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Cross Sectional Study on the Knowledge, Attitude, and Awareness of Biomedical Waste Management Among Medical Students

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Abstract

A good knowledge, attitude, and awareness of biomedical waste management among medical students is very important since inappropriate disposal of waste can lead to transmit many communicable diseases and cause environmental pollution. This study aimed to determine the knowledge, attitude and awareness of management among medical students in Melaka Manipal Medical College. We collected data of 217 medical students in semester 6 and 7 in Melaka Manipal Medical College by distributing a questionnaire on knowledge, awareness and attitude of biomedical waste management. Data was analysed using the chi-square test. Among the participants 55.3% of medical students had good knowledge and 44.7% of them needed to improve their knowledge on biomedical waste management. 70.5% of medical students had a good attitude and 29.5% of participants needed to improve their attitude on biomedical waste management. There was no significant association between age, gender, ethnicity, semester and knowledge and attitudes towards biomedical waste management. However, students that attended class on biomedical waste management in India were 2.73 times more likely to have a good attitude compared to those who did not attend the class (P value 0.029). Also, Chinese ethnicity are 2.42 more likely to have a good attitude compared to the other ethnicities (P value 0.047). Most of the students had good knowledge and the majority of them had good attitudes towards biomedical waste management. The students who attended class on biomedical waste management had better attitudes compared to those who never attended. Therefore more classes should be conducted for biomedical waste management.

Keywords

Knowledge, Attitude, Medical Students, Biomedical Waste

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1. Introduction

Biomedical waste is any solid or liquid waste generated throughout diagnosis, treatment or immunisation of human beings and animals or during a research that may appear as a threat of infection to humans. [1]

There are different types of wastes in public health care centres. Of the total amount of waste generated by health-care activities, about 85% is general, non-hazardous waste comparable to domestic waste. The remaining 15% is considered hazardous material that may be infectious, chemical or radioactive. [2]

Infectious and non-infectious waste are separated at the point of generation. The infectious waste will be discarded into clearly identifiable containers or plastic bags that are leak proof and puncture-resistant and the containers shall be marked with the universal symbol for biological hazards.

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Non-infectious waste will be handled with good safety practice and any written law relating to handling of such waste. All hazardous waste shall be packaged, transferred and disposed in a manner where it is accepted by the relevant authority to protect both the society and the environment. [3]

In recent years, human activities and life routines and consumption patterns changes caused vast amounts of several kinds of wastes. Inadequate clinical waste management will lead to both health hazards and environmental contamination and pollution. [4] In the worldwide, it is observed that there is steady global increment of healthcare waste production. Biomedical waste production is increasing with availability of access to healthcare services. [5]

In Malaysia, incineration method is the main method of disposal for clinical waste. A lot of effort have been done by the government to put more incinerators. 3 more giant incinerators have been put in three of the states in Malaysia which are Melaka, Johor and Kuala Lumpur. General population has the misconception that incineration will put more harm than sterile landfills. Education and more exposure need to be done to the general population. [4]

Worldwide, in 2010, unsafe injections were responsible for 33,800 new HIV infections, 1.7 million hepatitis B infections and 315,000 hepatitis C infections worldwide. A person who experiences one needle stick injury from an infected needle has risks of 30%, 1.8%, and 0.3% respectively of being infected with HBV, HCV and HIV. [8] Department of Environment (DOE) of Malaysia has formulated the Waste Pollution Prevention and Control Law and/or the Regulations on the management of biomedical hazardous wastes. However, hospital waste is generally collected and disposed of together with other domestic waste on the basis of the guidelines provided. In some of the larger states, individual hospitals have installed on-site incinerators for the disposal of clinical wastes. [3]

All around, in absence of mindfulness, poor transfer instruments and deficient assets result in around 18 to 64 percent of unacceptable biomedical waste management facilities in healthcare centres. Improper disposal alludes to open dumping, open burning, and inappropriate treatment of waste during generation, assortment, stockpiling, transport and treatment. Improper handling includes unsafe procedures pursued during treatment of wastes for example without wearing defensive gear, poor stockpiling (high temp, high residence), shipping physically for longer distances, revealed or unloaded compartments rather than puncture proof bags, all of which impact healthcare workers in various ways. [7]

Excessive quantity of waste are generated at the centres of care due to rise in the procedures performed at various health care centres. [8] Bio-medical waste has a tremendous potential of infection and injury to the healthcare worker, patient and the surrounding community. [9] The waste generated from the medical activities are life threatening because of their high latency of disease transmission. Although biomedical waste constitutes a small fraction of total municipal waste generated but it proves to be highly dangerous for human beings if not treated in proper scientific manner, as improperly disposed biomedical waste may enter the food chain either by air or by soil and shows harmful effects in animals and humans. And also can lead to transmission of infections like human immunodeficiency virus, hepatitis B virus, hepatitis C virus, HIV and many more. [10]

The hazardous effect of medical waste on the society and environment is high if there is no adequate and appropriate handling of these wastes. [11] In Malaysia, a study was conducted at Hospital Batu Pahat, Johor among medical practitioners on the knowledge and awareness of clinical waste management. As medical students will play one of the important roles of the healthcare system, they should have adequate knowledge on biomedical waste management. Therefore, awareness on various aspects of biomedical waste management has to be monitored consistently. [12, 13] Hence, this study was conducted to assess the awareness regarding biomedical waste management among undergraduate medical students in Melaka Manipal Medical College.

1.1. Research Question

What is the level of knowledge, attitude and awareness regarding biomedical waste management among undergraduate medical students in Melaka Manipal Medical College?

1.2. Research Objective

1. To assess the knowledge and awareness of undergraduate medical students in Melaka Manipal Medical College on biomedical waste management.
2. To assess the attitude of undergraduate medical students in Melaka Manipal Medical College on biomedical waste management.
3. To assess the association between age, gender, semester, ethnicity, exposure to waste management and knowledge, attitude and awareness on biomedical waste management.

1.3. Research Hypothesis

1. There is association between age, gender, semester, ethnicity, exposure to waste management and knowledge, attitude and awareness on biomedical waste management.

2. Methodology

2.1. Study Design, Study Setting, Study Population and Study Time

The study design selected was a questionnaire-based cross sectional study on the knowledge, awareness and attitude of biomedical waste management among Melaka Manipal Medical College students. There are 3 programs offered in Melaka Manipal Medical College which are Foundation in Science, Bachelor of Medicine and Bachelor of Surgery (MBBS) and Bachelor of Dental Surgery (BDS) with a population of 750 students. In Bachelor of Medicine and Bachelor of Surgery (MBBS) program, there are five semesters in Melaka Manipal Medical College of Malaysia. Semester 8, 9 and 10 in Melaka campus while semester 6 and 7 in Muar campus. The study was conducted among medical students of semester 6 and 7 in their clinical years in Muar campus of Melaka Manipal Medical College of Malaysia. There are approximately 300 students in the Bachelor of Medicine and Bachelor of Surgery (MBBS) program in Muar campus. The duration of the research was 6 weeks from November 2019 to December 2019.

2.2. Sample Size

The sample size for this research was calculated using the application Epi Info™ 7. Screenshot of the calculation was shown below:

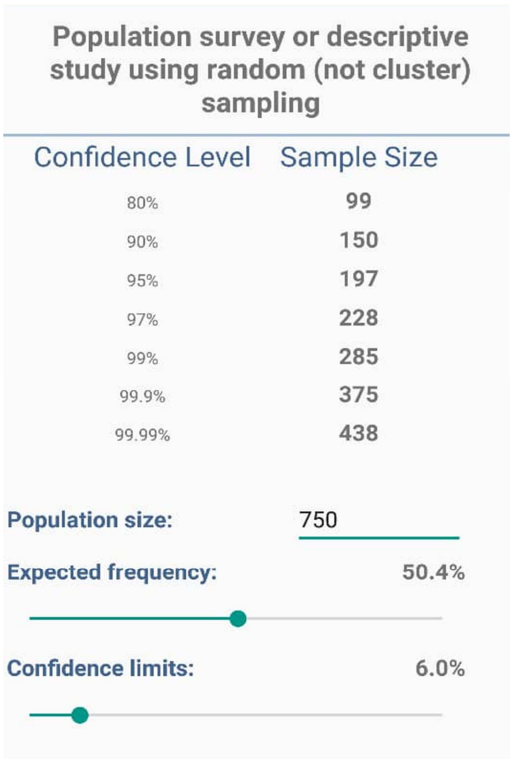

Figure 1. Sample size calculation by Epi Info ™ 7.

Where,

Population size: 750 students in Melaka Manipal Medical College of Malaysia

Expected Frequency: 50.4%, percentage of students had the knowledge on colour coding and segregation of the biomedical wastes [14]

Acceptable Margin of Error: 6.0%

Hence, based on the application Epi Info™ 7 we used the sample size of 197 for the minimum sample size according to the confidence level of 95%.

Minimum sample size needed: 197

The maximum percentage of non-response rate allowed in this research was 20%.

To allow for non-response, the final sample size was calculated using the formula below:

Non-response:

$$n_{final} = \frac{n_{calculated}}{1 - non - response\ (\%)}$$

$$n_{final} = \frac{197}{1 - 0.2}$$

$$n_{final} = \frac{197}{0.8}$$

$$n_{final} = 247$$

The minimum sample size collected was 197. The final calculation was done to include the non-response rate of 20%. Hence, the final sample size calculated for this study was 247 after rounding off.

2.3. Sampling

In this research, the sampling method used was a non-probability, purposive sampling method. For inclusion criteria, we included undergraduate medical students in their clinical years from semester 6 and 7 in Muar campus of Melaka Manipal Medical College of Malaysia. A self-administered questionnaire was distributed among students who were present on the day of data collection.

The exclusion criteria for participation in the research were students who were absent on the day of data collection, who refused to participate and whom did not provide informed consent. Students who did not complete the questionnaire were also excluded from this research.

2.4. Data Collection

The questionnaires were distributed by us in Melaka Manipal Medical College (Muar Campus). There are three parts in the questionnaire. For Part A, participants are required to fill in

their gender, age, batch, nationalities, ethnicity and if they have attended any classes on biomedical waste management before either in India or Malaysia. For Part B, there are 10 items which will assess their knowledge and awareness on biomedical Waste management. The questionnaires were adopted by the previous studies. [14, 24] For example, participants were assessed on their knowledge if clinical waste can cause risks and health hazards to their health when infected. Meanwhile for Part C, there are also 10 items which assess their attitude on biomedical waste management. As an example, they are asked on the different colours of the bins for different waste disposal. Participants are required to choose only one option from the multiple choice questions (A, B, C, D) and choose either yes or no for yes/no questions in Part B and Part C. One of the MCQ questions was: You discard used rubber materials (gloves, catheter, and other tubings) in which colour coded container or bag? Choices were Red plastic bag, Yellow plastic bag, Blue plastic bag, and Black plastic bag.

2.5. Data Processing and Analysis

Microsoft Excel is used to tabulate the data collected. Data was analysed using software Epi Info. The frequency and percentage was used to analyse age, gender, semester, ethnicity and whether they have attended classes on biomedical waste management either in India or Malaysia. The measure of association used in our study is odds ratio. For knowledge, awareness and attitude, a scoring of 1 is given for a correct response and scoring of 0 for a wrong response (higher score indicates better knowledge, awareness and attitude). Median is used as the cut off point for each dependent variable, Knowledge and Awareness (80%) and Attitude (60%). [26] We categorized the Knowledge into good knowledge (≥80%) and need to improve knowledge (<80%) and for Attitude into good attitude (≥60%) and need to improve attitude (<60%). We used the Chi-Square test to determine the association between different age groups, gender, ethnicity, semester, exposure to biomedical waste management and knowledge, awareness and attitude. We also used multiple bar charts to describe the association between different age groups, gender, ethnicity, semester, exposure to biomedical waste management and knowledge, awareness and attitude. All the statistical tests were two-sided and the level of significance was set at 0.05.

Independent variable	Dependent variable	Statistical test
Gender (2 groups)	Knowledge and awareness Attitude	Chi-square test
Age (3 groups)	Knowledge and awareness Attitude	Chi-square test
Semester (2 groups)	Knowledge and awareness Attitude	Chi-square test
Ethnicity (4 groups)	Knowledge and awareness Attitude	Chi-square test
Exposure to biomedical waste management class (2 groups)	Knowledge and awareness Attitude	Chi-square test

2.6. Ethical Consideration

The objectives of this study were briefed to the participants. Participants got the liberty to decide if they require to voluntarily participate during this study. Participants who were willing to participate got consent form. Participants were allowed to withdraw from the study at any time. Their confidentiality is going to be kept private thus no personal details will be exposed. The study protocol was reviewed and approved by the Research Ethics Committee, Faculty of Medicine, Melaka Manipal Medical College, Malaysia.

3. Results

Table 1. Sociodemographic characteristics of Medical students (n=217).

Variables	n (%)
Gender	
Male	83 (39.0)
Female	130 (61.0)
Age	
<22	63 (29.0)
22-23	138 (63.6)
>23	16 (7.4)
Mean (SD)	22.09 (1.1)
Semester	
6	117 (54.4)
7	98 (45.6)
Ethnicity	
Chinese	58 (27.1)
Indian	64 (29.9)
Malay	47 (22.0)
Others	45 (21.0)
Attended class on Biomedical Waste Management in India	
Yes	194 (90.7)
No	20 (9.3)
Attended class on Biomedical Waste Management in Malaysia	
Yes	29 (13.7)
No	182 (86.3)

A total of 217 MBBS students participated in this study and response rate was 84.1%. Among them, 39.0% were males while 61.0% were females. 54.4% were from semester 7 and 45.6% were from semester 6. Most of the participants (63.6%) were in the age range of 22-23 years. The mean age of the

participants was 22.1 years (SD 1.1) and the majority (29.9%) of them are of Indian ethnicity. Most of them have attended class on Biomedical Waste Management in India (90.7%) but not in Malaysia (86.3%).

Table 2. Correct response on Knowledge and Awareness on Biomedical Waste Management.

Questions regarding Knowledge and Awareness on Biomedical Waste Management	Correct response, n (%)
Which statement describes Biomedical Waste? Waste generated by health care activities including a broad range of materials, from used needles and syringes to soiled dressings, body parts, diagnostic samples, blood, chemicals, pharmaceuticals, medical devices and radioactive materials.	207 (97.2)
Waste should not be stored beyond? 48 Hours	123 (57.2)
Can clinical waste cause risks and health hazards to your health when infected? Yes	214 (99.5)
Do you know about the clinical waste management process? Yes	126 (59.2)
Do you know the correct method of handling clinical waste based on the categories? Yes	134 (62.0)
Are bags and containers for clinical waste marked with the international symbol? Yes	201 (93.1)
Do you know about the colour coding for waste separation? Yes	180 (83.3)
What is the colour of the clinical waste bin? Yellow	184 (85.9)
What is the amount of infectious waste that should be thrown in the container? Less than ¾ full	90 (42.1)
Do you know if the hospital must have a standard storage room for keeping hospital infectious waste? Yes	174 (86.1)

Table 2 showed the correct response about knowledge and awareness on biomedical waste management. 97.2% participants knew the correct description of the biomedical waste management as shown in table 2. 57.2% students knew the time period that waste should not be stored beyond (maximum hours that waste can be stored.) 99.5% students think clinical waste can cause risks and health hazards to health when infected. 59.2% of students knew about the clinical waste management process. And 62.0% knew the correct method of handling clinical waste based on the categories. 93.1% of students knew that the bags and containers for clinical waste are marked with the international symbol. 83.3% participants knew about the colour coding for waste separation. 85.9% of students knew the correct colour of the waste bin (which is yellow). Only 42.1% knew the correct amount of infectious waste that should be thrown in the container. 86.1% knew that the hospital must have a standard storage room for keeping hospital infectious waste.

Table 3. Correct response on Attitude on Biomedical Waste Management.

Questions regarding Attitude on Biomedical Waste Management	Correct Response, n (%)
Do you dispose of all kinds of waste into general garbage? No	122 (57.6)
Do you segregate the biomedical waste according to different categories? Yes	174 (84.1)
Where do you dispose of cotton, gauze and other items contaminated by blood? Yellow plastic bag	124 (57.7)
Where do you dispose of pharmaceutical waste? Black plastic bag	56 (26.1)
Where do you dispose of sharps waste? Puncture proof container	165 (76.4)
You dispose of the hazardous liquid waste in which colour coded container or bag? Yellow plastic bag	53 (24.5)
You discard used rubber materials (gloves, catheter, other tubings) in which colour coded container or bag? Red plastic bag	58 (26.9)
Wearing personal protective equipment necessary? Yes	214 (97.7)
Do needlestick and sharps injuries need to be reported? Yes	209 (97.7)
Do you think you require any further training on biomedical waste management? Yes	199 (92.1)

Table 3 showed the correct response on attitude on biomedical waste management. 57.6% of the students gave correct responses on not disposing all kinds of waste into general garbage. 84.1% segregated the biomedical waste according to

different categories. 57.7% of the students disposed of cotton, gauze and other items contaminated by blood into the correct category. For disposal of pharmaceutical waste only 26.1% gave the correct response. 76.4% disposed of sharps waste into the right category. 24.5% of the students disposed of the hazardous liquid waste into the right colour coded container or bag. 26.9% discarded used rubber materials into the right colour coded container or bag. 97.7% of the students gave responses that wearing personal protective equipment is necessary and also 97.7% of them responded that needlestick and sharps injuries need to be reported. 92.1% of the students think that they require further training on biomedical waste management.

Table 4. Knowledge and Attitude categories on Biomedical Waste Management among medical students.

Variables	n (%)
Knowledge categories	
Good (≥80% of the total score)	120 (55.3)
Need to improve (<80% of total score)	97 (44.7)
Mean (SD)	75.3 (15.8)
Attitude categories	
Good (≥60% of the total score)	153 (70.5)
Need to improve (<60% of total score)	64 (29.5)
Mean (SD)	63.3 (15.9)

Table 4 shows the Knowledge and Attitude categories on Biomedical Waste Management among medical students. 55.3% of the students have good knowledge on Biomedical Waste Management with mean of 75.3 and standard deviation 15.8. For the attitude, 70.5% of the students have a good attitude on Biomedical Waste Management with the mean of 63.3 and standard deviation 15.9.

Table 5. Association between gender, age, semester, ethnicity, attended class on Biomedical Waste Management class in India and Malaysia, and Knowledge

Independent variables	Knowledge		OR (95% CI)	Chi-square	P-value
	Good, n (%)	Need to improve, n (%)			
Gender					
Male	43 (51.8)	40 (48.2)	Reference		
Female	76 (54.5)	54 (41.5)	1.31 (0.8,2.3)	0.91	0.340
Age					
<22	34 (54.0)	29 (46.0)	Reference		
22-23	77 (55.8)	61 (44.2)	1.08 (0.6,2.0)	0.06	0.809
>23	9 (56.3)	7 (43.8)	1.10 (0.4,3.3)	0.03	0.870
Semester					
7	65 (55.6)	52 (44.4)	Reference		
6	55 (56.1)	43 (43.9)	1.02 (0.6,1.8)	0.01	0.934
Ethnicity					
Malay	31 (66.0)	16 (34.0)	Reference		
Chinese	32 (55.2)	26 (44.8)	0.64 (0.3,1.4)	1.26	0.262
Indian	35 (54.7)	29 (45.3)	0.62 (0.3,1.4)	1.43	0.232
Others	21 (46.7)	24 (53.3)	0.45 (0.2,1.0)	3.48	0.062
Attended class On Biomedical Waste Management in India					
No	7 (35.0)	13 (65.0)	Reference		
Yes	112 (57.7)	82 (42.3)	2.53 (1.0,6.6)	3.80	0.051
Attended class on Biomedical Waste Management in Malaysia					
No	99 (54.4)	83 (45.6)	Reference		
Yes	19 (65.5)	10 (34.5)	1.59 (0.7,3.6)	1.26	0.263

Table 5 showed the association between gender, age, semester, ethnicity, attended class on Biomedical Waste Management class in India and Malaysia with knowledge. There was a positive association between gender and knowledge where female was 1.31 more likely to have a good knowledge compared to male. However, the association was not significant as the chi-squared value was 0.91 and p-value was 0.340. There was also a positive association between age and knowledge with age group < 22 as a reference. Age group 22-23 was 1.08 more likely to have good knowledge compared to age group <22 and age group >23 was 1.10 more likely to have good knowledge compared to age group <22. The association of age with knowledge was not significant as the chi-squared values for age group 22-23 and >23 was 0.06 and 0.03 with p-value of 0.809 and 0.870 respectively. For association between semesters and knowledge, there was a positive association as semester 6 was 1.02 more likely to have good knowledge compared to semester 7 but the association was not significant as the chi-squared value was 0.01 and the p-value was 0.934. For ethnicity, Malay was used as a reference and there was a negative association with Chinese, Indian and others. Chinese, Indian and others were 0.64, 0.62 and 0.45 times less likely to have a good knowledge compared to

Malay. The association also not significant as the chi-squared values for Chinese, Indian and others were 1.26, 1.43 and 3.48 with p-values of 0.262, 0.232 and 0.062 respectively. For students that attended class on Biomedical Waste Management in India, there was a positive association where students that had attended class was 2.53 more likely to have good knowledge compared to students who did not attend the class. However, the association was not significant as the chi-squared value was 3.80 and the p-value was 0.051. For students that attended class on Biomedical Waste Management in Malaysia, there was a positive association where students that had attended class before was 1.59 more likely to have a good knowledge compared to those who did not attend the class but it was not significant as the chi-squared value was 1.26 and the p-value was 0.263.

Table 6. Association between gender, age, semester, ethnicity, attended class on Biomedical Waste Management class in India and Malaysia, and Attitude.

Independent variables	Attitude, n (%)		OR (95% CI)	Chi-square	P-value
	Good, n (%)	Need to improve, n (%)			
Gender					
Male	60 (72.3)	23 (27.7)	Reference		
Female	92 (70.8)	38 (29.2)	0.93 (0.50,1.71)	0.06	0.811
Age					
<22	43 (68.3)	20 (31.8)	Reference		
22-23	96 (69.57)	42 (30.4)	1.06 (0.56,2.02)	0.03	0.851
>23	14 (87.5)	2 (12.5)	3.23 (0.67,15.71)	2.35	0.125
Semester					
7	69 (70.4)	29 (29.6)	Reference		
6	84 (71.9)	33 (28.2)	1.07 (0.59,1.93)	0.05	0.823
Ethnicity					
Malay	30 (63.8)	17 (36.2)	Reference		
Chinese	47 (81.0)	11 (18.9)	2.42 (0.99,5.87)	3.93	0.047
Indian	42 (65.6)	22 (34.4)	1.08 (0.49,2.38)	0.04	0.845
Others	33 (73.3)	12 (26.7)	1.56 (0.64,3.79)	0.96	0.327
Attended class On Biomedical Waste Management in India					
No	10 (50.0)	10 (50.0)	Reference		
Yes	142 (73.2)	52 (26.8)	2.73 (1.07,6.93)	4.74	0.029
Attended class on Biomedical Waste Management in Malaysia					
No	125 (68.7)	57 (31.3)	Reference		
Yes	24 (82.8)	5 (17.2)	2.19 (0.79,6.03)	2.39	0.122

Table 6 showed association between gender, age, semester, ethnicity, attended class on Biomedical Waste Management in India and Malaysia and attitude. For gender, there was a negative association with attitude which female was 0.93 less likely to have a good attitude than the male. The chi square was 0.06 and p value was 0.811 which indicates not significant association. There was a positive association between age group and attitude where students with age <22 is the reference. Students who were around 22-23 years old were 1.06 more likely to have good attitudes and for students who aged >23 years old was 3.23 more likely to have good attitudes compared to the students aged <22 years old. The association for 22-23 years old and >23 years old age group were not significant as the chi square was 0.03 and 2.35 respectively while the p value would be 0.851 and 0.125, respectively. There was also a positive association between the semester and the attitude. The students who were in semester 6 are 1.07 was more likely to have good attitudes which were significant as the chi square was 0.05 and the p value was 0.823. Ethnicity and attitude on Biomedical Waste Management had positive association. Chinese students were 2.42, Indian students were 1.08 and students from other ethnicity were 1.08 more likely to have good attitudes compared to the Malay students. The association for the Chinese students was significant as the chi square would be 3.93 and p value 0.047 while association for the students from other ethnicity were not significant. Those students who attended class on Biomedical Waste Management in India had positive association which they were 2.73 more likely to have a good attitude compared to those who didn't attend the class. The association was significant with the chi square of 4.74 and p value of 0.029. There was also a positive association between those who attended class on Biomedical Waste Management in Malaysia. They were 2.19 more likely to have good attitude compared to those who did not attend class, but it was not significant with chi square of 2.39 and p value of 0.122

4. Discussion

A cross sectional study was done to assess the knowledge, awareness and attitude of undergraduate medical students of Melaka Manipal Medical College on biomedical waste management and to assess the association between age, gender, semester, ethnicity, exposure to waste management and knowledge and attitudes on biomedical waste management. Majority of the medical students are aware of the explanation, risks and hazards of biomedical waste and

also the international symbol for clinical waste. Less than 50% of the students do not know the amount of infectious waste to be thrown in the container. For the assessment of knowledge and awareness, 99.5% medical students in our study knew what is biomedical waste, whereas in the previous study among dental interns and students in India, only 58% of the participants answered correctly. In our study, 57.2% of medical students were aware of the duration of biomedical waste to be stored while only 49% of dental interns and students from a previous study got it right. [26] In our study, 99.5% of medical students were aware of the risks and health hazards of biomedical waste if infected, whereas in a previous study which had been conducted among medical students in India, 94.4% were aware of the risks and health hazards of biomedical waste if infected. [14] In our study, only 59.2% of medical students were aware about the clinical waste management whereas a previous study that has been conducted on the knowledge and awareness of biomedical waste management among medical practitioners in Hospital Batu Pahat, revealed that majority (93%) of their participants knew about the clinical waste management. [24] However there were 62% of medical students in our study who knew the correct method of handling clinical waste, while 78% of practitioners in Hospital Batu Pahat knew the correct method of handling clinical waste. [24] In our study 93.1% participants knew that there were international symbol marked on the bags and containers for clinical waste whereas 92% of practitioners in Hospital Batu Pahat knew about that in a previous study. [24]

By comparison, 83.3% medical students in our study were familiar with the colour coding for waste separation while 91% of practitioners in Hospital Batu Pahat were familiar with the colour coding for waste separation in an earlier study. [24] In our study, 85.9% medical students knew that yellow is the colour of the clinical waste bin whereas 92% of practitioners in Hospital Batu Pahat from a past study gave a correct response. [24] Although less than 50% of participants in our study were mindful of the amount of infectious waste that should be thrown in the container, there were 77% of practitioners in Hospital Batu Pahat from a previous study who were aware of the amount of infectious waste that should be thrown in the container. [24] 86.1% medical students in our study knew that the hospital must have a standard storage room for keeping hospital infectious waste whereas a previous study stated that 92% of practitioners in Hospital Batu Pahat were aware of it. [24]

For the assessment of attitude, 57.6% medical students in our study knew that not all wastes are to be disposed in the general garbage, which was lower than the response given by the MBBS 2nd professional students in a previous study conducted in India. [14] We also observed that 84.1% medical students from our study were mindful of the segregation of biomedical wastes while 75.2% of MBBS 2nd professional students in India were mindful. [14] However, when medical students were asked on the different colours of bags for the disposal of wastes, the results were worrisome. It was revealed that 57.7% of our medical students were apprised of the disposal of wastes contaminated with blood while there was a higher correct response of 94.4% from another study conducted among the MBBS 2nd professional students in India. [14] On the other hand, the disposal of pharmaceutical waste only got a correct response from 26.1% of medical students from our study which was an alarming result. Moreover, the response for the disposal of sharp waste in this study was 76.4% which is still lower than the study conducted among the MBBS 2nd professional students in India. [14] Another concerning response is for the disposal of hazardous liquid waste and rubber materials which only obtained 24.5% and 26.9% correct response from our participants. Nevertheless, a majority of the medical students were conscious about the need for personal protective equipment, reporting of needle-stick injury and if they required further training on biomedical waste management.

Our study revealed that 55.3% of them had good knowledge and 44.7% of them needed to improve their knowledge on biomedical waste management, and 70.5% of participants had good attitudes while 29.5% of participants needed to improve their attitude on biomedical waste management. A cross sectional study conducted among nursing students in Government Medical College and Hospital, Ananthapuram revealed that third year students answer better than first year and second year students regarding the knowledge, attitude and practices of biomedical waste management. However, all of them shown a decrease in practices component. [18] Meanwhile, a study conducted between Shaheed Kartar Singh Sarabha's students, Nursing College, and Shaheed Kartar Singh Sarabha Ayurvedic Medical College Ludhiana, Punjab, India revealed that although the students attitude towards biomedical waste management were optimistic, the awareness however were relatively below average. [19] A study guided to assess the knowledge, attitude and practices towards dental waste management among undergraduate dental students studying in Bapuji Dental College and Hospital, Davangere, revealed that participants had very good knowledge regarding transmission of infection through hospital waste, post prophylaxis measures, needle recapping, colour coding system and labelling of the container. However, practice of segregation of waste was very much lacking in the participants, also students were less aware of mercury management. [20]

We also found that there was no significance in the difference of knowledge between gender, age, semester, ethnicity and

whether students attended class on biomedical waste management in India or Malaysia. A cross sectional study conducted among Medical Students in a tertiary health care centre revealed that 1st professional students were less aware and knowledgeable as compared to second professional students regarding segregation and colour coding about biomedical waste management. [14] Meanwhile, a study conducted among third and final year students as well as the interns enrolled in the Bachelor of Dental Surgery (BDS) professional course from three Bhubaneswar dental schools showed that there was inadequate awareness among dental students about biomedical waste management and/or dental material recycling. [16] Another study conducted between 3rd year, final year and internal dental students at Saveetha Dental College, Saveetha University, Chennai, revealed that most dental students in their study had high level of knowledge and experience on biomedical waste management in dental clinic. Their biomedical waste disposal training however, was not satisfactory. [17] In a study that conducted among 6th year Belgrade medical and dental students, dental students showed better knowledge on biomedical waste management and were more disciplined in using personal infection compared to medical students. [21] A descriptive cross-sectional study which conducted for a period of 4 months from January to April 2016 at Lahore Medical and Dental College revealed that there was a poor level of knowledge and awareness about biomedical waste generation hazards and management among final year Medical students in Pakistan. [22] A study which was conducted during the academic year January-March 2018 in randomly selected four dental colleges in Chennai among undergraduate dental students, disclosed that not all dental students were aware of biomedical waste management. A large population of the dental students were not practicing proper method of health-care waste disposal. [23]

This study also revealed that there was no significant association between age, gender, ethnicity, semester and attitude. However, students that attended class on Biomedical Waste management in India were more likely to have a good attitude compared to those who did not attend the class. Also, Chinese ethnicity were more likely to have a good attitude compared to the other ethnicities. Older students (>23 years) are more likely to have a good attitude compared to younger students. In addition, a study conducted among dental students in different dental colleges in Nepal revealed that although there was a high attitude among dental students about biomedical waste management, yet the knowledge and practice were relatively low. [15]

We encountered a number of limitations in this study. One of them is, only semester 6 and 7 students could be approached due to time limitation. Since this study had been done in one private college, our results could not be generalised to other settings. Lastly, as this is a cross-sectional study, we are unable to see the changes of knowledge, awareness and attitude of medical students on biomedical waste management over the time.

In order to improve knowledge, awareness and attitude of medical students on biomedical waste management, a workshop, lecture class or a hospital visit on how the wastes are managed should be held. We also would like to recommend that knowledge, attitude, awareness and practice among healthcare professionals in Malaysian hospitals has to be assessed as hospitals are the main hub of infections which makes them directly linked to the number of cases caused by improper disposal of biomedical waste.

5. Conclusion

Our study revealed that 55.3% of them have good knowledge and 44.7% of them need to improve their knowledge on biomedical waste management, and 70.5% of participants have good attitude while 29.5% of participants need to improve their attitude on biomedical waste management. The students who attended class on biomedical waste management had better attitude compared to those who never attended. Chinese ethnicity also had a better attitude compared to other ethnicities. Those that attended class on biomedical waste management and Chinese ethnicity had a significant association with attitude towards biomedical waste management. However, there is still a good number of students that require further training on biomedical waste management to ensure that clinical waste is managed properly. In a nutshell, it is important to assess the knowledge, awareness and attitude of medical students on biomedical waste management in order to identify students that need to improve their knowledge.

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