analyze the degree of utilization of SWR and the results are presented in Tables 5 and 6. The survey regarding the degree of utilization of SWR was conducted by dividing the content into six questions, and the point total obtained was 16.13 ± 3.13 (percentile=67.2), demonstrating that many respondents were utilizing

Table 5. Usefulness of SWR by gender and job group.

Items	Variables		Total	Male (n=377)	Female (n=541)	t, p	Student (n=426)	Professional (n=319)	Housewife (n=161)	etc (n=12)	F, p Scheffe
	M±SD	%									
2-1	2.78±.72	69.5	2.76±.72	2.79±.72	-.488	2.70±.70	2.82±.72	2.89±.74	3.00±.74	3.807** a < c	
2-2	2.46±.74	61.5	2.30±.74	2.57±.71	-5.513**	2.45±.73	2.39±.76	2.57±.70	3.00±.74	4.233** c < d	
2-3	2.70±.72	67.5	2.58±.75	2.78±.69	-4.048**	2.70±.72	2.68±.73	2.69±.72	2.92±.79	.428	
2-4	2.80±.73	70	2.67±.75	2.89±.70	-4.387**	2.79±.76	2.77±.73	2.87±.65	3.08±.67	1.272	
2-5	2.79±.75	69.8	2.66±.78	2.88±.72	-4.340**	2.77±.74	2.81±.78	2.78±.72	3.00±.95	.494	
2-6	2.61±.76	62.3	2.50±.76	2.68±.76	-3.519**	2.53±.76	2.63±.79	2.72±.71	3.08±.79	4.353**	
Total	16.13±3.13	67.2	15.48±3.12	16.58±3.07	-5.323**	15.94±3.14	16.11±3.22	16.52±2.89	18.08±3.15	2.904*	

*p < .05, **p < .01

a: Student, b: Professional, c: Housewife, d: Etc

Table 6. Same as Table 5, except for an age group.

Items	Total		10 (n=125)	20 (n=401)	30 (n=136)	40 (n=109)	50 (n=83)	60 (n=64)	F, p Scheffe
	M±SD	%	M±SD						
2-1	2.78±.72	69.5	2.68±.71	2.69±.70	2.69±.68	2.97±.74	3.05±.71	3.05±.72	8.246** b<e, b<f, b<d, a<e, c<e, a<f, c<f
2-2	2.46±.74	61.5	2.45±.67	2.43±.76	2.39±.67	2.46±.78	2.55±.74	2.67±.78	1.739
2-3	2.70±.72	67.5	2.82±.69	2.67±.72	2.71±.65	2.63±.82	2.67±.77	2.81±.66	1.421
2-4	2.80±.73	70	2.86±.75	2.72±.74	2.80±.64	2.80±.76	2.95±.73	3.00±.69	2.800*
2-5	2.79±.75	69.8	2.83±.66	2.73±.76	2.79±.74	2.84±.72	2.80±.82	2.88±.81	.977
2-6	2.61±.76	65.3	2.57±.68	2.51±.78	2.62±.72	2.67±.75	2.78±.83	2.91±.71	4.355** b<f
Total	16.13±3.13	67.2	16.23±2.84	15.75±3.27	15.99±2.75	16.38±3.08	16.77±3.25	17.31±3.16	3.968** b<f

* $p < .05$, ** $p < .01$

a: Teenage, b: Twenties, c: Thirties, d: Forties, e: Fifties, f: Sixties

the information. There existed a significant difference among gender ($t = -5.323$, $p = 0.000$), with female students (16.58 ± 3.07) showing a higher degree of utilization compared to male students (15.48 ± 3.12) (Park *et al.*, 2010; Oh and Park, 2009). There were also significant differences among the occupational groups ($F = 2.904$, $p = 0.034$), with housewives (16.52 ± 2.89) scoring higher than professionals (16.11 ± 3.22) or students (15.94 ± 3.14). Housewives highly interested in the health of their families and women who use weather information frequently in their daily lives exhibited high scores. There was also a significant difference in the results by age group ($F = 3.968$, $p = 0.001$). Respondents in their sixties earned higher points than those in their twenties, and there was a relatively high degree of utilization of the weather information. Female students and housewives, and the older age groups had higher levels of utilization.

As for the individual questions, Question 2-1 presented the statement that “I pay constant attention to changes in SWR and check the reports”. The average point was 2.78 ± 0.72 (percentile=69.5), showing positive responses among many respondents. Although there wasn't a significant difference between gender, the analysis according to occupation ($F = 3.807$, $p = 0.010$) and age group ($F = 8.246$, $p = 0.000$) reached the level of statistical significance. In terms of occupation, the ranking was in the order of housewives (2.89 ± 0.74), professionals (2.82 ± 0.74), and students (2.70 ± 0.70) and the results of the Scheffe test confirmed that housewives check changes in SWR more vigilantly than students. Among the different ages, the ranking was in the order of respondents in their sixties (3.05 ± 0.72), fifties (3.05 ± 0.71), forties (2.97 ± 0.74), thirties (2.69 ± 0.68), twenties (2.69 ± 0.70) and teens ($2.68 \pm$

0.71) and the Scheffe test results were higher for those in their fifties and sixties compared to those in their teens, twenties or thirties. Even those in their forties scored higher than those in their twenties, indicating that older the respondent, the more likely they were to utilize weather information properly. It was particularly notable that among in the fifties and the sixties, there were absolutely no negative responses stating that “this was completely untrue”, demonstrating once again that the older age groups were relatively more likely to observe SWR with close attention.

Question 2-2 consisted of the statement “I do not go outdoors based on SWR”. The average point was 2.46 ± 0.74 (percentile=61.5) revealing that more than the average number of respondents were influenced in their decisions to go outdoors by SWR. There were statistically significant differences according to gender ($t = -5.513$, $p = 0.030$) and occupational category ($F = 4.233$, $p = 0.006$), with women (2.57 ± 0.71) being more likely to limit their movement outdoors based on SWR compared to men (2.30 ± 0.74), showing a relatively higher sensitivity to weather events (Park *et al.*, 2010; Oh and Park, 2009). In terms of occupation, the sensitivity to weather events was ranked in the order of housewives (2.57 ± 0.70), students (2.45 ± 0.73), and professionals (2.39 ± 0.76) and the results of the Scheffe test showed that there was a great difference between the categories of ‘other’ and ‘housewives’. No statistically significant differences were identified according to age.

Question 2-3 stated “I cancel or change plans for external events based on SWR”. The average was 2.70 ± 0.72 (percentile=67.5) showing a large number of respondents making cancellations or changes to their plans due to SWR. When analyzed by gender ($t = -4.048$,

$p=0.000$), as in the case of Question 2-2, women (2.78 ± 0.69) were more likely than men (2.58 ± 0.75) to be sensitive to weather events, which was consistent with the outcomes obtained by Park *et al.* (2010) and by Oh and Park (2009). The differences among occupations and ages did not reach the level of statistical significance.

Question 2-4 asked whether the respondent “make preparations according to SWR when I am required to go outdoors” and the average score was 2.80 ± 0.73 (percentile=70.0), with a significant number of respondents exhibiting a positive response stating that they do make preparations based on SWR when going outdoors. There existed statistically significant difference between gender ($t=-4.387$, $p=0.000$) and among ages ($F=2.800$, $p=.016$). Women (2.89 ± 0.70) were more likely to make preparations according to SWR compared to men (2.67 ± 0.75). As in Questions 2-2 and 2-3, women were found to make modifications to daily personal plans with greater sensitivity to SWR compared to men, identifying that women check SWR well reflect this information in their daily life.

Question 2-5 went a stage beyond the preceding survey asking whether respondents “inform family members or neighbors about SWR”. The average was 2.79 ± 0.75 (percentile=69.8) points, with a large number of respondents continuing to show a positive response, stating that they inform family or neighbors after checking SWR. There was a statistically significant difference between gender ($t=-3.519$, $p=.000$) but there were no significant variations across occupations or age groups. As in the preceding survey question, women (2.88 ± 0.72) were more likely than men (2.66 ± 0.78) to check SWR and apply this to their daily life, while also demonstrating initiative in informing close family members or neighbors. This is similar to the findings of Park *et al.* (2010), and hence promotion, education, and speedy transmission of weather information targeting women is seen to be capable of making a great contribution to reducing losses of property and lives during meteorological disasters.

Lastly, Question 2-6 required a more active response asking whether respondents “urge family members or neighbors to make preparations according to SWR” and the average was 2.61 ± 0.76 (percentile=62.3) points, with many respondents indeed urging family or neighbors to make preparations after checking SWR. The differences between gender ($t=-3.519$, $p=.000$), occupations ($F=4.353$, $p=.005$), and ages ($F=4.355$, $p=.001$) reached statistically significant levels. Women (2.68 ± 0.76) were more active than men (2.50 ± 0.76 %) in urging close acquaintances to make preparations after accessing SWR, and in terms of occupation, housewives (2.72 ± 0.71), professionals (2.63 ± 0.79),

and students (2.53 ± 0.76) were ranked in that order in their likeliness to urge family or neighbors to prepare according to SWR. The results of the Scheffe test did not reveal differences among detailed categories of groups. According to age, the likelihood of urging close acquaintances to make preparations based on SWR was ranked in the order of respondents in their sixties (2.91 ± 0.71) followed by those in their fifties (2.78 ± 0.83), forties (2.67 ± 0.75), thirties (2.62 ± 0.72), teens (2.57 ± 0.68) and twenties (2.51 ± 0.78). The Scheffe test results showed that there was a large difference between the sixties and the twenties.

As demonstrated above, the investigation of the level of utilization of SWR revealed a high degree of utilization, and women exhibited initiative in applying the information not only in their personal lives but also in persuading acquaintances to make proper preparations. Housewives or older age groups were found to be more sensitive than other groups to SWR, demanding the development of media for transmitting education and constant updates of weather information including EHW (Park *et al.*, 2010).

3.4 The Level of Satisfaction of SWR

To identify the level of user satisfaction regarding SWR currently provided on a regular basis by KMA, such as those regarding conditions of dryness or extreme heat, the third survey question inquired “How satisfied are you regarding SWR regarding extreme heat, dryness, etc. provided by KMA?” and measures responses with a five point Likert scale. The results categorized by gender and occupation are displayed in Table 7 and the results according to age group is shown in Table 8.

As indicated in the Tables, the score for the survey question was 3.27 ± 0.69 (percentile=65.4), demonstrating a general satisfaction. This was somewhat higher than the results of the survey conducted among university students (3.14 ± 0.71 , percentile=62.8) (Park *et al.*, 2010), and although there was no statistically significant difference between gender, occupation ($F=12.557$, $p=0.000$) and age ($F=12.152$, $p=0.000$) determined significant differences. The occupational groups were ranked in the order of housewives (3.42 ± 0.63), professionals (3.36 ± 0.66) and students (3.13 ± 0.72) with a high level of user satisfaction, and the Scheffe test results showed a notable difference when students were compared to housewives and professionals, with a somewhat high level of user satisfaction. By age group, respondents in their sixties (3.63 ± 0.60) ranked highest and were followed in order by those in their fifties (3.54 ± 0.65), forties (3.45 ± 0.60), thirties (3.29 ± 0.63), twenties (3.17 ± 0.71), and teens (3.06 ± 0.71) in terms of high level of user satisfaction, and the Sch-

Table 7. Satisfaction of SWR such as EHWW according to gender and job group.

Item	Total (n=918)		Male (n=377)	Female (n=541)	t, p	Student (n=426)	Professional (n=319)	Housewife (n=161)	etc (n=12)	F, p Scheffe
	M±SD	%	M±SD			M±SD				
3	3.27±.69	65.4	3.26±.71	3.28±.68	-.508	3.13±.72	3.36±.66	3.42±.63	3.75±.45	12.557** a<b, a<c, a<d

*p<.05, **p<.01

a: Student, b: Professional, c: Housewife, d: Etc

Table 8. Same as Table 7, except for an age group.

Item	Total (n=918)		10 (n=125)	20 (n=401)	30 (n=136)	40 (n=109)	50 (n=83)	60 (n=64)	F, p Scheffe
	M±SD	%	M±SD						
3	3.27±.69	65.4	3.06±.71	3.17±.71	3.29±.63	3.45±.60	3.54±.65	3.63±.60	12.152** a<e, a<f, b<f, a<d, b<e, b<d

*p<.05, **p<.01

a: Teenage, b: Twenties, c: Thirties, d: Forties, e: Fifties, f: Sixties

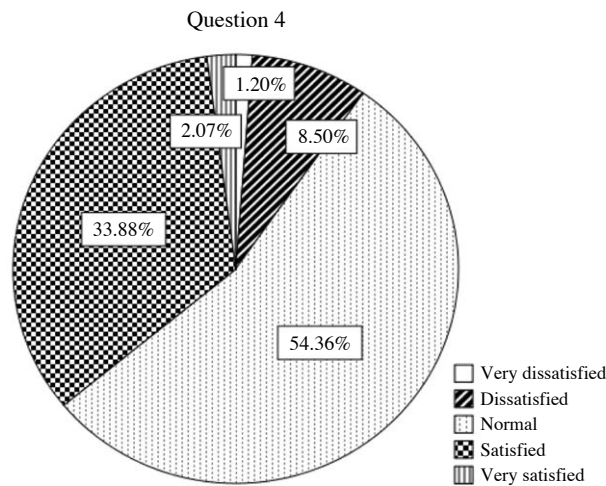


Fig. 5. Diagram for satisfactions of SWR.

effe test results showed that those in their sixties and forties were clearly distinguished from those in their twenties or teens with a high level of user satisfaction.

When the ranges of the score are examined closely (refer to Fig. 5), it can be seen that the ratio of positive responses stating ‘High satisfaction (5)’ and ‘Satisfaction (4 points)’ were respectively 2.07% and 33.88%, constituting merely 36% of the total number of respondents and the responses stating ‘Average (3)’ occupied 54.36%, slightly exceeding the average. On the other hand, the percentage of responses stating ‘Generally dissatisfactory (2)’ or ‘Very dissatisfactory (1)’ was

9.70%, a result that was lower than those obtained from university students but indicating an overall satisfaction. Housewives and the fifties and sixties age groups, which demonstrated high awareness regarding EHWW and an active attitude in taking response measures after checking SWR also exhibited high levels of user satisfaction. By contrast, the students group and the teens and twenties age group which had low awareness and a passive attitude toward response measures displayed the lowest level of user satisfaction, indicating that levels of awareness and interest regarding SWR have an impact on the level of user satisfaction with SWR.

Therefore, in order to raise the level of user satisfaction above the average, it is necessary not only to implement education and promotions targeting the public on the subject of SWR, but also to develop weather information contents related to health and life on topics such as extreme heat or dryness. It is also urgent to develop information transmission media for the speedy communication of such contents and to develop action guidelines for each stage of watch and warnings, as well as detailed response measures.

4. CONCLUSIONS

The recent climate change arising from global warming has led to frequent occurrences of high temperature phenomena in the summer seasons in the middle latitude regions, with severe consequences for human health. EHWW which is created as part of a climate

change adaptation efforts began to be implemented in the summer of 2008, but active response measures have been failed due to the low level of awareness about this service among citizens. Therefore, a survey was conducted targeting citizens in Busan and the Gyeongnam province to analyze their level of awareness regarding EHWW issued by KMA and to identify the media channels through which they obtain their information for the purpose of presenting measures for improving the degree of utilization of the weather information and the level of user satisfaction.

In terms of percentiles, the level of awareness regarding EHWW was not very high, reaching only 59.8%. Although distinctions by gender or occupation did not satisfy levels of statistical significance, there was a significant difference among age groups. Respondents in their fifties had the highest levels of awareness, because in that age they are mostly concerned about their own health and hence responding sensitively to external shocks such as climate change. However, with the number of occurrences of extreme heat in the summer seasons within the middle latitude regions predicted to increase each year, the level of awareness about EHWW among citizens is rather low, which indicates that active promotion and education is required (Park *et al.*, 2010). Programs regarding safety procedures or response measures should be developed and distributed to reduce the number of public health disasters arising from climate change.

The most common route by which residents in Busan and the Gyeongnam province obtained information regarding EHWW was TV, which was followed in ranking by the internet, acquaintance, SMS, the radio, newspapers, 131 weather telephone hotline, and other media. Across all occupations and age groups, the most frequently selected informational medium was TV, which constitute the highest percentage of responses from housewives (85.7%), professionals (80.3%), and students (67.6%) in that order. Also, the older the age, the higher was the dependency on TV. The internet was found to be a medium preferred by all age groups excluding respondents in their fifties and sixties, and by students and professionals. The 131 telephone number provided by KMA was utilized with very low frequency and thus requires review, and it may be meaningful to consider developing a channel exclusively devoted to communicating weather information such as EHWW.

The level of utilization of SWR in terms of percentile was 67.2%, demonstrating usage by a large number of the respondents, and female students utilized the reports to a higher degree than male student, while among the occupational groups, housewives and professionals scored higher than students, this seems to

be due to the high level of usage by housewives with high concern for the health of their families and women who utilize weather information frequently in their daily lives. Also, the degree of utilization increased with age, pointing to the need to develop media for constant communication and education regarding EHWW targeting such individuals.

The level of user's satisfaction regarding weather information (percentile=65.4) was somewhat higher than in the case of the survey targeting university students and indicated an overall satisfactory experience, with housewives and professionals exhibiting somewhat higher levels than students. The level of user's satisfaction also increased with age. By contrast, the student group and the age group in the teens and twenties, which exhibited low levels of awareness and passive attitudes toward response measures, also demonstrated the lowest level of user's satisfaction. This appears to indicate that the levels of awareness and interest have an impact on the level of user's satisfaction regarding SWR.

Therefore, in order to raise the level of user's satisfaction above the average, it will be necessary to develop not only educational and promotional programs regarding SWR targeting the public, but also weather information contents linked to health and life such as extreme heat or dryness conditions. It is also imperative to develop information communication media for speedily transmitting this content and detailed response measures and action guidelines for each respective stage of risk notice, including watch and warnings.

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