

A Preliminary Survey on Personal Magnetic Field Exposure of Sample Koreans

Kwang-Ho Yang, Mun-No Ju and Sung-Ho Myung

Abstract - The objective of this survey is to characterize personal magnetic field exposure of the general population in Korea. The participants of the survey on magnetic field exposure were selected randomly in some occupations. The participant wore the magnetic field meter for about 25 ~28 hours and the data were stored in the meter. Because this is a preliminary for the main survey, it was done with 36 participants only. For the main survey, about 400 subjects by occupation will be done. The statistics of the 24-hour exposure data are the major concern of this survey. However the survey provided the opportunity to analyze exposures corresponding to different types of activities. It was analyzed by separating periods of time corresponding to the following activities: entire 24-hour period, in bed, at work and by occupation.

Keywords - EMF, Personal Magnetic Field Exposure and Time-Activity

1. Introduction

There has been a growing concern over the possibility of the exposure to power line frequency EMF (electric and magnetic field) that is called the 4th environmental pollution as one of the problems of electromagnetic interference. This type of exposure has been affecting people health and the possible hazard is steadily getting worse. When Wertheimer and Leeper reported in 1979 that children living near power lines had an increasing risk for developing cancer, significant concern arose that the EMF from power lines and other source might be affecting the health of exposed individuals. Yet, despite a multitude of studies, there remains considerable debate over what, if any, health effects result from exposure to EMF. In order to solve the growing concern of the public about whether EMF might be adverse to human, the EMF RAPID (Research and Public Information Dissemination) Program was established in the United States. The RAPID program includes engineering research focused on exposure assessment and source characterization. The engineering research of the RAPID program started in 1995 and includes eight projects. The title of the sixth project is 'Survey of personal magnetic field exposure'. The goal of the project is to obtain accurate information on the distribution of exposure of the population of the United States. [1,2,3]

Therefore this paper describes the levels of personal magnetic field exposures and their influence on human health by occupation in the sample Korean population. This is a preliminary survey before the main survey. In the future, a full survey of 400 participants using small magnetic field (MF) meters will be carried out and the result

will be made public.

Table 1 A sample of activity diary by a housewife

Name: Hong Gil-Ja	
Start time	2002.5.30 14:00
Event No.	Contents of Event
1	Microwave oven
2	Vacuum cleaner
3	Gas oven
4	Washing machine
5	Elevator
6	Come home
7	Go to bed
8	Get out of bed
9	Hair drier
10	Watch TV
.	.
.	.
Stop time	2002.5.31 15:00

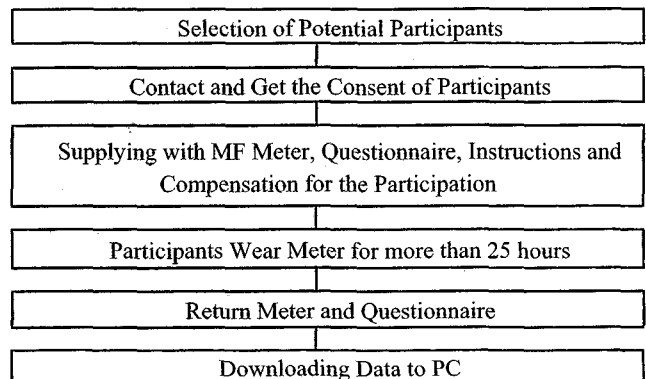


Fig. 1 Procedure of survey on personal magnetic field exposure

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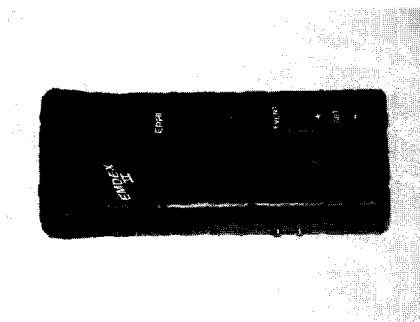
2. Survey Method

2.1 Selection of Participants and Survey Procedure

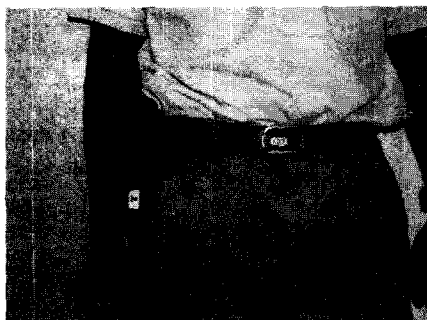
The participants of the survey of MF exposure were selected randomly in some occupations. Each person had to give his or her consent prior to the survey. Each participant received a MF meter, a questionnaire, and a fee. They were then informed about the survey method and procedure. The questionnaire includes the purpose of the survey, personal information of the participant, precautions to take for measurement, a form for private event recording, and basic information on electromagnetic fields. The participant wore the MF meter for about 25-28 hours and recorded important activities that happened during the measurement period. Table 1 shows an example of such an activity diary.

Table 2 Main specifications of standard EMDEX-II

Feature	Specification
Data Collection	Actual Measurements
Range	0.1 ~ 3,000 mG (0.01 - 300 μ T)
Resolution	0.1 mG (0.01 μ T)
Broadband Frequency	40 ~ 800 Hz
Max. Sample Rate	1.5 Seconds
Measurement Method	True RMS
Dimensions	16.8 x 6.6 x 3.8 cm
Weight	341 grams



(a) Front view



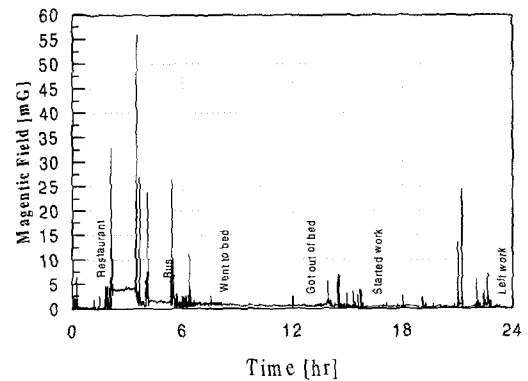
(b) The meter worn on the waist

Fig. 2 Personal MF exposure meter

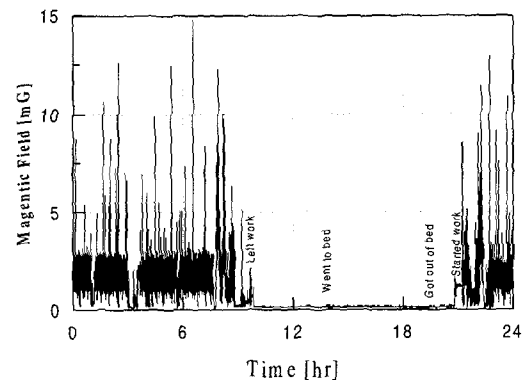
After completing the survey of exposure for 24 hours, the questionnaire that included the activity diary and the MF meter were recovered. The analyst transferred the data stored in the meter to a PC and processed it statistically. The survey procedure explained above is shown in Fig. 1

Table 3 Types of occupation and the status of preliminary survey

No.	Occupation	The number of persons	
1	Office Worker	9	
2	Electrician at Substation	3	
3	Factory Worker	3	
4	Housewife	Without Job	6
		With Job	3
5	Student	3 (Middle School)	
6	Warehouse Worker	3	
7	Hospital Worker	3	
8	Restaurant Worker	3	
9	Maintainer for Electric Utilities	0	
10	Electric Railroad and Train Operator	0	
	Total	36	



(a) Office Worker



(b) Factory Worker

Fig. 3 Time-Activity curves of the 24-hour personal MF exposure

2.2 Personal MF Exposure Meter

The personal MF exposure meter used for this survey is Model EMDEX-II made by Eneritech Consultants, Inc., USA. It displays the resultant level, which is the compound of the MF values of 3 axes. Even though its size and weight is somewhat excessive to be carried for a long time, it is capable of recording activities hourly. A picture showing a person wearing EMDEX-II is provided in Fig. 2. Its main specifications are shown in Table 2.

2.3 Survey Status

For the main survey, about 400 participants will be selected according to 10 types of occupation as shown in Table 3. For this preliminary survey, 36 people engaged in 8 types of occupation were surveyed.

3. Results of Survey and Analysis

3.1 24-Hour MF Exposure

The Time-Activity curve that shows 24-hour personal MF Exposure by hour is shown in Fig. 3, and the events, which are the main activities of the participant, were recorded and utilized for analysis.

Table 4 Percentage of people with 24-hour average MF above the given value

24-Hour Average [mG]	Percentage of Population with Field Equal to or Exceeding Given Value [%]
0.0	100.0
0.5	75.0
1.0	36.1
1.5	22.2
2.0	11.1
3.0	2.8

Table 5 Descriptive statistics of the distribution of 24-hour average MF

Statistical Parameters	Result [mG]	Parameters	Result [mG]
Mean	1.00	Min.	0.16
Standard Deviation	2.18	L90 %	0.27
Geometric Mean	0.52	L75 %	0.48
Median	0.77	L50 %	0.77
		L10 %	2.01
		L5 %	2.30
		L1 %	2.92
		Max.	3.24

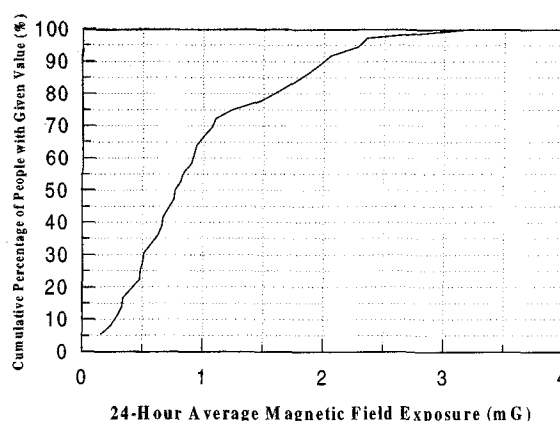


Fig. 4 Distribution of 24-hour average MF for all participants

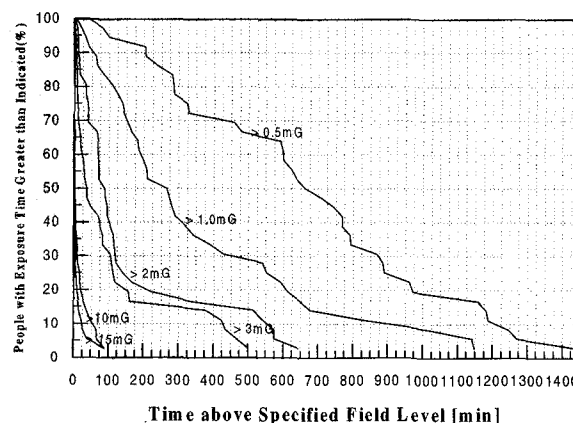


Fig. 5 Sample Korean population distribution of times above specified field level within a 24-hour period

The 24-hour average MF exposure for the 36 participants is shown in Tables 4 and 5, and it is shown in a graph Fig. 4. The average MF of the participants during a 24-hour period was 1.0mG and the median level was 0.8mG. The percentage of participants whose average MF being over 2mG was about 11% and over 3mG 2.8%. Therefore, it can be said that about 90% of sample Koreans are exposed to under 2mG of magnetic field daily, however, this is only the result of a preliminary survey.

Fig. 5 shows the population distribution of times during which the MF is over the specified level within a 24-hour period.

From this data, it can be said that approximately 25% of the participants were exposed to over 3mG of MF for about 2 hours, 10% over 10mG of MF for 1 hour, and 5% over 15mG of MF for 30 minutes.

3.2 Average MF During Different Types of Activity

The average MF at work and in the bedroom, which account for about 70% of one's daily life, was surveyed. For this survey, the hours of exposure in the bedroom and at work should be assessed separately.

Table 6 Distribution of MF for participants during the period "In Bedroom"

Magnetic Field, [mG]	Percentage of Population with Field Equal to or Exceeding Given Value [%]
0.0	100.0
0.5	37.2
1.0	11.4
1.5	5.7
2.0	2.9

Table 7 Descriptive statistics of the distribution of average MF during the period "In Bedroom"

Statistical Parameters	Result [mG]	Parameters	Result [mG]
Mean	0.47	Min.	0.04
Standard Deviation	0.16	L90 %	0.07
Geometric Mean	0.44	L75 %	0.14
Median	0.29	L50 %	0.29
		L10 %	0.84
		L5 %	1.32
		L1 %	2.48
		Max.	2.98

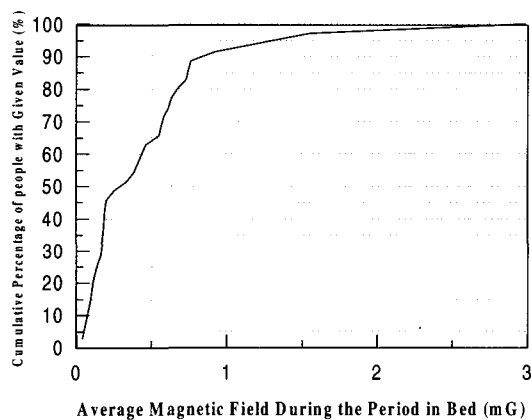


Fig. 6 Distribution of average MF for participants during the period "In Bedroom"

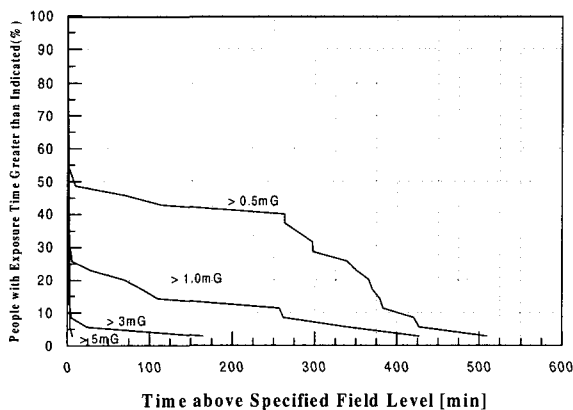


Fig. 7 Sample Korean population distribution of times above specified field level during the period "In Bed"

3.2.1 In Bedroom

The results of MF survey in the bedroom are shown in Tables 6 and 7 and Fig. 6. The average MF was 0.5mG and the median level was 0.3mG. The percentage of participants whose average MF in the bedroom being over 1mG was 11.4% and over 2mG 2.9%. Therefore, it can be said that there is no particular MF source in the Korean bedrooms and its MF environment is quite good on the whole.

Fig. 7 shows the population distribution of times during which the MF is over the specified level in the bedroom within a 24-hour period. Approximately 20 % of the participants were exposed to over 1mG for 1 hour and 5% over 3mG for 20 minutes. Almost all participants were exposed to under 1mG in the bedrooms.

3.2.2 At Work

The results of MF survey at work are shown in Tables 8 and 9 and Fig. 8. For the workplace statistics, housewives were excluded and only 27 participants whose work environment can be clearly classified were included. The average MF was 1.3mG and the median level was 0.9mG. The percentage of participants whose average MF at work that was over 2mG was 14.8% and over 5mG 3.7%.

Table 8 Distribution of MF for participants during the period "At Work"

Magnetic Field [mG]	Percentage of Population with Field Equal to or Exceeding Given Value [%]
0.0	100.0
0.5	74.1
1.0	37.0
1.5	18.5
2.0	14.8
5.0	3.7

Table 9 Descriptive statistics of the distribution of average MF during the period "At Work"

Statistical Parameters	Result [mG]	Parameters	Result [mG]
Mean	1.34	Min.	0.25
Standard Deviation	2.43	L90 %	0.30
Geometric Mean	0.97	L75 %	0.41
Median	0.86	L50 %	0.86
		L10 %	3.57
		L5 %	4.51
		L1 %	5.33
		Max.	5.48

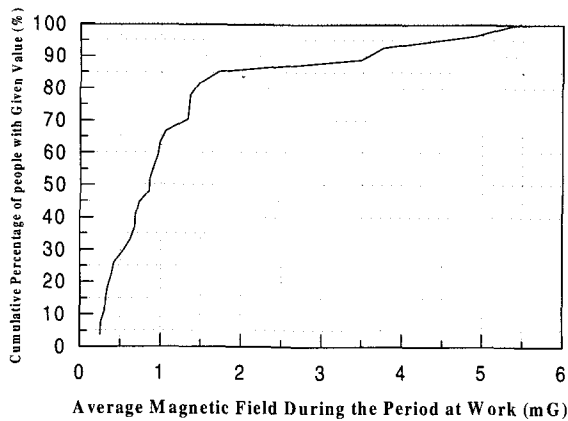
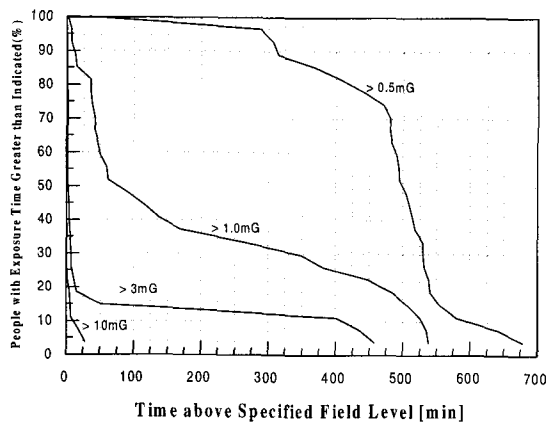
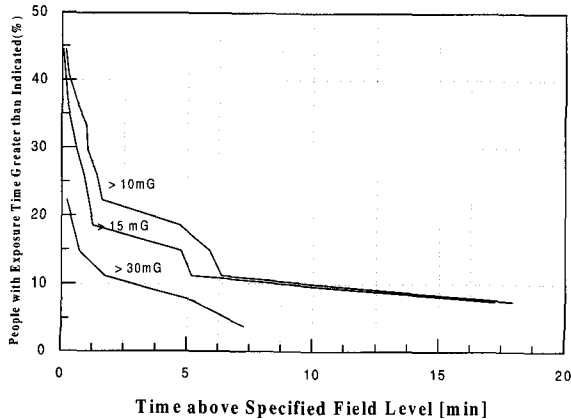


Fig. 8 Distribution of average MF for participants during the period "At Work"



(a) MF between 0.5 and 10mG



(b) MF between 10 and 30mG

Fig. 9 Sample Korean population distribution of times above specified field level during the period "At Work"

Fig. 9 shows the population distribution of times during which the MF is over the specified level at work within a 24-hour period. Approximately 10% of the participants were exposed to over 3mG for 7 hours and 5% over 10mG for about 20 minutes. It is found that at certain workplaces, the workers were exposed to tens of mG of MF for more than 10 minutes continuously.

3.3 Comparison of MF Exposures by Occupation

The characteristics and differences of MF exposures by occupation were analyzed. As can be seen in Table 10, the people working at substations are likely to be exposed to high current power facilities and their maximum average MF was 3.24mG. The maximum MF for full-time housewives was 0.84mG, which was the lowest level among the participant groups, since they were mostly exposed to home appliances only. As for the maximum MF exposure for a short period of time, it is thought that the 24-hour average MF exposure of the substation workers was higher than people engaged in other occupations since they were exposed to 100 ~ 230mG of MF near the bus-bar for tens of minutes. There were participants who were temporarily exposed to 150mG or 299mG of MF at a hospital or a school. However, these values were obtained during the use of medical or school broadcasting facility and the duration of exposure was less than 5 minutes and thus their 24-hour average MF was not higher than that of the substation workers.

According to the 24-hour average MF exposure, the MF exposure at work was higher than that at home and other activity areas in general. Therefore, the working hours were specially analyzed. As can be seen in Table 11, the workers at substations were exposed to over 4mG of L50% MF at work and the workers at factories, hospitals, restaurants, and department stores were exposed to about 1mG of MF at work. Workers at offices and schools were exposed to under 0.5mG of MF at work, which is lower than other workplaces since the use of electric facility at these places is less frequent than other places. The MF exposure at substations and factories significantly affects the 24-hour average personal MF exposure. However, for the workers working at hospitals, restaurants, or department stores, there was not much difference between the MF exposure at work and that at other places.

4. Conclusions and Further Plan

1. This personal MF exposure survey is a preliminary for the main survey, and it was done with 36 participants according to occupations. This is the first unique survey even done in Korea.

2. The 24-hour average MF exposure of Sample Koreans was about 1mG, and the percentage of participants who were exposed to over 2mG was 11% and over 3mG 3%.

3. Approximately 25% of the participants were exposed to over 3mG for 2 hours, 10% over 10mG for 1 hour and 5% over 15mG for 30 minutes.

4. In the electrician group, there were cases where the participants were exposed to 100 ~ 230mG of MF continuously for about 20 minutes.

5. The average MF exposure in the bedroom was 0.5mG and the percentage of participants who were exposed to

over 1mG in the bedroom was 11%. Participants exposed to over 2mG were 3%. Also, approximately 20% were exposed to over 1mG for 1 hour and 5% over 3mG for 20 minutes. Therefore, the MF environment in the bedroom is under 1mG, which is quite low on the whole.

Table 10 Distribution of 24-hour average MF in mG according to occupations

Occupation	Max.	L5%	L50%	Min.	
Office worker	2.28	1.92	0.71	0.24	
Electrician (at substation)	3.24	3.12	2.16	1.87	
Factory worker	0.76	0.75	0.68	0.63	
Housewife	Without job	0.84	0.73	0.33	0.16
	With job	0.92	0.90	0.47	0.16
Student	1.97	1.94	1.16	0.57	
Warehouse worker	2.06	1.92	0.79	0.47	
Hospital worker	0.94	0.92	0.74	0.66	
Restaurant worker	1.61	1.51	0.84	0.67	
Total	3.24	2.30	0.77	0.16	

Table 11 Distribution of average MF during work time only

Occupation	Max.	L5%	L50%		Min.
			Work Time Only	24-Hour	
Office worker	1.48	1.42	0.37	0.71	0.25
Electrician (at substation)	5.48	5.39	4.34	2.16	3.76
Factory worker	1.37	1.37	1.2	0.68	1.06
Student	3.48	3.02	0.37	1.16	0.31
Warehouse worker	0.85	0.82	0.66	0.79	0.63
Hospital worker	0.99	0.98	0.82	0.74	0.73
Restaurant worker	1.71	1.58	0.78	0.84	0.69
Total	5.48	4.51	0.86	0.77	0.25

6. The MF exposures during work hours were surveyed and the average MF was 1.3mG. The percentage of participants who were exposed to over 2mG was 14.8%, and over 5mG, 3.7%. In addition, about 10% of the participants were exposed to over 3mG for about 7 hours, and about 5% over 10mG for about 20 minutes.

7. Of special note, it is found that the MF exposure at work for the substation and factory workers greatly affected the 24-hour personal average MF exposure.

8. For the main survey, about 400 subjects by occupation will be surveyed utilizing EMDEX-LITE, which is smaller and lighter than EMDEX-II that was used for this survey. A database will be established to analyze the status of personal MF exposure and safety.

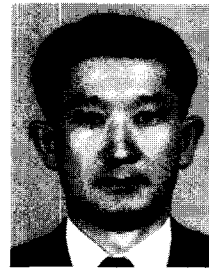
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