UNIVERSITI PUTRA MALAYSIA

KNOWLEDGE AND PRACTICES OF BPA RELATING TO USAGE OF POLYCARBONATE DRINKING BOTTLE

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BY

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ABSTRACT

KNOWLEDGE AND PRACTICES OF BISPHENOL A RELATING TO USAGE OF POLYCARBONATE DRINKING BOTTLE

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Introduction: Bisphenol A (BPA) is a synthetic chemical that is also known as 'environmental hormones'. It can disrupt the hormone-secreting glands that form a network known as the endocrine system. This system includes the thyroid, pituitary, pancreas, thymus, adrenal, ovaries and testicular glands. **Objectives:** This study was conducted to compare the knowledge and practices of BPA relating to usage of polycarbonate drinking bottle and to determine the association between socio demographic with knowledge and practice among students in Universiti Putra Malaysia (UPM). **Methodology:** This cross sectional study was conducted among 149 students, 75 from science based and 74 non-science based students. A set of pre-tested questionnaire was used to obtain socio-demographic, knowledge about BPA and practices on using polycarbonate drinking bottle. The collection of data was done between February 2012 to April 2012. **Results:** This study found that the knowledge on BPA between these two groups was generally poor but science based students were likely more knowledgeable as compared to non-science based students. The good practices on using polycarbonate drinking bottle between these two groups were almost equal. There was significant difference in knowledge (x^2= 25.899, $p<0.0001$) relating to BPA but there was no significant difference in practices of using polycarbonate drinking bottle between science based and non-science based students. No significant association was found between the knowledge of BPA and the respondent practice on usage of polycarbonate drinking bottle. No significant association was also found between socio demographic with knowledge and practice among students in UPM. **Conclusion:** The students mostly do not know about BPA and the health effects, but they were able to practice in usage of polycarbonate drinking bottle in a safe way. In general, knowledge on BPA among science based students was good than non-science based students and the practice of using polycarbonate drinking bottle among these two groups was good. Non-science based students are suggested to take related course regarding environmental pollutants and health effect to human body. Concern of knowledge on chemical that can give adverse health effect to body should be raised among students and public. Awareness of improper plastic uses should be raised, knowledge relating to purchasing and using plastic containers for food and drinks should be distributed to the public. Biological exposure of respondents could be conducted to evaluate and confirm BPA level in body.

Keyword: knowledge, practices, BPA, polycarbonate drinking bottle

ABSTRAK

PENGETAHUAN DAN AMALAN BISPHENOL A YANG BERHUBUNGAN DENGAN PENGGUNAAN BOTOL AIR POLIKARBONAT

NURUL KHAIRUNISA BT MANSOR

Pengenalan: Bisphenol A (BPA) adalah bahan kimia sintetik yang juga dikenali sebagai 'hormon alam sekitar'. Ia boleh mengganggu kelenjar-merembeskan hormon yang membentuk satu rangkaian yang dikenali sebagai sistem endokrin. Sistem ini termasuk tiroid, pituitari, pankreas, timus, adrenal, ovari dan kelenjar testis. **Objektif:** Kajian ini dijalankan untuk membandingkan pengetahuan dan amalan BPA berkaitan dengan penggunaan botol minuman polikarbonat, untuk menentukan perkaitan antara sosio-demografi dengan pengetahuan dan amalan di kalangan pelajar di Universiti Putra Malaysia (UPM). **Metodologi:** Kajian rentas lintang telah dijalankan di kalangan 149 pelajar, 75 pelajar berasaskan sains dan 74 pelajar bukan berasaskan sains. Satu set soal selidik pra-uji telah digunakan untuk mendapatkan sosio-demografi, pengetahuan mengenai BPA dan amalan menggunakan botol minuman polikarbonat. Pengumpulan data telah dilakukan di antara Februari 2012 hingga April 2012. Kajian ini mendapati bahawa pengetahuan mengenai BPA antara kedua-dua kumpulan adalah lemah tetapi pelajar berasaskan sains lebih berpengetahuan berbanding dengan pelajar bukan berasaskan sains. **Hasil kajian:** Amalan-amalan yang baik mengenai penggunaan botol minuman polikarbonat antara dua kumpulan ini adalah hampir sama. Terdapat perbezaan yang signifikan dalam pengetahuan (X^2 = 25,899, p <0.0001) berkaitan dengan BPA tetapi tidak terdapat perbezaan yang ketara dalam amalan menggunakan botol minuman polikarbonat antara pelajar berasaskan sains dan pelajar bukan berasaskan sains. Tiada perkaitan di antara pengetahuan berkaitan dengan BPA dan amalan responden pada penggunaan botol minuman polikarbonat. Tiada hubungan yang signifikan juga didapati antara sosio-demografi dengan pengetahuan dan amalan penggunaan botol minuman polikarbonat di kalangan pelajar di UPM. **Kesimpulan:** Pelajar-pelajar kebanyakannya tidak tahu mengenai BPA dan kesan kesihatan, tetapi mereka mampu untuk mengamalkan penggunaan botol minuman polikarbonat dengan cara yang selamat. Secara amnya, pengetahuan mengenai BPA di kalangan pelajar berasaskan sains adalah baik daripada pelajar berasaskan bukan sains dan amalan menggunakan botol minum polikarbonat di kalangan kedua-dua kumpulan ini adalah baik. **Cadangan:** Pelajar berasaskan bukan sains dicadangkan untuk mengambil kursus yang berkaitan dengan pencemaran alam sekitar dan kesan kepada kesihatan badan manusia. Pengetahuan mengenai bahan kimia yang boleh memberi kesan kesihatan yang buruk terhadap badan perlu dibangkitkan di kalangan pelajar dan orang awam. Kesedaran tentang penggunaan plastik, pengetahuan yang berkaitan dengan pembelian dan penggunaan bekas plastik untuk makanan dan minuman perlu disebarkan kepada orang ramai. Pendedahan biologi responden boleh dijalankan untuk menilai dan mengesahkan tahap BPA dalam badan.

Kata-kata: pengetahuan, amalan, BPA, botol minuman polikarbonat

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BPA	Bisphenol A
EFSA	European Food Safety Authority
FDA	Food and Drug Administration
NHANES	National Health and Nutrition Examination Survey
TDI	Tolerable Daily Intake
PC	Polycarbonate
PVC	Polyvinyl Chloride
UPM	Universiti Putra Malaysia

CHAPTER 1

INTRODUCTION

1.1 Introduction

The plastic monomer and plasticizer bisphenol A (BPA) is one of the highest volume chemicals produced worldwide, with over six billion pounds produced each year (Burridge, 2003). BPA is used as an ingredient to produce polycarbonate plastic and epoxy resins. These materials are used in a variety of products including baby feeding bottles, microwave ovenware and inner coatings of cans for food and beverages. Recent reports also indicate the potential for transferability of BPA from cash register receipts (Biedermann et al., 2010). The most relevant exposure route seems to be dietary ingestion. Orally administered BPA is absorbed nearly 100% in the digestive tract and is rapidly biotransformed to a glucuronide metabolite. Due to the very rapid and complete excretion of this metabolite, urine is considered as the appropriate body fluid for exposure assessment. National data from 2003 to 2004 indicated that 93% of the US population over age five years had measureable BPA metabolites in urine (Calafat et al., 2008). Pregnant women who regularly consume canned vegetables, work as cashiers, or

are exposed to tobacco smoke have higher urinary BPA concentrations than pregnant women without these characteristics (Braun et al. 2010).

BPA is now deeply imbedded in the products of modern consumer society, not just as the building block for polycarbonate plastic from which it then leaches as the plastic ages but also in the manufacture of epoxy resins and other plastics, including polysulfone, alkylphenolic, polyalylate, polyester-styrene, and certain polyester resins. Its uses don't end with the making of plastic. BPA has been used as an inert ingredient in pesticides although in the US this has apparently been halted, as a fungicide, antioxidant, flame retardant, rubber chemical, and polyvinyl chloride stabilizer. These uses create a myriad of exposures for people. BPA-based polycarbonate is used as a plastic coating for children's teeth to prevent cavities, as a coating in metal cans to prevent the metal from contact with food contents, as the plastic in food containers, refrigerator shelving, baby bottles, water bottles, returnable containers for juice, milk and water, micro-wave ovenware and eating utensils.

Other exposures result from BPA's use in films, sheets, and laminations, reinforced pipes, floorings, watermain filters, enamels and vanishes, adhesives, artificial teeth, nail polish, compact discs, electric insulators, and as parts of automobiles, certain machines, tools, electrical appliances, and office automation instruments (Takahashi and

Oishi, 2000). BPA contamination is also widespread in the environment. For example, BPA can be measured in rivers and estuaries at concentrations that range from under 5 to over 1900 nanograms/liter. Sediment loading can also be significant, with levels ranging from under 5 to over 100 µg/kg (ppb).

BPA is known to have a weak oestrogenic activity and thus might have an impact on the endocrine system of humans. Low levels of BPA have also been reported to cause biological effects and its mode of action appears to mimic that of the female hormone, estrogen and is therefore classified as an endocrine-disrupting chemical (VomSaal et al., 1998). The panel has recently set and confirmed a tolerable daily intake (TDI) of 0.05 mg/kg bw/day based on the results of reproductive and development toxicity studies (EFSA-European Food Safety Authority, 2008; EFSA-European Food Safety Authority, 2006).World production capacity of this compound was 1 million tons in the 1980s, (Fiege et al., 2002) and more than 2.2 million tons in 2009. In 2003, U.S. consumption was 856,000 tons, 72% of which was used to make polycarbonate plastic and 21% going into epoxy resins. In the US, less than 5% of the BPA produced is used in food contact applications.

In packaging applications, there are seven classes of plastics used (Appendix 1). Type 7 is the catch-all "other" class and some type 7 plastics, such as polycarbonate which sometimes identified with the letters "PC" near the recycling symbol and epoxy

resins, are made from bisphenol A monomer (Fiege et al., 2002). Type 3 (PVC) can also contain bisphenol A as an antioxidant in plasticizers (Fiege, 2002). In general, plastics that are marked with recycle codes 1, 2, 4, 5, and 6 are very unlikely to contain BPA.

1.2 Problem Statement

BPA is primarily used in the production of polycarbonate plastics and epoxy resins, which are widely used in applications such as baby feeding bottles, toys, epoxy food-can linings, medical equipment and tubing, and consumer electronics. BPA is one of the highest production volume chemicals, with three million tons produced each year worldwide (Burridge, 2003). Exposure of humans to BPA occurs predominantly through the diet (Braun et al., 2011). BPA levels have been measured in human fluids and tissues such as plasma, serum, placenta, breast milk, semen, and urine in some industrialized countries around the world (Calafat et al., 2008; He et al. 2009). The National Health and Nutrition Examination Survey (NHANES) of the United States, conducted in 2003-2004, showed that 93% of 2517 urinary specimens contained detectable level of BPA (Calafat et al. 2008).

An important source of human exposure is thought to be the ingestion of food and drink that has been in contact with epoxy resins or polycarbonate plastics (Kang et

al., 2006). Polycarbonate is a durable, lightweight, and heat-resistant plastic, making it popular for use in plastic food and beverage containers. Leaching occurs when the chemical bond linking BPA monomers together to form plastic for example polymerization breaks. BPA is ingested when it leaches into food and beverages for human consumption. Heating cans to sterilize food, storing acidic or basic food/beverages in cans or polycarbonate plastic, and repeated washing of polycarbonate products all increase the rate at which leaching occurs.

Laboratory studies have demonstrated that biologically active BPA is released from polycarbonate bottles after simulated normal use (Brede et al., 2003; Le et al., 2008). High temperatures as well as acidic and alkali solutions cause polymer degradation via hydrolysis, resulting in increased BPA migration. After incubation for 8, 72, and 240 hour in food-simulating solvents (10% ethanol at 70°C and corn oil at 100°C), mean BPA migration increased with incubation time (Onn Wong et al., 2005). After a sequence of washing and rinsing, Le et al. (2008) found that new poly-carbonate bottles leached 1.0 ± 0.3 μg/mL BPA (mean ± SD) into the bottle content after incubation at room temperature for 7 days. Although exposure to boiling water increased the rate of BPA migration up to 55-fold, used bottles did not leach significantly more BPA than new ones. However, other studies have found that higher concentrations of BPA leach from used polycarbonate plastic than from new. Similarly, after incubation in 100°C water for 1 hour, the amount of BPA leached from baby bottles subjected to

simulated use including dishwashing, boiling, and brushing into the bottle exceeded the amount that leached from new baby bottles (Brede et al., 2003).

1.3 Study Justification

As much as researcher is aware off, there are no studies relating to the BPA polycarbonate drinking bottle conducted in Malaysia. Firstly, this study aims to obtain initial information from the students of UPM regarding knowledge and practices of using polycarbonate drinking bottle. Secondly, to obtain information in term of practices to determine the exposure of BPA due to usage of polycarbonate drinking bottle. Thirdly, we concern on the health effect on human due to widely use in daily lives. Lastly, we hope that intervention and preventive measures can be done by the university management in order to give knowledge to students regarding this topic.

1.4 Definition of Term

1.4.1 Conceptual Definition

1.4.1.1 Knowledge

Information and skills acquired through experience or education; the theoretical or practical understanding of a subject.

1.4.1.2 Practices

Perform (an activity) or exercise (a skill) repeatedly or regularly in order to improve or maintain one's proficiency

1.4.1.3 Polycarbonate drinking bottle

Polycarbonate bottles is drinking container which are refillable and a popular container among students, campers and other that made with BPA which is primarily used in the production of polycarbonate plastics.

1.4.1.4 Bisphenol A

The organic compound BPA is a key monomer in the production of polycarbonate plastics and epoxy resins. Polycarbonate is clear, heat stable and nearly shatter-proof and therefore used in a lot of common products like baby and water bottles, electronics, CDs and DVDs or eyeglass lenses. Epoxy resins are used as coatings on the inside of almost all food and beverage cans.

1.4.1.5 Bisphenol A exposure

Laboratory studies have demonstrated that biologically active BPA is released from polycarbonate bottles after simulated normal use. High temperatures, acidic, and alkali solutions as well as brushing into the bottle resulting in increased BPA migration. (Brede et al., 2003; Le et al., 2008). To lower their exposure to BPA, avoid canned food and polycarbonate plastic containers unless the packaging indicates the plastic is Bisphenol A-free (Ashley Ahearn, 2008).

1.4.2 Operational Definition

1.4.2.1 Knowledge

Regarding knowledge about BPA, the total score was 10. Participants who scored 8-10 (≥75%) were ranked as "good", scored 5-7 (≥50%) as "fair", and scored 1-4 (≤50%) as "poor".

1.4.2.2 Practices

Regarding practice of using polycarbonate drinking bottle, the total score was 9. Participants who scored 7-9 (≥75%) were ranked as "poor", scored 5-6 (≥50%) as "fair", and scored 1-4 (≤50%) as "good".

1.4.2.3 Polycarbonate drinking bottle

Polycarbonates drinking bottle in this study specifically refer to the recycling number 7 or there is no number stated at the bottom of bottle.

1.4.2.4 Bisphenol A

In this study, BPA indicated by product of polycarbonate drinking bottle which is primarily used in the production of polycarbonates plastics. It is normally identified with letters "PC" near the recycling symbol at the bottom of drinking bottle.

1.4.2.5 Bisphenol A exposure

The factors involve of the BPA exposure in polycarbonate drinking bottle in this study include acidity, alkalinity and the temperature of the water in the bottle, washing

with detergents, duration of bottle use and whether they use BPA free bottle. The risk of BPA exposure in drinking water can be estimated regarding practice of using polycarbonate drinking bottle, the total score was 9. Participants who scored 7-9 (≥75%) were ranked as "high risk", scored 5-6 (≥50%) as "medium risk", and scored 1-4 (≤50%) as "lower risk".

1.5 Conceptual Framework

A conceptual framework is used in research to outline possible courses of action present in preferred approach to an idea or thought. It is a type of intermediate theory that attempt to connect to all aspects of inquiry problem definition, purpose, literature review, methodology, data collection and analysis. Figure 2.0 below is a conceptual framework for this research on BPA exposure and its health effect in our daily lives.

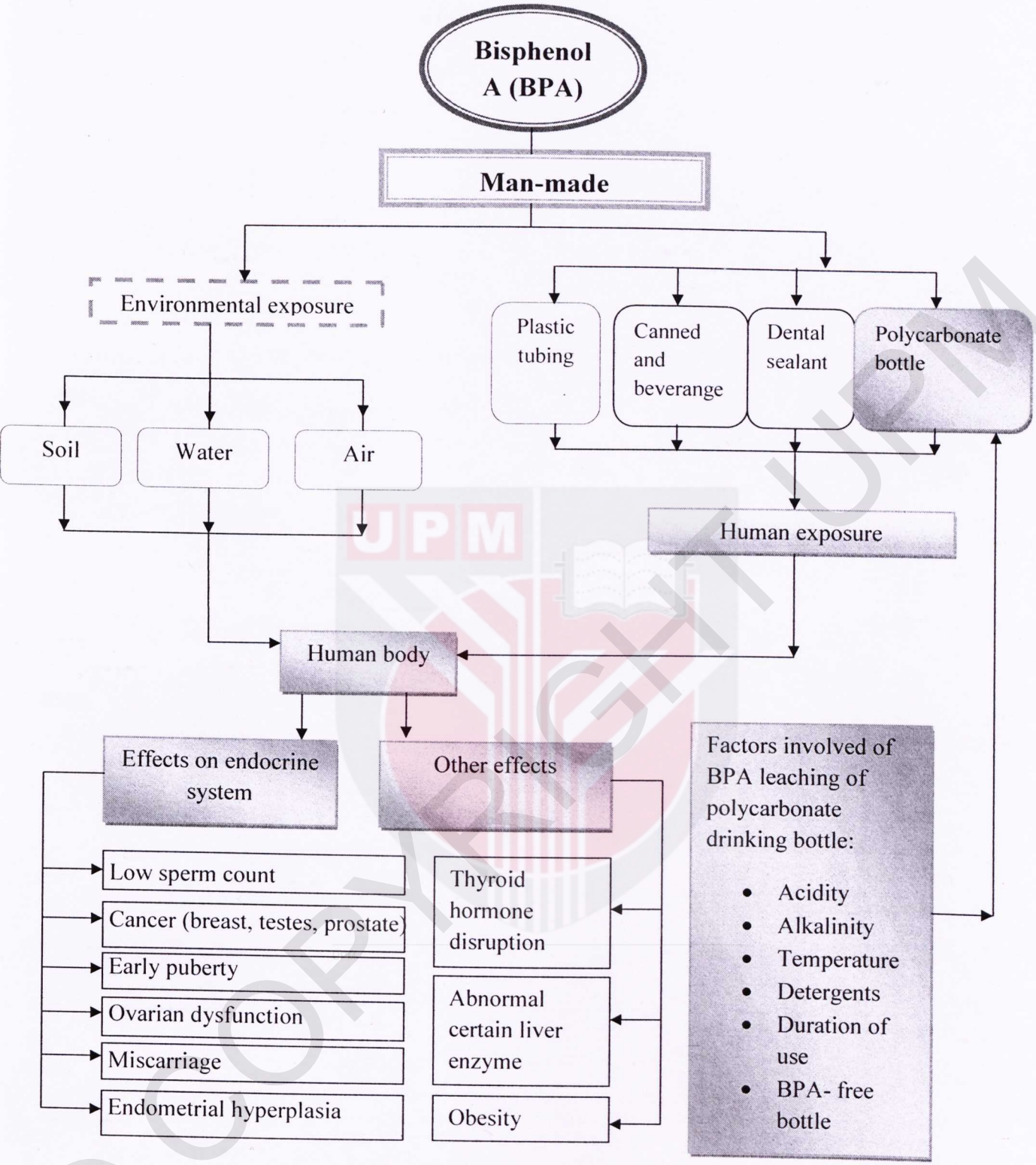

Figure 1: The conceptual framework of BPA exposure and its health effect

1.6 Study Objectives

1.6.1 General Objectives

To determine the knowledge and practices of BPA relating to usage polycarbonate drinking bottle among students at UPM.

1.6.2 Specific Objectives

1) To determine the socio demographic information of students at UPM.
2) To compare the knowledge of BPA in polycarbonate drinking bottle between science based and non-science based students at UPM.
3) To compare the practices of using polycarbonate drinking bottle between science based and non-science based students at UPM.
4) To compare the risk of BPA exposure based on practices of using polycarbonate drinking bottle between science based and non-science based students at UPM.
5) To determine the association between the knowledge on BPA and the practice of using polycarbonate drinking bottle among science based and non-science based students at UPM.
6) To determine the association between socio demographic and knowledge on BPA among science based and non-science based students at UPM.

7) To determine the association the socio demographic and practices of using polycarbonate drinking bottle between science based and non-science based students at UPM.

1.7 Hypothesis

1) There is a significant difference of knowledge on BPA between science based and non-science based students at UPM.
2) There is a significant difference of practices of polycarbonate drinking bottle between science based and non-science based students at UPM.
3) There is significant difference of risk BPA exposure in drinking water based on practices using polycarbonate drinking bottle between science based and non-science based students at UPM.
4) There is a significant association between the knowledge and practices of using polycarbonate drinking bottle among science based and non-science based students at UPM.
5) There is a significant association between socio demographic and knowledge on BPA among science based and non-science based students at UPM.
6) There is significant association between socio demographic and practices of using polycarbonate drinking bottle among science based and non-science based students at UPM.

CHAPTER 2

LITERATURE REVIEW

2.1 Health Effect of BPA

2.1.1 Studies on human

The first large study of health effects on humans associated with BPA exposure was published in September 2008 by Iain Lang and colleagues in the Journal of the American Medical Association (Lang Iain et al., 2008). The cross-sectional study of almost 1,500 people assessed exposure to bisphenol A by looking at levels of the chemical in urine. The authors found that higher BPA levels were significantly associated with heart disease, diabetes, and abnormally high levels of certain liver enzyme (VomSaal et al., 2008).A later similar study performed by the same group of scientists, published in January 2010, confirmed, despite of lower concentrations of BPA in the second study sample, an associated increased risk for heart disease but not for diabetes or liver enzymes. Patients with the highest levels of BPA in their urine carried a 33% increased risk of coronary heart disease (Melzer et al., 2010).

Studies have associated recurrent miscarriage with BPA serum concentrations, (Sugiura et al., 2005) oxidative stress and inflammation in postmenopausal women with urinary concentrations, (Yang et al., 2009) externalizing behaviors in two-year old children, especially among female children, with mother's urinary concentrations, (Braun et al., 2009) altered hormone levels in men and declining male sexual function (Meeker et al., 2009) with urinary concentrations. The Canadian Health Measures Survey, 2007 to 2009 published in 2010 found that teenagers carry 30 percent more BPA in their bodies than older adults. The reason for this is not known. A study done in 2010 reported the daily excretion levels of BPA among European adults in a large-scale and high-quality population-based sample, and it was shown that higher BPA daily excretion was associated with an increase in serum total testosterone concentration in men. A 2011 study found higher BPA levels in women with polycystic ovary syndrome compared to controls. Furthermore, researchers found a statistically significant positive association between male sex hormones and BPA in these women suggesting a potential role of BPA in ovarian dysfunction.

2.1.2 Endocrine disrupter

A panel convened by the U.S. National Institutes of Health in 2007 determined that there was some concern about BPA's effects on fetal and infant brain development and behavior. The concern over the effect of BPA on infants was also heightened by the fact that infants and children are estimated to have the highest daily intake of BPA. A

2008 report by the U.S. National Toxicology Program (NTP) later agreed with the panel, expressing some concern for effects on the brain, behavior, and prostate gland in fetuses, infants, and children at current human exposures to BPA and minimal concern for effects on the mammary gland and an earlier age for puberty for females in fetuses, infants, and children at current human exposures to BPA.

2.1.3 Obesity

A 2008 review has concluded that obesity may be increased as a function of BPA exposure, which merits concern among scientists and public health officials (Elobeid et al., 2008). A 2009 review of available studies has concluded that perinatal BPA exposure acts to exert persistent effects on body weight and adiposity (Rubin et al., 2009). Another 2009 review has concluded that eliminating exposures to BPA and improving nutrition during development offer the potential for reducing obesity and associated diseases (Heinde et al., 2009; Newbold et al.,2009; Grun et al., 2009).

2.1.4 Thyroid function

A 2007 review has concluded that BPA has been shown to bind to thyroid hormone receptor and perhaps have selective effects on its functions (Zoeller,2007).A 2009 review about environmental chemicals and thyroid functions, raised concerns

about BPA effects on triiodothyronine and concluded that available evidence suggests that governing agencies need to regulate the use of thyroid-disrupting chemicals, particularly as such uses relate exposures of pregnant women, neonates and small children to the agents (Boas et al., 2009).A 2009 review summarized BPA adverse effects on thyroid hormone action (Kashiwagi et al., 2009).

2.1.5 Breast cancer

A 2008 review has concluded that perinatal exposure to low doses of BPA, alters breast development and increases breast cancer risk (Brisken, 2008). Another 2008 review concluded that animal experiments and epidemiological data strengthen the hypothesis that fetal exposure to xenoestrogens may be an underlying cause of the increased incidence of breast cancer observed over the last 50 years (Soto et al., 2010).

2.1.6 Prostate development & cancer

A 1997 study in mice has found that neonatal BPA exposure of 2 µg/kg increased adult prostate weight (Nagel et al., 1997). A 2005 study in mice has found that neonatal BPA exposure at 10 µg/kg disrupted the development of the fetal mouse prostate. A 2006 study in rats has shown that neonatal BPA exposure at 10 µg/kg levels increases

prostate gland susceptibility to adult-onset precancerous lesions and hormonal carcinogenesis (Ho et al., 2006).

2.1.7 Sexual difficulties

A 2009 study on Chinese workers in BPA factories found that workers were four times more likely to report erectile dysfunction, reduced sexual desire and overall dissatisfaction with their sex life than workers with no heightened BPA exposure (Li et al., 2009). BPA workers were also seven times more likely to have ejaculation difficulties. They were also more likely to report reduced sexual function within one year of beginning employment at the factory, and the higher the exposure, the more likely they were to have sexual difficulties.

2.2 Sources of human exposure

Various studies have examined specific products or activities for potential for human exposure to BPA, including canned foods, microwave containers (Mariscal-Arcas et al., 2009), soft drinks (Cao et al., 2009), polycarbonate bottles including baby bottles (Vandenberg et al., 2007; Carwile et al., 2009), smoking, alcohol consumption (He et al. 2009), medical procedures/products including cardiopulmonary y bypass and

hemodialysis (Calafat et al., 2009; FDA, 2009), dental sealants, and plastic tubing (Vandenberg et al. 2007).

2.2.1 Polycarbonate plastics

BPA has been known to be leached from the plastic lining of canned foods and polycarbonate plastics, especially those that are cleaned with harsh detergents or those which contain acidic or high-temperature liquids. In 2009, a study found that drinking from polycarbonate bottles increased urinary BPA levels by two thirds, from 1.2 micrograms/gram creatinine to 2 micrograms/gram creatinine (Carwile et al., 2009). Consumer groups recommend that people wishing to lower their exposure to BPAavoid canned food and polycarbonate plastic containers which shares resin identification code 7 with many other plastics unless the packaging indicates the plastic is bisphenol A-free(Ashley Ahearn, 2008). In order to avoid the possibility of BPA leaching into food or drink, the National Toxicology Panel recommends avoiding microwaving food in plastic containers, putting plastics in the dishwasher, or using harsh detergents.

2.2.2 Canned food and beverages

A 2011 study published in *Environmental Health Perspectives*, "Food Packaging and Bisphenol A and Bis(2-Ethyhexyl) Phthalate Exposure: Findings from a Dietary Intervention," selected 20 participants based on their self-reported use of canned and packaged foods to study BPA. Participants ate their usual diets, followed by three days of consuming foods that were not canned or packaged. The study's findings include evidence of BPA in participants' urine decreased by 50% to 70% during the period of eating fresh foods and participants' reports of their food practices suggested that consumption of canned foods and beverages and restaurant meals were the most likely sources of exposure to BPA in their usual diets. The researchers note that, even beyond these 20 participants, BPA exposure is widespread, with detectable levels in urine samples in more than an estimated 90% of the U.S. population.

2.2.3 Dental products

Several resin-based monomers are used in dentistry as preventative sealants, adhesives and restorative materials. Since the 1960's, BPA diglycidyl methacrylate has been used as a component of many dental restorative materials. In a study of 18 adults, approximately 50 mg total of sealant to 12 molars. Total saliva was collected continuously for 1 h before and 1 h after the application procedure. After the treatment,

all samples were found to contain variable amounts of BPA, ranging from 3.3 to 30.0 µg/ml saliva (Olea et al., 1996). Subsequent studies, using different composite applications and saliva collection techniques, have added some controversy to this topic when applied 38 mg of fissure sealant to four molars in eight volunteers and found detectable levels of BPA in small saliva samples taken immediately after placement of the sealant (Arenholt-Bindslev et al., 1999).

2.2.4 Sewage leachates and water

Several studies have demonstrated that BPA can be detected in landfill (Kawagoshi et al., 2003) used both chemical analysis GC–MS and a yeast two-hybrid system to analyze estrogenic compounds leaching into groundwater from a landfill located in Osaka North Port, Japan. Several xenoestrogens and anti-estrogens were detected, but BPA was identified as the greatest contributor to the measured estrogenic activity, with a contribution ratio estimated at 84% and levels detected at 740 ng/ml. In a study of leachates from a landfill in West Germany, the BPA concentration measured from the raw leachates was 3.61 mg/l in the upper range of levels detected in Japan (Yamamoto et al., 2001). While treatment of raw leachates using methods similar to those used to care for landfill waste throughout Europe removed 97% of the estrogenic activity, traces of BPA remained (Coors et al., 2003). The authors from these studies suggest that BPA degradation from plastic waste buried in the landfill is the primary

contributor to these high levels. These findings contrast with the view of plastic products as primarily posing a problem because of their resistance to degradation in contrast with biodegradable materials. The reality is that the leaching of chemicals such as BPA from plastics in landfills has the potential to contribute to contamination of the environment, particularly because such a large volume is produced annually and such a small proportion is recycle.

2.2.5 Air and dust

Air and dust levels of BPA serve as another potential source for human BPA exposure. Because of the large amounts of BPA produced annually, it is plausible that BPA enters air particles during production at plastics manufacturing plants. It has been speculated that the presence of BPA in other environmental samples such as water and soil could lead to its vaporization, despite its low vapor pressure, allowing it to be adsorbed into the core portion of airborne particles (Kolpin et al., 2002).

In a survey of 120 homes for the presence of endocrine disrupting chemicals, found BPA present in 86% of house dust samples at concentrations ranging from 0.2 to17.6 µg/g (Rudel et al., 2003). Another study from the same group found BPA in three of six residential and office dust samples (Matsumoto et al., 2005). BPA was also

detected in air samples, including a sample from a plastics workplace (208 ng/m3). An additional study measured BPA levels in urban ambient outdoor air particulates in Osaka, Japan (Matsumoto et al., 2005). BPA was detected in air samples with an average level of 0.51 ng/m3. This study also found mild seasonal variation in BPA levels, with increasing levels from autumn to winter and decreasing levels from winter to spring.

2.2.6 Occupational exposure

A 2009 study on Chinese workers in BPA factories found that workers were four times more likely to report erectile dysfunction, reduced sexual desire and overall dissatisfaction with their sex life than workers with no heightened BPA exposure (Li et al., 2009). It was indicated that workers in epoxy resin and BPA manufacturing process are occupationally exposed to BPA at high level.

CHAPTER 3

METHODOLOGY

3.1 Study Location

This study was conducted at Universiti Putra Malaysia (UPM), Serdang, Selangor Darul Ehsan.

3.2 Study Design

Cross sectional study was used because this study had been done in the short time frame which is within 4 months. Flow chart on how the process of data collection and Gannt chart can be found in Appendix 2 and Appendix 3 respectively.

3.3 Study population

The target population for this study is students at UPM who were using polycarbonate drinking bottle.

3.4 Sampling frame

One from science based faculty and one from non-science faculty at UPM were randomly chosen from the list to be the representative faculty in this study

3.5 Inclusion criteria

a) Undergraduate students of UPM who used polycarbonate drinking bottle.

3.6 Sampling method

For this research, one from 9 science based faculty and one from 7 non-science based faculty were randomly chosen to be the representative faculty in this study. The respondents were purposely recruited from each selected faculty among those who used polycarbonate drinking bottle.

3.7 Sample size

For sample size, 10% of total population was recruited as sample (Neuman et al., 1997). According to Neuman et al, if the total population was between the ranges of 1000 to 10000, 10% was sufficient to represent the total population. Hence, the sample size of this study was as follow:

a) Faculty of Medicine and Health Sciences: Total population= 1010

$$\frac{10}{100} \times 1010 = 101$$

b) Faculty of Economic and Management: Total population=1015

$$\frac{10}{100} \times 1015 = 102$$

So, total population for both faculties: 101+102=203 respondents were targeted in conducting this study. The response rate of this study was 74% (149 respondents) which did not reach the actual amount of respondents as the calculation of sample size (203 respondents). It was due to the time constraint, the respondents refused to take part in the study and unavailability of students during study was conducting. However, according to Groven, (2006), a working assumption for a survey to be construed as "good" it must attain a high response rate 70%. Hence, 72 % of response rate could represent the total studied population.

3.8 Instrumentation

3.8.1 Questionnaire

A set of pre-tested questionnaire was developed based on information gathered from previous study to assess knowledge and practices of BPA relating to usage of polycarbonate drinking bottle by using a threepoint Likert type scale (Appendix 4). There were 3 parts in the questionnaire form which was Part A, Part B and Part C. Part A was the respondent's background information which includes name of respondents, faculty, course taken, batch, age, gender, and races. Second part was Part B which is respondents' general knowledge of BPA. Here, the respondents had been asked about the type of bottle that they used, the items relating symbols on plastic container, BPA and BPA-free drinking bottle, the product that contained BPA and the health effects regarding BPA exposure to human. Part C which was practice part asked questions such as the duration of respondents using their current drinking bottle, whether they have changed the bottle before, do they had put acidic water, alkaline water and boil water into the bottle, how they wash the bottle and used of BPA-free drinking bottle.

When acidity and alkalinity water or beverage had been put in the bottle, the BPA leaching from the surface of the bottle into the water could be increase. The high temperature of water or boil water in bottle can give higher risk of leaching. The good condition of bottle was around 6 month of usage then the bottle must be changed in

order to reduce the exposure of BPA. The usage of detergent with sponge or brush when washed the bottle also could caused cracking surface of bottle and increased the potential of BPA leaching into the water. The usage of BPA-free bottle could reduced the exposure of BPA but some other factors must be taking into consideration while using this type of bottle because it could come with other exposure like bacterial infection from unhygienic condition of bottle.

3.9 Statistical Analysis

All data were analyzed using SPSS Version 19.0. Descriptive analysis was used to describe socio-demographic and background of the respondents. Statistical comparison analyses were using Pearson Chi-square and Mann Whitney-U and the appropriateness of the normality distribution type of data. Spearman Rho used to determine the association between groups in this study. The significant level was set at p value <0.05.

3.10 Quality control

Pre testing questionnaire was distributed randomly to 15 students from Faculty of Environmental to ensure the understanding and the comprehensiveness of questions that would be asked to actual respondents. The students were guided and briefed by researcher herself to minimize any biases that could arise.

3.11 Study Ethics

The approval was obtained from Medical Researcher Ethic Committee, UPM (Appendix 5). All information about the respondents was confidential. Written consent will be obtained from the respondents prior to the study. Respondent's consent and information sheet can be found in Appendix 6 and Appendix 7 respectively.

CHAPTER 4

RESULT

4.1 Study background

The study was purposely to obtain the knowledge of BPA and practice of polycarbonate drinking bottle among students of UPM. One from 9 science based faculty and one from 7 non-science based faculty were randomly chosen to be the representative faculty in this study. Science based faculty represented by Faculty of Medicine and Health Sciences while non-science based faculty represented by Faculty of Economic and Management. This cross sectional study was conducted among 149 respondents, 75 from science based and 74 students from non-sciences based faculty. The target population could not achieve two hundreds and six respondents because they were purposely recruited from each selected faculty among those who used polycarbonate drinking bottle.

4.2 Socio-demographic of the Respondents

The total respondents from science based and non-science based faculty were almost equal in proportion. Majority of the respondent was female (91.9%) and Malay (61.7%). All respondents were purposely recruited from every course and every batch from first year until final year of selected faculty. The demographic data comparing between two groups were presented in Table 1.

Table 1 Socio-demographic information of respondents (N=149).

Variables	Science based (n=75)		Non-science based (n=74)	
	Frequency	(%)	Frequency	(%)
Course				
BSc(Occupational & Environmental	13	(8.7)	-	-
Health)	10	(6.7)	-	-
BSc(Biomedic)	21	(14.1)	-	-
BSc(Nutrition)	22	(14.8)	-	-
BSc(Dietetic)	9	(6)	-	-
MD(Medical Doctor)	-	-	28	(18.8)
BA(Account)	-	-	32	(21.5)
BA(Business)	-	-	14	(9.4)
BA(Economic)				
Batch(year)				
1st	16	(21.3)	18	(24.3)
2nd	15	(20)	21	(28.4)
3rd	15	(20)	20	(27)
4thv	29	(38.7)	15	(20.3)
Gender				
Male	6	(8)	6	(8)
Female	69	(92)	68	(91.9)
Races				
Malay	43	(57.3)	49	(66.2)
Non-malay	32	(42.7)	25	(33.8)

4.3 Respondent's knowledge of BPA

This section comprises 10 questions on the respondent's knowledge on BPA relating to polycarbonate drinking bottle. The knowledge part consists of questions regarding type of drinking bottle and items relating symbols on plastic container, BPA and BPA-free drinking bottle, the product that contained BPA and the health effects regarding BPA exposure to human. The total score of knowledge on BPA was 10 which could be ranked as "good" score, 8-10 (> 75%), scored 5-7 (> 50%) as "fair", and scored 0-4 (< 50%) as "poor". The frequency of knowledge score was shown in Figure 2 and it indicate that almost 68% of the respondents had poor knowledge score on BPA. However, the science based students showed better score (11%) as compared to non-science based students.

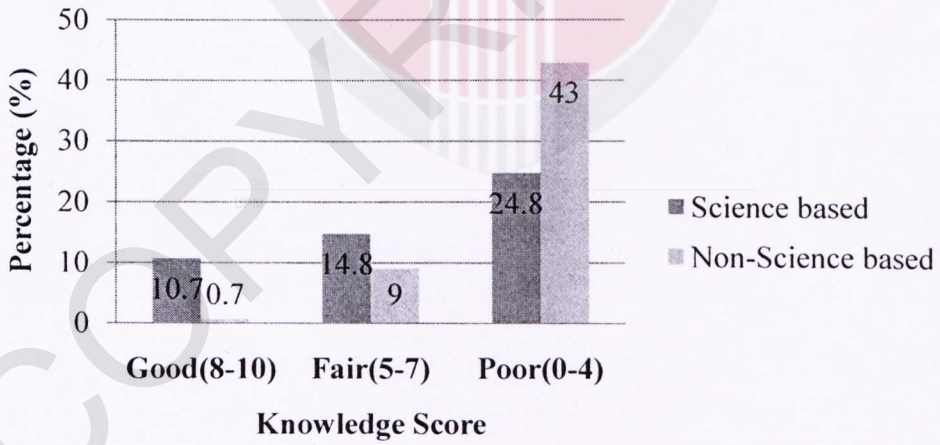

Figure 2 Knowledge Score between science based and non-science based

4.4 Respondent's practice on using polycarbonate drinking bottle

This section comprises 9 questions on the respondent's practice on polycarbonate drinking bottle. The practice part asked questions such as the duration of respondents using their current drinking bottle, whether they have changed the bottle before, do they put acidic water, alkaline water and boiled water into the bottle, how they wash the bottle and used of BPA-free drinking bottle. Respondents who scored 0-4 (> 75%) were ranked as "good", scored 5-6 (> 50%) as "fair", and score 7-9 (< 50%) as "poor". The frequency of practice score shown in Figure 3 showed that about 78% of all respondents had good practice in using their drinking bottle in the correct way.

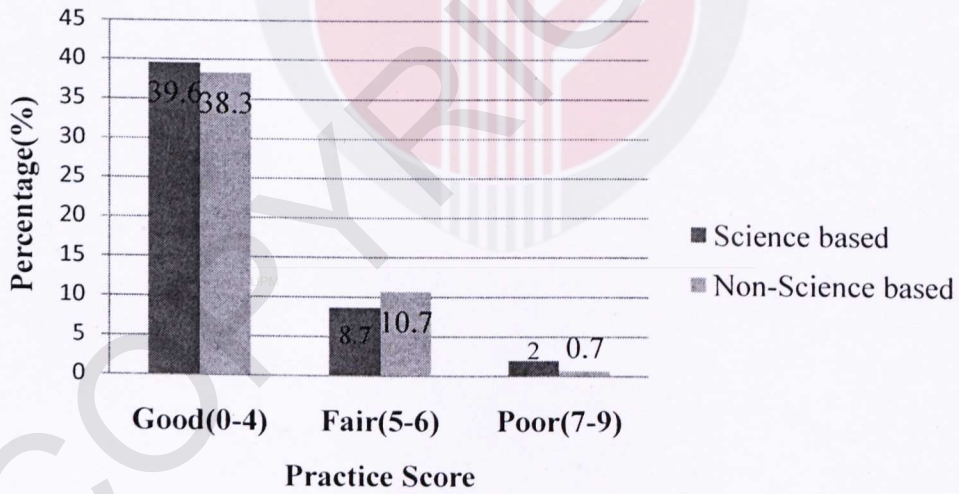

Figure 3 Practice Score between science based and non-science based

4.5 Association between knowledge of BPA and practices of using polycarbonate drinking bottle.

Spearman's rho was performed to analyze the continuous data and Chi-Square test was used to analyze categorical data between knowledge on BPA and the practices of using polycarbonate drinking bottle. Figure 4 showed that there were no significant associations between the knowledge of BPA and practices of using polycarbonate drinking bottle among science based and no-science based students.

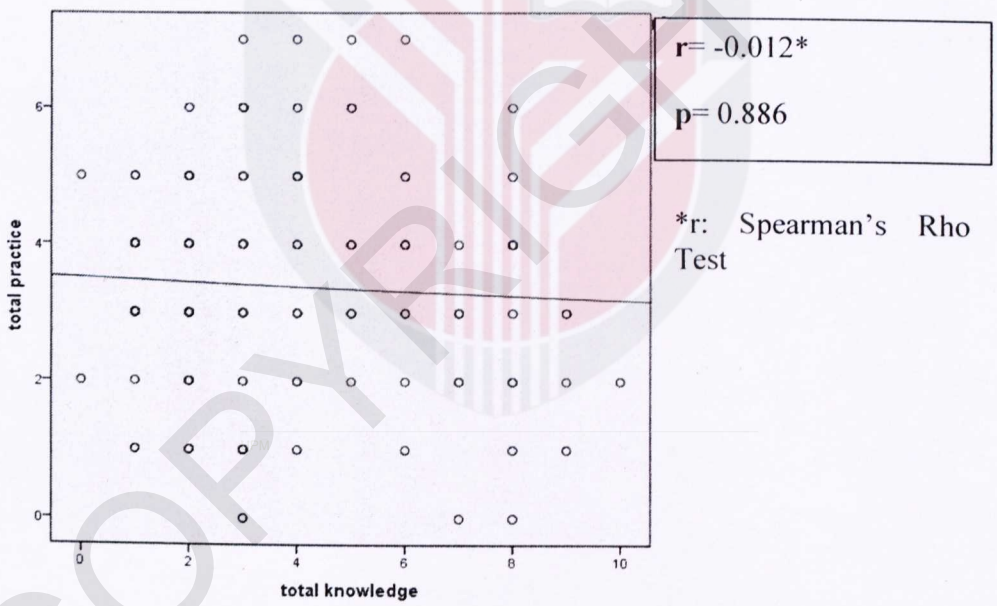

Figure 4 Association between knowledge on BPA and practice of using polycarbonate drinking bottle

4.6 Comparison of knowledge on BPA and practice of using polycarbonate drinking bottle between science based and non-science based students.

Mann-Whitney U test was performed to analyze the continuous data of knowledge of BPA and practices and Chi-Square test was used to analyze categorical data of knowledge of BPA and practices to compare the knowledge of BPA and practices of using polycarbonate drinking bottle between science based and non-science based students at UPM. Table 2 showed that there was significant difference in knowledge relating to BPA ($Z= -5.322$, $p<0.0001$), ($X^2= 25.899$, $p<0.0001$) but there was no significant difference in practices of using polycarbonate drinking bottle between science based and non-science based students.

4.7 Association between gender and knowledge of BPA

Chi Square test was used to determine the association between the gender of the respondents and knowledge on BPA among science based and non sciences based student. Table 3 showed that there was no significant association between the gender and knowledge of BPA among respondents.

Table 2 Comparison of knowledge and practice between science based and non-science based students of UPM (N=149)

Variable	Science based (n=75)			f(%)	Mean Rank	Non-science based (n=74)			f(%)	Mean Rank	Total(%)	Statistical Analysis
	Median	**IQR**	**Range**			**Median**	**IQR**	**Range**				
Knowledge (score)	5	4	1-10		93.47	2	2	0-8		56.28		Z= -5.322 p= <0.0001***
Good (8-10)				16(10.7)					1(0.7)		17(11.4)	
Fair (5-7)				22(14.8)					9(6)		31(20.8)	X^2 = 25.899
Poor (0-4)				37(24.8)					64(43)		101(67.8)	p= <0.0001***
Practice (score)	3	2	0-9		71.71	3	1	0-7		78.34		Z= -0.959 p= 0.338
Poor (7-9)				3(2)					1(0.7)		116(77.9)	
Fair (5-6)				13(8.7)					16(10.7)		29(19.5)	X^2= 1.338
Good (1-4)				59(39.6)					57(38.3)		4(2.7)	p= 0.512

Z: Mann -Whitney U test

X^2 :Chi Square test ***significant at p<0.001

Table 3 Association between gender and knowledge of BPA (N=149)

Sosio-demographic	Knowledge			X^2	P
	Good	Fair	Poor		
Gender				1.392	0.499
Male	2	1	9		
Female	15	30	92		
Total	17	31	101		

X^2: Pearson Chi-Square

4.8 Association between races and knowledge of BPA

Chi Square test was used to determine the association between races of respondents and knowledge on BPA among science based and non-science based students. Table 4 showed that there was no significant association between races and knowledge of BPA among respondents.

Table 4 Association between races and knowledge of BPA (N=149)

Sosio-demographic	Knowledge			X^2	P
	Good	Fair	Poor		
Races				3.760	0.153
Malay	14	17	61		
Non Malay	3	14	40		
Total	17	31	101		

x^2: Pearson Chi-Square

4.9 Association between age and knowledge of BPA

Chi-Square test was used to analyze categorical data while Spearman's rho was used to analyze continuous data between age of respondents and knowledge of BPA. Table 5 and Table 6 indicated that there were no significant associations between age and knowledge of BPA among respondents.

Table 5 Association between age and knowledge of BPA (N=149)

Sosio-demographic	Knowledge			X^2	P
	Good	Fair	Poor		
Age				5.343	0.069
19-21	4	18	49		
22-24	13	13	52		
Total	17	31	101		

x^2: Pearson Chi-Square

Table 6 Association between age and knowledge of BPA (N=149)

Sosio-demographic	Knowledge	
	r	p
Age (years)	0.091	0.269

r :Spearmen's rho

4.10 Association between gender and practice of using polycarbonate drinking bottle.

Chi Square test was performed to determine the association between gender and practices of using polycarbonate drinking bottle among science based and non-science based students. Table 7 showed that there was no significant association between gender and practices of using polycarbonate drinking bottle among respondents.

Table 7 Association between gender and practice of using polycarbonate drinking bottle (N=149)

Sosio-demographic	Practice			X^2	P
	Good	Fair	Poor		
Gender				3.713	0.516
Male	12	0	0		
Female	104	29	4		
Total	116	29	4		

x^2: Pearson Chi-Square

4.11 Association between races and practice of using polycarbonate drinking bottle.

Chi Square test was performed to determine the association between races and practice of using polycarbonate drinking bottle among science based and non-science

based students. Table 8 showed that there was no significant association between races and practices of using polycarbonate drinking bottle among respondents.

Table 8 Association between races and practice of using polycarbonate drinking bottle (N=149)

Sosio-demographic	Practice			X^2	P
	Good	Fair	Poor		
Races					
Malay	71	19	2	0.423	0.810
Non Malay	45	10	2		
Total	116	29	4		

x^2: Pearson Chi-Square

4.12 Association between age and practice of using polycarbonate drinking bottle.

Chi-Square test was used to analyze categorical data while Spearman's rho was used to analyze continuous data between age of respondents and practice of using polycarbonate drinking bottle. Table 9 and Table 10 indicated that there were no significant associations between age and practice of using polycarbonate drinking bottle among respondents.

Table 9 Association between age and practice of using polycarbonate drinking bottle (N=149)

Sosio-demographic	Practice			X^2	P
	Good	Fair	Poor		
Age (years)				0.016	0.992
19-21	55	14	2		
22-24	61	15	2		
Total	116	29	4		

x^2: Pearson Chi-Square

Table 10 Association between age and practice of using polycarbonate drinking bottle (N=149)

Sosio-demographic	Practice	
	r	p
Age (years)	0.048	0.562

r :Spearmen's rho

CHAPTER 5

DISCUSSION, CONCLUSION, RECOMMENDATION

5.1 Discussion

5.1.1 Socio-demographic of respondents

The total respondents from science based and non-science based faculties were almost equal in proportion. Majority of the respondent was female and Malay. This condition was due to currently populations of female students in higher education institutions were greater than male student. Generally, female students in secondary schools outperformed male students resulting in more female students getting a place in undergraduate studies in the IPTA (Idris, 2008). Furthermore, based classification of levels of intellectual behavior important in learning, girls tend to do better academically because they have better cognitive abilities while boys have better psychomotor skills (Bloom, 1956). According to racial composition, 27,829 of students in IPTA were

bumiputera, 10,116 are Chinese and the remaining 2,421 comprise the Indians and others (M. Khuzairi, 2010).

5.1.2 Comparison on knowledge of BPA between science based and non-science based students.

Generally, almost 68% of all respondents had poor knowledge on BPA. About 83% of the respondents did not know the products contain BPA while 85% of them did not know the health effect of BPA exposure to human body. About 75% of the respondents did not notice symbols on plastic containers and 64% of them never heard about BPA-free drinking bottle. Previous study of a quite similar study was done by Kasemsup (2011) which compare the knowledge and practice of plastic container between health personnel and parents showed the similar result which the majority of the respondent's knowledge was inadequate. However, in this study, it was found that science based students were more knowledgeable as compared to non-science based students. As revealed from the questionnaire, most of science based students learnt about BPA in health sciences class while for non-science based, they obtained the information via mass media such as television, internet and newspapers.

5.1.3 Comparison of the practices and risk of BPA exposure relating to usage of polycarbonate drinking bottle between sciences based and non-science based students.

With regards of practice of using polycarbonate drinking bottle, the study showed that there was no significant difference between these two groups. About 78% of the respondents revealed good practice on how they used drinking bottle correctly. However, some inappropriate practices were reported among respondents such as brushing the bottle while washing (64%), duration of used the bottle for more than 6 months, do not change the bottle from average 6 month to 6 years (66%) and did not use BPA-free bottle (72%). Even though these factors were expected to increase the risk of BPA exposure, other factors such as high temperatures, acidic, and alkali solutions as well as repeated washing the bottle were took into concern (Onn Wong et al., 2005; Le et al., 2008.; Brede et al., 2003). However, the result on practice obtained from similar study by Kasemsup (2011) contradicted with the present study. It was found that the respondents had practice on using plastic container in an inappropriate way and the knowledge on plastic container was also inadequate. The risk of BPA was reflected from practicing polycarbonate drinking bottle. Majority of respondents revealed good practice on how they used drinking bottle correctly, so, the risk of BPA exposure was also low among respondents. The exposure to BPA can be decreased by avoiding canned food and polycarbonate plastic containers unless the packaging indicates the plastic is BPA-free (Ashley Ahearn, 2008).

5.1.4 Association between the knowledge on BPA and the practice of using polycarbonate drinking bottle among science based and non-science based students.

There was no significant association between knowledge of BPA and practices of polycarbonate drinking bottle among respondents. It showed that knowledge of BPA level did not influence the practice of using polycarbonate drinking bottle. There was no previous study relating to knowledge of BPA and practice of using polycarbonate drinking bottle had been conducted. However, the result from the previous study which was quite similar study from Kasemsup (2011), parents and health personnel were aware on the health effects of plastic containers, but they do not know how to use and purchase plastics properly. The result obtained supported this study which the knowledge of BPA was not reflected on how they were practice on using polycarbonate drinking bottle.

5.1.5 Association between socio-demographic with knowledge on BPA and practice of using polycarbonate drinking bottle among science based and non-science based students.

The factors that had been considered in socio-demographic information were age, gender, races and batch. There was no significant association between gender, age and races with knowledge on BPA and practice of using polycarbonate drinking bottle. There was no previous study on the association of socio-demographic with knowledge

on BPA and practice of using polycarbonate drinking bottle. As this study was the first study conducted in Malaysia, the researcher would like to know whether there was association between the knowledge on BPA and practice of using polycarbonate drinking bottle. However, age, gender, races and batch were identified do not had association between of these two variables. The limitation of study population which targeted students in UPM as the respondents might be as one of the reason why there were no differences between variables.

5.2 Conclusion

This study evaluated the knowledge and practice of BPA relating to usage of polycarbonate drinking bottle among UPM students. This study found that most of the students had poor knowledge on BPA but science based students have better understanding on BPA as compared to non-science based students. Even though the students have poor knowledge on BPA, they were able to show proper and appropriate way in using the drinking bottle. It may conclude that the knowledge did not influence the practice of using polycarbonate drinking bottle. With regards to knowledge and practice of BPA relating to usage of polycarbonate drinking bottle, the research was only focused on students. So, there was no much difference of the result obtained after conducting this research. For the next time research, maybe it can be expended to other group such as staff, employer, or lecturers to determine the knowledge and practice

about the similar study. However, an appropriate method need to be use as there might have challenge regarding time consuming in order to obtain the information from them.

The finding of this preliminary data on knowledge of BPA was quite alarming as majority of the respondents with higher education level do not know about BPA which might lead to negative health effects to human. It was a good start on research relating to BPA conducting in UPM where the result obtained could illustrated on how the knowledge and awareness of this issue to the community. It was essential to monitor BPA exposure level of the respondents to obtain the evidence which could relate with the practice of using polycarbonate drinking bottle in this study.

5.3 Recommendation

For the recommendation, concern of knowledge on chemical that can give adverse health effect to body should be raised among students and public. Students and public awareness of improper plastic uses should be raised, knowledge relating to purchasing and using plastic containers for food and drinks should be distributed to the public. As the researchers have found out that BPA can leach in the bottle contents through normal wear, it is recommended that the bottle must not expose to heat by avoiding to pour hot water directly into the bottle, avoid cleansing agents, brushing by using appropriate cleaning utensils such as soft sponge, avoid scratching the surface of the bottle, do not put alkaline water and acidic water into the bottle. BPA-free bottle are

usually labeled as "BPA- free or BPA 0%" is also important to look for when choosing polycarbonate plastic container.

Recycling number stated on the bottle must be check first especially before buying any plastics container. If it is stated number 2 which is HDPE (high density polyethylene), or number 4 which is LDPE (low density polyethylene), or number 5 which is PP (polypropylene), the bottle is fine. The type of plastic bottle number 1 which is PET (polyethylene terephtalates) usually uses for mineral drinking bottle is only recommended for one time use and it is advisable do not refill it. It is better to use a reusable water bottle, fill it with our own filtered water from home and keep these single-use bottles out of the landfill.

For food and drinking bottle number 3 which is PVC (polyvinyl chloride) are at risk of releasing toxic breakdown products like phthalates into food and drink. Also, the manufacturing of PVC is known to release highly toxic dioxins into the environment. As plastic container number 6 which is PS (polystyrene) for example cups which, when heated can release potentially toxic breakdown products like styrene into coffee or tea. Therefore, there are several alternative drinking bottles in the market made from number 2 (HDPE), number 4 (LDPE), number 5 (PP) as well as glass steel or glass bottle was preferred and it cost about the same as a polycarbonate bottle.

Moreover, the researcher also would like to conduct biological monitoring to reveal the information and evidence to support the results obtained from practice of using polycarbonate drinking bottle among the respondents. The concerns regarding its exposure should be raised especially among infants and toddlers because BPA is composed in baby bottles. Furthermore, if looking at the community nowadays, children brought drinking bottle to school. Based on the previous research, even parents and health personnel did not really know about BPA and they practicing plastic container in an inappropriate way. This condition can affect their children in increasing BPA exposure level in body. Children were highlighted as the highest concentration group of BPA exposure level hence, the researcher would likes to conduct biological monitoring among school children in Malaysia for further study.

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APPENDIX 1

American Chemistry Council

Plastic Packaging Resins

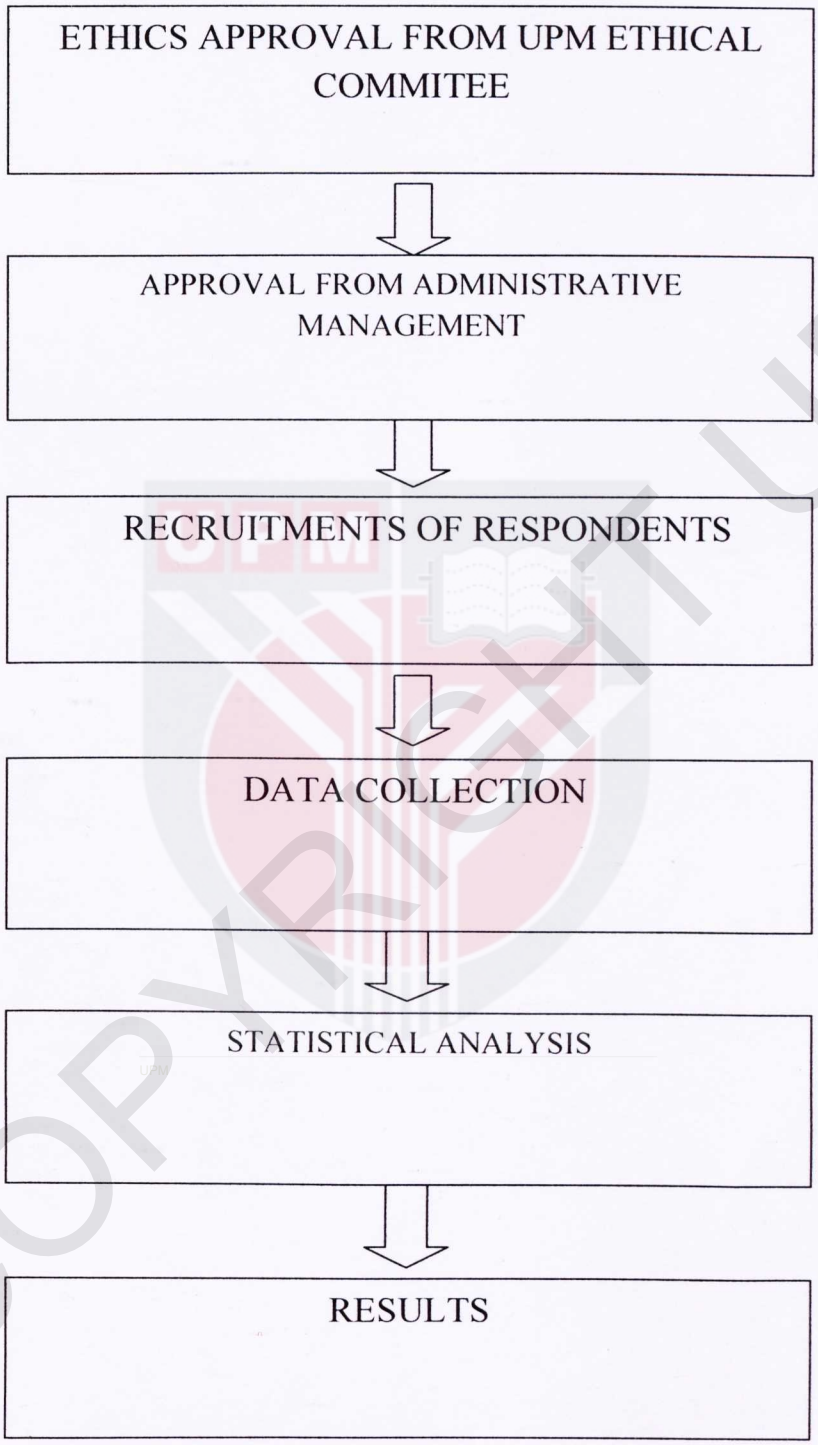
Resin Codes	Descriptions	Properties	Product Applications	Products Made with Recycled Content*
1 PET	**Polyethylene Terephthalate (PET, PETE).** PET is clear, tough, and has good gas and moisture barrier properties. This resin is commonly used in beverage bottles and many injection-molded consumer product containers. Cleaned, recycled PET flakes and pellets are in great demand for spinning fiber for carpet yarns, producing fiberfill and geo-textiles. Nickname: Polyester.	• Clear and optically smooth surfaces for oriented films and bottles • Excellent barrier to oxygen, water, and carbon dioxide • High impact capability and shatter resistance • Excellent resistance to most solvents • Capability for hot-filling	Plastic bottles for soft drinks, water, juice, sports drinks, beer, mouthwash, catsup and salad dressing. Food jars for peanut butter, jelly, jam and pickles. Ovenable film and microwavable food trays. In addition to packaging, PET's major uses are textiles, monofilament, carpet, strapping, films, and engineering moldings.	Fiber for carpet, fleece jackets, comforter fill, and tote bags. Containers for food, beverages (bottles), and non-food items. Film and sheet. Strapping.
2 HDPE	**High Density Polyethylene (HDPE).** HDPE is used to make many types of bottles. Unpigmented bottles are translucent, have good barrier properties and stiffness, and are well suited to packaging products with a short shelf life such as milk. Because HDPE has good chemical resistance, it is used for packaging many household and industrial chemicals such as detergents and bleach. Pigmented HDPE bottles have better stress crack resistance than unpigmented HDPE.	• Excellent resistance to most solvents • Higher tensile strength compared to other forms of polyethylene • Relatively stiff material with useful temperature capabilities	Bottles for milk, water, juice, cosmetics, shampoo, dish and laundry detergents, and household cleaners. Bags for groceries and retail purchases. Cereal box liners. Reusable shipping containers. In addition to packaging, HDPE's major uses are in injection molding applications, extruded pipe and conduit, plastic wood composites, and wire and cable covering.	Bottles for non-food items, such as shampoo, conditioner, liquid laundry detergent, household cleaners, motor oil and antifreeze. Plastic lumber for outdoor decking, fencing and picnic tables. Pipe, floor tiles, buckets, crates, flower pots, garden edging, film and sheet, and recycling bins.

Resin Codes	Descriptions	Properties	Product Applications	Products Made with Recycled Content*
	**Polyvinyl Chloride (PVC, Vinyl).** In addition to its stable physical properties, PVC has good chemical resistance, weatherability, flow characteristics and stable electrical properties. The diverse slate of vinyl products can be broadly divided into rigid and flexible materials.	• High impact strength, brilliant clarity, excellent processing performance • Resistance to grease, oil and chemicals	Rigid packaging applications include blister packs and clamshells. Flexible packaging uses include bags for bedding and medical, shrink wrap, deli and meet wrap and tamper resistance. In addition to packaging, PVC's major uses are rigid applications such as pipe, siding, window frames, fencing, decking and railing. Flexible applications include medical products such as blood bags and medical tubing, wire and cable insulation, carpet backing, and flooring.	Pipe, decking, fencing, paneling, gutters, carpet backing, floor tiles and mats, resilient flooring, mud flaps, cassette trays, electrical boxes, cables, traffic cones, garden hose, and mobile home skirting. Packaging, film and sheet, and loose-leaf binders.
	**Low Density Polyethylene (LDPE).** LDPE is used predominately in film applications due to its toughness, flexibility and relative transparency, making it popular for use in applications where heat sealing is necessary. LDPE also is used to manufacture some flexible lids and bottles as well as in wire and cable applications. Includes Linear Low Density Polyethylene (LLDPE).	• Excellent resistance to acids, bases and vegetable oils • Toughness, flexibility and relative transparency (good combination of properties for packaging applications requiring heat-sealing)	Bags for dry cleaning, newspapers, bread, frozen foods, fresh produce, and household garbage. Shrink wrap and stretch film. Coatings for paper milk cartons and hot and cold beverage cups. Container lids. Toys. Squeezable bottles (e.g., honey and mustard). In addition to packaging, LDPE's major uses are in injection molding applications, adhesives and sealants, and wire and cable coverings.	Shipping envelopes, garbage can liners, floor tile, paneling, furniture, film and sheet, compost bins, trash cans, landscape timber, and outdoor lumber.
	**Polypropylene (PP).** PP has good chemical resistance, is strong, and has a high melting point making it good for hot-fill liquids. This resin is found in flexible and rigid packaging, fibers, and large molded parts for automotive and consumer products.	• Excellent optical clarity in biaxially oriented films and stretch blow molded containers • Low moisture vapor transmission • Inertness toward	Containers for yogurt, margarine, takeout meals, and deli foods. Medicine bottles. Bottle caps and closures. Bottles for catsup and syrup. In addition to packaging, PP's major uses are in fibers, appliances and	Automobile applications, such as battery cases, signal lights, battery cables, brooms and brushes, ice scrapers, oil funnels, and bicycle racks. Garden rakes, storage bins, shipping pallets, sheeting, trays.

Resin Codes	Descriptions	Properties	Product Applications	Products Made with Recycled Content*
		acids, alkalis and most solvents	consumer products, including durable applications such as automotive and carpeting.	
	**Polystyrene (PS).** PS is a versatile plastic that can be rigid or foamed. General purpose polystyrene is clear, hard and brittle. It has a relatively low melting point. Typical applications include protective packaging, foodservice packaging, bottles, and food containers. PS is often combined with rubber to make high impact polystyrene (HIPS) which is used for packaging and durable applications requiring toughness, but not clarity.	• Excellent moisture barrier for short shelf life products • Excellent optical clarity in general purpose form • Significant stiffness in both foamed and rigid forms. • Low density and high stiffness in foamed applications • Low thermal conductivity and excellent insulation properties in foamed form	Food service items, such as cups, plates, bowls, cutlery, hinged takeout containers (clamshells), meat and poultry trays, and rigid food containers (e.g., yogurt). These items may be made with foamed or non-foamed PS. Protective foam packaging for furniture, electronics and other delicate items. Packing peanuts, known as "loose fill." Compact disc cases and aspirin bottles. In addition to packaging, PS's major uses are in agricultural trays, electronic housings, cable spools, building insulation, video cassette cartridges, coat hangers, and medical products and toys.	Thermal insulation, thermometers, light switch plates, vents, desk trays, rulers, and license plate frames. Cameras or video cassette casings. Foamed foodservice applications, such as egg shell cartons. Plastic mouldings (i.e., wood replacement products). Expandable polystyrene (EPS) foam protective packaging.
	**Other.** Use of this code indicates that a package is made with a resin other than the six listed above, or is made of more than one resin and used in a multi-layer combination.	Dependent on resin or combination of resins	Three- and five-gallon reusable water bottles, some citrus juice and catsup bottles. Oven-baking bags, barrier layers, and custom packaging.	Bottles and plastic lumber applications.

***Recycling may not be available in all areas. Check to see if plastics recycling is available in your community.**

APPENDIX 2



Flow chart on how the process of data collection

APPENDIX 3

Activities	2011				2012					
	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Selection of topic	/									
Proposal draft writing	/	/								
Submission of proposal draft		/								
Presentation of proposal			/							
Preparation of equipment			/	/						
Submission proposal to Ethic Committee			/							
Follow up permission letter			/	/						
Approve from Ethic Committee				/						
Data collection					/	/				
Analyses of data						/	/			
Submission of first draft							/	/		
Submission of second draft and thesis summary								/		
Submission full thesis									/	/
Poster presentation, seminar and oral exam									/	/

Gannt Chart

APPENDIX 4

Respondent ID: _____

ENVIRONMENTAL AND OCCUPATIONAL HEALTH UNIT
DEPARTMENT OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH
FACULTY OF MEDICINE AND HEALTH SCIENCES
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG, SELANGOR

Questionnaire

TITLE: KNOWLEDGE AND PRACTICES OF BISPHENOL A (BPA) RELATING TO USAGE OF POLYCARBONATE DRINKING BOTTLE

Information: This study aims to determine knowledge and practices of BPA relating to usage of polycarbonate drinking bottle among UPM students. Luckily, you have been selected to be a respondent in this study. Please give accurate and correct information. All information provided will be used for research purposes only. Thank you for your cooperation and kindness.

Respondent ID: _____

Date: _____

CONFIDENTIAL

For research purpose only

Respondent ID: _____

PART A: BACKGROUND INFORMATION

Please (/) tick the appropriate answer and fill the blank where necessary.

1. Name: _____

2. Faculty: _____

3. Course: _____

4. Batch:
   a) 1st year ☐
   b) 2nd year ☐
   c) 3rd year ☐
   d) 4th year ☐

5. Age: _____

6. Gender :
   a) Male ☐
   b) Female ☐

7. Races :
   a) Malay ☐
   b) Chinese ☐
   c) Indian ☐
   d) Others ☐ Please specify: _____

Respondent ID: _____

PART B: GENERAL KNOWLEDGE

Please (/) tick the appropriate answer and fill the blank where necessary

1. What type of drinking bottle that you use?
   a) Polyethylene Terephthalate (PET) ☐
   b) High Density Polyethylene (HDPE) ☐
   c) Polyvinyl Chloride (PVC,Vinyl) ☐
   d) Low Density Polyethylene (LDPE) ☐
   e) Propylene (PP) ☐
   f) Polystyrene (PS) ☐
   g) Others(Polycarbonate) ☐
   h) Do not know ☐

2. Do you know what a resin code is?
   a) No ☐
   b) Yes ☐

3. Do you know where you can find resin codes?
   a) No
   b) Yes. If yes, please specify: _____

4. Have you ever heard about Bisphenol A (BPA)?
   a) No ☐
   b) Yes ☐ If yes, where do you get the information from? _____

5. Do you know what product contain Bisphenol A (BPA)?
   a) No ☐
   b) Yes ☐ If yes, please state the product: _____

Respondent ID: _____

6. Please tick (/) the product that you think may contain Bisphenol A (BPA).

No.	Item	Yes	No
i.	Baby bottle		
ii.	Polycarbonate plastics		
iii.	Canned food		
iv.	Medical equipment		
v.	Lotion		
vi.	Shampoo		
vii.	Pen		
viii.	Paper		

7. Do you know any effect regarding Bisphenol A (BPA) exposure on human health?
   a) No ☐
   b) Yes ☐ If yes, please indicate the effect: _____

8. For the target system listed below, which system do you think affected by Bisphenol A exposure? Please tick (/) your choice of answer.

No.	Target system	
i.	Reproductive	
ii.	Liver	
iii.	Hematological	
iv.	Developmental	
v.	Renal	
vi.	Musculoskeletal	
vii.	Urinary	

9. Will you minimize the using of product contain Bisphenol A (BPA) that you will use frequently in you daily lives if you know that it can affect human health?
   a) No ☐
   b) Yes ☐

10. Have you heard about BPA free drinking bottle?
   a) No ☐
   b) Yes ☐

PART C: PRACTICES OF USING POLYCARBONATE DRINKING BOTTLE

Please (/) tick the appropriate answer and fill in the blank where necessary

1. Information of drinking bottle use.
   a) Type of resin code _____
   b) Volume of water (ml) _____
   c) Color of bottle _____
2. How long do you use this drinking bottle?
   a) < 6 month ☐ Please state the exact duration: _____
   b) > 6 month ☐ Please state the exact duration: _____
3. Have you ever changed this drinking bottle?
   a) No ☐
   b) Yes ☐ If yes, please choose your answer below.
      i. In 6 month ☐
      ii. In 1 year ☐
      iii. More than 1 year ☐ Please state: _____

Respondent ID: _____

4. Have you put any acidic water/beverages in this bottle?

   a) No ☐

   b) Yes ☐ If yes, please state the type of water: _____

5. Have you put any alkaline water/ beverages in this bottle?

   a) No ☐

   b) Yes ☐ If yes, please state the type of water: _____

6. Have you put the boil/hot water into this bottle?

   a) No ☐

   b) Yes ☐

7. Have you washed your drinking bottle?

   a) No ☐

   b) Yes ☐ If yes, please choose your answer below:

      i. How frequent do you wash your bottle?

         Everyday ☐

         Once a month ☐

         Once a week ☐

         Seldom ☐

      ii. How do you wash your bottle?

         Using hot water ☐

         Using detergents ☐

         Using tap water ☐

         Others ☐ Please state: _____

iii. Do you use brush/ sponge while washing the bottle?

No ☐

Yes ☐

8. Are you aware of BPA free statement at the bottle that you use or when you buy drinking bottle?

a) No ☐

b) Yes ☐

9. Are you use BPA free drinking bottle?

a) No ☐

b) Yes ☐

Are you interested to know the finding of this survey?

a) No ☐

b) Yes ☐ *Please indicate you phone number and email address*

Phone number: _____

Email address: _____

The End

~Thank You for your cooperation~

Have A Nice Day!!!

APPENDIX 5

APPENDIX 6

FAKULTI PERUBATAN DAN SAINS KESIHATAN
FACULTY OF MEDICINE AND HEALTH SCIENCES
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA

BORANG PERSETUJUAN RESPONDEN

TAJUK KAJIAN: KNOWLEDGE AND PRACTICES OF BISPHENOL A (BPA) RELATING TO USAGE OF POLYCARBONATE DRINKING BOTTLE

PENYELIDIK : NURUL KHAIRUNISA BT MANSOR

Saya ..... No.K/P: .....
alamat.....
. .....dengan ini secara sukarela bersetuju untuk mengambil bahagian dalam penyelidikan yang dinyatakan di atas. Saya telah dimaklumkan mengenai latar belakang penyelidikan ini dari segi kaedah, kemungkinan kesan buruk dan komplikasi(rujuk kepada risalah maklumat). Saya faham bahawa saya mempunyai hak untuk menarik diri dari kajian ini pada bila-bila masa tanpa memberikan apa jua sebab. Saya juga faham bahawa kajian ini adalah sulit dan semua maklumat yang diberikan mengenai identiti saya adalah sulit dan persendirian.

Saya ingin *tahu/tidak ingin mengetahui keputusan ujian yang dijalankan ke atas sampel saya.

* potong mana yang tidak berkaitan

Tandatangan ..... Tandatangan.....
(*Responden*) *(Saksi)*

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

No. K/P:.....

Saya mengesahkan bahawa saya telah menjelaskan kepada responden latar belakang dan tujuan penyelidikan di atas.

Tarikh ..... Tandatangan.....
(Penyelidik)

APPENDIX 7

FAKULTI PERUBATAN DAN SAINS KESIHATAN
FACULTY OF MEDICINE AND HEALTH SCIENCES
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA

RESPONDENT'S INFORMATION:Please read the following information carefully, do not hesitate to discuss any questions you may have with your researcher.

STUDY TITLE : KNOWLEDGE AND PRACTICES OF BISPHENOL A (BPA) RELATING TO USAGE OF POLYCARBONATE DRINKING BOTTLE

Researcher: Nurul Khairunisa bt Mansor

INTRODUCTION :

BPA is used as an ingredient to produce polycarbonate plastic and epoxy resins. These materials are used in a variety of products including baby feeding bottles, microwave ovenware and inner coatings of cans for food and beverages.BPA is known to have a weak oestrogenic activity and thus might have an impact on the endocrine system of humans. Low levels of BPA have also been reported to cause biological effects and its mode of action appears to mimic that of the female hormone, estrogen and is therefore classified as an endocrine-disrupting chemical. This study evaluated the knowledge of BPA and the practice of using polycarbonate drinking bottle among UPM students.

WHAT WILL YOU HAVE TO DO?

You need to sign the respondent consent form that show you are interested in this study.It can be done after you are finished read and understanding the contain of this sheet.This form need to be returned to the researcher before the test is conducted.

WHAT WILL BE BENEFITS OF THE STUDY:

(a) TO YOU AS THE SUBJECT?

The benefits for the subject is he/she able to get more knowledge regarding the issues and this will helping them in order to create more awareness regarding the health and environment

b)TO THE INVESTIGATOR?

This research will give a chance to the reseacher to share knowledge and create awareness regarding the issues of human health and environment

ARE THERE ANY RISKS?

There is no risk that can effect the subject if they join the research

WILL THE INFORMATION AND MY IDENTITY REMAIN CONFIDENTIAL?

All the information and respondent's identity is remain confidential.

WHO SHOULD I CONTACT IF I HAVE ADDITIONAL QUESTIONS DURING THE COURSE OF THE RESEARCH?

If you need more information and have any problems you can contact the researcer and the researcher will help you .

Thanks you for your cooperation and kindness.

Nurul Khairunisa bt Mansor,
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Environmental and Occupational Health Unit,
Community Health Department,
Medicine and Health Sciences Faculty,
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