

# EPIDEMIOLOGICAL SURVEY ON EFFECT OF EMF EMITTED BY PHOTOCOPY MACHINES GENERALLY USED IN DHAKA CITY BANGLADESH

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## Abstract

Significant concerns has been raised about possible health effects from exposure to radiofrequency (RF) electromagnetic fields specially after the rapid introduction of modern amenities specially the mobile telecommunication systems. The biological effects of low level EMF and a possible potential relation various diseases specially blood cancer causation are controversial. There are many epidemiological studies of the possible adverse health effects associated with environmental exposure to extremely low frequency (0-300 Hz) non-ionizing radiation such as that emitted by power cables and electrical substations linking such exposure to leukemia, brain cancer, male breast cancer, skin cancer and eye melanoma. Far less attention has been paid to health hazards from environmental exposure to radiation in RF range (100 kHz-300GHz) at field strengths much below to these required to produce thermal effects. Laboratory studies in this area have also been confusing and conflicting. While some animal studies suggest that RF fields accelerate the development of cancers, other studies found no carcinogenic effect. Obviously, there is an urgent need for extensive, well conducted epidemiological and laboratory studies.

Photocopy machines are being used all over the world as it has made the life easy for academic, office, business. Hundreds of photocopy machines are also being used in Bangladesh. EMF is also emitted by photocopy machines. There has been no such study performed in Bangladesh. The data were collected from various places in Dhaka city, Bangladesh: Banani Super Market, Mohakhali, Farmgate Green Road, Nilkhet and Uttara. Both Electric and Magnetic fields were measured for photocopy machines. Both epidemiological survey and EMF measurements were done for these locations. These results showed that in many cases the magnetic field radiated from the different sources are greater than the threshold limit and photocopier operators suffered from various types of ailments like indigestion, vomit, insomnia, pain in hands and legs, stomach ache, mental depression, skin disease, cataract, sexual problems, hairs turning white etc. due to prolonged exposure to EMF. In many of the photocopier shops the operators were working in congested space with lots of machineries around. There are many devices and power lines around them, having a congested environment and low circulation of air. Also smoking contributed to their overall health problems.

**Keywords:** EMR, NIR, WHO, ICNIRP, IARC, ITU, DNA.

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## 1. INTRODUCTION

It is well known that electricity is the main source for the development of modern civilization. At the same time, it is also known to the people about the adverse effects of varying degrees of Electro-Magnetic Fields (EMF) commonly known as non-ionizing radiation (NIR) which do not ionize the media like that of ionizing radiation (i.e.  $\alpha$ ,  $\beta$  and  $\gamma$ , etc.) It is reported by the scientists that high power transmission lines [1][2], computer monitor/video display unit, radio waves of different frequencies in (extremely low frequency to microwaves) telecommunication, satellite, radar etc. also cause harm to living systems [3][4], especially in human beings for example. It is proven that high power transmission lines cause human health hazards rather than a common electrocution. Even there are evidences that the cause of clinical depression and commitment of suicide are related with the emission from the power lines [5][6]. There are several epidemiological

survey reports that occupational hazards like risk of developing Acute Myeloid Leukemia (AML) may occur among the people working in the field of telecommunication. Cancerous thyroid tumor, suppression of T- lymphocyte cell etc. are also found to occur among the persons exposed to non-ionizing radiation.

Photocopy machine is one of the widely used machines in Bangladesh which radiates NIR. The workers/machine operators working for 8-10 hours a day standing beside the machine without any precautionary measures are the focal point of this paper. There have been various papers published on EMF of radio, TV etc. but not much on photocopy machines. There are hundreds of machine operators working all over Bangladesh. People nowadays are very much used to get photocopies of any things specially students' photo copy from teacher's note, books, journals, magazine, documents etc.

There are basically three types of photocopier machines. One with heating effect, another dot and the other type is laser copier. Most current photocopier machines use a technology called xerography, it is a dry process that uses electrostatic charges on a light sensitive photoreceptor to first attract and then transfer toner particles (a powder) onto paper in the form of an image. [7] Heat, pressure or a combination of both is then used to fuse the toner onto the paper. There are other technologies such as inkjet but xerography is standard for office copying. Some devices sold as photocopiers have replaced the drum-based process with inkjet or transfer film technology. There are also color photocopiers. There is an increase in digital technology, which replaces the older analog technology. With digital copying machine, the copier consists of both an integrated scanner and a laser printer. Most of the laser printers commercially used in Dhaka Bangladesh use ultraviolet light.

Exposure to ultraviolet light has side effects. At the beginning of photocopying era, the sensitizing light source was filtered green to match the optimal sensitivity of the photoconductive surface. Therefore, this filtering removed all ultraviolet [8]. Recently, a variety of light sources are used. As glass can transmit ultraviolet rays between 325 and 4000 nanometers, copiers with ultra-violet producing lights (e.g. xenon flash, halogen, fluorescent). These expose documents to some ultraviolet. [8]. There has been some concern related to emissions from photocopier machines which uses selenium and ozone and fumes from heated toner. [9][10]

## 2. METHODS

A magnetic Science International MF meter (Serial No 624335) was used for measuring the magnetic field values for the various photocopy machines. A Cughill Field Mouse for Biohazard Awareness was used for measuring the threshold values for both electric field and magnetic field around the machines. This Cughill Field Mouse instrument was designed by Dr. Roger Coghill of UK. The students filled the measurement table for measuring the photocopy machines.

## 3. RESULTS

### 3.1 Epidemiological Survey

Findings at different EMF sources: All the readings were taken from various parts of Dhaka, Bangladesh. In Table-1, epidemiological survey data were collected from the Banani Super Market Dhaka from 5 photocopier shops. The operators were asked questions form questionnaire forms regarding their age, working years, number of hours working per day, smoker/non-smoker, various symptoms of their health and other observations. These data from table-1 Banani Super Market, Dhaka were taken on the date 12.12.2013

**Table-1: Photocopy Operators at Banani Super Market, Dhaka (12.12.2013)**

S.N.	Age (years)	Working years	Working Hours/day	Smoker?	Symptoms	Other observations
1	46	10	3	No	Indigestion, insomnia, cataract, pain in legs & wrists, mental depression	Depressed & tense
2	18	1	10	Yes (20/day)	No symptoms	Young & seems he is suffering from some sickness, he is not concerned about it
3	29	15	12	Yes (10/day)	Indigestion, insomnia, pain in hands, cataract	Works in congested space with lots of machineries around
4	27	1.5	11	Yes (10/day)	Stomach ache, pain in hands, sexual problems	Lots of device & power lines around him, congested space & air circulation is very low
5	29	13	12	Yes (10/day)	Depression but not so deep	He is young, gives time in physical exercise regularly

In Table-2, epidemiological survey data were collected from the Mohakhali Dhaka from 3 photocopier shops. The operators were asked questions form questionnaire forms regarding their age, working years, number of hours working per day, smoker/non-smoker, various symptoms of

their health and other observations. These data from table-2 Mohakhali, Dhaka were taken on the date 1.04.2013

**Table-2: Photocopy Operators at Mohakhali, Dhaka (1.04.2013)**

S.N.	Age (years)	Working years	Working Hours/day	Smoker?	Symptoms	Other observations
1	24	1	10	Yes (5/day) 5 years	Indigestion, insomnia, cataract, pain in legs, mental depression, stomach ache	Stomach ache and pain in legs common problem
2	20	4 months	12	No	Insomnia, pain in hands & legs, mental depression, stomach ache, skin disease	Pain in hands and legs common problem
3	30	2	12	Yes (10/day)	Indigestion, insomnia, pain in hands, skin disease	He feels insomnia and pain in hands

In Table-3, epidemiological survey data were collected from Farmgate Green Road Dhaka from 9 photocopier shops. The operators were asked questions form questionnaire forms regarding their age, working years, number of hours

working per day, smoker/non-smoker, various symptoms of their health and other observations. These data from table-3 Farmgate, Green Road Dhaka were taken on the date 9.11.2013

**Table-3: Photocopy Operators at Farmgate, Green Road Dhaka (9.11.2013)**

S.N.	Age (years)	Working years	Working Hours/day	Smoker?	Symptoms	Other observations
1	30	5	13	Yes (11-14/day)	Pain in legs, mental depression, stomach ache	He looked unhealthy & is addicted to smoking
2	19	2	10	No	Insomnia, pain in hands & legs, mental depression, stomach ache, skin disease	Pain in hands and legs common problem
3	15	3	13	No	Indigestion, insomnia, pain in hands & legs, mental depression	He feels insomnia and pain in hands
4	22	6 months	8	No	Pain in hands & legs, mental depression	He is NOT aware of health effects due to EMF
5	22	6 months	6-7	Yes (2-3/day)	Stomach ache, pain in hands & legs, mental depression	He is aware of health effects due to EMF
6	30	4	10	No	Indigestion, insomnia, pain in hands & legs, mental depression	He is NOT aware of health effects due to EMF
7	26	4	8	No	pain in hands & legs (1 yr), mental depression (3 months), skin disease (6 months)	He is aware of health effects due to EMF
8	26	6 months	10	No	pain in legs, mental depression	He is NOT aware of health effects due to EMF
9	27	4	10	No	Insomnia	He is NOT aware of health effects due to EMF

In Table-4, epidemiological survey data were collected from the Nilkhet Dhaka from 20 photocopier shops. The operators were asked questions form questionnaire forms regarding their age, working years, number of hours

working per day, smoker/non-smoker, various symptoms of their health and other observations. These data from table-4 Nilkhet, Dhaka were taken on the date 04.4.2013

**Table-4:** Photocopy Operators at Nilkhet, Dhaka (4.4.2013)

S.N.	Age (years)	Working years	Working hours/day	Smoker?	Symptoms	Other observations
1	37	7-8 years	8-10 hours	Yes	Pain in legs and hands, cataracts	He is NOT aware of health effects due to EMF
2	19	3 years	10 hours	Yes: 2 years	Pain in legs, mental depression	He is aware of health effects due to EMF
3	18	3 years	12 hours	No	Pain in legs and hands, cataracts, mental depression	He is NOT aware of health effects due to EMF
4	25	6 years	12 hours	No	Pain in legs and hands, stomach ache, vomit, indigestion	He is aware of health effects due to EMF
5	29	1.5 months	12 hours	Yes: 8-10/day (8 years)	None	He is NOT aware of health effects due to EMF
6	34	20 years	12 hours	No	Mental depression	He is NOT aware of health effects due to EMF
7	25	10 years	12 hours	Yes	Insomnia, pain in hands, eye problem	He is NOT aware of health effects due to EMF
8	34	5 years	12 hours	Yes	Insomnia, pain in legs and hands	He is NOT aware of health effects due to EMF
9	48	25 years	10 hours	Yes: 10-15/day	Pain in hands, cataracts, mental depression, skin disease, stomach ache, Insomnia	He is NOT aware of health effects due to EMF
10	38	5 years	8 hours	Yes: 15 years	Indigestion, cataract, mental depression, sometimes: stomach ache, pain in legs and hands	He is aware of health effects due to EMF
11	27	6 years	8 hours	Yes: 8 years	Pain in hands and legs	He is NOT aware of health effects due to EMF
12	20	4 years	13 hours	Yes: 1 year	Mental depression, skin disease	The man looked weak. He is NOT aware of health effects due to EMF
13	25	6 years	14 hours	Yes: 2 years	Cataract, pain in legs and hands	The man seemed weak. He is NOT aware of health effects due to EMF
14	21	2 years	8 hours	Yes: 1 year	Mental depression, skin disease	He is NOT aware of health effects due to EMF
15	24	4 years	8 hours	Yes:	Pain in hands	He is NOT aware of health effects due to EMF
16	32	8 years	11 hours	Yes	Vomit, insomnia, cataract, stomach ache, pain in legs, mental depression, sometimes indigestion	He is aware of health effects due to EMF but he does not take any protection to prevent it.
17	28	4 years	10 hours	Yes: 8 years	Indigestion, cataract, pain in legs and hands, skin disease	He is NOT aware of health effects due to EMF
18	28	12 years	12 hours	No	Cataract, pain in legs, mental depression	He is aware of health effects due to EMF
19	20	4 years	12 hours	No	Pain in legs	He is NOT aware of health effects due to EMF
20	22	2 years	12 hours	No	Sometimes pain in legs and hands	He seemed like a smoker and have insomnia. He is NOT aware of health effects due to EMF.

Finally in table-5, epidemiological survey data were collected from the Nilkhet Dhaka from 8 photocopier shops. The operators were asked questions form questionnaire forms regarding their age, working years, number of hours

working per day, smoker/non-smoker, various symptoms of their health and other observations. These data from table-5 Uttara, Dhaka were taken on the date 01.4.2013

**Table-5: Photocopy Operators at SR Tower photocopier shops, Uttara, Dhaka (8.03.2014)**

S.N	Age (years)	Working years	Working hours/day	Smoker?	Symptoms	Other observations
1	23	1 year	15 hours	No	Indigestion, pain in legs and hands, mental depression, eye problem	Sometimes he has pain in his eyes. Usually he gets very little rest. He is aware of health effects due to EMF
2	22	2 years	10 hours	Yes: 5-10/day	Indigestion, pain in legs and hands, mental depression	He is NOT aware of health effects due to EMF
3	28	6 years	10 hours	No	Indigestion, pain in legs and hands, mental depression, skin disease, eye problem	He is aware of health effects due to EMF
4	31	15 years	8 hours	No	Insomnia, pain in legs and hands, mental depression, eye problem	He is NOT aware of health effects due to EMF
5	24	4 years	10 hours	Yes: 10-15/day	Indigestion, pain in legs and hands, skin disease	He is NOT aware of health effects due to EMF
6	19	3 years	6 hours	No	pain in legs and hands	He is NOT aware of health effects due to EMF
7	20	2 months	13 hours	No	None	He is NOT aware of health effects due to EMF
8	25	1 year	5 hours	No	pain in legs	He is NOT aware of health effects due to EMF

It has been observed from the epidemiological study that there are the common problems found for these operators:

- (1) People working for 8-10 hours a day have various sufferings
- (2) People working for 15 years have severe health problems like indigestion, stomach ache, insomnia, pain in hands, cataract, and sexual problems.
- (3) People working for 20-25 years have mental depression.

### 3.2 EMF Measurements

In table 6, machine information for EMF is given for these 5 machines mentioned in table 1. Equipment information, country made, the threshold distances for both electric and magnetic fields were measured. Also, the maximum magnetic field value around the copier machine was measured for these machines. These data from table-6 at Banani Super Market, Dhaka were taken on the date 12.12.2013

**Table-6: Photocopy Machines at Banani Super Market, Dhaka (12.12.2013)**

Serial No.	Equipment info. (Machine #, Machine Model, Country made, Date of installation)	Threshold dis. in front of the screen measured from the centre of the equipment (cm)		Magnetic Field maximum (mG)
		Electric field (EF)	Magnetic field(MF)	
1	Toshiba 360 e studio Japan 2009	25	65	10.7 mG
2	Toshiba 450 Singapore	18 inches	45	4.2 mG
3	Toshiba 452 e studio Singapore 2009	24 inches	60	2.7 mG
4	Toshiba 350 e studio Japan	26 inches	65	5.5 mG
5	Toshiba 350 e studio Japan 2008	17 inches	50	10.7 mG

In table-7, machine information for EMF is given for these 3 machines mentioned in table-2 were taken from shops at Mohakhali Dhaka. Equipment information, country made, the threshold distances for both electric and magnetic fields

were measured. Also, the maximum magnetic field value around the copier machine was measured for these machines. These data from table-7 at Mohakhali, Dhaka were taken on the date 01.4.2013

**Table-7: Photocopy Machines at Mohakhali, Dhaka (1.04.2013)**

Serial No.	Equipment info. (Machine #, Machine Model, Date of installation)	Threshold dis. in front of the screen measured from the centre of the equipment (cm)		Magnetic Field maximum (mG)
		Electric field (EF)	Magnetic field(MF)	
1	Studio 452, Toshiba 452, Japan	55	400	135.50 mG
2	Studio 450, Toshiba 450, Japan	70	600	145.60 mG
3	Toshiba e-Studio 305, Japan	1300	1500	62 mG

In table-8, machine information for EMF is given for these 9 machines mentioned in table-3 were taken from shops at Farmgate Green Road, Dhaka. Equipment information, country made, the threshold distances for both electric and magnetic fields were measured. Also, the maximum

magnetic field value around the copier machine was measured for these machines. These data from table-8 at Farmgate Green Road, Dhaka were taken on the date 01.4.2013

**Table-8: Photocopy Machines at Farmgate Green Road, Dhaka (1.04.2013)**

Serial No.	Equipment info. (Machine #, Machine Model, Country made, Date of installation)	Threshold dis. in front of the screen measured from the centre of the equipment (cm)		Magnetic Field maximum (mG)
		Electric field (EF)	Magnetic field(MF)	
1	Toshiba 3560 Japan 1990	45.1	72.1	7 mG
2	Toshiba 2652 China 1998	47	83	8 mG
3	Toshiba 3560 Japan 2010	42	58	10 mG
4	Canon NP- 3050 Japan 2010	38	45	8 mG
5	Toshiba 3560 China 2007	45	50	8 mG
6	Toshiba 3560 Japan 2010	43	58	9mG
7	Toshiba DS 1012 China 2008	40	76	9 mG
8	Toshiba 3560 Japan 2001	41	56	9 mG
9	Toshiba 2860 China 2009	45	52	8 mG

In table-9, machine information for EMF is given for these 20 photocopier machines mentioned in table-4 were taken from shops at Nilkhet photocopier shops, Dhaka. Equipment information, country made, the threshold distances for both electric and magnetic fields were measured. Also, the maximum magnetic field value around the copier machine was measured for these machines. These

data from table-9 at Nilkhet photocopier shops, Dhaka were taken on the date 04.4.2013

**Table-9:** Photocopy Machines at Nilkhet photocopier shops, Dhaka (4.04.2013)

Serial No.	Equipment info. (Machine #, Machine Model, Country made, Date of installation)	Threshold dis. in front of the screen measured from the centre of the equipment (cm)		Magnetic Field maximum (mG)
		Electric field (EF)	Magnetic field(MF)	
1	Toshiba 3560 Japan 2010	47	>180	194 mG
2	Toshiba 3560 Japan	24	>180	45 mG
3	Toshiba 3560 Japan	54	>180	196 mG
4	Toshiba 3560 Japan	47	>180	26.5 mG
5	Toshiba 3560 Japan 1998	39	>180	140.3 mG
6	Toshiba 3560 Japan	65	>180	172.9 mG
7	Toshiba 3560 Japan	50	>180	46 mG
8	Toshiba 3560 Japan	54	>180	157 mG
9	Toshiba 3560 Japan	42	>180	192 mG
10	Toshiba 3560 Japan	36	>180	2 mG
11	Toshiba 3560 Japan	36	>180	30 mG
12	Toshiba JE074177 Malaysia	66	>180	176 mG
13	Lanier 3560 Japan 2002	31	>180	11.5 mG
14	Toshiba JE074177 Malaysia	66	>180	176 mG
15	Toshiba 3560 Japan	46	>180	134 mG
16	Toshiba 5660 Japan	56	>180	170 mG
17	Panasonic SP204 China	53	>180	153 mG
18	Toshiba 3560 Japan	51	>180	191 mG
19	Toshiba 3560 Japan 1999	50	>180	85 mG
20	Toshiba 3560 Japan	38	>180	78 mG

Finally in table-10, machine information for EMF is given for these 8 photocopier machines mentioned in table-5 were taken from SR Tower photocopier shops, Uttara, Dhaka. Equipment information, country made, the threshold distances for both electric and magnetic fields were

measured. Also, the maximum magnetic field value around the copier machine was measured for these machines. These data from table-10 Uttara, Dhaka were taken on the date 8.3.2014

**Table-10:** Photocopy Machines at SR Tower photocopier shops, Uttara, Dhaka (8.03.2014)

Serial No.	Equipment info. (Machine #, Machine Model, Country made, Date of installation)	Threshold dis. in front of the screen measured from the centre of the equipment (cm)		Magnetic Field maximum (mG)
		Electric field (EF)	Magnetic field(MF)	
1	Toshiba DP-4540 China 2006	46	18	168 mG
2	Studio 352; DP-4430 Japan 2011	32	15	106 mG
3	Toshiba e- studio 452; DP-4540 Japan 2009	35	19	137 mG
4	Toshiba DP-4540 Japan 2005	48	17	172 mG
5	Toshiba studio 352; DP-4438 Japan 2011	30	14	102 mG
6	Toshiba e- studio 350; A7820 Japan 2010	33	11	130 mG
7	Toshiba e- studio 452; DP-4540 China 2010	52	22	177 mG
8	Toshiba e- studio 452; DP-4540 China 2006	34	14	150 mG

#### 4. DISCUSSIONS

From epidemiological studies given in tables 1-5 it has been found that common diseases from among the workers are indigestion, vomit, insomnia, pain in hands and legs, stomach ache, mental depression, skin disease, cataract, sexual problems, hairs turning white etc. In many of the photocopier shops the operators were working in congested space with lots of machineries around. There are many devices and power lines around them, having a congested environment and low circulation of air. Some of the operators are smokers and have been for a couple of years, which might have had some negative effects on their health.

From the EMF measurement studies given in tables 6-10, it was found from the results that the magnetic field values are much higher than the threshold level. Because of the nature of the wiring both in the ceiling and floor, all the rooms had higher magnetic field than threshold value. Operators work on an average of 10-13 hours a day in those shops. We have in mind to include other regions for the study to continue.

A potential hazard to health can be produced either as a result of the exposure of the human body to NIR, or by interaction with technical devices, which are themselves affected by NIR and they give rise to health hazards (e.g. interference with electro medical devices, unintentional triggering of electrically activated detonator and ignition of flammable materials). This is especially true if the individuals concerned are not aware of the potential hazard to be unable to identify it.

#### 5. CONCLUSION

From the above lab results, it has been found that in most cases the magnetic field has crossed threshold value. The electric field also has a higher threshold value in some of the equipments. Also, the magnetic field maximum exposure was nearly 200 mG in many cases. Wiring must be done according to the building code 2012. It is hoped that this survey will be helpful as a preventive measure for photocopier operators who might get affected tomorrow. Same kind of experimental data on epidemiological survey can be done in other parts of Bangladesh.

In order to get rid of the health hazards caused by all those systems, people should be aware of them and accordingly precautionary measures should be taken. It is necessary to be acquainted with the harmful effects of non-ionizing radiations on living systems and also on the environment that we are living in and to find appropriate corrective measures for minimizing or controlling the hazards of NIR as far as practicable.

Since magnetic field is more harmful than electric field, there must be a limit both in the residential and occupational levels between 0.2 to 0.3  $\mu\text{T}$  or 2.5 mG. (This value is internationally recognized as standard limit in many countries). However, for the staff working at very high frequency transmitting stations, safe precautions such as wearing of special clothing, screened helmets and secured

goggles should be taken. The duration of exposure must be kept to the minimum possible. It must be ensured that intensity of radiation in the body does not exceed the recommended maximum level (10  $\text{mW}/\text{cm}^2$ , 195V/m in U.S.A. and 0.1  $\text{mW}/\text{cm}^2$ , 20 V/m in CIS).

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#### BIOGRAPHIES

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