QATAR UNIVERSITY

COLLEGE OF HEALTH SCIENCES

BIOMEDICAL WASTE MANAGEMENT AWARENESS AMONG HEALTH SCIENCE STUDENTS AT QATAR UNIVERSITY

BY

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ABSTRACT

AL MANSOURI, SHAIKHA J., Masters of Science: October : 2021, Biomedical Sciences

Title: Biomedical Waste Management Awareness Among Health Science Student in Qatar University; A Cross-Sectional Survey

Supervisor ofThesis: Dr. Atiyeh Abdallah.

Introduction: Biomedical waste is any kind of waste that contains infectious or potentially infectious products that are generated during diagnosis, treatment, or research. At Qatar University (QU), the production of waste is growing proportionately to the number of students joining the university, and numbers of research performed at QU at different research labs and centers. Inadequate management of this waste may lead to catastrophic consequences. Therefore, the aims of this study are: (1) to evaluate QU student's knowledge and attitude regarding waste management regulations, (2) to understand the main determinants influencing safe handling of biomedical waste.

Methods: A cross-sectional study using a constructed questionnaire was conducted among QU-Health cluster at QU. Statistical analysis was performed using SSPS software.

Results: A total of 257 responses were received, however only 246 were suitable for analysis. Surprisingly, only 9.3 % (23/246) of the respondents reported being fully aware of waste management, and only 39.4% (97/246) picked the correct answer regarding the duration beyond which biomedical waste should not be stored. A very few participants (5.7%) reported that they have full awareness of the authorized agencies by the government which collect biomedical waste from clinical sites. When

respondents were asked to identify the correct color-code (yellow) for the biomedical waste to be autoclave-disinfected, only 41.1% (101/246) correctly answered the question. Regarding their recommended actions to improve waste management awareness, attending workshops and conferences was selected by 79.3% (195/246) of participants. The majority (93.9%, 231/246) thought that it is highly recommended to understand about the management of biomedical waste and was interested to join workshops to improve their knowledge.

Conclusion: This survey showed a clear gap in the knowledge and awareness of the waste management among QU-Health cluster students. Therefore, continuous training and awareness campaigns are still required at all levels, and there is a need for more focus on the regular monitoring of these students.

DEDICATION

A special gratitude to my loving and blessing mother and my family for their support from the beginning of my master studies, whose love, prayers and supports during the study to reach this level of success and appreciation

Finally, to all my friends with whom I started working hardly and finished my master's degree with lots of fun.

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Chapter 1

1.1. Introduction

Medical waste management is a very important issue, especially with increased public concern and in the expense of transport and removing such waste. Waste management is considered to have a great impact on health, economic, and environment. The most crucial waste management mission is to reduce or to eliminate the risk (Ansari Mohsen, 2019).

Due to its life-threatening and hazardous effect on the health of the population and also the environment, biomedical waste (BMW) requires special management. At Qatar University (QU), the production of waste is growing proportionally to the number of students joining the University. Inadequate waste management will trigger potential health risks to the students, workers, and staff and damage the environment. Laboratories at QU Health Departments is a critical area with a huge amount of waste production, such as gloves, gauze, glass slides, plastics, tissues, and other contaminated material with potentially infectious and hazardous agents. Therefore, raising students' knowledge and awareness about how to deal with the different types of laboratory waste is a priority.

The laboratory supervisors are encouraged to think about steps to reduce amount of BMW. They need to form maximum effort within the laboratory to deal the non-hazardous research materials at the end of each experiment. Improper management and disposal methods of biomedical waste increase health risks.

The quantity of biomedical waste generated is proportional to population and urbanization (Demirbas, 2011). Increases in the number of healthcare and academic facilities within Qatar lead to increases in number of procedures that generate large amounts of infectious and hazardous waste (Licy, Vivek, Kamath, & T., 2013) (Zafar,

2019) (Desa, 2011) (Hossain, 2011).

The procedures practiced at QU to manage biomedical waste according to the Facilities and General Services Department are:

1. In each laboratory, there is a storage cabinet/area for the biomedical waste, where waste are kept while in building. These special areas are available in H10, C01, B02, C06 & A07.
2. The Laboratory Technician will send a request for collection to the Environmental & Sustainability Section (ESS).
3. The ESS will then advise the service provider (Tanzifco Company which has a contract with QU) to collect the biomedical waste for disposal. This is usually done twice every week.

BMW management needs continuous assessment to increase awareness through educational training programs. Universities, research institutes, and health care facilities are responsible about the waste they generate. They have to also ensure no opposing health and environmental concerns causing from waste handling, treatment, and disposal activities. The goals of BMW management primarily include keeping the transmission of infection from patient to patient, from patient to medical staff or vice versa, reducing the cost of BMW disposal, and minimizing the risk of cross-contamination.

The new pandemic Coronavirus 2019 (COVID-19) is highly contagious and highlights the importance of professional BMW management. A few studies reported issues with waste management during the pandemic period. A study presented by (Wang, et al., 2020) showed that the BMW better to be categorized before removal and the decontamination regularity of waste containers should be more applied. Decontamination using with an available chlorine content of 500 mg/L was

suggested. That highlights the disease transmission of non-hazardous waste mostly from health care facilities. Another study indicates the virus's stability for hours in air and days on surface (van Doremalen, et al., 2020). The current situation of the COVID-19 is a big environmental challenge that emphasizes the importance of BMW management. Up to the researcher's knowledge there is a paucity of a research that investigated the level of knowledge mong students regarding BMWM. Therefore the current study was performed to identify any gap in knowledge.

1.2. Objectives

As in many developing countries, BMW has expanded essentially in the last decade and managing this sort of waste keeps on being a significant challenge. Therefore, we hypothesized that with fast development in different research activities in QU-Health cluster, the knowledge and awareness of BMW management is low. Hence, our main aim is to investigate the level of awareness and knowledge of QU students at the QU-Health Cluster toward BMW management.

The objectives of this project are:

- To evaluate the QU student's knowledge regarding waste management regulations.
- To evaluate students' attitude toward waste management practice at QU.
- To understand the main determinants influencing safe handling of biomedical waste.

1.3. Background

1.3.1. Definition of Biomedical Waste

BMW characterized as any waste that is produced through determination, inoculation, teaching laboratory practical sessions, treatment and research that may lead to hazardous waste. BMW generated mostly from QU health departments because of the nature of their work that require laboratory session and research dealing with many biological and chemical hazardous material. College of Medicine, College of Pharmacy, Biomedical Research Centre and College of Health Sciences (Dept. of Biomedical Sciences, Dept. of Nutrition and Dept. of Public Health) are sources of different types of BMW.

BMW disposal procedures vary from one institute to another, protocols and regulations also vary across different countries (Desa, 2011). The level of hazard is also different between different laboratories (ROUGHTON, 2001). This leads to differences in disposal methods (Demirbas, 2011b). Every organization has its guidelines and rules to be followed for BMW disposal (World Health Organization., 1999).

Many issues are associated with BMW management, including logistic, environmental impact, and social responsibility. In addition, the economic factor of an organization or system for dealing with a set of activities associated with production, transportation, storage, and treatment of BMW. Proper waste management enables the organization to reduce any risk and create a safe and healthy environment resulting in optimum performance and profitability. This can be achieved by proper education and high awareness of all employees regarding the proper way of waste handling and disposal (Demirbas, 2011) (Licy, Vivek, Kamath, & T., 2013) (Procedure, HSE Standard Operating, 2013).

1.3.2. Purpose of biomedical waste management

The primary motivation behind BMW is to guarantee that the waste is removed from the source or the area where it was produced to the treatment site using appropriate methods. Moreover, to minimize environmental problems and/or eliminate health hazards as much as possible. Minimizing imply reducing the waste amount and the activity to an acceptable or as low level as reasonable (Demirbas, 2011) (Hyatt & Ojovan, 2019).

1.3.3. Biomedical waste classification

World Health Organization (WHO) classifies biomedical waste into six classifications: general waste, infectious or bio-hazardous waste, chemical waste, pathological waste, pressurized containers, and pharmaceuticals. Institutions that generate biomedical waste have to implement proper waste management systems according to WHO guidelines to minimize the any risk (Licy, Vivek, Kamath, & T., 2013) (Guidance Manual, 2014).

1.3.3.1. Classification of waste at Qatar University.

According to Facilities and General Services Department at QU, the Ministry of Municipality and Environment (MME) regulates the biomedical waste by the following laws:

- Executive law for the Protection of the Environment, No. 30
- Executive law on solid waste management, No. 303

Hazardous waste at QU is categorized into hazardous chemical, bio-hazardous materials, radioactive waste, Electrical and Electronic Equipment Waste (WEEE).

Hazardous Waste in Qatar University

#	Classifications	2018	2019	2020	Total (kg) (2018 - 2020)
1	Biological Waste (kg)	7,013.60	6603.02	4531.02	18,147.64
2	Chemical Waste (kg)	2,505.60	1122.2	673.78	4,301.58
3	Electronic Products (kg)	1.30	4087.7	0	4,089.00
4	Sharps material (contaminated Biological) (kg)	922.70	635.2	366.61	1,924.51
5	Sharps material (contaminated Chemical) (kg)	231.00	787.7	477.93	1,496.63
6	Batteries (kg)	17.30	199.5	420.2	637.00
7	Empty container (container for chemical) (kg)	190.50	258.2	155.8	604.50
8	Unknowns – Containers missing their chemical labels, chemical names or formulas, or labeled (kg)	15.70	53.9	131.4	201.00
9	Oil (kg)	70.80	73.3	14.5	158.60
10	Mercury Compounds (kg)	28.22	1.9	0	30.12
11	Compressed Gases (kg)	8.50	0	0	8.50
12	Fluorescent lamp (kg)	0.00	0.7	0.2	0.90
13	Asphalt (kg)	0.00	0	0	0.00

Figure 1: Qatar University Hazardous Waste amounts and Classifications for the last three years (Source:Qatar University, Facility and general service Department, Environment and Sustainbility section)

Figure 1 shows the volume of biomedical waste for QU during last three years, from 2018 to 2020. It shows that some waste production have decreased, which indicates the efficiency of BMW management strategies used at QU, however, there are some classifications have increased.

1.3.3.2. Biomedical waste at Hamad Medical Corporation

Department of Laboratory Medicine & Pathology (DLMP) at Hamad Medical Corporation (HMC) classifies BMW into; hospital general waste (non-hazardous regular waste), regulated medical waste (infectious pathological, sharps, and anatomical material), and hazardous waste (Chemical-liquids, Solid or gas).

The annual estimation of each category percentages are: Hospital General Waste (Non-hazardous regular waste) is 70,380 kg/year which presents 85% of total waste,

Regulated Medical Waste (Infectious, pathological, sharps & anatomical material) is 8,280 kg/ year (10%), and Hazardous waste (chemicals-liquids, solid or gas) is 4,140 kg/ year (5%) (Figure 2).

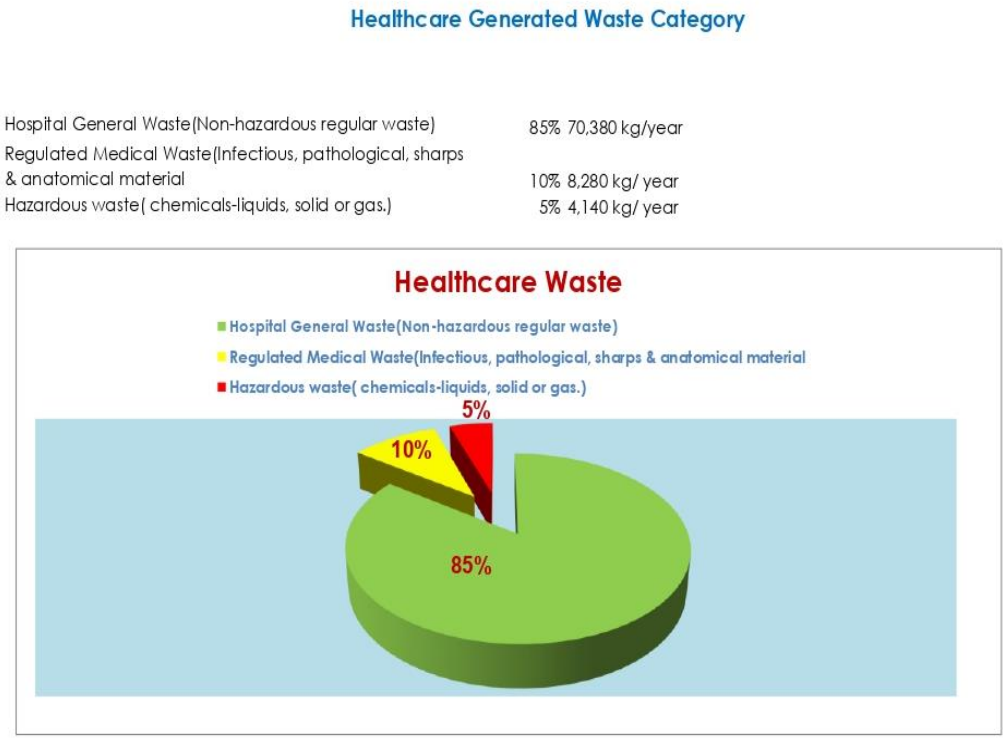


Figure 2: DLMP Healthcare Waste Category Generation Annual Estimate

(Source: http://www.sustainabilityroadmap.org)

1.3.4. Chemical waste

Chemical waste postures actual risks like flammability, corrosion, or radio-reactivity. It tends to be divided to: irritants, asphyxiants, explosives, liquids or solids, oxidizers, self-reactive, and flammable materials such as gases. In most of the health laboratories at QU, chemicals used may introduce a physical hazard and/or health hazard. Physical hazard includes: oxidizer, explosives or reactivity and incidents such as fire, chemical spills or leakage of toxic chemicals pose a potential danger. Hazard to the employee and students may cause acute toxicity, irritation or corrosive effect on the skin, irritation and serious problem with eyes, sensitization or allergic reaction of

respiratory or skin. (Procedure, HSE Standard Operating, 2013).

1.3.5. Biological waste

Biomedical waste within a university context, is defined as any contaminated material that is generated or material that being produced during teaching activity and/ or research process that need Biosafety level (BSL) 1, 2, or 3. **BSL** are guidelines for biomedical laboratories for dealing with infectious agent. Biological wastes can include any of the following:

- Cultures of infectious agents.
- Remains of anatomical tissue.
- Contaminated animal carcasses and bedding.
- Material contaminated with human tissue or tissue culture.
- Sharps: blades, scalpels, lancets, syringes…etc.
- Specimen tubes and biotechnology by-product (i.e., recombinant DNA) and body fluid or blood of human or animal. Biological waste requires specific prevention methods to be deal with each infection with each specific BSL level (Petrangeli, 2006).

1.3.5.1. Biological waste and biosafety level

BSL has specific guidelines for dealing with infectious agents such as bacterial, viral, and any other hazardous microbial agents. The guidelines enable the laboratory workers, supervisors, managers and others to recognize the ideal requirements of the facilities and the work practice, resulting in providing the optimum level of protection for laboratory workers, and to minimize or eliminate bio-hazardous agents (Hill, Gaunce, & Whitehead, 1999).

Biosafety levels are classified into the following levels:

BSL1 laboratories characterized by a low -risk infectious agent without or with a little

harm. An example would be a research lab, which requires only immediate decontamination after any spills (Ta, Gosa, & Nathanson, 2019).

BSL2 is applied to a lab which, deals with human disease and which may cause moderate risk. Infectious organisms such as HIV and staphylococcus aureus require only to maintain the same precaution level as BSL1 with more reinforce measures.

BSL3 applies to a lab deals with indigenous or exotic microbes such as yellow fever, tuberculosis which can cause lethal disease by inhalation and is required to be strictly controlled and reports to authorized governmental institutes (Ta, Gosa, & Nathanson, 2019).

BSL4, labs are unique and present in small numbers globally. It requires a high level of safety standards and precautions dealing with highly infectious or fatal microbes with no vaccine or treatment available, such as Ebola. Labs with safety level BSL4 are completely isolated with a highly specialized exhaust air system in a separate area of the building (Prevention & Centers for Disease Control and Prevention, 2009).

At QU, majority of the Biosafety Levels remain within the three categories of **BSL1** (low risk), **BSL2** (moderate risk), **BSL3** (substantial risk) as shown in Figure 3 (Procedure, HSE Standard Operating, 2013).

Photo showing Biosafety Level-3 (BSL-S)

Figure 3: Shows BLS3 at QU Biomedical Research Center (BRC)

source http://www.qu.edu.qa/static_file/qu/research/magazine/English-13.pdf

1.3.6. Radioactive waste

Radioactive waste is a material which consists of or may be infected with radionuclides at a certain level of concentration greater than the standard or established rules and regulations (Hyatt & Ojovan, 2019).

Radioactive waste also means materials or substances that come into direct contact with the radioactive medium or that have or may possess radionuclides. Alternatively, it could be material that had been removed from a technological process, form an active region, or taken out from areas that no more used (Oh, 2001) (United States Nuclear Regulatory Commission, 2019) (Hyatt & Ojovan, 2019).

1.3.7.Waste Electrical and Electronic Equipment (WEEE)

WEEE, known also as E-waste, is any part of the products or can include all components, subassemblies, and consumables that are being discarded or going to be discarded (Procedure, HSE Standard Operating, 2013). It refers to the entire stream of equipment and electronic devices that being expired or intended to be not in use, that

consists of hazardous components that may be produced directly or through the recycling process that result in electronic waste. (Licy, Vivek, Kamath, & T., 2013). It is one of fastest growing waste section due to increase use of short lifetime equipment. WEEE at QU is classified into different categories for easy management process:

1. IT and telecommunications gears central devices for data processing such as mainframes, printer, and personal computers,
2. Consumable devices (audio and video system and other instruments),
3. lighting system (fluorescent lamps and other lamps controlling),
4. Electronic tools fixing and repairing such as drills, sewing machines, saws, nailing, or screwing,
5. Medical devices and maintenance gears,
6. Auditing and monitoring instruments to be under control (smoke detectors, heating monitoring system, thermostats, and measuring appliances, scaling or adjusting laboratory equipment),
7. Automatically appliance dispensers (Procedure, HSE Standard Operating, 2013).

Laboratories are one of the places that may be full of devices that are categorized as a potential for producing this kind of waste (WEEE), so it is important to make sure that staff is aware of QU protocols for managing this kind of waste.

1.3.8. Risk and the outcome

1.3.8.1. Health Risk

Exposure to BMW could potentially affect individual health or causing serious problems such as acute toxicity, skin allergy, serious eye damage, respiratory

problems, and carcinogens such as liver cancer and mesothelioma. Moreover, reproductive health can be affected, such as causing congenital disability, developmental defects, and blindness (Lestari, 2016). Headache, dizziness, vomiting, malignancies and fetal defects, and death can be caused by radioactive waste (Classification of Radioactive Waste, 2009)

1.3.8.2. Environment Risk

The production of BMW increased significantly with increased health facilities that lead to large waste production that cause potential risk the environment, including global warming, air, soil, and water pollution (Licy, Vivek, Kamath, & T., 2013) (Desa, 2011). Several studies reported that solid waste generated from health care sector should get more attention and it has to be controlled carefully due to its unsafe impact on the environment. Disposal of solid waste generated in health care sectors may negatively impact the environment worldwide, especially in developing countries. Best practice regarding biomedical waste management is essential in different sectors such as health, environment, and economics (Ansari Mohsen, 2019) (Nkechi Chuks Nwachukwu, 2013) (WHO/UNICEF, 2015).

1.3.9. Steps of biomedical waste management

Steps to be applied in medical laboratories to manage BMW are:

Segregation, Identification (Pre-treatment), Labelling / Packaging, Transport and Treatment, Storage, and Final Disposal (Kamran, 2019) (Aden, 2019). Ultimately, the assigned manager or the individual should have certain knowledge such as updated information about the current and future management protocols and procedures of the good practice and good behavior to manage the waste. The assigned individual should also understand the volume and nature of waste on-site, which helps manage it properly (Òscar Saladié, 2016) (Oh, 2001) (Demirbas, 2011).

1.3.10. Negative impact

It is well known that improper management and poor practice such as careless handling and disposal of BMW lead to severe problems and negatively impact both humans and the environment. The improper management leads to pollution and may cause an epidemic worldwide. In hospitals, any kind of mismanagement regarding BMW could negatively impact the entire medical organization (Desa, 2011) (M.Jain, 2016). Waste management could have some challenges such as; improper storage, mixing the biomedical waste with general waste, employees' poor awareness and disposal of the waste safely in a proper time (Desa, 2011) (M.Jain, 2016) (ROUGHTON, 2001).

1.3.11. Hazardous management worldwide

One of the worldwide waste management objectives is to control the abandoning and exposed burning of the waste. Furthermore, taking possible steps to reach successfully sustainable and environmental management of all waste especially hazardous waste. Proper waste management needs a financial asset in current waste and resource management services (Wilson, David; Velis, Costas, 2015). Increasing environmental awareness and individual’s attitude development would help humans to support environmental behaviour (Al-Rabaani, Ahmed; Mohammed, 2009).

1.3.12. Hazardous management in GCC

Biomedical waste in the Gulf Cooperation Council (GCC) is rapidly increasing, similar to the rest of the world. Based on the conservative estimation, more than 150 tons of BMW is produced in the GCC on daily bases that indicates a serious problem. The increased waste amount generation creates a demand to be dealt with by high authorities (M.Jain, 2016). BMW management is a great challenge in the GCC area and more complicated because of the GCC area's climate state. It is highly recommended to use

modern technology of waste treatment to control the risk and protect the environment (Zafar, 2019).

1.3.13. Hazardous management in Qatar

Qatar is a part of the **GCC** area and has a great awareness of the increased generation of bio-hazardous waste due to increased population, industrial, and increased economic factors (Development, College of Arts and Sciences - Center for Sustainable, 2018). In Qatar, waste is managed through applying different methods such as incineration and different treatment methods. **Mesaieed** Treatment Office and **Ras Laffan** Plant, for dangerous waste burning, revealed that a large portion of the waste is created at administrative buildings, fire stations, structures of protections, and labs. However, **Qatar** is facing different challenges to reach its objectives, including reducing the emission of hydrocarbon and the upcoming event of the world cup 2022, and the different priorities for 2030 vision. The country is planning to forbidden toxic chemicals, looking for monitoring and inspection of the industrial product regarding the proper storage of hazardous waste chemical, trying to reduce or minimize the waste generation through improving engineering facilities and other processes while considering the development of the infrastructure for treatment of expired reagents and pesticides (Sonkie, 2018) (Charfeddine, 2018).

1.3.14. Qatar and vision 2030

The objectives are aiming to transform Qatar into a more successful with decent life for future generations. One of the objectives that Qatar focuses on is environmental development through programs aligned with the global agenda. Qatar is giving many energies on decreasing plastic pollution. (Sonkie, 2018)

Also, economic development and environmental protection are prioritized demands. (Charfeddine, 2018). Moreover, Qatar is an active member in the International Register

of Potentially Toxic Chemicals, a network for data registry of dangerous chemicals. The main objectives of this registry network are:

(1) Providing the data of chemicals that are available to those who need it;

(2) Searching and looking for gaps in the available information and try to fill those gaps;

(3) Recognizing the potential hazards chemical that is used and provides the knowledge for people to be aware;

(4) Establish regulations and policies for hazardous chemicals nationally and globally through assembling information on existing policies.

These objectives help users make the correct decision by identifying the hazardous effect of the chemicals applicable at the global level (Wexler, 2000). A number of developing countries were assisted upon their request with their national registry by IRPTC, and Qatar was a member. Improving the awareness among the population and adopting new knowledge and information about the proper use of toxic chemicals are the main objectives of IRPTC. Therefore, Qatar implemented regulation for proper disposal of the chemical waste following universal precautions and working with neighboring GCC countries to provide the best practice (Sonkie, 2018) (Charfeddine, 2018).

1.3.15. Qatar University (QU)

Based on the Qatar vision 2030 and word-wide initiative, QU is taking the lead by guiding and encouraging all colleges to be a part of this vision (Aden, 2019) (Kamran, 2019) (Sonkie, 2018). The College of Health Sciences (CHS) in Qatar University is one of the academic leaders' foundations of health care with exciting nutrition, biomedical

sciences, and public health. At QU, the production of waste is growing apportionable to the number of students joining the University. QU Health cluster includes three main colleges; College of Pharmacy, College of Medicine, and College of Health Sciences. The research and unique teaching integration provide the best environment for innovation and practice for students. Meanwhile, QU is committed to supporting the innovative strategy of education and research, QU follows international standards to manage BMW that is produced by QU Health colleges (University, QATAR University Health Vision, 2018).

Due to the nature teaching and activity of QU-Health cluster which produce large amount of hazardous waste, it requiring proper BMW management. For example; Pharmaceutical waste is a medical waste, which contains unused medication or expired drugs, and open drug containers generated through several activities at the college (Sreekanth, 2014). Another example is the BRC which generates waste during research activities such as dealing with animals and testing biological samples. (University, About Biomedical Research Center, 2017).

Qatar strategic plans (Kumar, 2018) are set to improve environmental protection protocols by integrating different management strategies, increasing environmental awareness, and supporting environmental sustainability. It is a serious challenge to raise awareness among the student generation to prepare them with the necessary information to show an important role in the future managing of biomedical waste (Licy, Vivek, Kamath, & T., 2013) (Yusooff, 2012).

Education and awareness of waste management is globally important. Previous studies have showed that the person's knowledge and awareness levels and commitment to the community and the sense of responsibility would have a great impact on the environment. Therefore, future generations must have adequate knowledge about the

standards and guidelines of biomedical waste management (Kapoor, 2014) (Ferronato, 2019) (Desa, 2011) (Òscar Saladié, 2016).

In January 2020 WHO pronounced the spread of a deadly disease in China to be a public health emergency. WHO expressed there is a high danger of the 2019 coronavirus (COVID-19) spreading to different nations globally? WHO and public health authorities are making a move trying to control the COVID-19? Waste produced by hospital and research maybe contaminated with COVID-19 and requires great deal of caution. This put an extra burden on health authorities to make sure that the medical waste is handled properly to avoid any adverse event on the pandemic. Holbrook et al 2020 reported COVID-19 can be stable in different material (including cardboard, copper, plastics and stainless steel) for different time periods start from hours to days (Peng, et al., 2020). Therefore, the management of the BMW should account for this development. Throughout the crisis a special teams across the world were established sharing the knowledge and discussing the problems and coordinating the COVID-19 training, monitoring, safety precautions, supply of the material and proper disposal of the medical waste. Qatar has established a multi-sectoral team and national awareness campaign with different assigned tasks to be discussed and reported to highly authorized management leaders. The campaign includes crisis management programs aimed at raising public awareness with governmental support, to decrease the spread of the Covid-19 epidemic.

Chapter 2: Methodology

1.4. Study Design

A cross-sectional study was performed to evaluate students' knowledge, attitudes, awareness, and practices to deal with BMW. The study was carried out among Qatar University students through emails announcement to participate in the survey. All participants were above 18 years old. Students from Colleges of Health Sciences (including Dept. of Biomedical science, Dept. of Human Nutrition, Dept. of Public health), College of Medicine, College of Pharmacy, and Biomedical Research Centre (BRC) were requested to participate. The total numbers of registered students in fall 2020 semester are 607 in these colleges. The total duration of the announcement was six weeks during September and October.

The sample size was estimated to be 236 participants calculated by Cochran's formula (including 95% confidence interval and 5% margin of error) (Frank L. Schmidt, 2015).

1.5. Ethical Approval

The study has been approved by QU Institutional Review Board (IRB) prior to initiation (Appendix "2"). Participation in this study is voluntary, and an electronic online informed consent has been obtained from each participant (Appendix "1"). A brief description of the project was given as an introduction in the online application section, where participants had the right to withdraw if they do not agree at any time from the study without consequences. No personal information such as name, email, and address was requested. Research records will only be kept electronically on an encrypted computer, and all records will be erased, and all data will be deleted after 5 years upon completion of collecting data.

1.6. Questionnaire

The questionnaire was an online self-administered questionnaire using QSURVEY

(https://www.qsurvey.qa/). The contents of the questionnaire (Appendix 3) were adapted from previously validated and published surveys (Boatright, Daniel T.; Edwards, Alicia J.; Shaver, Kathleen A., 1995). Questions were translated into The Arabic language. To determine the validity of the survey, the questions were reviewed by Dr. Atiyeh Abdallah (Supervisor), Ashish Kumar Bhandarkar and, Rana Mahmoud Kurdi (statistician). Pilot study was conducted on 10 participants to examine the consistency of the questionnaire and to evaluate the readability and easy understanding of the questions. Then these participants were excluded from the study. After consulting with the committee members and the outcome of the pilot study, questions were re-formulated.

The questionnaire consists of five parts including 27 questions;

Part A: *Socio-demographic information for participants (5 items)*

Items included sex, age, nationality, current academic year, college, and department.

Part B: *Knowledge of BM waste generation hazards (7 items)*

This section was aiming to understand the volume of participant knowledge about BM Waste. According to (An, 2011), BM Waste Legislation, type of agency that responsible for regulating BM Waste management, storing period, BM waste Transportation, and types of BM waste. It consists of a set of questions, and responses were given using multiple-choice questions. The knowledge level was numerically coded to be 1 for the correct answer and zero for the incorrect one to calculate the knowledge index by adding all items for each student.

Part C: *The awareness level on BM waste management practice (10 items)*

This section was intended to know participant awareness level. According to (Lakshmikantha Ramesh, 2016) the reasons for better BM waste management comes from a high level of awareness. In this section, we asked about some BM waste management practices to determine participant awareness level. It consists of a set of

questions, and responses were given using multiple-choice questions. Questions from 1-4 regarding the level of the awareness were ranked as agree, neutral or sometimes, and disagree, which are numerically coded as 2, 1, and zero, respectively. While the questions from 5-10 were numerically coded 1 for the correct answer and zero for the incorrect one to calculate the level of student awareness index.

Part D: *The attitude or behavior toward BM waste (7 items)*

This section was intended to assist the attitude toward proper BM waste management practices. The assessment questions were constructed based on a validated survey established by (Rao, Skm; Ranyal, R. K.; Bhatia, S. S.; Sharma, V. R., 2004). It consists of 7 items multiple-choice questions, which were numerically coded as 1 for the correct and zero for an incorrect answer to calculate the attitude index of the students.

Part E: *How to improve BM waste management (4 items)*

This section has been developed to predict the effective ways to improve BM waste management in Qatar. It consists of 2 items with a multiple-answers, a multiple choice question, and an Open-Ended Question for any more suggestions (Tabasi, 2013).

1.7.Inclusion and Exclusion Criteria

Only registered students of the QU from different scientific disciplines.

Any student who is not at Qatar University were excluded.

1.8.Statistical Analysis

Data were fed to IBM SPSS version 26 (IBM Statistics, Chicago, IL, USA). Descriptive statistics with frequency and percentage were performed. Scoring system was adopted. Descriptive statistics included: means, and SD, frequencies and percentages, medians and interquartile ranges and the inferential statistical analyses. $P < 0.05$ was considered to be significant, and it a two tailed *p-value*, since the alternative hypothesis assumes that there is a difference between the two groups without suggesting a specific direction

for the difference.

1.9. Inferential statistics

Total knowledge, total awareness, and total attitude, were tested for normality using Kolmogorov-Smirnov normality test. To compare if there is any statistically significant difference in knowledge or attitude based on sex (male and female groups) and nationality (Qatari, Non-Qatari), the Mann-Whitney test was applied.

For knowledge or attitude based on age groups, students' academic year, and respondents' college, the Kruskal Wallis test was applied at a significance level less than 0.05, Since Kruskal Wallis test compares the ranks of the different groups rather than the actual raw values. Mean rank will help compare if the there is a difference among the groups.

CHAPTER 3: RESULTS

1.10. Introduction

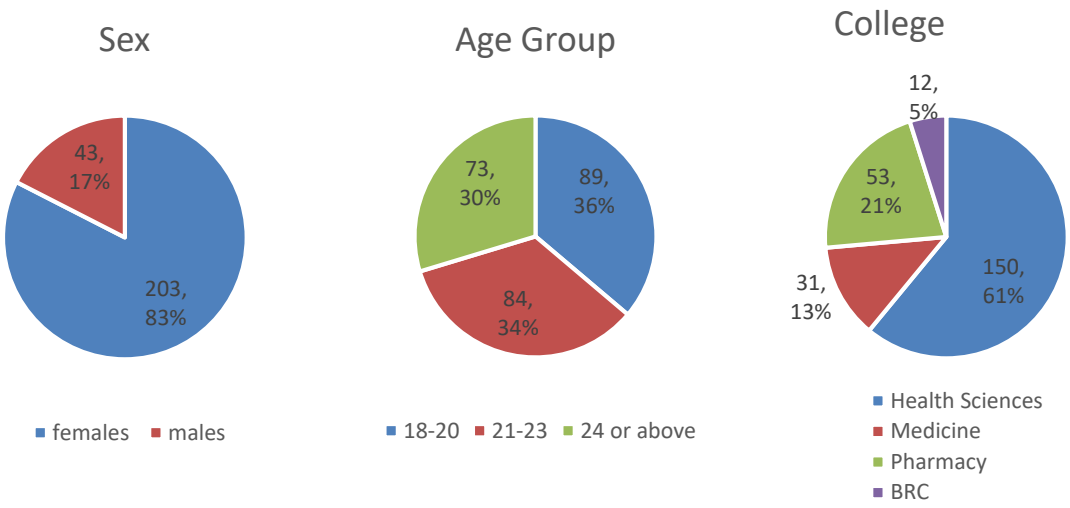
Study outcomes are essentially separated into three major sections: survey response and completion rates, the demographic profile of the participants, and descriptive statistical analysis of the sample data, and inferential statistics used to achieve research objectives.

1.11. Participants Demographics

Out of 607 registered students, 257 responded (42.3%). However, 11 were excluded due to incomplete responses, resulting in 246 complete responses for analysis (96% completion rate).

The demographic data of the respondents are shown in Table 1. Most of the respondents were females (82.5%, 203/246). The non-Qatari nationality outnumbered the Qatari nationality (56.1% (138/246), and 43.9% (108/246) respectively). The most frequently encountered age group among the respondents was 18-20 years (36.2%, 89/246), followed by 21-23 years (34.1%, 84/246), and 24 years or above (29.7%, 73/246).

Freshmen (1st-year students) were the most frequent academic year students (25.6%, 63/246), closely followed by graduate students (23.6%, 58/246), then by juniors (3rd-year students) (19.1%, 47/246), and sophomores (2nd-year students) and seniors (4th-year students) (15.9%, 39/246 each). Students from the Department of Biomedical Sciences were the highest responders (41.1%, 101/246), followed by those from the College of Pharmacy (21.5%, 53/246), Department of Public Health (13.4%, 33/246), College of Medicine (12.6%, 31/246), Department of Nutrition (6.5%, 16/246), and finally Biomedical Research Center (4.9%, 12/246) (Figure 4).



Sex Age Group College

Figure 4: Distribution of respondents according to sex, age group, and college

Table 1

Demographic profile of respondents (n=246)

Item	Total number (%)
Sex	
Females	203 (82.5)
Males	43 (17.5)
Age [years]	
18-20	89 (36.2)
21-23	84 (34.1)
24 or above	73 (29.7)
Nationality	
Qatari	108 (43.9)
Other	138 (56.1)
Student Academic Year	
Freshman (1st Year)	63 (25.6)
Sophomore (2nd Year)	39 (15.9)
Junior (3rd Year)	47 (19.1)
Senior	39 (15.9)
Graduate student	58 (23.6)
College	
Biomedical - College of Health Science	101 (41.1)
Nutrition - College of Health Science	16 (6.5)
Public Health - College of Health Science	33 (13.4)
College of Medicine	31 (12.6)
College of Pharmacy	53 (21.5)
Biomedical Research Center BRC	12 (4.9)

1.12. Knowledge

Knowledge of respondents about waste management is shown in Table 2. Only 9.3% (23/246) of the respondents stated being fully aware of waste management. Almost half of the respondents (120/246) stated that the governmental agencies are those that regulate biomedical waste management. The vast majority of the respondents (93.9%, 231/246) thought it is important to be aware about BMW management. Only 39.4% (97/246) picked the correct answer regarding the duration beyond which biomedical waste should not be stored (which is 24 hours). Slightly above half of the participants (126/246) chose the correct answer that assures the need for a special permission to transport biomedical waste. Responders who correctly identified the proper authority responsible for regulating the safe transport of biomedical waste were 43.1% (106/246). Fifty-five percent of the responses (135/246) correctly identified the description of biomedical waste.

Table 2 Respondents' knowledge about waste management (n=246)

Item	n (%)
How aware are you about BM waste legislation	
I have limited awareness	107 (43.5)
I have some awareness	57 (23.2)
I have a good awareness	59 (24.0)
I'm fully aware	23 (9.3)
What agency(ices) regulate(s) BM wastes?	
Government	120 (48.8)
Private	90 (36.6)
Not Sure	36 (14.6)
Do you think it is important to know about BMW legislation?	
Yes	230 (93.5)
No	10 (4.1)
Maybe	6 (2.4)
According to the BMW rules, waste should not be stored beyond (hours)	
12	23 (9.3)
24	97 (39.4)
48	11 (4.5)
96	2 (0.8)
Don't know	113 (45.9)
Do you need a separate permit to transport BMW?	
Yes	126 (51.2)
No	79 (32.1)
Don't know	41 (16.7)
Who regulates the safe transport of BMW?	
Pollution control board of State of Qatar	106 (43.1)
Transport corporation of State of Qatar	14 (5.7)

University administration	16 (6.5)
Don't Know	110 (44.7)
Which statement describes one type of BMW?	
Materials that may be poisonous, toxic, or flammable and do not pose disease-related risk	108 (43.9)
Waste that is saturated to the point of dripping with Blood or body fluids contaminated with blood	135 (54.9)
Waste that does not pose a disease-related risk	3 (1.2)

1.13. Awareness

Awareness of respondents about waste management is shown in Table 3. Most of the responses (92.3%, 227/246) were aware of the importance of the safe management of BMW by disagreeing with the statement that safe BMW management is not an issue at all. Similarly, most of them (95.5%, 235/246) were aware of the importance of teamwork in ensuring safe management of biomedical waste by agreeing to the statement asking if safe waste management is teamwork. Compared to the former two questions, a lower proportion of participants (67.5%, 166/246) correctly disagreed with the statement states that safe management efforts increase the financial load on the organization. Almost three-quarters of the respondents (181/246, 73.6%) correctly disagreed with the statement stating that safe management efforts are an extra burden on work. When respondents were asked if using gloves during biomedical waste handling was important, most of them correctly agreed (97.2%, 239/246).

Table 3 Respondents' awareness about waste management (n=246)

Item	n (%)
Safe management of BMW is not an issue at all	
Agree	11 (4.5)
Disagree	227 (92.3)
Neutral	8 (3.2)
BMW management is a team work	
Agree	235 (95.5)
Disagree	5 (2.1)
Neutral	6 (2.4)
Safe management increase the financial load on management	
Agree	35 (14.2)
Disagree	166 (67.5)
Neutral	45 (18.3)
Safe management of BMW is an extra burden on work	
Agree	24 (9.8)
Disagree	181 (73.6)
Neutral	41 (16.6)
It's important to use gloves during handling of BMW	
Yes	239 (97.2)
No	4 (1.6)
Don't know	3 (1.2)
Would you like to attend voluntarily programs about BMW management?	
Yes	204 (82.9)
No	7 (2.9)
May be	35 (14.2)
Do you think that infectious waste should be sterilized from infections by autoclaving before shredding and disposal?	
Yes	178 (72.4)
No	45 (18.3)

Don't know	23 (9.3)
Do you think that labeling the container before filling it with waste is of any clinical significance?	
Yes	237 (96.4)
No	3 (1.2)
Don't know	6 (2.4)
Are you aware of the agencies authorized by government to collect waste from hospital?	
I have some awareness	48 (19.5)
I have Limited awareness	132 (53.7)
I have good awareness	52 (21.1)
I'm fully aware	14 (5.7)
Do you think it is important to report to the authority about a particular institution if it is not complying with the guidelines for BMW management?	
Yes	234 (95.1)
No	2 (0.8)
Neutral	10 (4.1)

Eighty-three percent of the respondents (204/246) agreed to attend voluntary programs that improve knowledge about biomedical waste management. Seventy-two percent of the participants (178/246) correctly agreed about autoclave infectious waste before discarding. The vast majority of them (96.4%, 237/246) correctly agreed to label the container. On the other hand, very few participants (5.7%, 14/246) reported being fully aware of the agencies authorized to collect BMW. Finally, ninety-five percent (234/246) of the respondents agreed that it is important to report institutions that do not comply with waste management guidelines to the authorities.

1.14. Attitudes

Table 4 shows the respondents' attitudes towards waste management. Eighty-two

percent (202/246) of the participants reported that they follow color-coding for biomedical wastes. Almost the same proportion (81.7%, 201/246) agreed that disposal practices within their organizations are correct. Most of the responses (92.3%, 227/246) correctly identified sharps containers as the right ones for disposing sharp objects. Eighty-five percent of the participants (208/246) correctly disagreed with the statement stating that documents containing patients' confidential information should be disposed into paper recycle bins. When respondents were asked to identify the correct color-code (yellow) for the biomedical waste to be autoclave-disinfected, only 41.1% (101/246) of them correctly responded. Respondents were asked to correctly exclude the option that is not recommended after contaminated sharps; only 40.7% (100/246) of them picked the correct answer. However, the majority of participants (95.9%, 236/246) were able to correctly exclude the wrong statement that does not truly describe hazardous waste containers.

Table 4

Respondents' attitude towards waste management (n=246)

Item	**n (%)**
Do you follow color-coding for BMW?	
Yes	202 (82.1)
No	1 (0.4)
Sometimes	32 (13.0)
Not applicable	11 (4.5)
Is the BMW disposal practice correct at your organization?	
Yes	201 (81.7)
No	6 (2.4)
I don't know	39 (15.9)
Objects that may be capable of causing injury that have been exposed to blood or body fluids are	

considered BMW. How should these objects be disposed of?	
Black bags	6 (2.4)
Yellow bags	7 (2.9)
Clear bags	2 (0.8)
Sharp's container	227 (92.3)
Don't Know	4 (1.6)
Documents with confidential information are to be disposed of into the paper recycling waste	
True	17 (6.9)
False	208 (84.6)
Don't know	21 (8.5)
The color code for the BMW for autoclaved disinfected is	
Red	20 (8.1)
Black	13 (5.3)
Yellow	101 (41.1)
Blue/white	7 (2.8)
Don't Know	105 (42.7)
All the following steps should be followed after an exposure with infected blood/body fluid and contaminated sharps except	
Exposed parts to be washed with soap and water	28 (11.4)
Pricked finger should be kept in antiseptic lotion	100 (40.7)
Splashes to eyes should be irrigated with sterile irrigations	65 (26.4)
Splashes to skin to be flushed with water	53 (21.5)
All of the following statements about hazardous waste containers are true, except for	
Containers must be closed except when removing or adding waste	6 (2.5)
Containers must be clean on the outside	4 (1.6)
Any type of container, including food containers, be used to contain hazardous waste	236 (95.9)

1.15. Improvement and Recommendations

Table 5 shows the respondents' improvement and recommendations regarding waste

management. When participants were asked to select the biggest challenge(s) they face in biomedical waste management, the majority (95.5%, 235/246) chose education and awareness. Third of participants (36.6%, 90/246) chose the existence of a gap between knowledge and practice, and (26%, 64/246) chose lack of self-discipline/motivation, on other hands (95.5%, 235/246) chose improper delivery of information. Regarding their recommended action to improve waste management awareness, the selection order was as follow; attending workshops and conferences 79.3% (195/246), followed by using modern technology (36.2%, 89/246), a site visit to experience the waste management settings (34.6%, 85/246), and finally providing go-green courses (34.1%, 84/246). Most of the respondents (91.1%, 224/246) agreed that the college should provide special classes or continuous training programs to improve waste management knowledge.

Table 5. Respondents' improvement recommendations about waste management (n=246)

Item	**n (%)**
In your opinion what is the biggest challenge in BM waste management	
Education and awareness level	235 (95.5)
Improper delivery of the information	65 (26.4)
A gap between knowledge and actual practice	90 (36.6)
Lack of self-discipline and motivation	64 (26.0)
What do you think it should be done to improve waste management awareness?	
Attending workshops and conferences to be updated	195 (79.3)

Site visit to other experienced areas in the same field	85 (34.6)
Providing going green courses for all at first year of attending the colleges	84 (34.1)
Using modern technology for mass media & Cultural programs in the fairs and festivals	89 (36.2)
Do you think that the college should organize separate classes and CPD to upgrade existing knowledge about BMW management?	
Agree	224 (91.1)
Disagree	5 (2.0)
Neutral	17 (6.9)

Table 6 presents the summary scores of total knowledge, awareness, and attitude. These variables are computed variables that were obtain by mathematical addition of all the items under each domain (e.g., responses for all the items under knowledge domain, were summed to obtain the total knowledge score).

Table 6 Summary of scores of total knowledge, awareness, and attitude (n=246)

Item	Min	Max	Mean	SD	Median	Q1	Q3
Total knowledge	0	7	3.65	2.342	3.00	1.00	6.00
Total Awareness	4	15	11.39	1.496	12.00	11.00	12.00
Total Attitude	0	8	6.13	1.553	6.00	6.00	7.00

1.16. Inferential statistics

Total knowledge, total awareness, and total attitude, were found to be non-normally distributed. To compare if there is any statistically significant difference in knowledge

or attitude based on sex, Mann-Whitney test was run at significance level less than 0.05. The male group (43/246) showed statistically significant higher total knowledge and higher total attitude scores than the female group (203/246) ($p < 0.05$) (Table 7).

Table 7 Comparison of knowledge, and attitude between the two sex groups (n=246)

Variable	**Sex**					
	Male	**Female**				
	n=43	**n=203**				
	Median Score	**Median Score**	**Mann-Whitney U**	**W**	**Z**	***P-Value***
Total Knowledge	5	3	2781.5	23487.5	-3.817	* p<0.05
Total Attitude	7	6	3472.5	24178.5	-2.179	* p<0.05

Note: Mann Whitney U test was used

* p<0.05 considered to be significant

To compare if there is any statistically significant difference in knowledge or attitude based on age groups, Kruskal Wallis test was used. Comparison of the total knowledge and total attitude scores among diverse age groups (18-20, 21-23, 24 or above), measured in years, showed statistically significant variance among the groups ($p < 0.05$, Kruskal Wallis test) (Table 8). Post-hoc pairwise comparisons revealed that both knowledge and attitude scores of the youngest age group (18-20 years) was significantly lower than each of the older age groups (21-23 years, and 24 or above years) ($p < 0.05$) (Table 8).

Table 8 Comparing knowledge and attitude between three age groups (n=246)

Variables	Age Groups (in years)								
	18-20	**21-23**	**24 or above**						
	n=13	**n=217**	**n=10**						
	Group 1	**Group 2**	**Group 3**						
	Median	**Median**	**Median**	**H**	**df**	***P Value***	**1 vs. 2**	**1 vs. 3**	**2 vs. 3**
Total knowledge	2	5	4	22.07	2	* p<0.05	* p<0.05	* p<0.05	p>0.05
Total attitude	6	7	6	19.26	2	* p<0.05	* p<0.05	* p<0.05	p>0.05

Kruskal-Wallis test was used

* p<0.05 considered to be significant

To compare if there is any statistically significant difference in knowledge or attitude based on nationality, Mann-Whitney test was used. There was no statistically significant difference between the respondents with Qatari nationality (108/246) and non-Qatari (138/246) ($p > 0.05$) (Table 9).

Table 9 Comparing knowledge, and attitude between two nationality groups (n=246)

Variable	Nationality					
	Qatari	**Others**				
	n=108	**n=138**				
	Median Score	**Median Score**	**Mann-Whitney U**	**W**	**Z**	***P-Value***
Total Knowledge	4	3	6575.0	16166.0	-1.619	p>0.05
Total Attitude	6	6	7055.0	16646.0	-0.742	p>0.05

Note: Mann Whitney U test was used

* p<0.05 considered to be significant

To compare if there is any statistically significant difference in knowledge or attitude based on students' academic year, Kruskal Wallis test was used. Comparison of both of the total knowledge and total attitude scores among different students' academic year groups (freshmen, sophomores, juniors, seniors, graduates) showed a significant difference in both of knowledge and attitude (Table 10). Post-hoc pairwise comparisons revealed that both knowledge and attitude scores of the freshmen were significantly lower than juniors, seniors, and graduates ($p < 0.05$). Sophomores were also found to be significantly lower than juniors and seniors ($p< 0.05$). Graduates were found to be significantly lower than seniors ($p<0.05$) (Table 11).

Table 10 Comparison of knowledge and attitude among different students' academic years (n=246)

Students' Academic Year	**N**	**Mean**	**Kruskal-Wallis H**	***P-Value***
Total Knowledge			30.252	* p<0.05
Freshmen	63	97.63		
Sophomores	39	102.62		
Juniors	47	124.76		
Seniors	39	169.08		
Graduates	58	133.97		
Total Attitude			30.408	* p<0.05
Freshmen	63	94.71		
Sophomores	39	101.78		
Juniors	47	145.29		
Seniors	39	159.18		
Graduates	58	127.72		

Note: Kruskal-Wallis test was applied

* p<0.05 considered to be significant

Table 11 Pairwise comparison of knowledge and attitude among different pairs of students' academic years (n=246)

Students' Academic Year	***P Value***
Total Knowledge	
Freshmen vs. Sophomores	NS
Freshmen vs. Juniors	* p<0.05
Freshmen vs. Seniors	* p<0.05
Freshmen vs. Graduates	* p<0.05
Sophomores vs. Juniors	NS
Sophomores vs. Seniors	* p<0.05
Sophomores vs. Graduates	* p<0.05
Juniors vs. Seniors	* p<0.05
Juniors vs. Graduates	NS
Seniors vs. Graduates	* p<0.05
Total Attitude	
Freshmen vs. Sophomores	NS
Freshmen vs. Juniors	* p<0.05
Freshmen vs. Seniors	* p<0.05
Freshmen vs. Graduates	* p<0.05
Sophomores vs. Juniors	* p<0.05
Sophomores vs. Seniors	* p<0.05
Sophomores vs. Graduates	NS
Juniors vs. Seniors	NS
Juniors vs. Graduates	NS
Seniors vs. Graduates	* p<0.05

* p<0.05 (difference is statistically significant). NS: not significant

Comparison of both of the total knowledge and total attitude scores among different college groups indicated a statistically significant variance ($p < 0.05$) (Table 12). Post-hoc pairwise comparisons showed that knowledge scores of the students from the College of Health Sciences were significantly higher than those from both Colleges of Pharmacy and the BRC ($p < 0.05$). Similarly, knowledge scores of students from the College of Medicine were significantly higher than those from both the Colleges of Pharmacy and the BRC ($p < 0.05$). With regards to attitude scores, it was found that students from the College of Health Sciences had statistically significant higher scores than those from both the Colleges of Pharmacy and the BRC ($p <0.05$) (Table 13).

Table 12 Comparison of knowledge, and attitude among different colleges (n=246)

Students among different colleges	N	Mean	Kruskal-Wallis H	*P Value*
Total Knowledge			37.129	* p<0.05
Health Sciences	150	143.10		
Medicine	31	118.82		
Pharmacy	53	82.69		
BRC	12	70.79		
Total Attitude			12.466	* p<0.05
Health Sciences	150	134.86		
Medicine	31	114.81		
Pharmacy	53	105.81		
BRC	12	82.08		

Note: Kruskal-Wallis test was applied

* p<0.05 considered to be significant

Table 13 Pairwise comparing knowledge, and attitude among different pairs of Students among different colleges (n=246)

Students among different colleges	*P-Value*
Total Knowledge	
Health Sciences vs. Medicine	NS
Health Sciences vs. Pharmacy	* p<0.05
Health Sciences vs. BRC	* p<0.05
Medicine vs. Pharmacy	* p<0.05
Medicine vs. BRC	* p<0.05
Pharmacy vs. BRC	NS
Total Attitude	
Health Sciences vs. Medicine	NS
Health Sciences vs. Pharmacy	* p<0.05
Health Sciences vs. BRC	* p<0.05
Medicine vs. Pharmacy	NS
Medicine vs. BRC	NS
Pharmacy vs. BRC	NS

* p<0.05 (difference is statistically significant)

Chapter 4: Discussion

The current study evaluates students' knowledge and attitude level regarding BMW management in QU-Health departments. According to WHO, well–trained, and well-motivated employee could make an important change more than an expensive system which managed by staff who have improper knowledge about the risks of BMW (Lakshmikantha Ramesh, 2016).

In our study female participated more than male, 82.5% vs 17.5% respectively. This was expected, as the majority of registered students at QU Health departments are females. However, the male group showed statistically significantly higher total knowledge and total attitude scores than the female group ($p < 0.05$) (Table 7). The non-Qatari nationals marginally outnumbered the Qatari nationality with a $p > 0.05$.

Regarding the age, most of the respondents were 18-20 years (36.2%), and the least was 24 years and above (29.7%). Total knowledge and total attitude scores among different age groups showed a statistically significant difference. Both knowledge and attitude scores of the youngest age group were significantly lower than each of the older age groups ($p < 0.05$) (Table 8). Among the 246 participants, freshmen (1^{st}-year students) percentage was (25.6%) and, graduate students' percentage was (23.6%) those two categories were the frequent academic years who responded. The least group was seniors (4^{th} year students) with 15.9%. Total knowledge and total attitude scores among different academic years showed that both knowledge and attitude scores of the freshmen were significantly lower than juniors, seniors, and graduates ($p < 0.05$). Sophomores were also found to be significantly lower than juniors and seniors ($p< 0.05$). Graduates were found to be significantly lower than seniors ($p<0.05$) (Table 11). These findings are logically and unsurprisingly because the freshmen and junior students did not develop enough experience to be reflected in their level of knowledge compared with more senior

students.

Majority of the respondents were from the Biomedical Science Department, College of Health Science, where the percentage was (41.1%, 101/246), followed by participants from the College of the pharmacy where the percentage was (21.5%, 53/246). The Public-Health Department, College of Health Science the percentage was (13.4%, 33/246), College of Medicine percentage was (12.6%, 31/246), Nutrition Department, College of Health Science the percentage was (6.5%, 16/246), and BRC the percentage was (4.9%, 12/246). Findings revealed that knowledge scores of the students from the College of Health Sciences were significantly higher than those from both Colleges of Pharmacy and the BRC ($p < 0.05$) this could be attributed to those two colleges have more laboratory sessions and required more knowledge related to BMW management than the others. Similarly, knowledge scores of students from the College of Medicine were significantly higher than those from both the Colleges of Pharmacy and the BRC ($p < 0.05$). This is in consistent with the study performed among health care providers in Dhaka, Bangladesh, where the doctors had better knowledge than other professional groups, so the level of education affects the level of knowledge (Sarker, 2014). Also a study conducted in Mysuru, India to evaluate knowledge, attitudes, and practices level among all hospital employees found that the level of knowledge was higher among doctors followed by nursing staff. The postgraduate student, interim, and technicians were nearly similar (Rao, 2018). With regards to attitude scores, it was found that students from the College of Health Sciences had statistically significant higher scores than those from both the Colleges of Pharmacy and the BRC (Table 13). this could be attributed to respondents from the BRC were found to be seldom, which lead to a suggestion of further research with a larger number to explore the possible underline factors that led to this result.

1.17. Knowledge of Biomedical waste management

In our cohort, there was a lack of knowledge of waste management; only 9.3% of the students responded to being fully aware of BMW management. Another study conducted in Ethiopia regarding the assesment of BMW management among hospital employees using bivariate analysis found that BMW educational level, management, previous training , attitude and practice sores of the particant revealed association with the knowledge score (Deress, 2018). This study that conducted in Ethiopia among all health care participants of different health occupations who have at least one year experience at work, and were mainly involved in the BMW management. The study found 56.8% of the participants have acceptable knowledge of BMW management practice (Deress, 2018) which can be attributed to the level of experience and education level could be the reason of better practice. In accordance with another study conducted in Dental College in Maharashtra, India, which showed that the BMW knowledge was poor among health care personnel (M.Jain, 2016). Similarly a study in Southeast Nigeria showed a limitation in health care waste disposal system and lack of waste segregation, handling improperly and disposal of the waste lead to insufficient BMW management (Harhay, 2009) (Oli, 2016). Almost half of the responders knew about the governmental agencies that regulate BMW management. Majority of students in our study (93.9%) agree on the importance of knowing about BMWM regulations which is similar to other studies such as a study conducted in Bengaluru which showed (88.4%) knew about the BMW generation and legalization (Lakshmikantha Ramesh, 2016). On the other hand, knowledge of the duration of waste storage, ideally 24 hours, was not sufficient, only 39.4% (97/246) picked the correct answer, because the laboratory session time is limited, most of them around three hours, and the students leave after the session directly, so they will not have the proper knowledge regarding the duration of the waste storage.

Even though, half of the participants (126/246) knew about some regulations bout the BMW safety transporting and more than fifty percent of the responses correctly identified the description of BMW.

1.18. Attitude and behavior

In the current study, the respondents' attitudes towards waste management showed a positive response; most of participants were able to pick the correct answers. Eighty-two percent (202/246) of the participants reported that they follow color-coding for biomedical wastes, which is consistent with the study conducted in Ethiopia, which was 78.9% of the participants' favorable attitude score of the practice which can be due to the level of experience and education could affect the level of awareness (Deress, 2018). The majority of the students (92.3%, 227/246) were capable to identify the right sharp containers. This was in line with the results from a study in Botswana regarding the proper segregation of BMW (Mugabi, 2018). Another study conducted in Saudi Arabia, revealed that 95% of primary health-care labors in Jazan scored a high level of knowledge about the proper disposal of needles and sharp waste (Mahfouz, 2009).

In the current study, correct identification of color-coding of BMW to be autoclaved was (41.1%), whereas, in the study conducted in Bengaluru only (16.9%) identified the correct response, this was because of the lack of information about the risks linked to BMW and the proper procedure regarding the segregation was not displayed well on posters in assigned areas on the waste segregation and the various method to be applied regarding the proper disposal (Lakshmikantha Ramesh, 2016). A study conducted in Ethiopia demonstrated that (77.2%) knew color-coding segregation, that attributed to good level of experience and education (Deress, 2018). Regarding the improper procedure in needle puncture, 40.7% (100/246) of participants picked the correct answer, nearly similar to a study conducted in Bengaluru, were 38.9% picked the correct

answers. The majority of participants (95.9%, 236/246) were able to correctly exclude the wrong statement that does not truly describe hazardous waste containers.

1.19. Awareness of Biomedical waste management practice

Around 90% or above Mostly reported that being well aware of the BMW practice, in a study conducted in Maharashtra regarding the awareness of BMW management among clinical teaching staff in private medical college revealed that the overall awareness was 99% (M.Jain, 2016). Similarly, most of them (95.5%, 235/246) were aware of the importance of teamwork in ensuring safe management of BMW by agreeing to the statement asking if safe waste management is teamwork. This is aligned with another study conducted in Ethiopia where the participants agreed to the declaration that the safe BMW management is an issue involving a team work (Deress, 2018), while a less proportion of participants (67.5%, 166/246) correctly disagreed with the statement that states that safe management efforts increase the financial load on the organization. This result supports the finding of a study conducted in Bengaluru that a high percentage (50%-70%) were the correct answers (Lakshmikantha Ramesh, 2016). The financial awareness level regarding the BMW belongs to policymaker and have more knowledge about it. That could be the explanation for that. On the other hand, very few participants (**5.7%**) reported being fully aware of the agencies responsible to collect BMW. This lack of information regarding the agencies and protocol for collection and transporting is because students are not on the front line to deal with a task of collecting or transporting.

1.20. Limitation

Since the study used a cross-sectional self-administered questionnaire, self-reporting bias and social desirability bias could have affected the responses. However, the high reliability score for the questionnaire, which was assessed to validate the tool before its

use, and the consistency of responses among different participants suggest that both types of biases didn't affect the responses.

Also, it presents the results at a specific period of time and may not be generalizable. As with all studies relying on voluntary participation, results can be one-sided by an absence of respondents, if there are precise contrasts between individuals who react and individuals who don't. However, when self-reporting data are operated correctly, it could support to provide a wider range of responses than many other data collection tools. Finally, the lack of sectional or colleges-based annual statistics regarding generated waste for each limit our analysis. Moreover, I tried to collect data from other local and international universities such as Weill Cornell Medicine-Qatar by sending an e-mail requesting information regarding their BMW management to compare data from QU, but I did not receive any reply (Appendix "4").

1.21. Recommendations

When participants were asked to select the biggest challenge(s) they face in biomedical waste management, the majority of them (95.5%, 235/246) chose education and awareness, while much less (36.6%, 90/246) chose the existence of a gap between knowledge and practice, whereas similar proportions chose improper delivery of information, and lack of self-discipline/motivation. Therefore, most participant recommended to improve waste management awareness, majority (79%) suggested that attending workshops and conferences would be very effective, followed by using modern technology (36.2%), site visits to experience the actual activities (34.6%), and finally providing go-green courses (34.1%). Most of the respondents agreed that the college should launch separate programs or ongoing training programs to improve waste management knowledge level.

In my interview with the Environment & Sustainable specialist at QU, Mr. Aziz

indicates that, the biggest challenge in the management of biomedical waste is the segregations of waste and storage containers. Technician are aware of where to put these things but still, sometimes it is not being followed. Availability of containers is one of the problems and designated area are not labeled properly. Another issue is the missing spill kits to be used in case of any spillages. Furthermore, Mr. Aziz suggested that Training/Awareness campaigns will be enough to educate and encourage staff/students/faculty member for the proper BM waste management and encourage everybody to report any problem to the Call-Centers or send an email to ESS.

Future studies can assess the level of awareness of graduate students and research assistant and compare it related to finding of currents study which focus on undergrad. In addition, studies that can detect incident related to improper management of BMW could be useful.

1.22. Conclusions

This survey showed clearly that a gap is found in knowledge and awareness levels regarding BMW production and management among QU-Health students at QU. Training programs should be provided more regularly to achieve the desired objectives. Therefore, there should be constant training to assure acceptable knowledge and good awareness among QU-Health students. The research hypothesis was to be found correct and supported by study result.

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2. Appendix

2.1. Appendix "1"

Title

Invitation to participate in a survey about The Biomedical waste management awareness among health science students at Qatar University.

دعوة للمشاركة في استبيان حول الوعي بإدارة النفايات الطبية الحيوية بين طلاب العلوم الصحية في جامعة قطر.

Dear participant,

You are invited to participate in a research study that aims in identifying the awareness and practice of biomedical waste segregation and to decide or differentiate if there are any gaps in the waste administration practices, student's information and awareness about how to deal with the various types of laboratory waste among students at Qatar University.

The study is approved by the Qatar University Institutional Review Board with the approval number:

Participation in this study is voluntary. You have the right to withdraw from the research study at any time, or you may skip any question(s) that they do not wish to answer.

Your responses will be completely confidential and we do not collect any identifying information such as your name, email address or IP address. Research records or data will be stored electronically on a password protected computer, and all records will be destroyed after 5 years upon completion of collecting data.

Participating in this study may not benefit you directly, but it will help us identify the gaps in the knowledge, attitudes and practice among students, the future generation, in assigned medical and allied health colleges in Qatar University in Qatar, which will help us in developing future strategies for waste management awareness.

The procedure involves filling an online questionnaire that will take approximately **10-15 minutes.**

- **The questionnaire consists of four parts:**

Part A: (knowledge of BM waste generation hazards) (7 items)
Part B: (the level of awareness on BM waste management practice) (9 items)
Part C: (the attitude or behavior toward BM waste) (7 items)
Part D: (the participant view on how to improve BM waste management) (9 items)

The study is approved by QU-IRB with approval number **QU-IRB 1353-EA/20**. You may contact them at QU-IRB@qu.edu.qa if you have any question related to the ethical compliance of this research.

If you have any questions or concerns, you may contact me at:

Shaikha Al Mansoori

Email: **199251189@qu.edu.qa**
Phone Number: **55895434**
Master's in Biomedical Laboratory Management with Project Option at Qatar University.
Research Supervisor: **Dr. Atiyeh Abdallah,**
Assistant Professor of Biomedical Sciences
Email: aabdallah@qu.edu.qa

If you have read, understood and agree to participate, please proceed with the survey.

Thank you for your participation and support.

Please find the survey link below:
https://www.qsurvey.qa/home/en#/response/UZZ6RXF690

عزيزي المشارك،

أنت مدعو للمشاركة في دراسة بحثية تهدف إلى الوعي والممارسات الخاصة بفصل النفايات الطبية الحيوية وتحديد ما إذا كانت هناك أي ثغرات في ممارسات إدارة النفايات ، ومعلومات الطلاب وفهمهم حول كيفية التعامل مع الأنواع المختلفة من نفايات المختبر أو التمييز بينها بين الطلاب في جامعة قطر.

تم أخذ الموافقة لهذا البحث من مجلس مراجعة البحوث في جامعة قطر تحت رقم:

المشاركة في هذه الدراسة اختيارية. لديك الحق في الانسحاب من الدراسة البحثية في أي وقت، أو يمكنك تخطي أي سؤال (أسئلة) لا ترغب في الإجابة عليه.

سيتم الاحتفاظ بالبيانات التي تم جمعها بسرية تامة. ولن تجمع أي معلومات تعريفية مثل اسمك أو عنوان بريدك الإلكتروني .سيتم تخزين السجلات أو البيانات البحثية إلكترونيًا فقط على جهاز كمبيوتر محمي بكلمة مرور، وسيتم إتلاف جميع البيانات بعد 5 سنوات من انتهاء من جمع البيانات.

قد لا تفيدك المشاركة في هذه الدراسة بشكل مباشر، لكنها ستساعدنا في تحديد الفجوات المعرفية والمواقف والممارسات بين الطلاب الحاليين، جيل المستقبل ، في الكليات الطبية المعينة والمرتبطة بالصحة في جامعة قطر. في قطر، مما سيساعدنا في تطوير استراتيجيات مستقبلية للتوعية بإدارة النفايات الطبية الحيوية

سوف تستغرق مشاركتك ما بين **10-15** دقيقة.

- يتكون الاستبيان من أربعة أجزاء:

الجزء أ : (معرفة مخاطر توليد النفايات الطبية الحيوية) (7 بنود)
الجزء ب : (مستوى الوعي بممارسات إدارة النفايات الطبية الحيوية) (9 بنود)
الجزء ج : (الموقف أو السلوك تجاه النفايات الطبية الحيوية) (7 بنود)
الجزء د : (وجهة نظر المشاركين حول كيفية تحسين إدارة النفايات الطبية الحيوية) (4 بنود)

تمت الموافقة على الدراسة من قبل لجنة QU-IRB مع رقم الموافقة **QU-IRB 1353-EA/20** ويمكنكم الاتصال بهم على QU-IRB@qu.edu.qa لأي توضيح يتعلق بالامتثال الأخلاقي لهذا البحث.

إذا كان لديك أي أسئلة، يمكنك التواصل على البريد الإلكتروني على:

الطالبة: (شيخة المنصوري)
ماجستير في إدارة المختبرات الطبية الحيوية مع خيار المشروع في جامعة قطر
رقم الجوال : 55895434
199251189@qu.edu.qa
المشرف البحثي: (د. عطية عبد الله)
أستاذ مساعد في كلية العلوم الطبية الحيوية
aabdallah@qu.edu.qa

إذا كنت قد قرأت وفهمت ووافقت على المشاركة ، يرجى متابعة الاستبيان.

شكرا لمشاركتك ودعمك.

يرجى العثور على رابط الاستبيان أدناه:
https://www.qsurvey.qa/home/en#/response/UZZ6RXF690

2.2. Appendix "2"

جامعة قطر
QATAR UNIVERSITY

Qatar University Institutional Review Board **QU-IRB**
QU-IRB Registration: IRB-QU-2020-006, QU-IRB, Assurance: IRB-A-QU-2019-0009

August 10th, 2020

Dr. Atiyeh Abdallah
College of Health Sciences
Qatar University
Phone: 4403 7578
Email: aabdallah@qu.edu.qa

Dear Dr. Atiyeh Abdallah,

Sub.: Research Ethics Expedited Approval
Ref.: Student, Shaikha Jedea Al-Mansoori / e-mail: 199251189@student.qu.edu.qa
Project Title: "Biomedical waste management awareness among health science students at Qatar University; a cross-sectional survey"

We would like to inform you that your application along with the supporting documents provided for the above project, has been reviewed by the QU-IRB, and having met all the requirements, has been granted research ethics **Expedited Approval** based on the following category(ies) listed in the Policies, Regulations and Guidelines provided by MOPH for Research Involving Human Subjects. Your approval is for one year effective from August 10th, 2020 till August 9th, 2021.

1) present no more than minimal risk to human subject, and
2) involve only procedures listed in the following category(ies).
Category 7: Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Documents Reviewed: QU-IRB Application Human Subject- Ver 2_Bilingual-Shaikha (2) correction (1), QU-IRB Application Material Check List3 correction, Research proposal for IRB, Informed consent (1), Survey Arabic, Survey English, QU-IRB Review Forms, responses to IRB queries and updated documents.

Please note that expedited approvals are valid for a period of **one year** and renewal should be sought one month prior to the expiry date to ensure timely processing and continuity. Moreover, any changes/modifications to the original submitted protocol should be reported to the committee to seek approval prior to continuation.

Your Research Ethics Expedited Approval Number is: **QU-IRB 1353-EA/20**. Kindly state this number in all your future correspondence to us pertaining to this project. In addition, please submit a closure report to the QU-IRB upon completion of the project.

Best wishes,
Dr. Ahmed Awaisu
Chairperson, QU-IRB

Institutional Review Board
(IRB)
Office Of Academic Research

Qatar University-Institutional Review Board (QU-IRB), P.O. Box 2713 Doha, Qatar
Tel +974 4403-5307 (GMT +3hrs) email: QU-IRB@qu.edu.qa

2.3. Appendix "3"

➢ Part A (socio-demographic information):

☐ Female ☐ Male
Age: ☐ 18-20 ☐ 21-23 ☐ 24 or above
Nationality: ☐ Qatari ☐ Other
Student academic year : ☐ Freshman (1st Year) ☐ Sophomore (2nd Year) ☐ Junior (3rd Year) ☐ Senior ☐ Graduate student
College: ☐ **College of Health Science** ☐ a- Biomedical ☐ b- Nutrition ☐ c-Public Health ☐ **College of Medicine** ☐ **College of Pharmacy** ☐ **Biomedical Research Center BRC**

➢ Part B : knowledge of BM waste generation hazards

1. How aware are you about BM waste legislation

- ○ I have limited awareness
- ○ I have some awareness
- ○ I have good awareness
- ○ I'm fully aware

2. What agency(ies) regulate(s) BM wastes?

- ○ Government
- ○ Private
- ○ Not Sure

3. Do you think it is important to know about BM waste generation, hazards and legislation?

- ○ Yes
- ○ No
- ○ Somewhat

4. According to the BM waste (management and handling) rules, waste should not be stored beyond

- ○ 12 Hours
- ○ 24 Hours
- ○ 48 Hours
- ○ 96 Hours
- ○ Don't Know

5. Do you need a separate permit to transport BM waste?

- ○ Yes
- ○ No
- ○ Don't Know

6. Who regulates the safe transport of medical waste?

- ○ Pollution control board of State of Qatar
- ○ Transport corporation of State of Qatar
- ○ University administration
- ○ Don't Know

7. Which statement describes one type of BM waste?

- ○ Materials that may be poisonous, toxic, or flammable and do not pose disease-related risk
- ○ Waste that is saturated to the point of dripping with Blood or body fluids contaminated with blood
- ○ Waste that does not pose a disease-related risk

➢ Part C: the level of awareness on BM waste management practice

1. **Safe management of health care waste is not an issue at all**

- ○ Agree
- ○ Disagree
- ○ Neutral

2. **Waste management is a team work to ensure safe management**

- ○ Agree
- ○ Disagree
- ○ Neutral

3. **Safe management efforts by the Organization increase the financial load on management**

- ○ Agree
- ○ Disagree
- ○ Neutral

4. **Safe management of health care waste is an extra burden on work**

- ○ Agree
- ○ Disagree
- ○ Neutral

5. **It's important to Use gloves during handling of BM waste**

- ○ Yes
- ○ No
- ○ Don't Know

6. **Will you like to attend voluntarily programs that enhance and upgrade your knowledge about waste management?**

- ○ Yes
- ○ No
- ○ Maybe

7. **Do you think that infectious waste should be sterilized from infections by autoclaving before shredding and disposal?**

- ○ Yes
- ○ No
- ○ Don't Know

8. **Do you think that labeling the container before filling it with waste is of any clinical significance?**

- ○ Yes
- ○ No
- ○ Don't Know

9. **Are you aware of the agencies authorized by government to collect waste from hospital/clinical set up?**

- I have some awareness
- I have Limited awareness
- I'm fully aware
- I have good awareness

10. **Do you think it is important to report to the proper authority about a particular institution if it is not complying with the guidelines for BM waste management?**

- Yes
- No
- Neutral

➢ Part D: the attitude or behavior toward BM waste

1. **Do you follow color-coding for BM waste?**

- Yes
- No
- Sometimes
- Not applicable

2. **Is the waste disposal practice correct in your organization?**

- Yes
- No
- Don't Know

3. **Objects that may be capable of causing punctures or cuts that may have been exposed to blood or body fluids are considered BM waste. How should these objects be disposed of?**

- Black bags
- Yellow bags
- Clear bags
- Sharps container
- Don't Know

4. **Documents with confidential patient information are to be disposed of into the paper recycling bins**

- True
- False
- Don't Know

5. **The color code for the BM waste to be autoclaved disinfected is**

- Red
- Black
- Yellow
- Blue/white
- Don't Know

6. **All the following steps should be followed after an exposure with infected blood/body fluid and contaminated sharps except**

- Exposed parts to be washed with soap and water
- Pricked finger should be kept in antiseptic lotion
- Splashes to eyes should be irrigated with sterile irrigations
- Splashes to skin to be flushed with water

7. **All of the following statements about hazardous waste containers are true, except for**

- Containers must be closed except when removing or adding waste
- Containers must be clean on the outside
- Any type of container, including food containers, be used to contain hazardous waste

➢ Part E: how to improve BM waste management

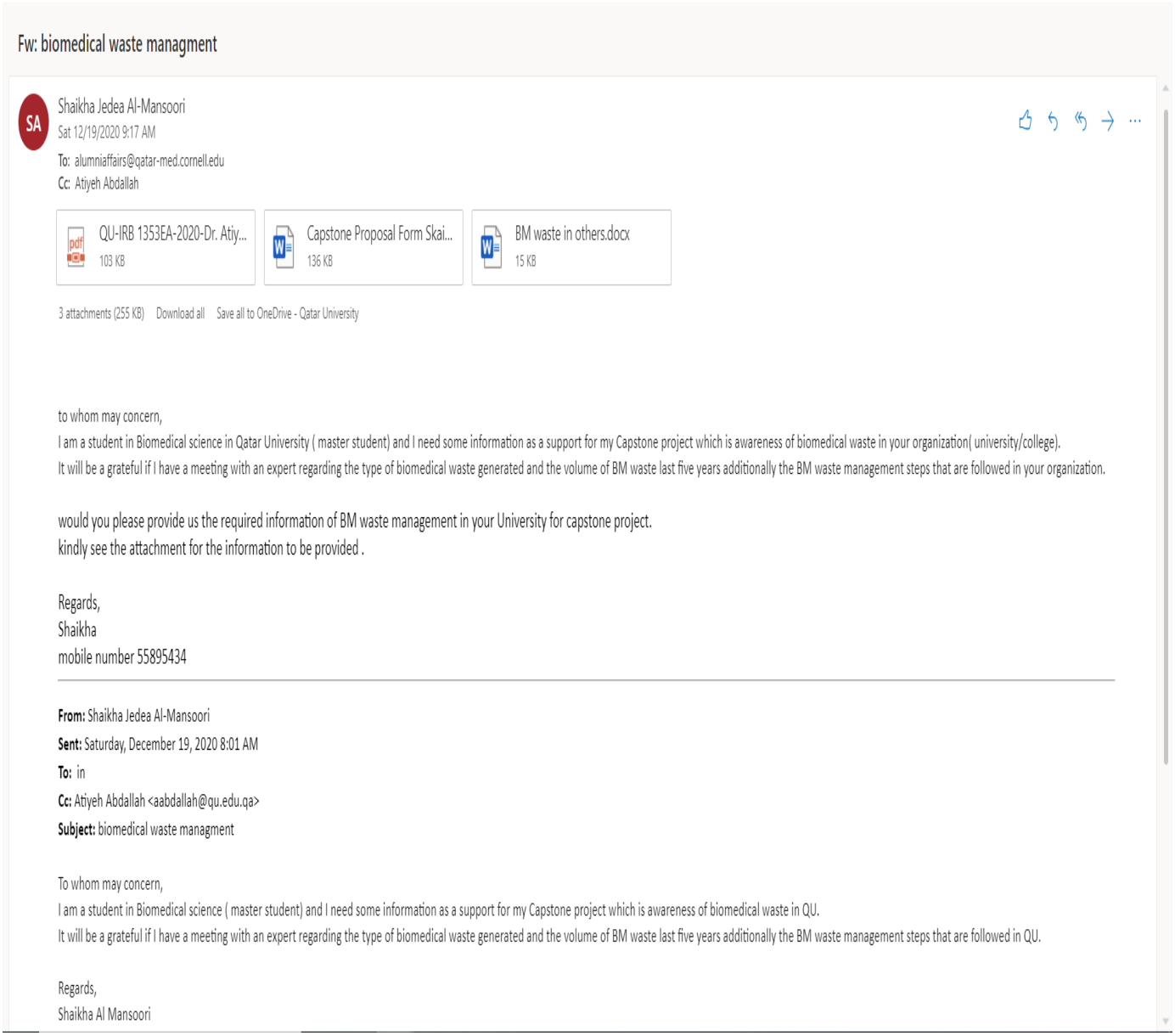
1. **In your opinion what is the biggest challenge in BM waste management**

- Education and awareness level
- Improper delivery of the information
- A gap between knowledge and actual practice
- Lack of self-discipline and motivation

2. **What do you think it should be done to improve waste management awareness?**

- Attending workshops and conferences to be updated
- Site visit to other experienced area in the same field
- Providing going green courses for all at first year of attending the colleges
- Using modern technology for mass media & Cultural programs in the fairs and festivals

2.4. Appendix “4”



Fw: biomedical waste managment

SA

Shaikha Jedea Al-Mansoori
Sat 12/19/2020 9:17 AM

To: alumniaffairs@qatar-med.cornell.edu
Cc: Atiyeh Abdallah

QU-IRB 1353EA-2020-Dr. Atiy... 103 KB
Capstone Proposal Form Skai... 136 KB
BM waste in others.docx 15 KB

3 attachments (255 KB) Download all Save all to OneDrive - Qatar University

to whom may concern,
I am a student in Biomedical science in Qatar University (master student) and I need some information as a support for my Capstone project which is awareness of biomedical waste in your organization(university/college).
It will be a grateful if I have a meeting with an expert regarding the type of biomedical waste generated and the volume of BM waste last five years additionally the BM waste management steps that are followed in your organization.

would you please provide us the required information of BM waste management in your University for capstone project.
kindly see the attachment for the information to be provided .

Regards,
Shaikha
mobile number 55895434

From: Shaikha Jedea Al-Mansoori
Sent: Saturday, December 19, 2020 8:01 AM
To: in
Cc: Atiyeh Abdallah <aabdallah@qu.edu.qa>
Subject: biomedical waste managment

To whom may concern,
I am a student in Biomedical science (master student) and I need some information as a support for my Capstone project which is awareness of biomedical waste in QU.
It will be a grateful if I have a meeting with an expert regarding the type of biomedical waste generated and the volume of BM waste last five years additionally the BM waste management steps that are followed in QU.

Regards,
Shaikha Al Mansoori