



UNIVERSITI PUTRA MALAYSIA

***COMPARATIVE STUDY ON THE RELATIONSHIP BETWEEN
ELECTROMAGNETIC FIELD (EMF) WITH GENOTOXICITY AND
HEALTH SYMPTOMS AMONG CHILDREN IN KLANG VALLEY.***

NUR SYUHaida NADHIRAH BINTI AHMAD SHaIFUDIN

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FPSK4 2018 14**

ACKNOWLEDGEMENT

First and foremost, praise to Allah SWT for the strength and His blessings in completing this thesis. Special gratitude to my supervisor, Prof. Dr. Zailina Hashim for her supervision and constant support. Her valuable advice and guidance throughout the experimental and thesis work have contributed to the completion of this project. Not forgotten, I would like to thank my co-supervisor, Dr. Vivien How for her understanding, encouraging and personal guidance have provided a good basis for the preparation of this thesis.

I also would like to express my gratitude and appreciation to Headmaster of Sekolah Kebangsaan Putrajaya Presint 14(1) and Sekolah Kebangsaan Puchong Batu 14 for their permission and cooperation in carrying out this project in their school. My gratitude is also expressed to parents and children who were involved in this study.

Special gratitude to beloved parents for the endless support and encouragement. Last but not least, sincere thanks to all my friends for their kindness and moral support throughout this project and also to those who were involved directly and indirectly in my project. Thank you very much.

ABSTRACT

COMPARATIVE STUDY ON THE RELATIONSHIP BETWEEN ELECTROMAGNETIC FIELD (EMF) WITH GENOTOXICITY AND HEALTH SYMPTOMS AMONG CHILDREN IN KLANG VALLEY.

NUR SYUHaida NADHIRAH BINTI AHMAD SHAI FUDIN

Introduction: There is a growing concern about the possible effects of electromagnetic field (EMF) exposure from high voltage power lines (HVPL) towards human health especially in causing childhood, however, this issue still remain controversial. HVPL emitted both electric and magnetic field, but the concern is more on magnetic field as it cannot be shielded or blocked by any materials unlike electric field. **Objective:** To determine relation between the electromagnetic field (EMF) exposure from nearby high voltage power line (HVPL) with genotoxicity and reported health symptoms among school children in Klang Valley. **Method:** A comparative cross sectional study was carried out among 128 primary school children. Study group involved 81 children from school located less than 50m from HVPL while another 47 children from school which had no HVPL within 4km as a comparative group. A set of questionnaire were completed by their parents. The magnetic field at both selected school was measured using EMDEX II meter. Genotoxicity was assessed by examining the frequency of micronuclei in the buccal cells of the children. **Result and Discussion:** The magnetic field levels at the study school were higher than the comparative school, however, the levels were still below the guideline from the International Commission on Non-Ionizing Radiation Protection (ICNRIP 2010) and were also lower than level which were known to be associated with childhood leukemia. The micronuclei frequency in comparative group was significantly higher than study group ($p < 0.001$). Other factors that might influenced micronuclei frequency among children was parents education ($p = 0.004$). There was no association of reported health symptom with magnetic field levels among the study as well as the comparative group. **Conclusion:** The magnetic fields levels at study school posed no hazard to the children. However the comparative group showed sign of genotoxicity which were not related to EMF exposure but other environmental hazards which need to be studied further.

Keywords: electromagnetic field (EMF), genotoxicity, children

ABSTRAK

KAJIAN PERBANDINGAN TENTANG HUBUNGAN PENDEDAHAN KEPADA DAYA ELEKTROMAGNETIK DENGAN GENOTOXICITI DAN SIMPTOM KESIHATAN DALAM KALANGAN KANAK-KANAK DI KLANG VALLEY

NUR SYUHaida NADHIRAH BINTI AHMAD SHAIFUDIN

Pengenalan: Kesan daripada pendedahan kepada medan elektromagnetik yang dihasilkan melalui talian elektrik voltan tinggi (TEVT) terhadap kesihatan manusia terutama dalam menyebabkan leukemia dalam kalangan kanak-kanak semakin membimbangkan, namun, hal ini masih menjadi kontroversi. TEVT memancarkan medan elektrik dan magnetik, tetapi medan magnetik lebih membimbangkan kerana ia tidak boleh dihalang atau dihentikan seperti medan elektrik. **Objektif:** Untuk mengkaji hubungan antara pendedahan kepada medan elektromagnetik dengan genotoxicity dan simptom kesihatan dalam kalangan kanak-kanak di Lembah Klang. **Metodologi:** Kajian perbandingan dijalankan terhadap 128 kanak-kanak sekolah rendah. Kumpulan kajian melibatkan 81 kanak-kanak dari sekolah yang terletak kurang daripada 50m daripada TEVT, manakala 47 kanak-kanak dari sekolah yang terletak sejauh 4km daripada TEVT sebagai kumpulan perbandingan. Borang kaji selidik telah diedarkan dan dilengkapi oleh ibu bapa atau penjaga. Ukuran medan magnetik di sekolah dijalankan menggunakan EMDEX II Meter. Sel bukal telah diambil daripada kanak-kanak untuk mengukur kesan genotoxicity. **Keputusan dan Perbincangan:** Tahap medan magnetik di sekolah kajian lebih tinggi daripada sekolah perbandingan namun tahap medan magnetik masih kurang daripada tahap yang dikeluarkan oleh International Commission on Non-Ionizing Radiation Protection (ICNIRP 2010) dan juga kurang daripada tahap yang dikaitkan dengan leukemia antara kanak-kanak. Bilangan micronucleus antara kumpulan kajian lebih rendah berbanding kumpulan perbandingan ($p < 0.001$). Tahap pendidikan ibu bapa mempengaruhi bilangan micronucleus antara kanak-kanak ($p = 0.004$). Tiada hubungan antara simptom kesihatan dan tahap medan magnetik antara kumpulan kajian dan perbandingan. **Kesimpulan:** Pendedahan kepada medan elektromagnetik di sekolah kajian tidak memberikan risiko kepada kanak-kanak kerana tahap yang rendah, tetapi kumpulan perbandingan menunjukkan tanda genotoxicity yang mana mungkin disebabkan faktor persekitaran lain yang perlu dikaji.

Kata kunci: medan elektromagnetik, genotoxicity, kanak-kanak

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LIST OF ABBREVIATIONS

EMF	Electromagnetic Field
ELF	Extremely Low frequency
MF	Magnetic Field
T	Tesla
G	Gauss
mG	milligauss
μT	microtesla
HVPL	High Voltage Power Lines
WHO	World Health Organization
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IARC	International Agency for Research Cancer
IR	Ionizing Radiation
NIR	Non-Ionizing Radiation
TNB	Tenaga Nasional Berhad
kV	kilovolts
Hz	Hertz
kHz	kilohertz
MHz	megahertz
GHz	gigahertz
>	more than
<	less than

CHAPTER 1

INTRODUCTION

1.1 Background

Electricity is undeniably important to modern technology nowadays. Electricity demand in Malaysia increasing rapidly as Malaysia is a developing country with the increasing population and industrial growth. In order to ensure a smooth distribution of energy supply for all consumers, Tenaga Nasional Berhad (TNB) Transmission Division manages and operates the high voltage electric power transmission network known as National Grid which comprises 132kV, 275kV and 500kV transmission or power lines.

Power line is one of the common sources of extremely low frequency of electromagnetic field (ELF EMF) radiation which is consider as non-ionizing radiation (NIR). According to World Health Organization, electromagnetic field of non-ionizing radiation is categorized into extremely low frequency (ELF) fields from 0 > 300 Hz, intermediate frequency (IF) fields from 300 Hz to 10 MHz and radiofrequency (RF) fields from 10 MHz to 300 GHz. However, ELF is usually referring to frequency of up to 100 Hz and the most prominent power or transmission line frequency are 50 and 60 Hz.

Electromagnetic field (EMF) consist of electric and magnetic field which are produced whenever electricity is used. Electric field is exist when there is an electric charges or voltage. The higher the voltage, the higher the electric field. The strength of electric field is usually measured as volts per meter (V/m) or, kilovolts per meter (kV/m). Magnetic field is produced by current and the higher the current, the higher the magnetic field. The strength of a magnetic field can be expressed in Tesla (T) or microtesla (μT) and also Gauss (G) or milligauss (mG). The concern is more concentrated on magnetic field because it can induce electric fields and current in the body (WHO 2007).

However, there is a growing concern about the potential effects of power lines on human health especially children and this issue has become a topic of interest for over 30 years. High voltage power line has been associated with the probability of getting leukemia, breast cancer, neuropsychological disorder and reproductive (Djalel et al., 2014). Besides, there was also a study conducted to investigate the non-specific health complaint such as headache, however, the evidence of the relationship is considered weak. Baliatsas et al (2012) reported that the general population experienced health complaints such as fatigue and concentration difficulties because of the exposure to EMF emitted from various electrical appliances, mobile base station and power line.

In 1979, Wertheimer and Leeper found that the risk of getting leukemia in children living near to high voltage power line was doubled. Since then, a lot of researches have been conducted to investigate the association (Gallastegi et al., 2017). Leukemia in children was related to exposure from magnetic field rather than electric field (Draper et al., 2005). Due to the observation of ELF EMF in childhood leukemia, International Agency for Research Cancer has classified ELF EMF in Group 2B as possible carcinogen to human.

1.1 Problem Statement

More and more project is being developed involving high voltage power lines due to the high demand of energy supply. Most of power lines nowadays are being develop near to the residential and occupational area and this has become a concern to the public as power lines produce extremely low frequency of electromagnetic field (ELF EMF) and people living near to the transmission lines will be exposed to ELF EMF (Tukimin et al, 2011).

Extremely low frequency electromagnetic field (ELF EMF) is believed to cause detrimental effects on human health and this issue has increasing the public awareness towards transmission lines. ELF EMF exposure need to be controlled because of the effects to human health and electromagnetic field (EMF) could disturb immune function and tissue repair process which can attribute to cancer. (Daryoush et al, 2017). Based on the previous

study, the association between the exposure to ELF EMF and the health effects are still remain unclear even there is a lot of research have been conducted by scientist to confirm the consequences from the exposure (Tukimin et al, 2011)

ELF EMF are known to cause acute effects when the magnetik field induces electric field and currents in the body. ELF EMF exposure can affect a number of cells activities including gene expression (Fatemeh et al, 2016). From the previous epidemiological study, magnetik field exposure between 3 – 4mG is associated with the increased in case of leukemia among children (WHO, 2007). Environmental exposures can be harmful especially to children because they are more vulnerable (Kheifets 2005). Children are more sensitive to EMF exposure rather than adult because they are still period of development.

1.2 Study Justification

To date, limited study has been conducted to investigate the field-dependent effects in children. Advancement in electromagnetic field (EMF) technologies nowadays contribute to the increasing exposure of EMF among children at earlier age make their lifetime of exposure is longer than adults.

Since there is less study performed locally about the effects on DNA damage and the association with low frequency of electromagnetic field (ELF EMF) from high voltage power line (HVPL), this study will be able to make a comparison about the biological effects on children in the vicinity of high voltage power.

The school which located near to high voltage power line (HVPL) is chosen to investigate the biological effects in children from the exposure of ELF EMF produced by nearby power line which is DNA toxicity based on frequency of micronuclei. To make a comparison, another school selected has no HVPL in close proximity within 4km because magnetic field reduced rapidly with distance.

By conducting this study, it can help to determine whether there is an association between micronuclei frequency in children and the exposure to ELF EMF. It also help to provide more insight on the effect of ELF EMF produced from power line. This data might also be useful for other studies to investigate the health effects from exposure to power line. This study need to be addressed to prevent such health effects from power line especially children.

1.3 Conceptual Framework

Electromagnetic field comprising of ionizing and non-ionizing radiation. Extremely low frequency electromagnetic field (ELF EMF) is categorized as non- ionizing radiation. Based on scientific research that has been conducted, the excessive exposure towards ELF EMF could lead to various health effects.

ELF EMF exposure to the surrounding environment such as power line and household sources has become a matter of public concern because of the health effects shown in studies (references). Exposure to ELF EMF can lead to DNA impairment such as an increase in the frequency of micronuclei.

The aim of this study is to determine the exposure of primary school children to extremely low electromagnetic field since the school is located near to the power or transmission line and to determine the DNA toxicity based on the higher frequency of the micronuclei in the DNA as a resulted of the exposure to ELF EMF

Conceptual Framework

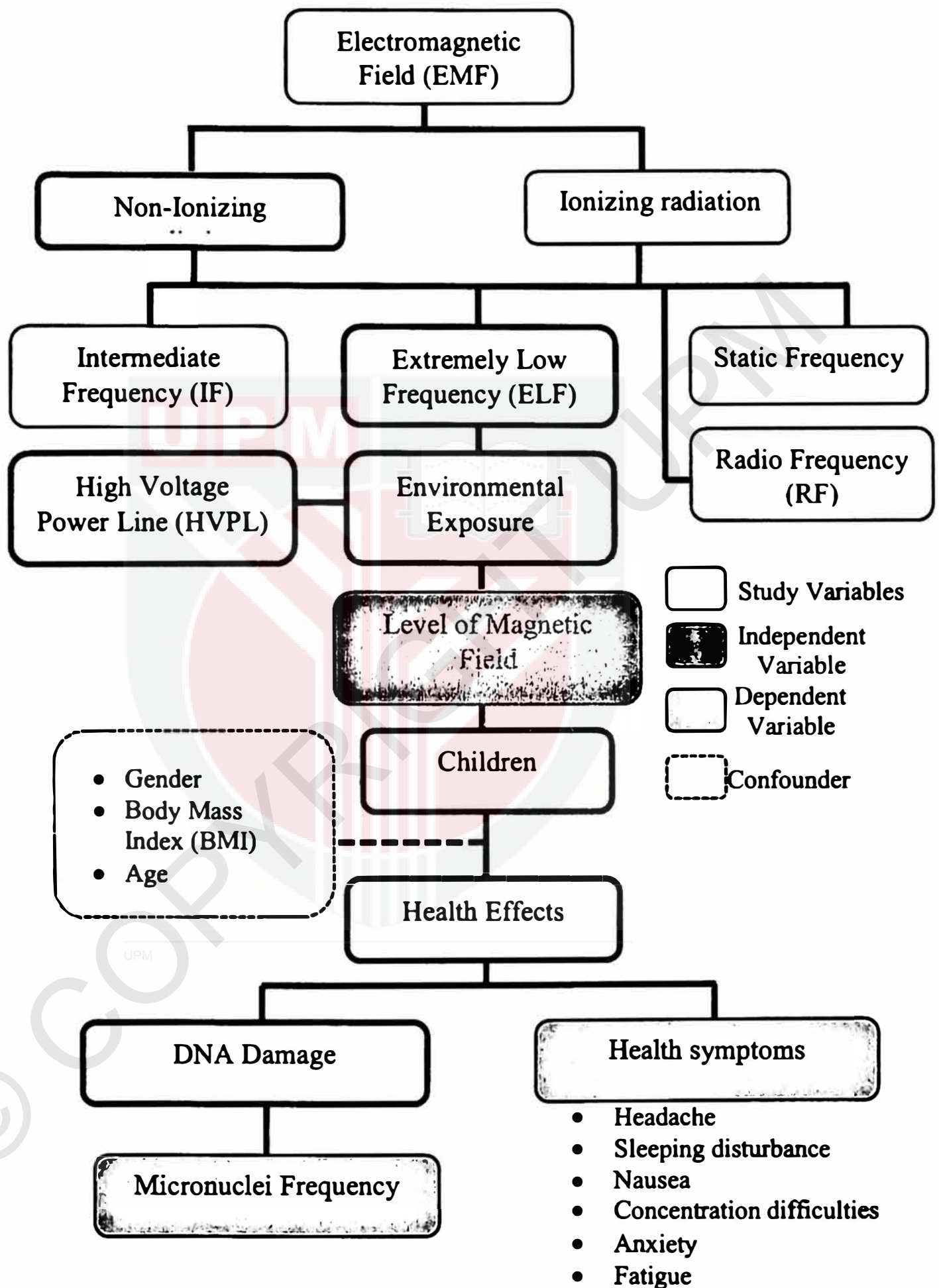


Figure 1.1 Conceptual Framework

1.5 Research Objectives

1.5.1 General Objective

To determine the electromagnetic field (EMF) exposure and the association with genotoxicity and reported health symptoms among children in Klang Valley.

1.5.2 Specific Objectives

1. To determine socio-demographic characteristics of the children.
2. To determine the reported health symptoms (headache, nausea, concentration difficulties, anxiety, sleeping disturbance and fatigue) of the children.
3. To compare the level of magnetic field at the two selected schools.
4. To compare the micronuclei frequency and total score of reported health related symptoms between the study and comparative group.
5. To determine the relationship between magnetic field exposure and total score of reported health symptom in children.
6. To determine the relationship between magnetic field exposure and micronuclei frequency in children.
7. To determine the selected factors (gender, BMI, parent's education, second hand smoke, length of residency, total of household appliances) that have significant relationship with micronuclei frequency of the children.

1.6 Research Hypothesis

- 1. The levels of magnetic field of study groups' school are significantly higher than the comparative group.**
- 2. The micronuclei frequency of study group is significantly higher in the study group than the comparative group.**
- 3. There total score of reported health symptoms is significantly higher in the study group than the comparative group.**
- 4. There is a significant relationship between magnetic field exposure and total score of reported health symptoms.**
- 5. There is a significant relationship between magnetic field exposure and micronuclei frequency in children**
- 6. The selected factors (gender, BMI, parent's education, second hand smoke, length of residency, total of household appliances) have a significant relationship with micronuclei frequency of children.**

1.7 Term and Definition

1.7.1 Conceptual Definition

Electromagnetic Field (EMF)

An electromagnetic field (also EMF or EM field) is a magnetic and electric field produced by movement electrically charged substance. It affects the actions of charged objects in the surrounding area of the field. (Hafizudin, 2012).

Extremely Low Frequency (ELF)

Extremely low frequency (ELF) radiation is positioned at the low-energy end of the electromagnetic spectrum and is a type of Non-Ionizing Radiation (NIR). Extremely low frequency range from 1 up to 300Hz (WHO, 2007).

Genotoxicity

Genotoxicity is a word in genetics defined as a destructive effect on a cell's genetic material (DNA, RNA) affecting its integrity. In most cases, genotoxicity leads to mutations in various cells and other bodily systems. (Shaily, 2012).

Primary School Children

Children start primary education at the age of seven (year 1) until the end of their studies the age of 12 (year 6). (Ministry of Education Malaysia).

1.7.2 Operational Definition

Electromagnetic Field (EMF)

Electromagnetic field (EMF) is a combination of electric and magnetic field which produced both naturally and from human activity.

Extremely Low Frequency (ELF)

Extremely low Frequency (ELF) is categorized under non-ionizing radiation and range from 1Hz to 300Hz. Power line and household appliances are the example of ELF sources.

Genotoxicity

Genotoxicity associate with progression of cancer as the cell DNA is damage and rupture. Higher micronuclei frequency is one of the biomarker for genotoxicity.

Primary School Children

Children aged 10 and 11 years old.

CHAPTER 2

1.0 LITERATURE REVIEW

2.1 Electromagnetic field

An electromagnetic field (EMF) is generated when there is a charged particles or when electrical devices is on. EMF consists both electric and magnetic field. Electric fields are produced by electric charges and magnetic fields are produced by the flow of current through wires or electrical devices. EMF is made up of waves of electric and magnetic energy moving together (radiating) through space and usually EMF is related with power lines (Hafizudin, 2012). EMF is a non-ionizing radiation (NIR) consist of extremely low frequency (ELF) field, intermediate frequency (IF) and radiofrequency (RF) field (WHO, 2017).

2.2 Electromagnetic spectrum

The electromagnetic (EM) spectrum is the range of all types of EMF radiation and divided into non-ionizing and ionizing radiation as shown in Figure. EMF radiation is classified by wavelength or frequency into are microwaves, infrared light, ultraviolet light, X-rays and gamma-rays. Power line emitted EMF at extremely low frequency which is categorized under non-ionizing radiation.

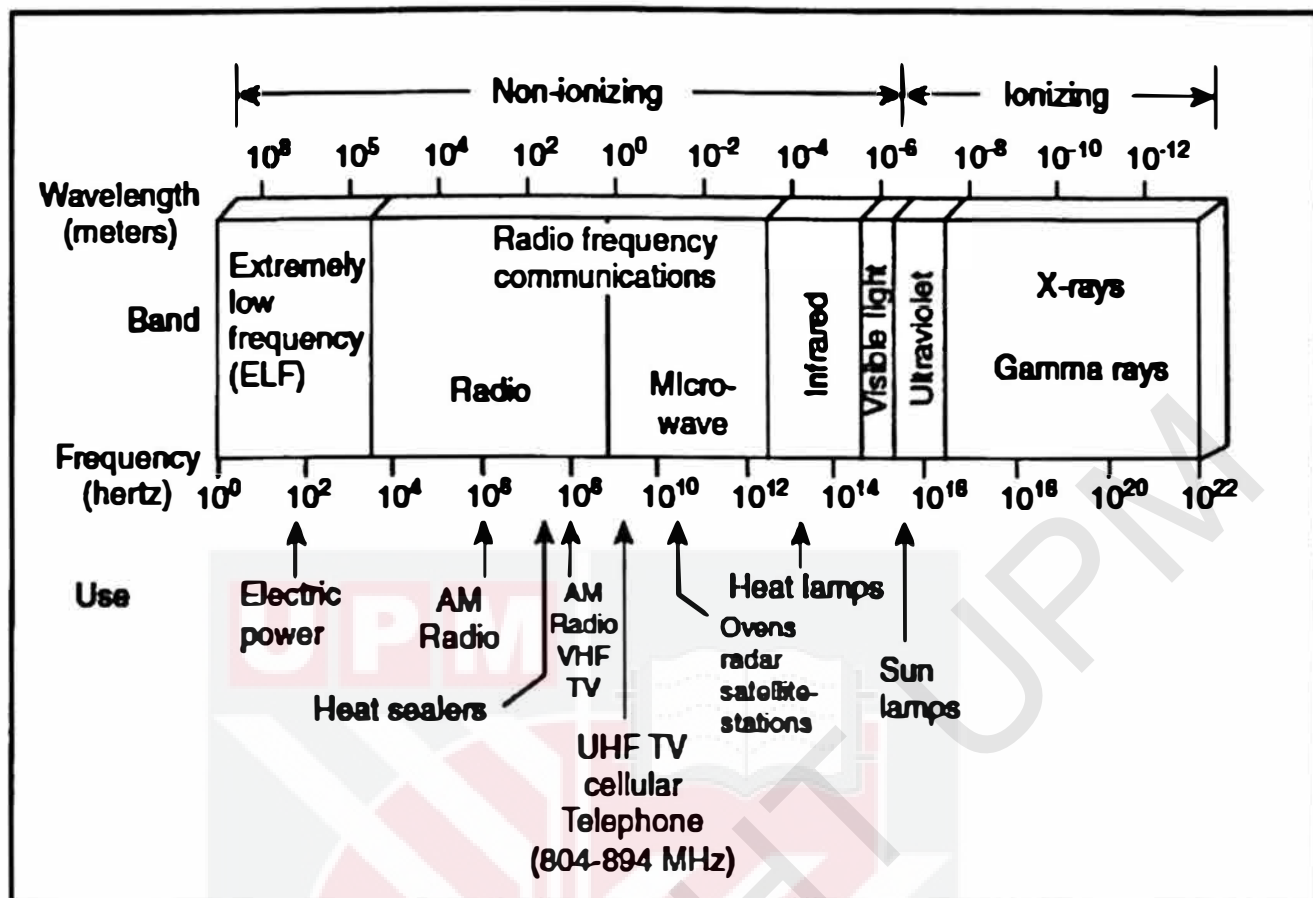


Figure 2.1 Electromagnetic Spectrum

2.3 Extremely low frequency electromagnetic field (ELF EMF) radiation from high voltage power line (HVPL).

HVPL produced electromagnetic field at extremely low frequency. Extremely low frequency (ELF) is range from 0 up to 300Hz. Frequency of typical power lines is usually in the range of 50Hz/60Hz. In Malaysia, the electric supply by overhead HVPL is at 50 cycles per second (Hz) and mainly exposure from power line and use of electrical energy is refer to power frequencies of 50Hz . Electrical power generating stations are mainly connected by overhead high voltage power or transmission lines (Usikalu et al, 2014). In Malaysia, Overhead High Voltage Power Lines (HVPL) are used to transmit electrical

power over a long distance and most of the Overhead HVPL used in Malaysia are 132kV and 275kV.

Exposure to ELF from power line for a long time is known to cause a various health effects to human. Electric and magnetic field generated is believed to have capability to induce current in human body when directly exposed to it (Tukimin et al., 2002). Low frequency electric and magnetic field induce weak electric current in human and animals as shown in Figure 2.2 (Nitsch et al, 2009)

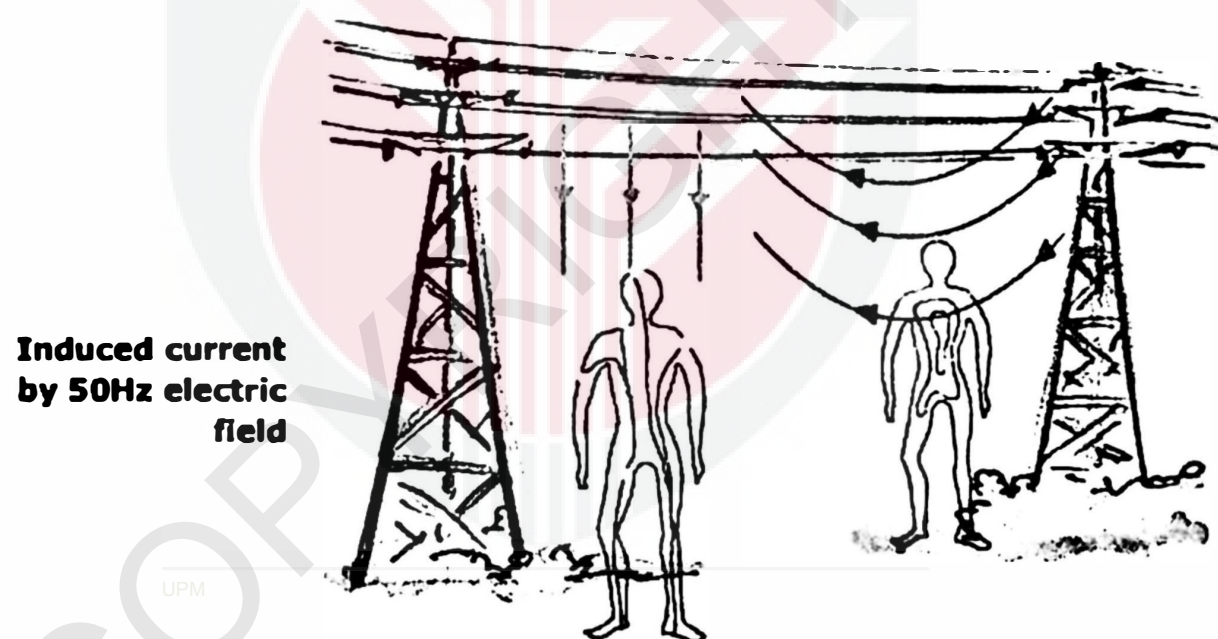


Figure 2.2 Low frequency electric and magnetic field under power lines

2.4 Living near to high voltage power line (HVPL)

Demand of energy supply led to a numerous construction of power lines near to residential area. Power line used to be located far away from residents area but everything has changed nowadays. Today, people live and work near overhead power lines and are potentially in harm's way due to the radiated magnetic fields being emitted from the power lines. People living in the vicinity of power lines might exposed to electric field and magnetic field from extremely low frequency (50Hz or 60Hz) emitted from power lines. In previous study, Shahbudin et al., (2010) found that the exposure level of electromagnetic field towards the public is low if the live or stay 30 meter away from power lines.

A few studies performed to investigate the level of electromagnetic field at residential and school area in proximity of high voltage power line. From the previous study by Huang et al., (2013) proved that the magnetic level at school located near power line was significantly higher than school located far away from power line which were in the range of $0.2\mu\text{T}$ to $0.4\mu\text{T}$. Another study by Chung et al., (2007) signifies that the children attending school in the vicinity of power line may have a higher chance of experiencing mean exposure more than $0.4\mu\text{T}$ during school hours. In Malaysia, a study conducted to measure magnetic field level at residential and school area located near to 132/275 kV power line found that the magnetic level at the area of 35m from power line was in the range $0.3\mu\text{T}$ to $0.4\mu\text{T}$ (Viloria , 2017). The range of this magnetic field is much lower compared to the permissible exposure limit for general public by ICNIRP. However,

this issue is become a subject of research as the magnetic field level in range 0.3 μ T to 0.4 μ T is associated with childhood leukemia as being emphasized by World Health Organization, 2007.

Extremely low frequency electromagnetic field radiation (ELF EMF) exposure and childhood leukemia.

Increasing concern regarding the effects of children who living near to power line as power line emitted ELF EMF which then causes an increased incidence of leukemia. Since late 1970s, a lot of research conducted to investigate the potential of ELF EMF in causing childhood leukemia. ELF EMF is classified as possibly carcinogenic (Class 2B) by International Agency for Research Cancer based on limited evidence by which EMF causes childhood leukemia (IARC, 2002). According to World Health Organization (2007), all the laboratory evidence failed to support the relationship between ELF EMF and biological function, thus, ELF EMF is still classified as Class 2B, a possible carcinogen. There are many researchers have argued that the average magnetic fields of 0.3–0.4 μ T are the levels that could interact with cells or tissues and cause impairment.

In 1979, study by Wheatmer and Leeper found an increase risk in childhood leukemia related with long exposure to power line magnetic field. Since then, a lot of research were conducted to prove the association. Another study conducted to confirm the issue also found a positive association where the risk of getting childhood leukemia was

doubled (Ahlbom et al., 2000, Greenland et al., 2000). Similar with a study conducted in Japan, Kabuto et al. (2006) found significant association between exposure level of EMF ($>0.4\mu\text{T}$) and childhood leukaemia (ALL). In contrary, Schuz et al. (2012), showed that there was no significant association between EMF exposure and childhood leukaemia.

2.6 Extremely low frequency electromagnetic field radiation (ELF EMF) exposure and genotoxicity.

Exposure to ELF EMF is believed to have an association with progression of cancer. ELF EMF have the potency to induce DNA and chromosomal damage and the possible effects ELF EMF on biological system were extensively investigated as the issue has become a public concern. Various studies conducted to understand the mechanism of ELF EMF in biological effects, but the association still poorly understood (Giorgi et al., 2017). Even ELF EMF is categorized as possibly carcinogenic, it is unlikely that ELF EMF cause direct genetic damage as their energy is not enough to damage biological molecules (Milena et al. 2017, Maes and Verschaeve, 2016). Maes and Verschaeve (2016) highlighted that only five out of 22 studies did not show cytogenic damage in the investigated ELF EMF exposed subject. However, it has been hypothesized that ELF EMF alone does not able to cause the effects unless in the presence of other genotoxic agents (Giorgi et al., 2017, Jin et al., 2014).

In occupational settings, the transformer or distribution line workers who were exposed to ELF EMF have higher frequency of chromosome abbreviation and micronuclei compared to non-exposed workers Celikler et al. (2009). The result of this study was in line with Carbonari et al. (2005) which reported that micronuclei frequency in workers exposed to low frequency radiation was significantly higher compared to the unexposed. Another study found a contradictory result where a cytogenetic investigation on workers exposed to ELF EMF, did not show any increased in cytogenetic damage. (Gadhia et al, 2010).

Even though there were studies found an association between EMF and biological effects among workers, most scientist does not consider that the available data pointed towards such effects. Jin et al. (2014) clarified that ELF magnetic field is unable to transfer enough energy to cell for damaging DNA directly. The facts that ELF magnetic field are more likely act as a promoter to enhance DNA damage is unclear as expert had that conclude that exposure to ELF magnetic field at 1mT for 4 or 16 hours in combination with DNA damage initiator did not cause additional DNA damage (Jin et al., 2012 and Jin et al., 2014).

2.7 Health symptom from extremely low frequency electromagnetic field radiation (ELF EMF) exposure.

Power line is one of ELF EMF sources and people living near to power line is exposed to ELF EMF and cause various health symptoms. Thus, it became a great concern toward the public as more power lines are built near to residential areas. A prospective study conducted by Jarry et al. (2015) discovered that there was a positive association between living near to power lines (up to 2 km away) and health symptoms. The evidence to prove the association between health symptoms is still weak.

Baliatsas et al. (2011) mentioned that 1.5% to 13.4% of the general population reported to have health symptoms mainly fatigue and concentration difficulties due to the exposure from various EMF sources including power lines. Electromagnetic field (EMF) exposure contributes to health symptoms and the most complaints reported were headache, sleeping disorder, nervousness, fatigue and concentration difficulties. (Roosli et al., 2004).

2.8 Micronuclei (MN) Assay

DNA damage can occur when the cell is exposed to carcinogens and if the damaged DNA is not repaired, it can lead to genetic mutations (Mihai et al., 2014). DNA damage at the chromosomal level is an important part of genetic toxicology and is a key event in carcinogenesis (Carbonari et al., 2005). Micronuclei (MN) are acentric fragments or

complete chromosomes which fail to attach to the mitotic spindle during cytokinesis and normally excluded from the nuclei (Maluf and Erdtmann, 2000). MN assay detects the level of the chromosomal damage that persist after the primary DNA breaks have been repaired (Jin et al., 2014). The quantification of micronuclei by micronucleus test is a non-invasive cytogenetic method which is a good indicator of chromosome mutation and has been used extensively in monitoring population exposed to known carcinogens and mutagens (Carbonari et al., 2005).



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CHAPTER 3

3.0 METHODOLOGY

3.1 Study Location

Two schools located in the Klang Valley were selected based on the distance to High Voltage Power Line (HVPL). Klang Valley was selected as it a highly dense populated area and the new power lines routing involved various residential areas and schools within the Klang Valley (Rahman et al., 2010). Study school (Figure 3.1) is located less than 50m away from the high voltage power line (HVPL) (132/275 kV HVPL) while the comparative school does not have any HVPL in close proximity of 4km (Figure 3.2).



Figure 3.1 Study School



Figure 3.2 Comparative School

3.2 Study Design

This was a comparative cross-sectional study. Data collection were carried out from 2nd January to 29 January 2017. Data and samples were collected and measured as follow (1) questionnaire, (2) magnetic field level around the school area and (3) and buccal mucosal cell.

3.3 Sampling

3.3.1 Study Population

The study population were children at the age of 10 and 11 years.

Inclusion criteria,

- Respondents with their consent form filled and signed by their parents to participate in this study.
- Respondents can be female or male students.

Exclusion criteria

- Had history of exposure to cytotoxic therapeutic drugs (e.g. chemotherapy) and radiation (Fatemeh et al., 2016).

- Had medical condition, e.g. malnutrition, anemia, nephritic problem, hepatic diseases and bleeding tendencies example easy bruising, nose bleeds, gum bleeds.

3.3.2 Sampling Frame

Different approaches were performed by the researcher in order to recruit the study population based on the inclusion and exclusion criteria as discussed in Section 3.3.1.

The sampling frame are Primary schools where children with 10-11 years (Std 4-5) were enrolled in the school.

A written permission were obtained from the Ministry of Education Malaysia, Department of Education Selangor and Putrajaya. Schools were selected based on the distance to HVPL. Children from the particular school were selected from the list of classroom obtained from the school office.

3.3.3 Sampling Method

Sampling location used in this study was purposive sampling. Children whose school located near to HVPL was a study group and school located more than 4km in radius to HVPL as a comparative group. Based on the sample size calculation (Section 3.4), a total

of 100 school children were recruited to participate in this study however, the total children in study group was more than the sample size calculated. A list of children from Standard 4 and 5 from schools were obtained from the corresponding school's office. After considering the inclusion and exclusion criteria of the students, students were selected randomly. Only student who had written consent from their parents or guardian were allowed to participate in this study.

3.4 Sample Size

The sample size was calculated. This estimation was calculated with a reasonable level of precision, confidence level of 95 percent (%) of the case sample estimates fall within 1.96 standard errors ($Z_{1-\alpha}$) of the specified population value. Therefore, the formula for estimating the size for group-comparison (two-group) design using the combined (or pooled) standard deviation ($2\sigma^2$) for the two groups adopted from Lemeshow et al. (1990) is used as follows:

$$\text{Formula, } n = \frac{2\sigma^2 [Z_{1-\alpha/2} + Z_{1-\beta}]^2}{(\mu_1 - \mu_2)^2}$$

Where,

σ = Estimated standard deviation (assumed to be equal to each group)

μ^1 = Estimated mean (larger)

μ^2 = Estimated mean (smaller)

$Z_{1-\alpha}$ = Standardized value for confidential interval, 95% CI=1.96

$Z_{1-\beta}$ = Standardized value for power, 80% of power =0.84

In order to estimate the minimum number of children to be recruited in this study, the calculation is estimated based on the total micronuclei experienced by exposed and non-exposed group of electromagnetic field (EMF) (Karina et al., 2005):

$$n = \frac{2\sigma^2 [Z_{1-\alpha/2} + Z_{1-\beta}]^2}{(\mu_1 - \mu_2)^2}$$

Where,

$$\sigma = 4.44+2.16/ 2$$

$$= 3.3$$

$$\mu^1 = 6.20$$

$$\mu^2 = 2.05$$

Hence,

$$n = \frac{2(3.3)^2 [1.96 + 0.84]^2}{(6.20 - 2.05)^2}$$

$$= 41.14$$

Based on this formula, it is estimated that a minimum number of children are required to examine the significant differences in the DNA damage and other related effects

experienced by the exposed and non-exposed group at 95% level of confidence and power of 80%. In order to increase 20% statistical power of test in general, an estimated number of respondents will be considered:

$$\begin{aligned}n &= 41.14 \times 0.2 + 41.14 = 49.36 \\ &= 50 \text{ respondents}\end{aligned}$$

Therefore, the total of two groups of children, $n = 2 \times n = 100$ children. In this study, sample size for respondents were increased to 128.

3.5 Data Collection

3.5.1 Data Collection Procedures

This study consists of two sections of data collection and data analysis. Each section was carried out among study and comparative children.

Part A was prepared using descriptive and explanatory closed-end questions to examine background information among the study population. The questionnaire consists of:

PART A : Background Information

PART B : EMF exposure from sources other than high voltage power line

PART C : Symptom or effects from electromagnetic field (EMF) exposure

3.5.2 General Quality Control

A pre- test was conducted to test the logistics and identify the potential deficiency in the study design. By recruiting at least 10% of the estimated studied population, a total of 10 children were obtained, coded and analyzed. Research protocol and quality control from each section were identified and analyzed. In order to ensure the reliability and validity of the collected samples throughout the study, the following steps were followed:

a) Chain-of-custody

A Chain-of-custody procedure was utilized for the purpose of sample and evidence management. To assure that procedures were being followed, tags or labels, field notes, picture capture and any other recorded information for accuracy was used and followed up by the research team.

b) Traceability of Sample

A checklist table were filled by the researcher when relevant samples were collected. This is to ensure that contaminated cotton linens from different body parts, and biological samples, such as buccal cells were made traceable through field records from the researcher who collected the samples or made the measurement.

c) Variability and Reproducibility of Samples

Samples were collected at once at the same time to minimize differences and samples were duplicated, e.g. replicated samples. For instance, buccal cells collected from inner oral cavity were replicated to two (2) microcentrifuge tube. Variation of biological samples might occur during sampling procedures, therefore duplicated samples are to ensure that the range of obtained results were around the mean values within the population.

d) Sample Collection Precautions

Precaution steps were emphasized during sample collection to prevent cross-contamination, particularly during biological sample collection. A detailed sample collection precaution which includes sample handling, mixing, preservation, storage and transport are discussed below (Section 3.9)

3.6 Quality Control for Questionnaire

3.6.1 Questionnaire

Self-constructed questionnaire was prepared by adapting question from Roosli et al. (2004), Barsam et al. (2012), and Huang et al. (2013). A group of research assistants were trained particularly to conduct survey questionnaire among study population.

3.7 Process Flow for Distribution of Questionnaire

After the school selection, a meeting with the teachers of the selected school was held to explain the objective of this study and to get the list of names of Year 4 and Year 5 students. The study sample was obtained from random sampling. A consent form and set of questionnaire were given to teachers to be distributed to the students which were to given to the parents to fill out and collected after a week. Students with completed questionnaire and consent form from parents were chosen for this study. Sample collection followed procedure in Section 3.9.2.

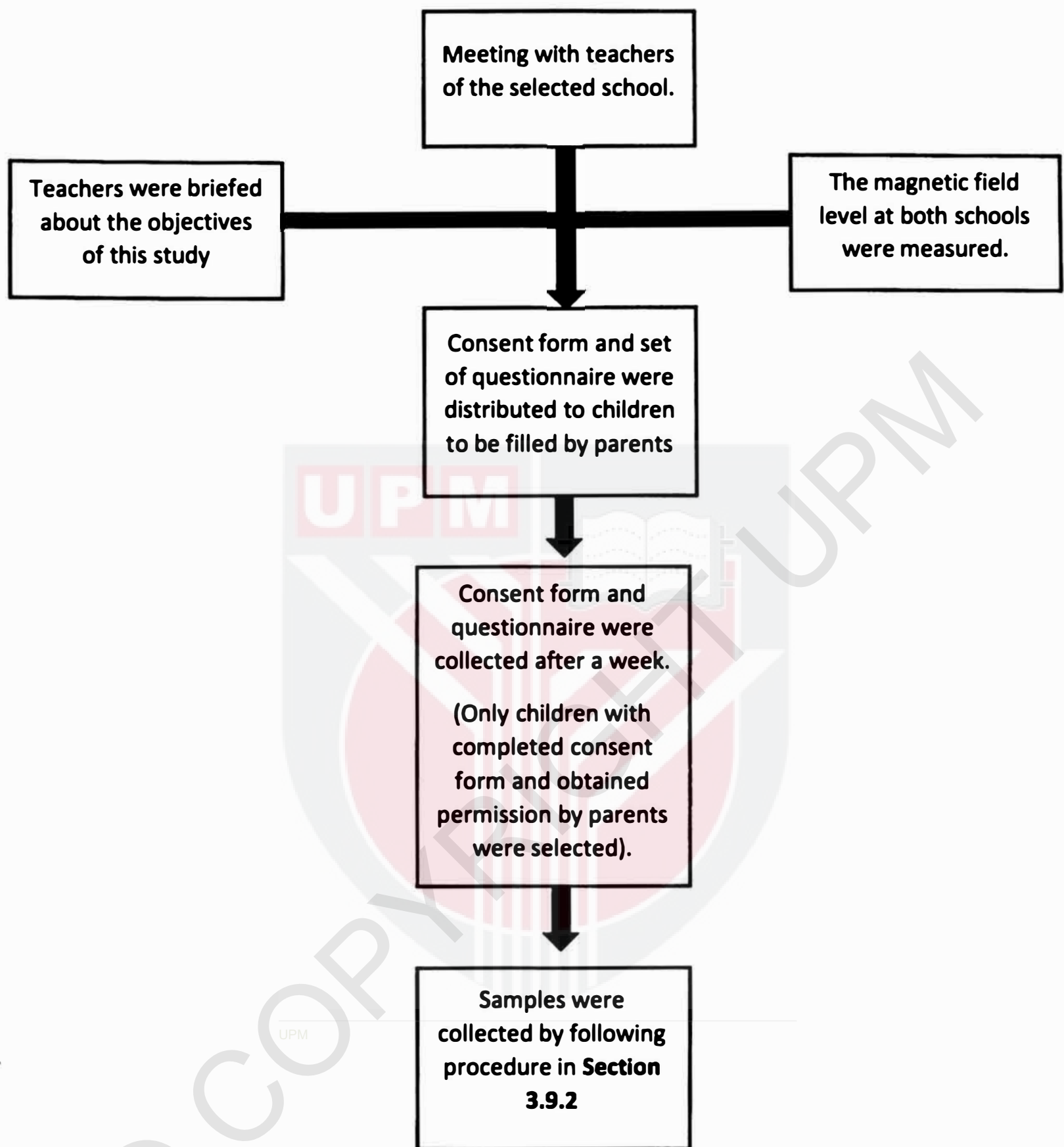


Figure 3.3 Process flow For Distribution of Questionnaire and Consent Form

3.8 Measurement of Magnetic Fields Level

Measurement was carried out by using EMDEX II Meter (Figure 3.4). This instrument was used to measure extremely low frequency magnetic field. EMDEX II was used to measure magnetic field level around the school. The level was displayed in mG. The EMDEX II was attached to E-Probe in order to measure magnetic field (Figure 3.5).



Figure 3.4 EMDEX II Meter

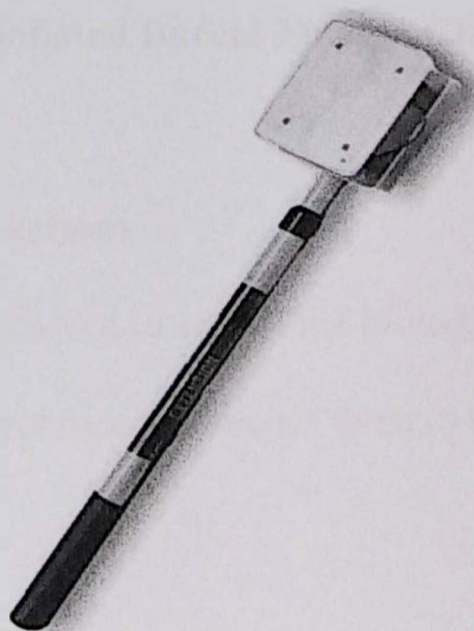


Figure 3.5 E-Probe

Spot measurements were carried out at both selected schools. The sites included classroom and the main activity areas such as football field, school compound and badminton court. Each measurement was repeated three times for every 15s and the minimum and the maximum value was recorded after stabilization with reference to Huang et al. (2013). According to the average height of the students, the probe was placed at height of 1.2m.

For study school, the measurements were conducted at all classroom within 30m from power line and the areas were very likely to have an exposure of 4.0mG or higher (Chung et al., 2007). In comparative school, stratified random was used to select a classroom for each grade. Measurements were conducted at five locations in the classroom including the center and four sites near the corners in both schools.

3.9 Micronuclei Assay

3.9.1 Quality Control for Exfoliated Buccal Mucosa Cells Collection

i. Sample Collection Precautions

Few precautionary steps were followed to ensure the biological integrity of samples, such as excluding children who had oral ulcer and avoid them to touch or rub the brush hand.

ii. Sample Handling and Mixing

Standard operating procedure (SOP) on “Buccal sample collection” from Centers of Disease Control and Prevention (CDC) (2006) were followed. Before sampling, a clean pair of new, non-powdered and disposable latex gloves be prepared.

A microcentrifuge tube was prepared by filling with phosphate buffer solution (PBS) and normal saline in the laboratory before sending to the field. The cytology brush was rinsed few times with the solution in microcentrifuge tube to ensure that the cell samples is preserved for laboratory analysis. The cytology brush was placed in a sterile plastic before being disposed in the biohazard container to avoid further cross-contamination.

iii. Sample Preservation, Storage and Transport

A buccal cell sample which contains normal saline and phosphate buffer solution (PBS) was kept at microcentrifuge tubes. The tube was kept upright at room temperature in a sealed container. Extra care was given throughout the storage and transportation process to ensure that buccal samples will be protected from strong light at all time until it reaches the laboratory. The sample with proper preservation can preserve up to 1-3 months.

3.9.2 Exfoliated Buccal Mucosa Cells Collection

In this study, exfoliated buccal mucosa was collected to ensure biological samples collected in a much convenient and less invasive manner. It provides a sensitive biomarker of genotoxic damage in target tissues (Jin et al., 2014).

Children was instructed to rinse their mouth with water for 3 times with mineral water before the sampling began. A sterile cytology brush (Gentra Puregene Buccal Cell Kit, Qiagen Ltd, Venlo, Limburg) was used to collect exfoliated buccal mucosa cell from respondents. Children were instructed to rub the brush firmly up and down along the inside of the cheek 30 times. Next, the cytology brush was washed with phosphate buffered saline (PBS) and normal saline in the different 1.5ml microcentrifuge tube. The specimens were stored in a sealed container before being transferred to the laboratory for laboratory analysis.

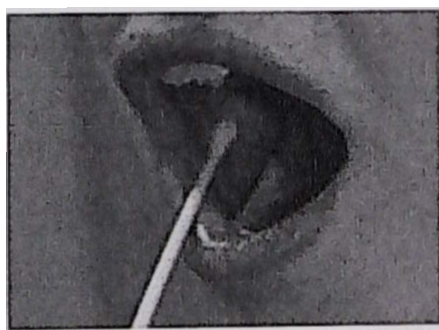


Figure 3.6 Scraping the Inner Part of the Cheek (Oral Cavity) with Sterile Cytology Brush

3.9.3 Laboratory Analysis (Micronuclei Assay)

Micronuclei (MN) assay is a suitable internal dosimeter used to monitor the presence of MN in tissue-specific cell by estimating the possibility of early cancer risk experienced by study population. This assay will be conducted based on the standard protocol as discussed by Thomas and Fenech (2008). The specimens were analyzed in Environmental Health Laboratory (Faculty of Medicine and Health Sciences, Universiti Putra Malaysia); microscope slide was examined by using a light microscope (LEICA, Germany) in Environmental Health Laboratory (Faculty of Medicine and Health Sciences, Universiti Putra Malaysia).

1. The microcentrifuge tube with normal saline was centrifuged at 1500 rpm to wash the cells in the buffer solution (80% methanol, absolute ethanol).
2. The supernatant was discarded, and the leftover cells was smeared on slide by using pulling technique. This slide was kept keep to dry up to one-day.
3. After one-day, the cells was fixed with cold methanol: acetic acid (3:1) solution in a 0.1% phosphate buffer (pH 7.5) for 20 minutes.
4. Next, the slide was stained by Feulgen reaction. It is to wash the slide with 5M Hydrochloride acid (HCl) for 30 minutes and then rinsed in running tap water for 3minutes.
5. After that, the slide was drained in room temperature with Schiff's reagent for 60 minutes in the dark. It was followed by counterstaining the slide with 0.1% of fast green for 20-40 seconds and rinsed well with deionized water (dH₂O).

6. Following all these chemicals treatment, the slide was place face-down in Whatman No.1 filter paper to blot away any residual moisture. The slide then placed on slide tray and allowed to dry for about 10-15 minutes. Slides were analyzed under light microscope with 400x magnification. A total of minimum 1000 cells per individual were scored for analysis of micronuclei.

The end point was to measure the cells with the presence of MN (s), which is scored based on the cells presented with a main nucleus and smaller nuclei called MN. The MN is either round or oval in shape and their diameter ranged between 1/3 to 1/10 the diameter of the main nucleus. The frequency of MN in 1000 cells was calculated by the following equation,

$$MN \text{ per } 1000 \text{ cells} = \frac{\text{Total number of MN in each cell}}{2000} \times 1000$$

3.10 Statistical analysis

Table 3.1 Objectives and related statistical analysis

Objectives	Statistical Analysis
1 To determine socio-demographic characteristics of the children.	Descriptive analysis
2 To determine the health related symptoms of children.	Descriptive analysis
3 To determine the relationship between magnetic field and total score of reported health symptoms in children.	Spearman correlation
4 To determine the relationship between magnetic field and micronuclei frequency in children.	Spearman correlation
5 To compare the level of magnetic field at the two selected schools.	Man-Whitney Test
6 To compare the micronuclei frequency and total score of reported health symptom between study and comparative group.	Man-Whitney Test
7 To determine the selected factors that might influenced the micronuclei frequency among children	Multivariate linear regression

3.11 Ethical Consideration

This study was approved by the University Research Ethics Committee of the Universiti Putra Malaysia (JKEUPM) [Ref: UPM/TNCPI/RMC/1.4.18.2(JKEUPM). Data collection was conducted after consents form were obtained from children's parents. Only children obtained permission from parents will be selected. They were allowed to withdraw from this study at any time during data collection. All the data collected were confidential.

CHAPTER 4

RESULTS

4.1 Background information of the children

Background information of the school children were obtained through self-constructed questionnaire. The information included in this study were age, race, gender, body mass index (BMI), parent's education, second-hand smoke and also length of residency at current area. This study involved 81 respondents as study group while 47 respondents as comparative group. About 81% of children aged 11 years old while the rest were 10 years old. Majority of the school children were Malay (98.4%). Children in study and comparative school had a similar distribution of BMI where, majority of the children were underweight in study (65.4%) and comparative group (57.4%) respectively. In the study group, majority of the parents obtained Diploma (28.4%) and secondary school (53.2%) certificate. The results were tabulated in Table 4.

Table 4.1 Background information

Background Information	Study Group	Comparative Group	Overall	Study Group	Comparative Group	Overall
	(n=81)	(n=47)	(n=128)	(n=81)	(n=47)	(n=128)
	n (%)	n (%)	n (%)	Mean (SD)		
Age						
10	81(100.0)	24(51.1)	24(18.8)			
11	-	23(48.9)	104(81.2)			
Race						
Malay	81(100.0)	45(95.7)	126(98.4)			
Others	-	2(4.3)	2(1.6)			
Gender						
Male	32(39.5)	18(38.3)	50(39.1)			
Female	49(60.5)	29(61.7)	78(60.9)			
Body Mass Index (BMI)						
Underweight	53(65.4)	27(57.4)	80(62.5)	17.95(4.25)	18.80(5.01)	18.27(4.54)
Normal	21(25.9)	13(27.7)	34(26.6)			
Overweight	5(6.2)	5(10.6)	10(7.8)			
Obese	2(2.5)	2(4.3)	4(3.1)			
Parents Education						
Secondary School	21(27.2)	25(53.2)	53(41.4)			
Diploma	23(28.4)	11(23.4)	34(26.6)			
Bachelor Degree	22(27.2)	7(2.1)	29(22.7)			
Master	6(7.4)	1(2.1)	7(5.5)			
Doctor of Philosophy (PhD)	3(3.7)	-	3(2.3)			
Second-hand smoke						
Yes	38(46.9)	30(63.8)	68(53.1)			
No	41(50.6)	15(31.9)	56(43.8)			

**Length of residency at
current house**

<5 years	15(18.5)	14(29.8)	29(22.7)	7.99(3.56)	12.13(12.80)	9.48(8.39)
5-10 years	37(45.7)	13(27.7)	50(39.1)			
>10 years	26(32.1)	16(34.0)	42(32.8)			

N=128, descriptive analysis



4.2 Prevalence of reported health symptoms

Health complaints were asked in the questionnaire as reported health symptom (headache, sleeping disturbance, concentration difficulties, nausea, anxiety and fatigue). Based on Table 4.2, the highest reported health symptoms experienced by children at both schools were difficulties in concentrating. However, there was no association between the reported health symptoms with the magnetic field levels in the two study groups.

Table 4.2 Prevalence of reported health symptoms

Reported Health Symptom	Study Group (n=81) n (%)	Comparative Group (n=47) n (%)	Overall (n=128) n (%)
Headache	4(4.9)	3(6.4)	7(5.5)
Sleeping disturbance	5(6.2)	-	5(3.9)
Nausea	1(1.2)	-	1(0.8)
Concentration difficulties	18(22.2)	11(23.4)	29(22.7)
Anxiety	1(1.2)	1(2.1)	2(1.6)
Fatigue	2(2.5)	1(2.1)	3(2.3)

N=128, descriptive analysis

4.3 Other sources of EMF exposure

Children were asked about the other exposure related to EMF at home. The other sources included in this study were the distance between power line and substation from home, the total number of household appliances and also the frequency of using TV, computers, mobile phones, telephone. From the results in Table 4.3, there were about 70% of the study group and 51% of the comparative group spend more than two hours on computers. For mobile phones, about 72.8% from study and 38.3% from comparative group used the phones for more than two hours.

Table 4.3: Other sources of EMF exposure

Sources	Study Group (n=81)	Comparative Group (n=47)	Overall (n=128)	Study Group (n=81)	Comparative Group (n=47)	Overall (n=128)
	n (%)	n (%)	n (%)	Mean (SD)		
High voltage power line surrounding residence area						
Less than 100 m	19(23.5)	4(8.5)	23(17.9)			
More than 100 m	51(63.0)	23(48.9)	74(57.8)			
Transformer of substation surrounding residence area						
Less than 500 m	8(9.9)	3(6.4)	11(8.6)			
More than 500 m	61(75.3)	23(48.9)	84(65.6)			
Frequent use of TV						
More than 2 hours per day	57(70.4)	24(51.1)	81(63.3)			
Less than 2 hours per day	16(19.8)	4(8.5)	20(15.6)			
Frequent use of computers						
More than 2 hours per day	24(29.6)	1(2.1)	25(19.5)			
Less than 2 hours per day	23(28.4)	2(4.3)	25(19.53)			
Frequent use of mobile phones						
More than 2 hours per day	59(72.8)	18(38.3)	77(60.1)			
Less than 2 hours per day	13(16.0)	5(10.6)	18(14.1)			
Frequent use of line telephone						
More than 2 hours per day	9(11.1)	1(2.1)	10(7.8)			
Less than 2 hours per day	22(27.2)	-	22(17.1)			
Total Number of household appliances				7.95(3.83)	6.66(2.97)	7.53 (3.61)

4.4 Correlation between magnetic field level with total score of health symptoms and micronuclei frequency between both groups.

Normality test was used to determine the normality of the data. Kolmogorov smirnov showed ($p < 0.05$) means that the data was not normally distributed. Spearman rank correlation was used to determine the correlation. The maximum score of total reported health symptom was 3 while the minimum score was 0. In Table 4.4, there was no significant correlation between magnetic field level and the total score of reported health symptom while there was a significant inverse correlation between magnetic field level and micronuclei frequency ($p < 0.001$).

Table 4.4: Correlation between total score of symptoms, micronuclei frequency and magnetic field level

Variables	Magnetic field level					
	Study Group (n=81)		Comparative Group(n=47)		Overall (n=128)	
	r	p	r	p	r	p
Total score of health symptom	0.194	0.083	0.231	0.119	0.125	0.160
Micronuclei frequency	0.126	0.264	-0.104	0.488	-0.311	<0.001***

N=128, Spearman rank correlation

*** significant at $p < 0.001$

4.5 Comparison of median total score of reported health symptom and micronuclei frequency between study and comparative group.

Since the data was not normally distributed, Mann-Whitney U Test was used to determine the differences between two groups. Based on table 4.5, there was a significant difference in micronuclei frequency between the two group ($p < 0.001$) while there was no significant differences in total score of reported health symptom between the groups.

Table 4.5: Comparison of median micronuclei frequency and total of reported health symptom between study and comparative group

Variable	Median(IQR)		Z-statistics	p
	Study Group (n=81)	Comparative Group (n=47)		
Total score of health symptom	0(1,0)	0(1,0)	-0.275	0.783
Micronuclei Frequency	5(10.5,2.5)	13.5(16.5,8.0)	-4.602	<0.001***

N=128, Mann Whitney U test
 *** significant at $p < 0.001$

4.6 Comparison of magnetic field level at school of study and comparative group.

Since the data was normally distributed, Independent t-test was used to determine the differences of magnetic field level between study and comparative school. The magnetic level at study school was higher than in comparative school. There was a significant difference of magnetic field level between study and comparative group ($p=0.014$). In Table 4.6, the level of magnetic field was below the limit the reference limit by WHO. The measurements in both schools were below than the reference limit and much more lower than limit in guideline for public exposure of magnetic field by ICNRIP (2010).

Table 4.6: Comparison of mean magnetic field level between selected schools.

Variable	Mean(SD)		Mean difference (95%CI)	T-statistics(df)	p
	Study School (n=22)	Comparative School (n=10)			
Magnetic Field level	1.03(0.29)	0.27(0.07)	0.7571 (0.62,0.89)	11.67 (25.68)	0.014*

Independent t-test
* significant at $p < 0.05$

Table 4.7: Magnetic field measurement

School	N	M±IQR	Min	Max	Reference limit*
Study	22	1.12(0.26)	0.60	1.30	4.0mG
Comparative	10	0.27(0.11)	0.20	0.50	4.0mG

N=number of spot measurement

*Reference WHO International EMF project

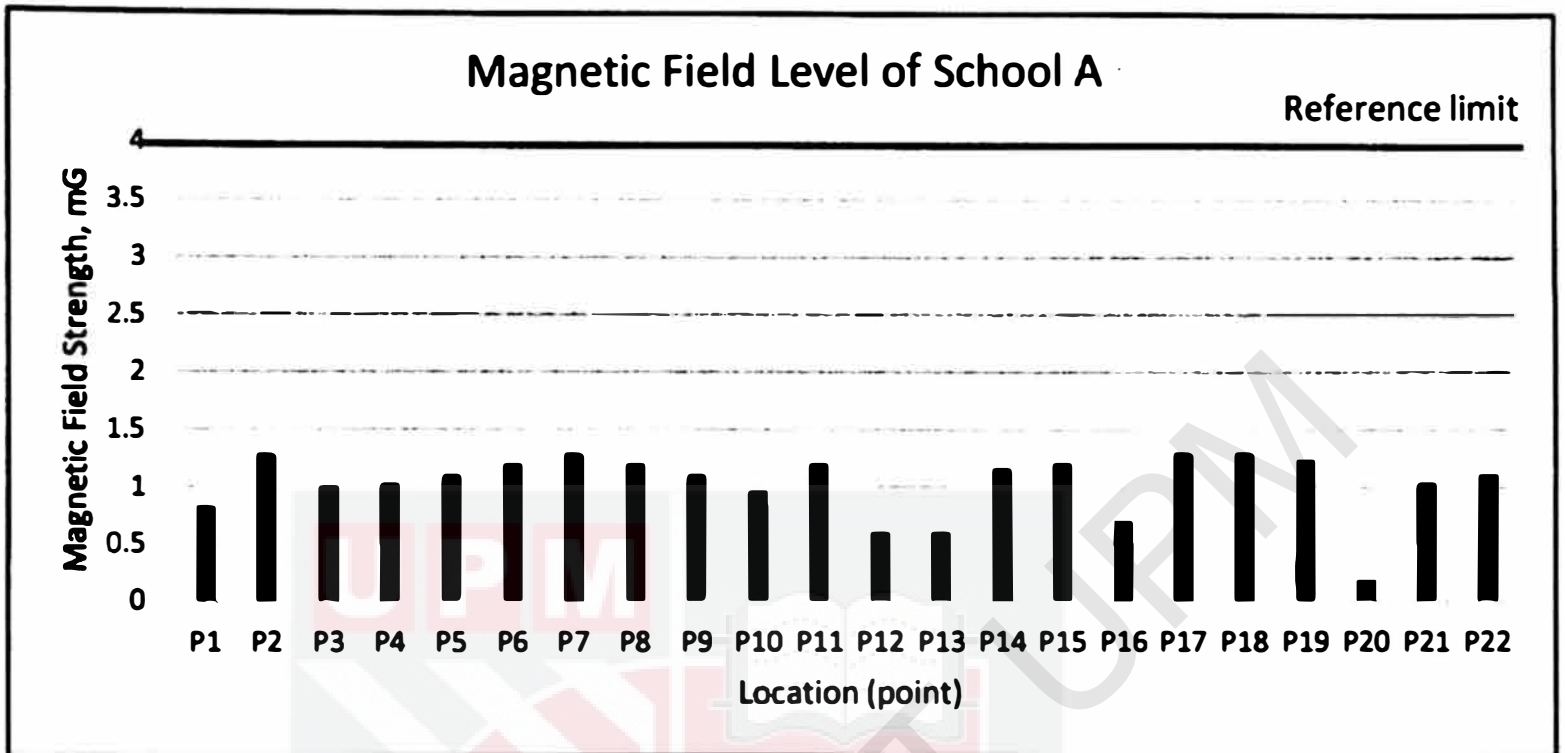


Figure 4.1 The magnetic field level and the reference limit of Study School

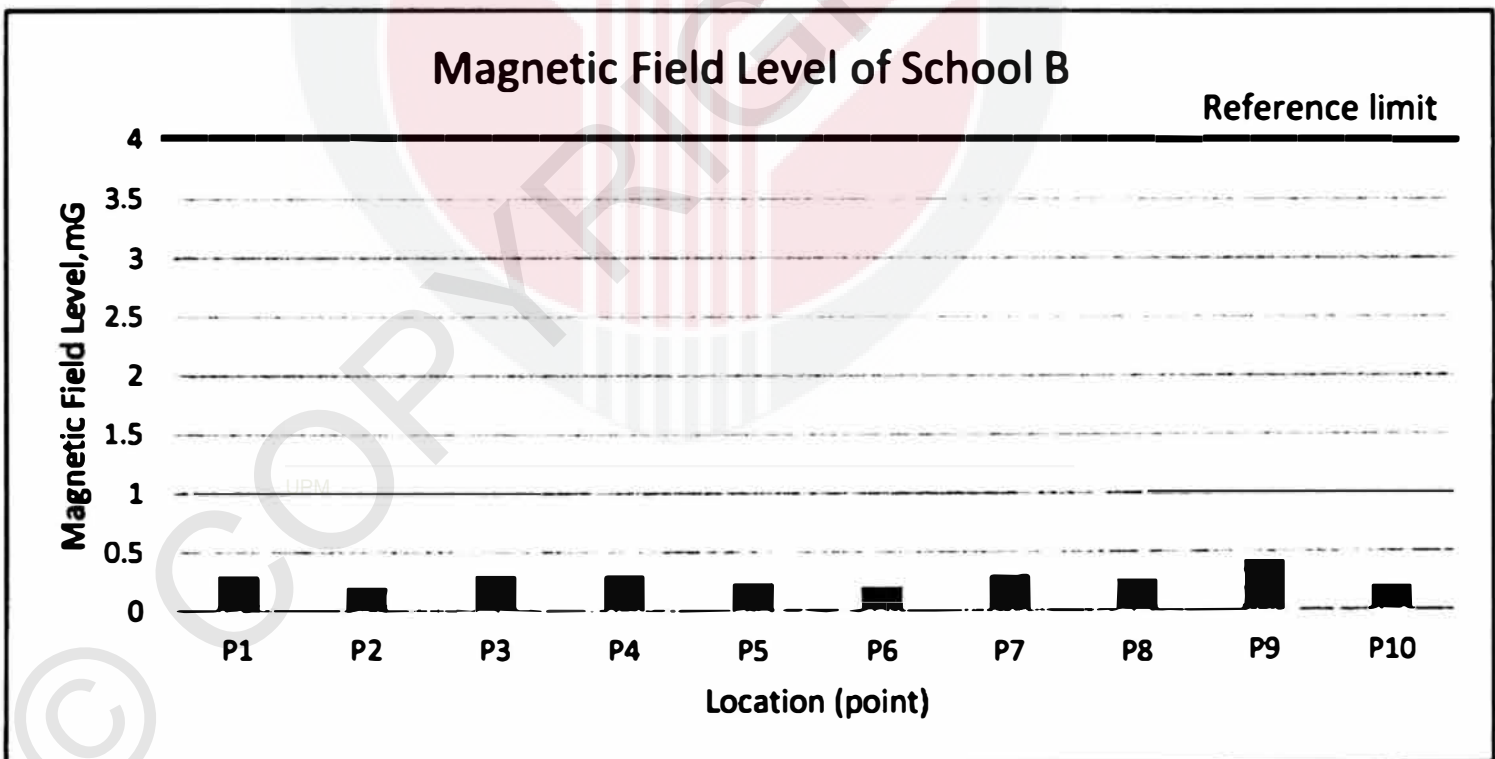


Figure 4.2 The magnetic field level and the reference limit of comparative School

4.7 Potential factors that might influenced micronuclei frequency among children.

Multivariate linear regression was used to determine which factors that have significant relationship with micronuclei frequency of all children. Table 4.8 showed the potential factors that might influenced micronuclei frequency among all children. The results show that parents' education ($p=0.004$) and magnetic field level ($p=0.007$) had significant relationship with micronuclei frequency. However, after all the factors were controlled, only parents' education had significant relationship with micronuclei frequency ($p=0.004$). Among the study group, as in Table 4.9, second-hand smoke showed positive relationship with micronuclei frequency after controlling the confounders ($p=0.048$). In Table 4.10, the results show that no factor had any significant relationship with micronuclei frequency in the comparative group.

Table 4.8: Potential factors that might influenced micronuclei frequency among two groups.

Variable	b(95% CI)	t	p	r ²	b(95% CI)	t	p
Magnetic field level	-7.911 (-13.61,-2.211)	-2.747	0.007**	0.056			
Gender	-0.966 (-5.439,3.506)	-0.427	0.670	0.001	-	-	-
BMI	-0.323 (-0.802,0.156)	-1.334	0.185	0.014	-	-	-
Parent's education	-2.281 (-3.807,-0.755)	-2.960	0.004**	0.069	-2.957 (-4.497,0.968)	-2.957	0.004**
Second-hand smoke	0.791 (-3.730,5.312)	-0.03	0.976	0.001	-	-	-
Length of residency	-0.051 (-0.278,0.176)	-0.443	0.659	0.020	-	-	-
HVPL surrounding area	-3.452 (-7.685,0.782)	-1.619	0.109	0.027	-	-	-
Total number of household appliances	-0.379 (-1.074,0.317)	-1.080	0.283	0.011	-	-	-

N=128, Simple linear regression

** significant at p< 0.01

Multivariate linear regression (Method: Enter)

** significant at p<0.01

R²=0.185

Table 4.9: Potential factors that influenced micronuclei frequency among children of study groups

Variable	b(95% CI)	t	p	r²	b(95% CI)	t	p
Magnetic field level	2.475 (-3.783,8.734)	0.787	0.434	0.008	-	-	-
Gender	0.082 (-3.296,3.459)	0.048	0.962	0.000	-	-	-
BMI	-0.139 (-0.529,0.251)	-0.709	0.480	0.006	-	-	-
Parent's education	-0.323 (-1.494,0.848)	-0.550	0.584	0.004	-	-	-
Second-hand smoke	-3.291 (-6.555,-0.027)	-2.008	0.048*	0.050	-3.757 (-7.487,-0.028)	-2.017	0.048*
Length of residency	-0.152 (-2.216,2.520)	0.128	0.898	0.000	-	-	-
HVPL surrounding area	-2.734 (-6.688,1.219)	-1.380	0.172	0.027	-	-	-
Total number of household appliances	-0.206 (-0.246,0.658)	-0.907	0.367	0.011	-	-	-

N=128, Simple linear regression

* significant at p<0.05

Multivariate linear regression (Method:Enter)

* significant at p<0.05

R²=0.144

Table 4.10: Potential factors that influenced micronuclei frequency among children of comparative groups.

Variable	b(95% CI)	t	p	r ²	b(95% CI)	t	p
Magnetic field level	36.676 (-24.601,97.960)	1.206	0.234	0.031	-	-	-
Gender	-3.078 (-13.280,7.125)	- 0.608	0.547	0.008	-	-	-
BMI	-4.974 (-10.717,0.768)	- 1.745	0.088	0.063	-	-	-
Parent's education	-4.091 (-7.896,-0.287)	- 2.170	0.036*	0.101	-	-	-
Second-hand smoke	4.161 (-6.578,14.901)	0.781	0.439	0.014	-	-	-
Length of residency	-0.250 (-0.650,0.150)	- 1.260	0.215	0.036	-	-	-
HVPL surrounding area	-4.392 (-23.281,14.598)	- 0.476	0.638	0.009	-	-	-
Total number of household appliances	-1.372 (-3.311,0.567)	- 1.439	0.160	0.059	-	-	-

N=128, Simple linear regression

* significant at p<0.05

Multivariate linear regression (Method:Enter)

* significant at p<0.05

R²=0.282

CHAPTER 5

DISCUSSION, RECOMMENDATION AND CONCLUSION

5.1 Background Information

This study involved a total of 128 school children from two selected school in Klang Valley. The schools were selected based on the proximity to power line. Study school located less than 50m from HVPL while comparative school had no HVPL in close proximity within 4km. About 18.8% school children from Year 4 while another 81.2% children from Year 5. There were 78 female respondents out of 128 respondents. Body mass index (BMI) were categorized into underweight, normal, overweight and obese. The number of underweight children were more than half of the total respondents (26.6%) and 7.8% classified as overweight while the other 3.1% children were obese.

Parents' education were asked and being classified into five categories started with secondary school, diploma, bachelor degree, master and also doctor of philosophy (PhD). 41.4% parent's educational background were from secondary school. Question about environmental tobacco smoke (TBS) also known as second-hand smoke also being asked and 53.1 % children were exposed to tobacco smoke in their house environment. Besides, the length of residency at current house also being included in the questionnaire. About 32.8% children's family stayed at current house for more than 10 years.

5.2 Prevalence of reported health symptom among children

The evidence of relationship between EMF exposure and health symptom is considered weak. Based on Table 4.2, there was no association of reported health symptom (headache, concentration difficulties, sleeping disturbance, fatigue, anxiety and nausea) with magnetic fields among study as well as the comparative group. Roosli (2004) reported that the health symptom related to EMF exposure were sleep disorder, headaches, nervousness and distress, concentration difficulties and fatigue. However, in this study the total score of health symptom between study and comparative group showed no significant difference. This might be due the reason of longer exposure towards EMF from high voltage power line and most of the studies related to power line and health symptoms only conducted among adult resident. (Barsam et al., 2012), (T. Porsius et al., 2014), (Baliatsas et al., 2012).

5.3 Magnetic fields with micronuclei frequency between study and comparative groups

Children in this study was selected according to their school distance with power line. Study school located less than 50m away from high voltage power line while comparative school had no power line within 4km. Both of the school located in urban area, however the comparative group showed a significantly higher micronuclei impairment ($p < 0.001$) than study group. This could be due to the others environmental

factors at the comparative school area. Study school located in Putrajaya, one of the city in Malaysia. Despite that, the school located in the residential area, there was no main road nearby, low traffic density and no factory within the area as oppose to the comparative group that exposed to many sources of environmental hazards as the school located in the industrial area. The possible factors that could affect the micronuclei frequency in comparative group were mobile base station, heavy traffic and dense population as the school located near the main road, factories within 500m from the school, and storage house for construction material located within 200m from the school whereby lorries had been passing back and forth in front of the school to transport the material. The environmental settings surrounding was explained in Figure 5.1.

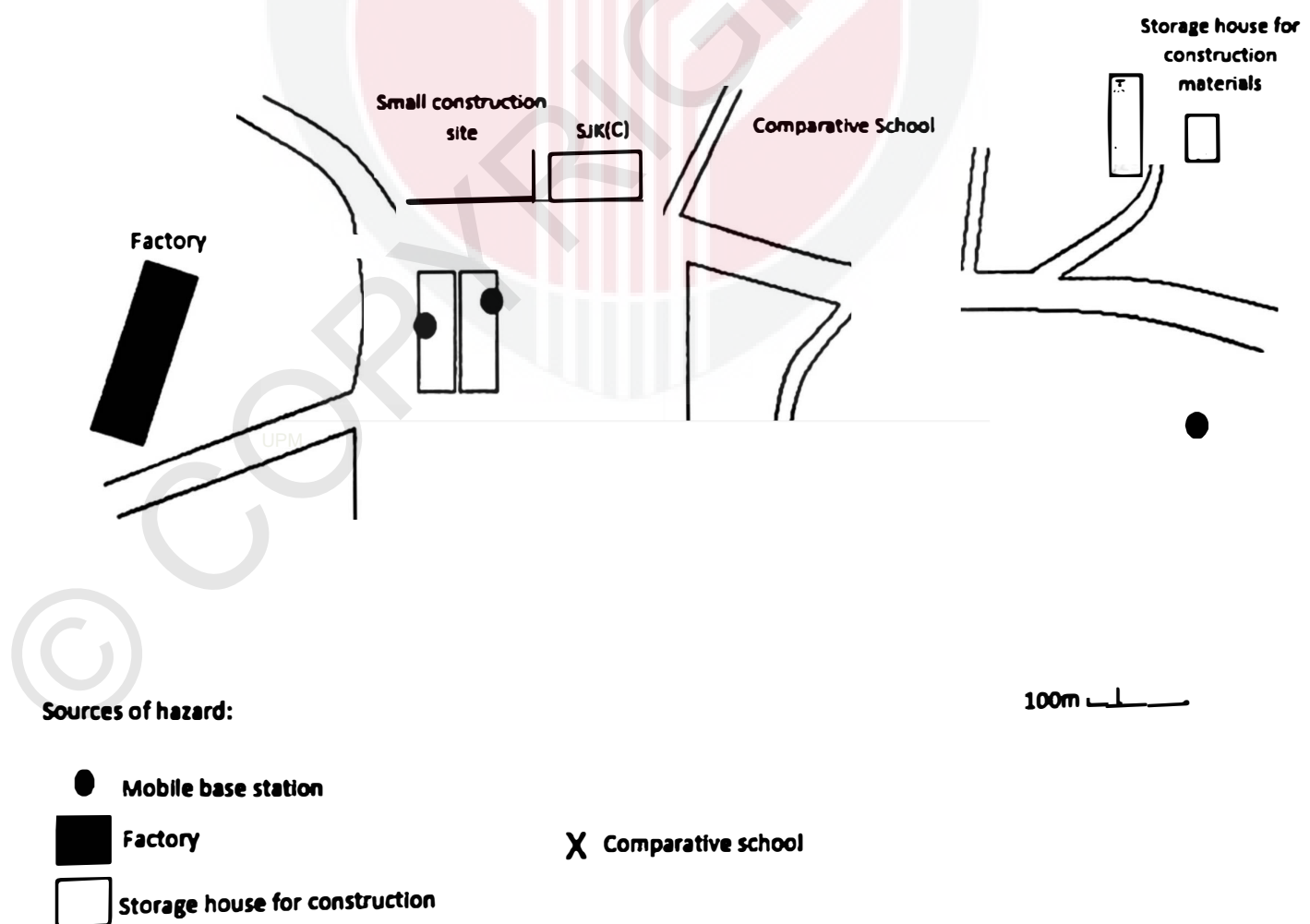


Figure 5.1 Potential sources of hazard in the environmental settings surrounding the comparative school

There were free-standing towers and mounted rooftop base station in the vicinity of comparative school Mobile base station produced radiofrequency (RF) wave to the surrounding environment because signal was transmitted when people used cell phones to make calls (American Cancer Society). There were studies conducted to investigate the effects of radiofrequency (RF) towards human health. In recent study, Zothansiana et al. (2017) found that people living closer to the cellular antennas had statistically significant effects in blood damage. In placing more emphasis, Gandhi et al. (2014) claimed that the power density in area within 300m from base station was higher compared to area of control sample and the genetic damage parameters of DNA migration length, damage frequency and damage index was significantly higher in study group.

Transportation and industrial emission were the major sources of pollutants in Klang Valley atmosphere and this problem become worst by the increasing number of mobile sources Rafia et al., (2005). A study by Rahman et al. (2015) mentioned that the motor vehicles are the major mobile sources in urban area. The international Agency for Research Cancer has classified outdoor air pollution as carcinogenic to human health. Comparative school in this study located near to main road, factory and storage house for construction materials. This condition has contribute to the air quality of the surrounding area and could be the reason for the increasing micronuclei frequency in comparative group. There were studies conducted to investigate the association between air pollutants and biomarkers of early biological effects in children. According to Cerretti et al. (2014), children living in town have high level of micronuclei (MN) in buccal cells due to the

exposure to high levels of air pollutants. In addition, Eunice et al., (2017) conclude that telomere shortening in children may be associated with exposure to traffic-related air pollution.

Comparative group children might be exposed to ELF magnetic field from others sources. Previous study by Chung et al. (2007) measured the personal exposure of the school children and some of the comparative group children experienced a higher exposure (>4.0mG) and this might be due to others factors than HVPL such as distribution line and transformer, electric wires with various configuration in the walls and also TVs. Therefore, the other sources of ELF magnetic field at home cannot be neglected. However, it is unlikely that ELF fields cause direct genetic damage due to the low level of energy.

5.4 Others sources of EMF Exposure

Table 4.3 summarizes the results of exposure other than HVPL at the school environment. In this study, the frequency of using household appliances by children only for TVs, computers, mobile phones and fixed-line telephones were identified as these types of appliances were often used by children (Huang et al., 2013). The number of household appliances were determined as household appliances could be the main sources of residential exposure to magnetic field in similar frequency emitted from power line (50Hz) in children's home environment (Huang et al., 2013). However, the household appliances were not the major problem as the typical values measure in areas away from it are in the

range of 1.0 to 2.0mG (Autralian Radiation Protection and Nuclear Safety Agency). Moreover, Kleinerman et al. (2005) reported that the magnetic fields level extremely reduce with the increasing distance from the sources. Another study also mentioned that the exposure from household appliances does not contribute much to children exposure rather than environmental exposure (Gallastegi et al., 2017).

5.5 Magnetic field level at selected schools

Children spend their time at school for about 6 to 7 hours per day. EMF emitted from the nearby power line are comprised of electric and magnetic field. The differences between electric and magnetic field is the capability to pass through any material. Electric field can be shielded or absorbed by any object, but not for magnetic field and that's the reason why the concern is more on magnetic field rather than electric field (Tukimin et al., 2011).

The measurement of magnetic field in study school were conducted and the result were compared to the school located more than 4m from HVPL. Based on the Table 4.7, the average reading of magnetic field level in study school was slightly higher than in comparative school. The highest reading in study school was 1.30mG. The level obtained was too much lower compared to the guideline limit of magnetic field exposure for public by ICNRIP 2010 and this result was also lower than the reference limit (4mG) which

known to be associated with childhood leukemia as mentioned in epidemiological studies (WHO, 2007). The magnetic field level in this study also lower compared to other studies. Huang et al., (2013) revealed that the maximum value recorded at school located less than 94m from power line was close to 4mG. Vilorio (2016) found that the level of magnetic field at 30m from power line was 3 to 4mG. According to Sharin et al (2014), the level of magnetic field could be affected by the environmental temperature and electricity consumption, high temperature influences the reading. The distance between conductor of power line and ground level at study school reduced the magnetic field level as power line located at higher ground. This is also supported by Huzaireee (2014) that the height of the conductor will affect the magnetic field reading. Moreover, Chung et al., (2007) claimed that certain indoor sources of ELF magnetic field reduced the impact of HVPL on the indoor ELF magnetic field exposure level.

5.6 Selected factors that might influenced micronuclei frequency among children

After controlling all the factors that might have influenced on micronuclei frequency of children in both group, only parents' education showed a significant relationship ($p=0.004$) as shown in Table 4.8. Parental education is one of the reasonable factors in affecting children diet. Sausenthaler et al (2007) has highlighted that low parental education were associated with a low intake healthy food in children. Moreover, DNA damage in healthy children might be influenced by blood micronutrient. (Elizabeth et al., 2015). Based on Table 4.9, in study group, there was a significant relationship ($p=0.048$)

between second-hand smoke and micronuclei frequency. Second hand-smoke also plays an important role in increasing DNA damage in children as mentioned by Zalata et al., (2007) where DNA damage in children exposed to tobacco smoke was higher compared to control group. In comparative group, all the selected factors had no significant relationship with micronuclei frequency as shown in Table 4.10.



5.7 Study Limitation

Firstly, the comparative school in this study was exposed to other environmental pollutant which was not measured as the first criteria to be considered was the distance of school from power line. The school located near to the small construction site which contribute to the air pollution, during the observation for the school selection, the site was not even started yet and that lead to the wrong selection of comparative group.

Secondly, only 47 children from both Year 4 and Year 6 were selected to this study due to some limitation during fieldwork. Consent form were given to Year 5 children a week earlier, however, only a few children returned back consent form and we have to distribute the consent form to Year 4 children also due insufficient participants and also because of the schedule fixed by the school management. In study group, the consent form were distributed to 212 Year 5 children, and less than 100 children returned back the consent form. After considered the inclusion and exclusion criteria, only 81 children were selected.

Lastly, only spot measurements were taken to assess exposure in school and questionnaires were used to know the exposure in the home environment. Using only environmental exposure data to access children's exposure at school hours may result in a potential for exposure misclassification (Chung et al., 2007).

5.8 Recommendation

The results of this study were not as expected. The comparative group were exposed to more environmental hazard rather than study group which contribute to the increasing number of micronuclei. Further studies are required to investigate the potential factors of genotoxicity in the comparative group.

We were not able to assess the personal exposure of children to the magnetic field. Personal exposure to other hazards than magnetic fields sources should be considered. Therefore, further studies were required to assess other sources of exposures besides the magnetic field among the comparative children.

5.9 Conclusion

In conclusion, data reported in this study showed that the exposure of magnetic field from nearby high voltage power line at study school did not pose any hazard as the level was low. The magnetic field strength measured at study school was below the reference limit which was known to be associated with childhood leukemia and also lower than guideline for public exposure by ICNRIP. Nevertheless, the comparative group showed sign of genotoxicity not because of the EMF exposure at school environment which might be due to other environmental sources of hazards existing near the school area.

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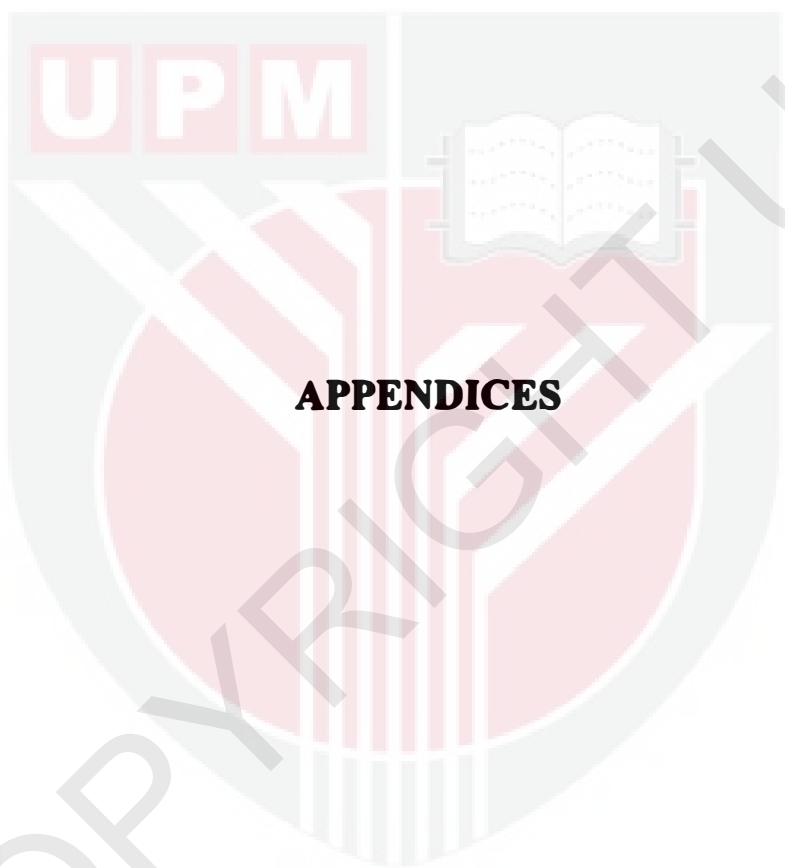
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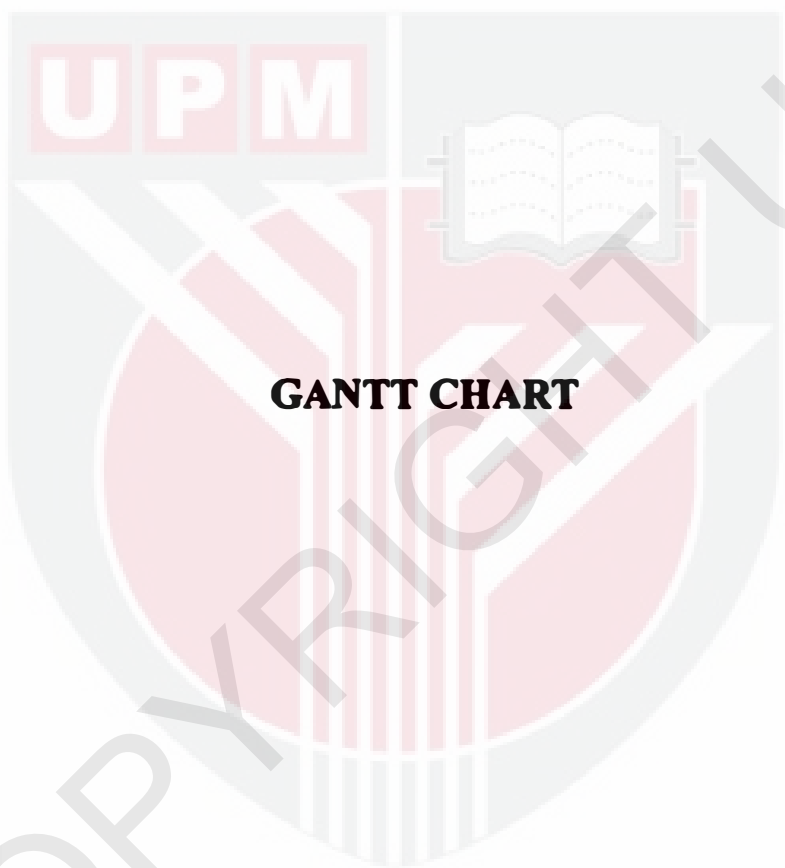
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APPENDICES

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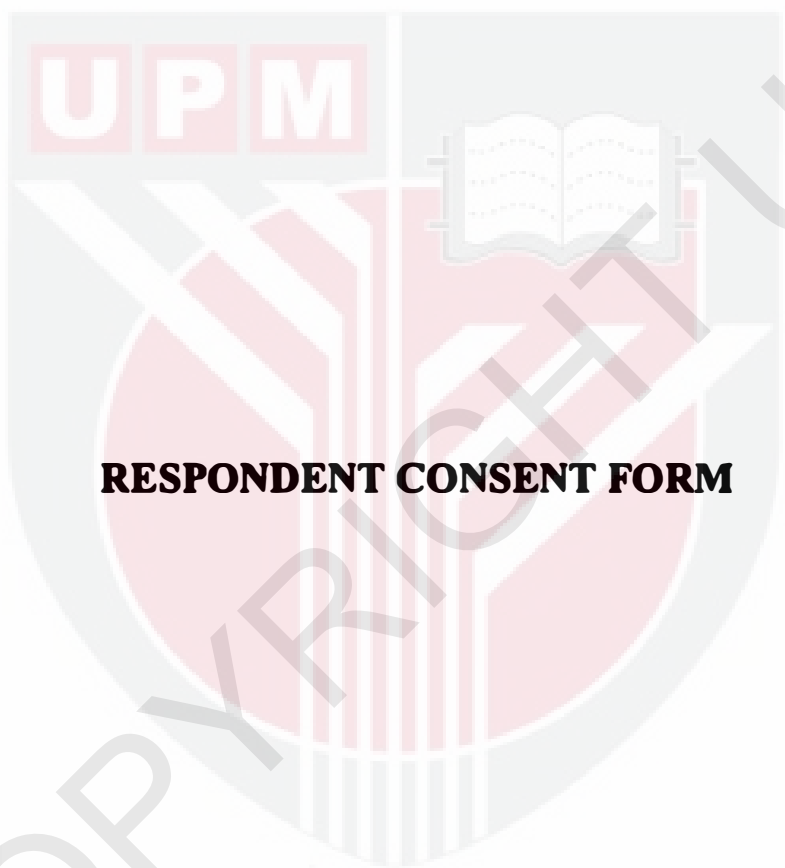
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Activities	Sep	Oct	Nov	Dis	Jan	Feb	Mar	Apr	May	June
Proposal writing										
Ethical Submission										
Site visit										
Proposal Presentation										
Data Collection										
Data analysis										
Thesis writing										
Poster presentation										
Thesis presentation										
Thesis submission										





RESPONDENT CONSENT FORM

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BORANG 2.4: PENERANGAN DAN PERSETUJUAN RESPONDEN

Sila baca maklumat berikut dengan teliti. Sekiranya anda mempunyai sebarang pertanyaan, sila kemukakan kepada penyelidik.

1. TAJUK KAJIAN

Kajian perbandingan mengenai hubungan genotoksiti, simptom kesihatan yang berkaitan, dan pendedahan kepada radiasi medan elektromagnet (EMF) terhadap dua kumpulan kanak-kanak di Lembah Klang.

2. PENGENALAN

Talian elektrik voltan tinggi banyak dibina berdekatan dengan kawasan penduduk yang menghasilkan radiasi medan elektromagnet pada frequency yang sangat rendah. Radiasi medan elektromagnet (EMF) menjadi sesuatu isu yang serius kepada orang awam kerana kesannya kepada kesihatan manusia terutama kanak-kanak. EMF merupakan kombinasi medan elektrik dan medan magnet yang berupaya memberi kesan kepada biologikal seseorang. Kanak-kanak lebih cenderung kepada pendedahan radiasi medan elektromagnet (EMF) kerana mereka masih di peringkat awal tumbesaran. Kesan pendedahan terhadap radiasi medan elektromagnet (EMF) boleh menyebabkan perubahan genetik dan mutasi. Banyak kajian yang dilakukan untuk mengkaji hubungan pendedahan terhadap radiasi medan elektromagnet (EMF) terhadap kanak-kanak terutamanya boleh menyebabkan leukemia. Frekuensi Micronuclei (MN) digunakan sebagai petunjuk untuk mengenalpasti potensi pendedahan genotoksiti dan ketidakstabilan kromosom dalam badan manusia. Tujuan kajian ini dijalankan adalah untuk mengetahui hubungan antara Frekuensi Micronuclei (MN) terhadap pendedahan kepada radiasi medan elektromagnet (EMF).

3. APAKAH YANG PERLU ANDA LAKUKAN?

Ibu bapa atau waris bagi kanak-kanak perlulah mengisi dan melengkapkan borang soal selidik yang telah diberikan bersama dokumen ini. Borang soal selidik dan borang persetujuan perlulah dikembalikan kepada penyelidik setelah anda menandatangani dan mengisi kesemua maklumat yang dikemukakan. Hanya pelajar yang mendapat kebenaran daripada ibu bapa akan dipilih untuk menjadi responden dalam kajian ini. Kajian ini melibatkan pengambilan sampel tisu pipi kanak-kanak (bukal mucosa).

Prosedur pengambilan sample bukal mucosa adalah seperti berikut:

- I. Penerangan ringkas mengenai prosedur ini akan disampaikan bagi memastikan kanak-kanak bersedia.
- II. Kanak-kanak diminta berkumur sebanyak 3 kali dengan air mineral.
- III. Tisu pipi pelajar diambil oleh penyelidik yang terlatih menggunakan 'Cytology Brush' dengan menggosok lembut (scraping) berus berkenaan sebanyak 30 kali di permukaan tisu pipi sebelah kanan. 'Cytology Brush' yang mengandungi tisu pipi seterusnya dicekup di dalam 1.5ml 'microcentrifuges tubes' yang mengandungi solusi Phosphate Buffer Saline (PBS) dan disimpan di dalam 'cool box'.
- IV. Sampel-sampel tersebut akan disimpan di dalam 'cool box' dan seterusnya dibawa ke makmal Fakulti Perubatan dan Sains Kesihatan , Universiti Putra Malaysia.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

- Kanak-kanak yang pernah menjalani radiasi atau kemoterapi
- Kanak-kanak yang mempunyai masalah kesihatan

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANDA SEBAGAI PESERTA?

Secara umumnya, kajian ini akan memberikan satu input kepada ibu bapa kanak-kanak khususnya tentang kesan tentang pendedahan medan elektromagnet terhadap kesihatan kanak-kanak. Kanak-anak atau responden yang terlibat dalam kajian ini dapat membantu penyelidik serta komuniti terlibat dalam menjayakan hasil kajian ini. Antara hasil kajian ini adalah untuk mengkaji hubungan di antara pendedahan terhadap medan elektromagnet terhadap kadar Micronuclei (MN) dalam badan seseorang.

b) KEPADA PENYELIDIK?

Penglibatan responden dalam kajian ini dapat membantu penyelidik dalam mendapatkan segala informasi berkaitan dengan pemboleh ubah yang dikaji, serta hasilnya objektif-objektif ini dapat dicapai. Selain itu, gejala-gejala kesihatan terhadap pendedahan kepada medan elektromagnet (EMF) dapat membantu dalam mengenal pasti indicator pendedahan kepada medan elektromagnet.

6. ADAKAH IA BERISIKO?

Kajian ini tidak mendatangkan sebarang risiko kesihatan kepada kana-kanak. Hal ini kerana, prosedur yang dijalankan adalah secara tidak invasif (non-invasive method) yang mana tidak mendatangkan sebarang kecederaan secara langsung terhadap kanak-kanak yang terlibat. Proses pengambilan sampel tisu pipi dengan menggunakan berus lembut yang telah disteril akan menyebabkan sedikit ketidakselesaan kepada responden. Penyelidik yang terlibat telah dilatih dengan prosedur standard operasi dalam mengendalikan semua ujian. Di akhir sesi ini, cenderahati akan diberikan kepada peserta dalam kajian ini dan penerangan mengenai risiko kecil dalam mengakibatkan ketidakselesaan akan diberikan selepas pengambilan data dilakukan.

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Segala maklumat serta identiti responden yang diberikan untuk kajian akan kekal sebagai sulit dan tidak akan didedahkan. Hasil kajian ini tidak akan diberitahu dan didedahkan kepada sesiapa pun termasuklah responden. Hasil kajian ini hanya digunakan untuk tujuan pembelajaran sahaja.

8. SIAPA YANG SAYA PERLU HUBUNGI SEKIRANYA SAYA MEMPUNYAI SOALAN TAMBAHAN SEMASA MENGIKUTI PENYELIDIKAN INI?

Bagi sebarang soalan tambahan, anda boleh menghubungi :

Nur Syuhaida Nadhirah Binti Ahmad Shaifudin (Pelajar Ijazah)	Professor Zailina Hashim (Penyelia Projek)
Email : syuhaidanadhirah@gmail.com	Email : zailina@upm.edu.my
Tel : 019-5451901	Tel : 03-8947 2406
Jabatan Kesihatan Persekitaran dan Pekerjaan, Fakulti Perubatan dan Sains Kesihatan, UPM, 43400, Serdang, Selangor Darul Ehsan	

Sila tandatangan di sini sekiranya anda telah membaca dan memahami kandungan halaman ini _____

9. PERSETUJUAN

Saya..... No Kad Pengenalan.
beralamat.....

.....dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(kajian klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).

Saya telah diberi penjelasan secara menyeluruh mengenai penyelidikan ini dari segi metodologi, risiko dan komplikasi (seperti tertulis pada Helaian Penerangan Responden). Saya memahami bahawa saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan.Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti saya akan dirahsiakan.

Saya* berminat / tidak berminat untuk mengetahui keputusan kajian yang melibatkan saya.

I setuju/tidak bersetuju untuk imei/gambar/rakaman video/ rakaman suara digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan Tandatangan
(Responden) (Saksi)

Tarikh :..... Nama :.....

No. K/P:

Saya mengesahkan bahawa saya telah menerangkan kepada responden ini sifat dan tujuan penyelidikan yang tersebut di atas.

Tarikh Tandatangan
(Penyelidik)



BORANG 2.5: PENERANGAN DAN PERSETUJUAN PENYERTAAN (IBU BAPA/PENJAGA)

Sila baca maklumat berikut dengan teliti. Sekiranya anda mempunyai sebarang pertanyaan, sila kemukakan kepada penyelidik.

1.TAJUK KAJIAN

Kajian perbandingan mengenai hubungan genotoksiti, simptom kesihatan yang berkaitan, dan pendedahan kepada radiasi medan elektromagnet (EMF) terhadap dua kumpulan kanak-kanak di Lembah Klang.

2. PENGENALAN

Talian elektrik voltan tinggi banyak dibina berdekatan dengan kawasan penduduk yang menghasilkan radiasi medan elektromagnet pada frequency yang sangat rendah. Radiasi medan elektromagnet (EMF) menjadi sesuatu isu yang serius kepada orang awam kerana kesannya kepada kesihatan manusia terutama kanak-kanak. EMF merupakan kombinasi medan elektrik dan medan magnet yang berupaya memberi kesan kepada biologi seseorang. Kanak-kanak lebih cenderung kepada pendedahan radiasi medan elektromagnet (EMF) kerana mereka masih di peringkat awal tumbesaran. Kesan pendedahan terhadap radiasi medan elektromagnet (EMF) boleh menyebabkan perubahan genetik dan mutasi. Banyak kajian yang dilakukan untuk mengkaji hubungan pendedahan terhadap radiasi medan elektromagnet (EMF) terhadap kanak-kanak terutamanya boleh menyebabkan leukemia. Frekuensi Micronuclei (MN) digunakan sebagai petunjuk untuk mengenalpasti potensi pendedahan genotoksiti dan ketidakstabilan kromosom dalam badan manusia. Tujuan kajian ini dijalankan adalah untuk mengetahui hubungan antara Frekuensi Micronuclei (MN) terhadap pendedahan kepada radiasi medan elektromagnet (EMF).

3. APAKAH YANG PERLU ANDA LAKUKAN?

Ibu bapa atau waris bagi kanak-kanak perlulah mengisi dan melengkapkan borang soal selidik yang telah diberikan bersama dokumen ini. Borang soal selidik dan borang persetujuan perlulah dikembalikan kepada penyelidik setelah anda menandatangani dan mengisi kesemua maklumat yang dikemukakan. Hanya pelajar yang mendapat kebenaran daripada ibu bapa akan dipilih untuk menjadi responden dalam kajian ini. Kajian ini melibatkan pengambilan sampel tisu pipi kanak-kanak (bukal mucosa).

Prosedur pengambilan sample bukal mucosa adalah seperti berikut:

- I. Penerangan ringkas mengenai prosedur ini akan disampaikan bagi memastikan kanak-kanak bersedia.
- II. Kanak-kanak diminta berkumur sebanyak 3 kali dengan air mineral.
- III. Tisu pipi pelajar diambil oleh penyelidik yang terlatih menggunakan 'Cytology Brush' dengan menggosok lembut (scraping) berus berkenaan sebanyak 30 kali di permukaan tisu pipi sebelah kanan. 'Cytology Brush' yang mengandungi tisu pipi seterusnya dicekup di dalam 1.5ml 'microcentrifuges tubes' yang mengandungi solusi Phosphate Buffer Saline (PBS) dan disimpan di dalam 'cool box'.
- IV. Sampel-sampel tersebut akan disimpan di dalam 'cool box' dan seterusnya dibawa ke makmal Fakulti Perubatan dan Sains Kesihatan , Universiti Putra Malaysia.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

- Kanak-kanak yang pernah menjalani radiasi atau kemoterapi
- Kanak-kanak yang mempunyai masalah kesihatan

. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANDA SEBAGAI PESERTA?

Secara umumnya, kajian ini akan memberikan satu input kepada ibu bapa kanak-kanak khususnya tentang kesan tentang pendedahan medan elektromagnet terhadap kesihatan kanak-kanak. Kanak-anak atau responden yang terlibat dalam kajian ini dapat membantu penyelidik serta komuniti terlibat dalam menjayakan hasil kajian ini. Antara hasil kajian ini adalah untuk mengkaji hubungan di antara pendedahan terhadap medan elektromagnet terhadap kadar Micronuclei (MN) dalam badan seseorang.

b) KEPADA PENYELIDIK?

Penglibatan responden dalam kajian ini dapat membantu penyelidik dalam mendapatkan segala informasi berkaitan dengan pemboleh ubah yang dikaji, serta hasilnya objektif-objektif ini dapat dicapai. Selain itu, gejala-gejala kesihatan terhadap pendedahan kepada medan elektromagnet (EMF) dapat membantu dalam mengenal pasti indikator pendedahan kepada medan elektromagnet.

6. ADAKAH IA BERISIKO?

Kajian ini tidak mendatangkan sebarang risiko kesihatan kepada kana-kanak. Hal ini kerana, prosedur yang dijalankan adalah secara tidak invasif (non-invasive method) yang mana tidak mendatangkan sebarang kecederaan secara langsung terhadap kanak-kanak yang terlibat. Proses pengambilan sampel tisu pipi dengan menggunakan berus lembut yang telah disteril akan menyebabkan sedikit ketidakselesaan kepada responden. Penyelidik yang terlibat telah dilatih dengan prosedur standard operasi dalam mengendalikan semua ujian. Di akhir sesi ini, cenderahati akan diberikan kepada peserta dalam kajian ini dan penerangan mengenai risiko kecil dalam mengakibatkan ketidakselesaan akan diberikan selepas pengambilan data dilakukan.

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Segala maklumat serta identiti responden yang diberikan untuk kajian akan kekal sebagai sulit dan tidak akan didedahkan. Hasil kajian ini tidak akan diberitahu dan didedahkan kepada sesiapa pun termasuklah responden. Hasil kajian ini hanya digunakan untuk tujuan pembelajaran sahaja.

8. SIAPA YANG SAYA PERLU HUBUNGI SEKIRANYA SAYA MEMPUNYAI SOALAN TAMBAHAN SEMASA MENGIKUTI PENYELIDIKAN INI?

Bagi sebarang soalan tambahan, anda boleh menghubungi :

Nur Syuhaida Nadhirah Binti Ahmad Shaifudin (Pelajar Ijazah)	Professor Zailina Hashim (Penyelia Projek)
Email : syuhaidanadhirah@gmail.com	Email : zailina@upm.edu.my
Tel : 019-5451901	Tel : 03-8947 2406
Jabatan Kesihatan Persekitaran dan Pekerjaan, Fakulti Perubatan dan Sains Kesihatan, UPM, 43400, Serdang, Selangor Darul Ehsan	

Sila tandatangan di sini sekiranya anda telah membaca dan memahami kandungan halaman ini _____

9. PERSETUJUAN

Saya..... No Kad Pengenalan.
beralamat.....
.....dengan ini secara sukarela bersetuju untuk membenarkan *anak / jagaan saya
..... menyertai penyelidikan yang tersebut di atas *(kajian klinikal/percubaan
ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).

Saya telah diberi penjelasan secara menyeluruh mengenai penyelidikan ini dari segi metodologi, risiko dan komplikasi (seperti tertulis pada Helaian Penerangan Responden). Saya memahami bahawa *anak / jagaan saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan. Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti *anak / jagaan saya akan dirahsiakan.

Saya* berminat / tidak berminat untuk mengetahui keputusan kajian yang melibatkan *anak/ jagaan saya.

Saya setuju/tidak bersetuju untuk imei/gambar/rakaman video/ rakaman suara digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan Tandatangan
(Responden) (Saksi)

Tarikh : Nama :
No. K/P:

Saya mengesahkan bahawa saya telah menerangkan kepada responden ini sifat dan tujuan penyelidikan yang tersebut di atas.

Tarikh Tandatangan
(Penyelidik)



QUESTIONNAIRE

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ID RESPONDEN
(diisi oleh penyelidik)



UPM
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BERILMU BERBAKTI

JABATAN KESIHATAN PERSEKITARAN DAN PEKERJAAN

FAKULTI PERUBATAN DAN SAINS KESIHATAN

UNIVERSITI PUTRA MALAYSIA

BORANG SOAL SELIDIK

TAJUK:

KAJIAN HUBUNG KAIT ANTARA GENOTOXICITI DAN SIMPTOM KESIHATAN TERHADAP PENDEDAHAN
MEDAN ELEKTROMAGNET (EMF) KEPADA KANAK-KANAK

ARAHAN SOALAN

1. Borang soal selidik ini mengandungi **empat (3)** bahagian iaitu:

- Bahagian A : Latar Belakang kanak-kanak
Bahagian B : Sumber radiasi selain daripada talian elektik voltan tinggi
Bahagian C : Simptom kesihatan yang berkaitan

SEKALUNG PENGHARGAAN DAN UCAPAN RIBUAN TERIMA KASIH ATAS KESUDIAN ANDA MENYERTAI
KAJIAN INI. ADALAH DIMAKLUMKAN BAHAWA SEGALA KENYATAAN YANG ANDA BERIKAN ADALAH SULIT
DAN HANYA UNTUK KEGUNAAN KAJIAN KESIHATAN SEPENUHNYA

BAHAGIAN A: LATAR BELAKANG KANAK-KANAK

1. Nama : _____
2. No tel :
3. Umur : tahun
4. Warganegara : Warganegara Bukan warganegara
5. Kaum : Melayu Cina
 India lain-lain
6. Jantina : Lelaki Perempuan
7. Tahun berdaftar di sekolah ini (SK Putrajaya Presint 14(1)) :
8. Tinggi : _____ cm
9. Berat : _____ kg

Maklumat Kesihatan

10. Adakah anak anda telah didiagnosis untuk sebarang penyakit di bawah?

No	Penyakit	Ya	Tidak
1	Kencing Manis		
2	Asma		
3	Karis gigi		
4	Sebarang penyakit berkaitan dengan gigi (cth: Periodontal)		

11. Adakah anak anda mengambil sebarang ubat-ubatan dalam tempoh 48 jam yang lepas?

Ya Tidak

12. Jika Ya pada soalan 11, nyatakann ubat-ubatan tersebut?

.....

13. Alamat rumah

.....
.....
.....
.....

14. Sudah berapa lama tinggal di alamat sekarang?

.....

15. Apakah hubungan anda dengan pelajar?

Ayah

Ibu

Lain-lain (nyatakan)

.....

16. Apakah tahap pendidikan anda?

Penilaian Menengah Rendah

Sijil Penilaian Menengah

Diploma

Ijazah Sarjana Muda

Ijazah Sarjana

Doktor Falsafah (PhD)

17. Apakah pekerjaan anda?

.....

18. Adakah mana-mana ahli keluarga anda merokok sejak anak anda dilahirkan?

Ya Tidak

19. Adakah anda mempunyai sebarang penyakit serius?

Ya Tidak

Jika ya, nyatakan

.....

BAHAGIAN B: SUMBER RADIASI SELAIN DARIPADA TALIAN ELEKTRIK KUASA TINGGI

1. Lokasi rumah

a) Adakah terdapat talian elektrik kuasa tinggi (HVPL) di sekitar kediaman anda?

Ya (kurang daripada 100m)

Tidak (lebih daripada 100m)

b) Adakah terdapat stesen jana kuasa di sekitar kediaman anda ?

Ya (kurang daripada 500m)

Tidak (lebih daripada 500m)

2. Perkakas rumah

a) Sila tandakan nyatakan jumlah untuk setiap perkakas rumah di bawah.

Perkakas Elektrik	Jumlah
Radio	
Televisyen	
Ketuhar Mikro (microwave)	
Dapur elektrik	
Peti sejuk	
Penghawa dingin	
Komputer riba	
Telefon bimbit	
Telefon talian tetap	

- a) Berapa lamakah anak anda menggunakan perkakas berikut dalam kehidupan seharian?
(Sila tandakan (/))

	Perkakas Elektrik	Penggunaan	
		(kurang dari dua jam/hari)	(lebih dari dua jam/hari)
	Komputer		
	Televisyen		
	Telefon bimbit		
	Telefon talian tetap		



BAHAGIAN C: SIMPTOM BERKAITAN KESIHATAN

Tandakan mana-mana yang dihadapi oleh anak anda:

No	Perkara	Ya	Tidak
1.	Adakah anak anda pernah mengalami rasa pening yang berpanjangan tanpa melakukan sebarang aktiviti berat dan hanya berada dalam keadaan rehat di dalam rumah untuk tempoh yang lama?		
2.	Adakah anak anda sering mengalami gangguan/kesukaran untuk tidur?		
3.	Adakah anak anda kerap berasa loya?		
4.	Adakah anda anda sering mengalami masalah sukar memberikan tumpuan terhadap sebarang aktiviti yang memerlukan kadar penumpuan yang tinggi seperti mengulang kaji pelajaran?		
5.	Adakah anak anda sering berasa gelisah yang keterlaluan dan berpanjangan?		
6.	Adakah anda anda sering mengalami keletihan yang berpanjangan walaupun tidak melakukan aktiviti – aktiviti berat dan hanya berehat di dalam bilik?		
7.	Adakah anak anda mempunyai sebarang penyakit serius? Jika ya, nyatakan _____		

-tamat soal selidik-



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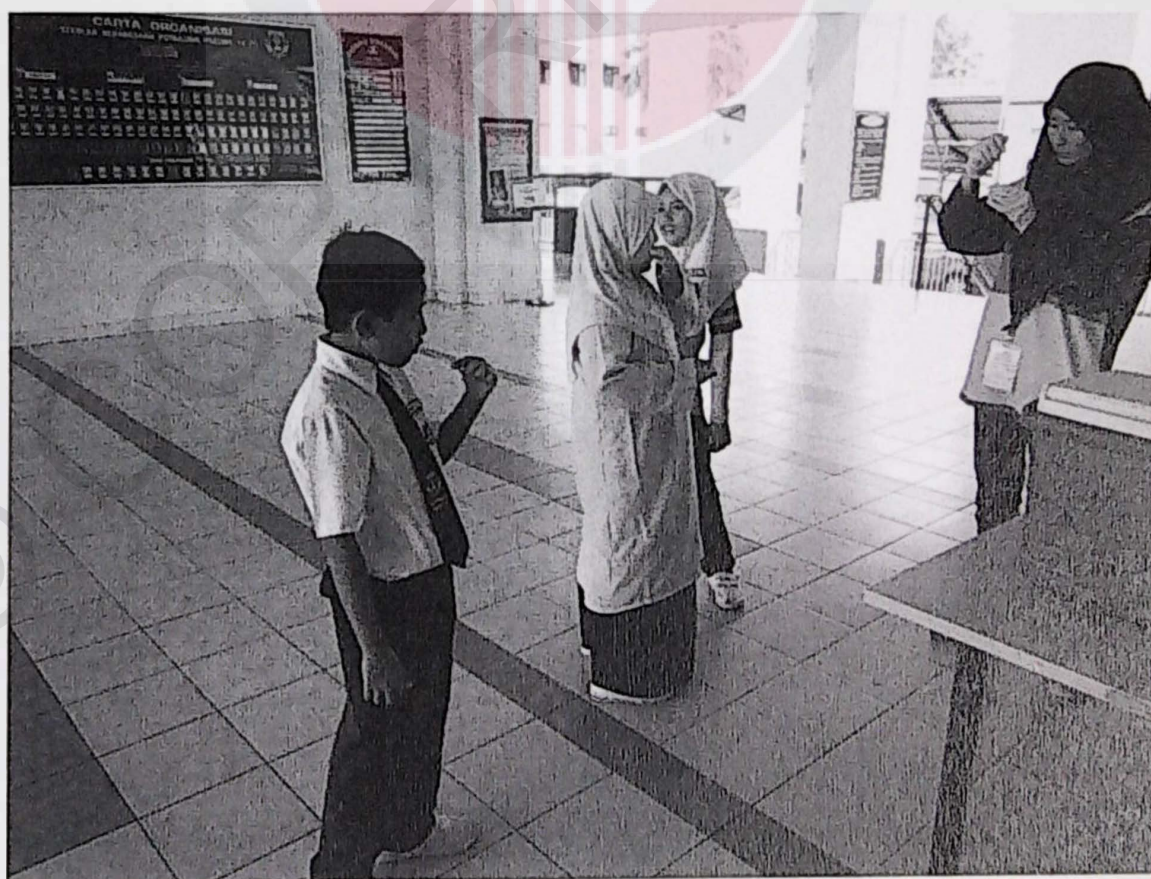


DATA COLLECTION ACTIVITIES

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a) Briefing session



b) Buccal cell collection